BSD-1. Introduction

Part II, Section C.b.5.a.i of the MS4 General Permit outlines the Watershed Protection elements of Minimum Measure #5. This section requires the MS4 or permittee to incorporate six Watershed Protection Elements into local development codes, policies, and ordinances, as well as comprehensive and master plans for land use, transportation, and neighborhoods. The six elements include:

1. Minimize impervious surfaces
2. Preserve, protect, create and restore ecologically sensitive areas
3. Prevent or reduce thermal impacts to streams
4. Avoid or prevent hydromodification of streams and other waterbodies
5. Protect trees and other vegetation
6. Protect native soils

Collectively, these techniques can be referred to as "better site design" (BSD) practices.

Better Site Design Practices Reduce the Design Treatment Volume

It is important to note that BSD practices create a link between the Watershed Protection and Site and Neighborhood Design Elements of the MS4 General Permit. Specifically, the use of these practices – by reducing impervious cover, managed turf, and site disturbance – will reduce the Target Treatment Volume associated with the one-inch rainfall event that must otherwise be managed by structural stormwater BMPs. In essence, BSD techniques provide cost-effective ways to reduce the Target Treatment Volume while providing multiple environmental benefits on a development or redevelopment site. Another benefit is that these practices can reduce permitting time and costs associated with stream corridor, wetland, and floodplain impacts.

Because of this relationship, BSD practices are referred to as "self-crediting." In other words, they do not have an assigned runoff reduction and/or pollutant removal rate as do the other BMPs in **Chapter 4**. However, they do help manage the one-inch Target Treatment Volume and should be considered early in the site planning process as "the first BMP."

See **Chapter 2** for a description of each Watershed Protection Element, and the MS4 General Permit and associated fact sheet for more detailed information on these elements and their benefits. The chief function of this section of the Manual is to more specifically identify the practices and conditions under which each can be considered a "self-crediting" BSD technique.

The specific BSD practices addressed in this section include:

- Preserve Undisturbed Natural Areas; Preserve and Protect Ecologically Sensitive Areas; Protect Trees and Other Vegetation
    - o Preserve Riparian Corridor; Reduce Thermal Impacts to Streams
    - o Preserve Natural Drainage Features/Incorporate Designs that Reduce Stream Impacts & Hydromodification
    - o Preserve Valuable Habitat Areas
- Preserve Porous and Erodible Soils; Protect Native Soils
- Preserve Steep Slopes
- Reduce Clearing and Grading Limits
- Reduce Setbacks and Frontages; Minimize Impervious Surfaces
- Reduce Roadway Lengths and Widths
- Reduce Sidewalk and Driveway Lengths and Widths
- Use Fewer or Alternative Culs-de-Sac
- Reduce Parking Lot Footprints
- Create Landscaping Areas in Parking Lots
- Reduce Building Footprints

The following sections outline the process of conducting a natural resources inventory so that these practices can successfully be incorporated into development designs, and also provide a brief overview of each BSD practice. Each practice description includes a "checklist" of standards that characterize successful implementation of the practice. It should be noted that any individual development design may not be able to incorporate all of the standards. Local program staff should work with developers and designers to incorporate the most appropriate elements on a given site.

BSD-2. Natural Resources Inventory

Conduct a Natural Resources Inventory at an Early Stage of Site Planning

In order to effectively incorporate some or all of the BSD practices into a development or redevelopment site, it is important as an early step in site planning to conduct a natural resources inventory to identify existing site conditions. This inventory can then serve as a basemap to explore different development designs and layouts that help accomplish various BSD objectives. A template for a natural resource inventory checklist is provided below.

