Conservation Strategies for Growing Communities

Urban Conservation Practices for Protecting and Enhancing Natural Resources

NRCS Natural Resources Conservation Service
Iowa NRCS - 2004

The Growth of Urban Conservation

Urban communities are expanding to meet demands of growing populations. More homes, schools, shopping centers, and more roads must be built to connect people with these services.

Local developers, planners, engineers, government officials and resource agencies must respond to these demands. They must collectively manage land development in ways that minimize negative environmental impacts that development activities can create.

Developing areas can account for a significant amount of soil erosion and off-site damage from sediment. Construction sites typically have far greater erosion rates than agricultural land, making runoff from urbanizing landscapes a significant source of sediment in surface water.

With urban development comes more impervious surfaces. Roofs, roads, parking lots, and compacted turf areas increase runoff and deliver more sediment, nutrients, hydrocarbons and other pollutants to receiving streams. Flood problems can also be aggravated, causing damage for residents and municipalities.

With the growing demand to address urban conservation issues, USDA's Natural Resources Conservation Service (NRCS) is working with its partners (Iowa Soil and Water Conservation Districts, Division of Soil Conservation, Department of Natural Resources, ISU Extension Service, Iowa Association of Municipal Utilities) to develop services that meet these needs. Providing conservation assistance in urban areas complements the traditional conservation services provided to agricultural lands. Fostering urban-rural coalitions for conservation will strengthen support for natural resource enhancement throughout the watersheds of Iowa.

What is in this brochure?

"Conservation Strategies for Growing Communities" provides information and direction relating to conservation in urban areas. This brochure discusses water quality laws and regulations and elements of effective erosion and sediment control plans. It includes sections on erosion control practices, sediment control practices, and concludes with a section on storm water management practices. For each practice, this guide will:

- provide a description
- list design techniques for implementation
- indicate challenges or limitations that may limit effectiveness
- illustrate with photos

What the Law Requires

NPDES

Pollutants degrade surface waters, making them unsafe for drinking, fishing, swimming and other activities. As authorized by the Clean Water Act, the Environmental Protection Agency's (EPA) **National Pollutant Discharge Elimination System (NPDES)** permit program is designed to control water pollution by regulating point and nonpoint sources that discharge pollutants into waters.

Great strides have been made to control point source pollution (i.e. pipes discharging industrial waste, outlets of waste water treatment facilities). Attention has now turned to **Nonpoint Source Pollution (NPS)**, which is precipitation driven storm water runoff generated by land-based activities. Examples include runoff from agriculture, construction, mining or silviculture activities, which carries pollutants from the land to surface waters.

Storm Water Regulations

Phase I of the EPA's storm water program relied on NPDES permit coverage to improve the quality of storm water runoff from "medium" and "large" municipalities with separate storm sewer systems (MS4's). Construction activity disturbing five acres of land or more was required to develop and implement a pollution prevention plan and obtain an NPDES permit. Ten categories of industrial activity were also regulated under Phase I. The only Iowa cities impacted by Phase I were Des Moines and Cedar Rapids.

NPDES Phase II expands Phase I by requiring 43 additional Iowa cities to improve storm water quality. Land disturbing activities affecting one acre or more are also subject to Phase II. Phase I and II cities in Iowa are listed on the next page. Iowa State University and the University of Iowa are also subject to Phase II.