Checklist for Natural Resources Inventory

Conduct the inventory at an early stage of site planning well before infrastructure and site layouts are locked down. The inventory should include the following (among other site-specific features):

- ❑ Soils: conducive to infiltration and/or most susceptible to erosion or instability
- ❑ Slopes: greater than 15% and greater than 25%
- ❑ Streams and drainage patterns
- ❑ Floodplains
- ❑ Probable wetlands
- ❑ Vegetation: forests, sensitive habitat areas
- ❑ Special natural resource areas, such as cold-water stream habitats, viewsheds, groundwater recharge or drinking water source protection areas
- ❑ Degraded areas that could be restored as part of an overall stormwater/site plan strategy
- ❑ Evidence of past mining activities that may affect surface water and groundwater interactions

4.1 "Self-Crediting" Better Site Design (BSD) Practices

BSD-3. Preserve Undisturbed Natural Areas; Preserve and Protect Ecologically Sensitive Areas; Protect Trees and Other Vegetation

Important terrestrial and aquatic resources, such as stands of trees and/or other vegetation, perennial and intermittent streams, wetlands, groundwater recharge areas and other important natural resources (e.g., wellhead protection areas) should be delineated and protected on development and redevelopment sites as natural resource conservation areas. Protecting natural resources on a development site helps preserve existing site hydrology, aids in reducing post-development stormwater runoff rates, volumes and pollutant loads and helps prevent soil erosion and provides areas that can be used to treat post-construction stormwater runoff generated elsewhere on the site (see **Specification 4.2.1: Sheet Flow to Vegetated Filter Strips and Conservation Areas**).

Standards that characterize this practice include:

- ❑ Identify natural areas as part of natural resources inventory.
- ❑ Identify one or several contiguous and/or interconnected areas for conservation; avoid too much fragmentation of areas across the site.
- ❑ Clearly show areas on all site plans and clearing and grading plans; note on these plans that area is to remain undisturbed and construction equipment should be kept out of these areas.
- ❑ Show some type of barrier or fencing (e.g., orange fencing) along the boundaries of natural areas on the erosion and sediment control plan (**Figure BSD-1**).
- ❑ Provide a mechanism for the long-term protection of natural areas, such as legally-enforceable deed restrictions, homeowner covenants and maintenance agreements, and/or conservation easements.
- ❑ Provide a maintenance agreement that clearly assigns long-term maintenance responsibility with specific management standards, practices, and objectives.
- ❑ Ensure that the areas are protected during construction.
- ❑ Provide signage and other landowner educational material to help inform residents about the function and management of the natural areas.

Figure BSD-1. Fencing to delineate limits of clearing and protect trees

Several specific BSD approaches can be considered subsets of the overarching practice of preserving natural areas:

- Preserve riparian corridors; reduce thermal impacts to streams
- Preserve natural drainage features
- Preserve porous soils
- Preserve steep slopes
- Preserve valuable habitat areas

Each is dealt with in turn below.

A. Preserve Riparian Corridor; Reduce Thermal Impacts to Streams

This is perhaps the most important subset of the practice outlined in **BSD-3**. Existing riparian corridors should be delineated and preserved as natural resource conservation areas on development and redevelopment sites. Intact riparian corridors provide the shading necessary to minimize thermal impacts while providing organic matter for aquatic organisms, slowing the velocity of flood waters, and allowing the flood waters to be absorbed into the ground or the floodplain instead of causing damage downstream. Riparian buffers provide a filter to remove sediment and other particles in stormwater as well as the pollutants which adhere to the particulates. In addition to being critical for stormwater management functions, headwaters, floodplains, and wetlands all serve a wide variety of ecological functions such as flood control, nursery habitat, and production of food to maintain fisheries.

- ❑ Clearly identify the riparian corridor on clearing and grading plans as natural resource conservation areas; note on these plans that the area is to remain undisturbed and construction equipment should be kept out of these areas. If development does occur in these areas, outline mitigation measures.
- ❑ Clearly mark the boundaries of the riparian corridor with temporary construction fencing prior to the start of land development activity.
- ❑ Provide a fixed or variable width riparian buffer; avoid too much fragmentation of the area. Provide a minimum 25-foot vegetated riparian buffer and an additional 75-foot development setback, which can managed as meadow transitioning to turf. A 100 foot natural vegetated buffer is strongly encouraged to achieve greater stormwater management and wildlife habitat value.
- ❑ As an alternative, a site design can use "buffer averaging." The average width of the riparian buffer across the site should be at least 50 feet, while no section of buffer should be less than 25 feet.
- ❑ Limit future development in the riparian corridor to structures necessary to protect human health and safety; include restrictions in final plat and deed.

B. Preserve Natural Drainage Features/Incorporate Designs that Reduce Stream Impacts & Hydromodification

Natural drainage features and patterns should be preserved by "designing with the landform" on development and redevelopment sites. Preserving these natural drainage features helps preserve existing site hydrology and reduces post-development stormwater runoff rates, volumes and pollutant loads. As appropriate, natural drainage features can be protected as natural resource conservation areas (see **BSD-3**).

- ❑ Locate buildings and impervious surfaces a minimum of 25 feet from natural drainage features (e.g. intermittent streams, wetlands) and out of the riparian corridor.
- ❑ Orient the major axis of buildings and other structures parallel to existing contours.

C. Preserve Porous Soils; Protect Native Soils

Pockets of porous soils, such as sands, sandy loams, and loamy sands, should be delineated and preserved on development and redevelopment sites. Sites that use mass grading will find this practice difficult and should consider the use of phased clearing. Native soils, especially topsoil, contain important organic materials generally not present in underlying soil layers.

In areas with thin soil layers (in many parts of West Virginia), pockets of porous soils are especially critical. Topsoil layers are often stripped off prior to or during construction operations. Also, construction and equipment access can compact soils so that they lose most of their ability to infiltrate stormwater and become effectively impervious. Native porous soils provide opportunities for the passive and active (engineered) infiltration of stormwater runoff and can be used to manage stormwater runoff generated elsewhere on the development site.

On sites with past mining activity, it is important to examine soils and groundwater to identify disturbed soils and how surface water/groundwater interactions may have been disrupted.

- ❏ Clearly identify porous soils and unstable and erodible soils on clearing and grading plans and the site layout or design as natural resource conservation areas to protect.
- ❏ Locate buildings and other impervious surfaces in areas with tight soils with the lowest infiltration rates (e.g. hydrologic soil group C and D soils).
- ❏ As appropriate, use areas of porous soils for Sheet Flow to Conservation Areas (**Specification 4.2.1**) and engineered Infiltration practices (**Specification 4.2.6**). For the latter, it is important to provide field verification of soil types and profiles compared to information in the soil survey.

D. Preserve Steep Slopes

During site layout and design, steep slopes should be avoided due to the potential for soil erosion and increased sediment loading. Sites that use mass grading will find this practice difficult and should consider the use of phased clearing. In West Virginia, many larger development sites are characterized by large cuts and fills, valley fills, and the creation of engineered steep slopes. In these cases, the pre-development slopes are less of an issue. However, many smaller or less intensive sites can do a better job of working with the pre-development topography and reducing the extent of site grading.

- ❏ Minimize excessive grading and flattening of slopes.
- ❏ Clearly identify slopes of 15% or greater on development plans; avoid excess clearing and grading; leave rolling terrain undisturbed where possible.
- ❏ Avoid land development activities in areas that have slopes greater than 25% unless necessary for roadway or utility construction.

E. Preserve Valuable Habitat Areas

Undisturbed natural areas that provide habitat for special ecological communities and rare plants and wildlife should be delineated and protected as natural resource conservation areas on development and redevelopment sites. A valuable habitat area is a special type of natural resource conservation area that provides a critical, protective environment for special ecological communities and rare plants and wildlife where development and disturbance is significantly restricted or prohibited.

- ❏ Identify valuable habitat areas as part of natural resources inventory.
- ❏ Clearly show areas on all site plans and clearing and grading plans; note on these plans that area is to remain undisturbed during construction and occupancy and construction equipment should be kept out of these areas.
- ❏ Clearly mark the boundaries of the valuable habitat areas with temporary construction fencing prior to the start of land development activity.