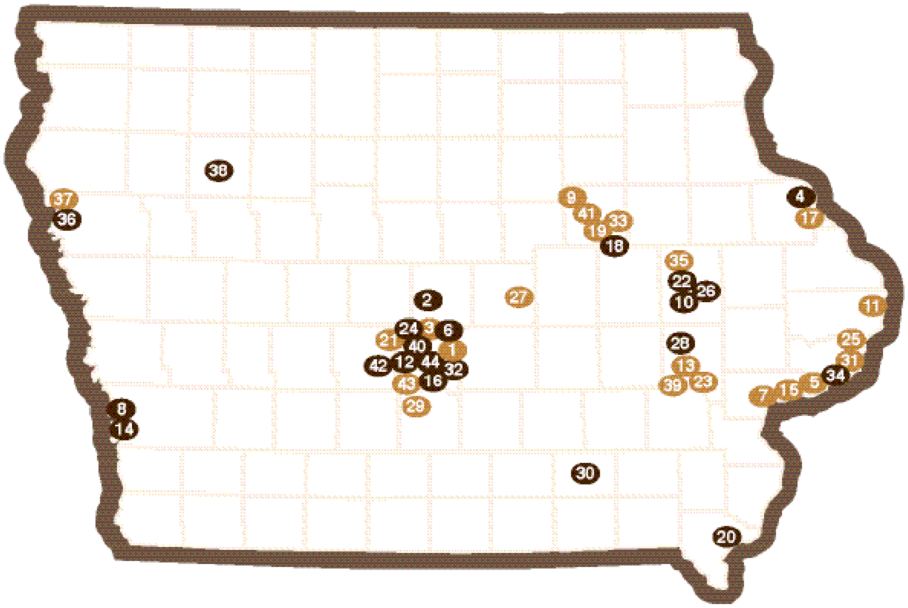
Nonpoint Pollutants Most Commonly Discharged From Construction Sites:

- Sediment
- Oil and Greases
- Concrete Truck Washout
- Construction Debris
- Construction Chemicals

Nonpoint Pollutants Most Commonly Discharged From Urban Land After Construction Is Completed:

- Nutrients
- Hydrocarbons
- Pathogens
- Sediment & Road Grit
- Organic Matter (i.e. Lawn Clippings)
- Litter
- Thermal Pollution (heated runoff from impervious surfaces)

Iowa Cities Subject to Phase I and II of NPDES



1	Altoona	16	Des Moines	31	Panorama Park
2	Ames	17	Dubuque	32	Pleasant Hill
3	Ankeny	18	Elk Run Heights	33	Raymond
4	Asbury	19	Evansdale	34	Riverdale
5	Bettendorf	20	Fort Madison	35	Robins
6	Bondurant	21	Grimes	36	Sergeant Bluff
7	Buffalo	22	Hiawatha	37	Sioux City
8	Carter Lake	23	Iowa City	38	Storm Lake
9	Cedar Falls	24	Johnston	39	University Heights
10	Cedar Rapids	25	Le Claire	40	Urbandale
11	Clinton	26	Marion	41	Waterloo
12	Clive	27	Marshalltown	42	Waukee
13	Coralville	28	North Liberty	43	West Des Moines
14	Council Bluffs	29	Norwalk	44	Windsor Heights
15	Davenport	30	Ottumwa		

Phase I and II cities are required to:

1. Control erosion and retain sediment on construction sites.
2. Improve storm water management to control flooding and protect water quality.
3. Inspect storm drain outlets regularly to detect and eliminate any unwanted discharges.
4. Implement “good housekeeping” practices to ensure municipal operations are not contributing to water quality degradation.
5. Educate residents how to contribute to water quality protection.
6. Involve the public, as communities implement their plan for protecting water quality.

Storm Water Pollution Prevention Planning (SWPPP)

Every construction project that will disturb **one acre** of land or more is subject to NPDES permit requirements. Rules mandate that a NPDES permit from the Iowa Department of Natural Resources (DNR) must be obtained. Each site greater than one acre must also have a **Storm Water Pollution Prevention Plan (SWPPP)** to obtain a permit. The key component of pollution prevention plans is to identify practices that reduce erosion and prevent sediment loss from construction sites.

Planning is the key to implementing and maintaining an effective SWPPP during construction activities. How erosion will be minimized and how sediment will be contained on site should be considered from the very beginning of new development designs. The first priority should be to maximize erosion control. Sediment control will be more effective when erosion is minimized.

Your local NRCS field office can provide assistance in developing and implementing effective pollution prevention plans.

Elements of an Effective Storm Water Pollution Prevention Plan (SWPPP):

- Minimize clearing and grading.
- Phase essential grading to limit soil exposure.
- Immediately stabilize exposed soils.
- Protect steep slopes and cuts.
- Protect and stabilize drainageways.
- Install perimeter controls to keep sediments on-site.
- Train contractors on SWPPP implementation.
- Inspect SWPPP practices after storms and perform needed maintenance.
- Adjust the plan once construction has started, if needed.