4.1 "Self-Crediting" Better Site Design (BSD) Practices

BSD-4. Reduce Clearing and Grading Limits

This practice is clearly interrelated with all of the practices discussed in **4.1.3**. Clearing and grading on development and redevelopment sites should be limited to the minimum amount needed for building footprints, infrastructure, and construction access. The land development process of clearing, grading and compaction can significantly reduce the ability of disturbed pervious areas to reduce post-development stormwater runoff volumes (Law et al., 2008; Schueler, 2000).

- ❑ Use "site fingerprinting," which is the process of mapping all of the limits of disturbance on a development or redevelopment site to identify the smallest possible land area that requires clearing and grading.
- ❑ Establish limits of disturbance that are based on maximum disturbance zone radii/lengths. These maximum disturbance zones should reflect the needs of the construction equipment and techniques that will be used as well as the physical characteristics of the development or redevelopment site.
- ❑ Where possible, use phased construction on larger sites. Each 20 acres of disturbance (or a locally appropriate threshold) should be stabilized before moving on to the next 20 acres. This will require balancing of cuts and fills within each phase.

4.1 "Self-Crediting" Better Site Design (BSD) Practices

BSD-5. Reduce Setbacks and Frontages

The intent of this BSD practice is to create more compact development footprints so that other areas of the site can be preserved. Using smaller setbacks and narrower frontages to reduce roadway, driveway and sidewalk lengths helps to minimize the creation of new impervious cover. Reducing front yard and side yard setbacks and using narrower frontages helps create compact site designs with reduced total street lengths. Reduced setback and frontage distances also allow site planning and design teams to use flexible lot shapes and "design with the landform," which helps minimize land disturbance. This practice is obviously related to local zoning, subdivision, and other development codes, and may be used most appropriately in certain zoning districts where conservation or open space design is authorized.

- ❑ Allow for front yard setbacks to 20 feet.
- ❑ Allow for side yard setbacks to 25 feet or less.
- ❑ Allow for narrower frontages of 80 feet or less.

4.1 "Self-Crediting" Better Site Design (BSD) Practices

BSD-6. Reduce Roadway Lengths and Widths

Roadway lengths and widths can be minimized to help reduce the creation of new impervious cover. Generally, compact site designs that make use of smaller lot sizes and reduced setbacks and frontages help reduce total street length. Site planning and design teams should strive to create site layouts that include smaller lots located off a few main roadways instead of site layouts that include long streets serving a relatively small number of large lots. In addition to minimizing street length, site planning and design teams should seek to reduce residential street width, as well as commercial, institutional and industrial street width, to the minimum needed to support travel, on-street parking and emergency, maintenance and service vehicle access. As with BSD-5, this is strongly linked with local development codes.

- ❑ Design development sites to include smaller lots located off a few main roadways instead of site layouts that include long streets serving a relatively small number of large lots.
- ❑ Reduce on-street parking to one lane or eliminate on local cul-de-sac and two-way loop roads.
- ❑ Use one-way single-lane loop roads.
- ❑ Reduce road width requirements for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicle access (**Figure BSD-2**). For local streets with less than 500 average daily trips, reduce road width to:
- ❑ 18 feet where parking is not expected or is restricted to one side
- ❑ 20-22 feet where parking is permitted on either side of the street.
- ❑ 22-24 feet for streets that provides a combination of on-street parking and moving lanes.
- ❑ Use Grass Swales (**Specification 4.2.5**) or Water Quality Swales (**Specification 4.2.3.A**) to treat roadway runoff .
- ❑ Consider Permeable Pavement (**Specification 4.2.4**) for parking and/or travel lanes in appropriate settings.

Figure BSD-2. Reduced Street Width

BSD-7. Reduce Sidewalk and Driveway Lengths and Widths

Sidewalk and driveway lengths and widths can be minimized to help reduce the creation of new impervious cover. Excessive sidewalk and driveway lengths and widths can significantly increase the amount of new impervious cover created on development sites, resulting in an increase in post-development stormwater runoff rates, volumes and pollutant loads. In fact, as much as 20% of the impervious cover in a typical residential subdivision may consist of sidewalks and driveways (CWP, 1998).

- ❑ Develop site layouts that minimize the overall sidewalk and driveway length in cases where additional sidewalk length is not needed for public safety or urban redevelopment.
- ❑ Locate sidewalks on only one side of the street.
- ❑ Use sidewalk widths of six feet in areas with higher foot traffic and four feet in areas with lower use.
- ❑ Use shared driveways where applicable to the design.
- ❑ Use alternative driveway designs, such as runner strips (**Figure BSD-3**).
- ❑ Use alternative or permeable surfaces, such as crushed rock or permeable pavement for sidewalk and driveway construction.

Figure BSD-3. Alternative driveway design with runner strips

4.1 "Self-Crediting" Better Site Design (BSD) Practices

BSD-8. Use Fewer or Alternative Culs-de-sac

The use of fewer or alternative culs-de-sac should be used to help minimize the amount of new impervious cover created on development and redevelopment sites. The dimensions of culs-de-sac should be reduced to the minimum area needed to accommodate emergency, maintenance and service vehicles and alternative cul-de-sac designs should be considered.

- ❑ Use alternative cul-de-sac designs that include landscaping islands, 30-foot radii, hammerheads and loop roads.
- ❑ Create landscaping islands located within culs-de-sac (**Figure BSD-4**). In cases where site grades allow, these islands can be used to manage stormwater runoff generated elsewhere on the development site (see **Specification 4.2.3, Bioretention**).

Figure BSD-4. Cul-de-sac with bioretention island

4.1 "Self-Crediting" Better Site Design (BSD) Practices

BSD-9. Reduce Parking Lot Footprints

Reduce the amount of new impervious cover created on development and redevelopment sites by revising parking lot design. Parking lots are the largest component of impervious cover in most commercial and industrial zones.

- ❑ Use the average parking demand for parking lot design instead of the highest hourly parking demand during the peak shopping season. This will still accommodate the parking demand for most of the year and create less impervious cover.
- ❑ Minimize the dimensions of parking spaces by reducing the length and width of parking stalls to 9 ft by 18 ft.
- ❑ Provide compact car spaces.
- ❑ Use alternative paving surfaces (Permeable Pavement **Specification 4.2.4**) for parking lot construction.
- ❑ Where applicable, provide structural parking facilities.
- ❑ Use shared parking where two adjacent land uses have peak demand parking at different times of the day or week (e.g. church and office building).

4.1 "Self-Crediting" Better Site Design (BSD) Practices

BSD-10. Create Landscaping Areas in Parking Lots

Reduce the amount of new impervious cover created on development and redevelopment sites by distributing landscaping areas, such as landscaping islands and buffer strips, throughout parking lots (**Figure BSD-5**).

- ❑ Design landscaping areas in parking lots as stormwater management practices that can treat stormwater runoff (**Specifications 4.2.1, Sheetfow to Vegetated Filter Strips, and 4.2.3, Bioretention**).
- ❑ Use long landscaping areas that are at least six feet wide and contain porous soils with enough organic matter and nutrients to support plant growth, especially trees (Cappiella et al., 2006).
- ❑ Use curb cuts to convey post-construction stormwater runoff from parking lots into these landscaping areas.

Figure BSD-5. Parking lot landscaping area that provides stormwater management

4.1 "Self-Crediting" Better Site Design (BSD) Practices

BSD-11. Reduce Building Footprints

Site planning and design teams can consolidate functions and buildings to create taller building designs that have smaller impervious footprints.

- ❑ Consider designing buildings with smaller footprints instead of large single story structures.

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