Soil Erosion

Erosion is a three-step process involving the detachment, transport, and deposition of soil particles. There are many kinds of erosion. Sheet and rill erosion, gully erosion, stream bank erosion and wind erosion are a few primary concerns. Each of these types of erosion involves the detachment and transport of soil and downstream/downwind deposition of sediment.

Types of Erosion

Sheet & Rill Erosion: Sheet erosion is the uniform movement of a thin layer of soil from sloping, bare, unprotected land. Falling raindrops detach soil particles which go into solution as runoff occurs. Detached particles are transported down slope to a point of deposition. Rills form with longer, harder rains when runoff volumes accelerate.

Gully Erosion: Rill erosion evolves into gully erosion as runoff increases, from one heavy rain or a series of storms over time. A gully is generally defined as a scoured out area that is not crossable with tillage or grading equipment.

Stream Bank Erosion: This type of erosion is the scouring away of stream banks. Degrading or downcutting streambeds and/or repeated high flows of extended duration cause bank erosion. Stream bank erosion is a significant contributor of sediment loads.

Wind Erosion: Wind erosion is similar to sheet erosion in that detachment, transport, and deposition of soil particles occur, except that wind is the transportation mechanism rather than water.

Erosion Control

Understanding the erosion process is essential to the design and implementation of effective erosion control plans. The key to erosion control is preventing the detachment of soil particles and reducing the volume of runoff. Erosion control is achieved by minimizing land disturbing activities, maintaining vegetative cover, mulching, applying a compost blanket, or installing rolled erosion control products (mats or blankets).

Erosion Control Practices

Erosion control practices discussed and examined in this section:

- ***Compost Blankets***
- ***Grading Strategies***
- ***Mulching***
- ***Rolled Erosion Control Products***
- ***Vegetative Establishment***

A compost blanket protects against erosion until vegetation is established on this storm water detention basin retrofit project at North High School in Davenport, Iowa. The darker color of the compost is due to its high organic matter content.

Compost Blankets . . .

an erosion control and soil quality enhancement practice. Compost blankets provide a soil amendment consisting of decomposed organic waste with a consistency similar to high quality topsoil but a much higher organic matter content. The high organic matter content of compost absorbs the impact of raindrops, which prevents detachment of soil particles. Organic matter also retains water on site to reduce runoff and potential transportation of sediment or other pollutants.

Early Spring

Applying compost and seed with a pneumatic blower truck.

Early Summer

Compost blankets control erosion until seeding is adequately established.

Design Techniques

- Compost can be applied to a depth specified for site conditions using manure spreaders, bulldozers, end loaders, or pneumatic blower trucks. Generally, a two inch minimum blanket depth is recommended.
- Compost blankets are effective as temporary site stabilization while vegetation is established.
- Seeding is completed after the compost blanket has been installed or as the blanket is being installed with a blower truck.
- Compost amended soils contribute to rapid establishment of vegetative cover and water retention.

Challenges/Limitations

- Compost blankets should not be used in areas of concentrated water flow.
- Access to composting facilities and adequate supplies of compost may limit use of compost blankets in some locations.

Pneumatic blower trucks are a new tool for compost-based erosion control practices.

ISU Research on Compost Blankets

According to research on compost blankets by Dr. Tom Glanville and his team of Iowa State University researchers, compost-treated slopes produced significantly less runoff (50-80 percent less) than slopes with bare soil. They also found that even at rainfall intensities of nearly four inches per hour, the water absorbing capacity of the compost blankets reduced erosion by 98 percent.

To learn more about ISU research on compost blankets, visit www.eng.iastate.edu/compost.

Grading Strategies . . . **designing developments to fit the existing landscape minimizes the amount of required grading. This reduces the amount of land exposed to erosion and saves money. Some grading will always be needed. Coordinate essential grading to minimize erosion potentials.**

Design Techniques

- Phased grading is recommended. Phasing divides essential grading into distinct portions. Grading of each phase is started and completed in sequence.
- Generally, it is best to start grading activities at the top of a site first and then move down the gradient. Try to maintain vegetative cover (buffer strips) as the site progresses.
- Phased grading maintains strategic vegetative cover and minimizes the amount of disturbed land at any given time to reduce erosion.
- Deep tillage should be done as the final step of grading activity to reduce soil compaction. This increases infiltration and decreases runoff.

Challenges/Limitations

- Each grading phase needs to be planned carefully to assure time and cost efficiencies are realized.

Minimize the amount of land exposed to erosive rain and wind with phased grading.

Mulching . . . **applying vegetative residue to protect the soil surface from the impact of raindrops or the erosive forces of wind until vegetative cover is established. Mulching conserves moisture for seedlings and protects them from temperature extremes. Mulching limits soil erosion, lessens the need to contain sediment and enhances water quality. Mulches most often used include straw, fiber or wood chips.**

Applying Straw Mulch

Design Techniques

- Straw mulches do not bond to the soil. They will blow off the site or be carried away by water if they are not tacked in by disking. They can also be held in place by spraying on a tackifier (glue) or fiber mulch to hold the straw in place.
- Straw mulch is usually applied at a rate of 1-2 tons per acre.
- Fiber mulches are chopped up paper or wood fiber and are typically sprayed on as a slurry along with seed.
- Wood chip mulches are rarely used on larger sites because of the expense. They can be a good solution, though, for smaller critical areas.
- Mulching is one of the best ways to provide instant erosion control on a bare site to protect it until vegetation can be established.

Challenges/Limitations

- Mulches can be used on most sites and are generally only limited by severe slopes. On steeper slopes, rolled erosion control products should be used.
- Mulch is not effective at stabilizing channels or other areas of concentrated flows. A rolled erosion control product is recommended for areas of concentrated flow.
- Too much mulch or uneven distribution of mulch can smother new grass seedlings.

Straw mulch was disked in where vegetative cover is starting to establish. The mulch blew off the bare ground to the right because it was not tacked in by disking.

Rolled Erosion Control Products (RECP's) . . .

mats or blankets of organic or synthetic materials applied to the soil surface to protect disturbed areas from erosion until vegetative cover is established. Rolled erosion control products are especially effective at controlling erosion on severe slopes or areas of concentrated flows.

Design Techniques

- Proper selection and installation of RECP's is critical to successful use of these products.
- Trenching, overlapping, and stapling must be completed according to manufacturer's recommendations.
- Seeding is done prior to blanket installation (some blankets have seed embedded).
- RECP's are highly recommended for protecting areas of concentrated flows.

Challenges/Limitations

- RECP's may not be cost-effective for flat grades.

"I have never seen a rolled erosion control product fail. When problems occur, it is always improper product selection or installation errors to blame."
-Dwayne Stenlund, CPESC
Erosion Control Specialist
Minnesota DOT

This roll of coconut fiber matting will be used to provide cover until vegetation is established.

Vegetative Establishment . . . **establishing vegetative cover is the best way to control erosion. Temporary vegetation with fast-growing annual species is an economical way to stabilize a construction site until permanent vegetation is established. Mulching or compost blankets should always be used with temporary or permanent seeding.**

A two week old seeding applied with a compost blanket protects this slope. Note the problems with establishing vegetative cover in the area of concentrated flow. Compost socks were added as a remedial measure after gullying had occurred.

Design Techniques

- Two options available for establishing permanent vegetation are **seeding** and **sodding**.
- Sodding can be applied at any time, but regular watering is required until root systems are established.
- Seeding is usually less expensive than sodding, but is typically restricted to Spring (March 1-May 15) or Fall (August 1-September 15). Seeding periods can be extended when mixtures of native (prairie) species are seeded.
- When seeding, always include mulch, compost blankets or rolled erosion control products to control erosion, improve seed germination and enhance establishment of vegetative cover.
- Use a mix of native grasses and forbs (flowering species) when possible to increase infiltration, reduce maintenance costs, increase wildlife habitat, improve soil quality and protect water quality.
- Temporary vegetative cover can be established by broadcasting oats, wheat or rye. Temporary seeding should be used to provide cover until the next permanent seeding period.

Challenges/Limitations

- The two greatest challenges to establishing vegetation are the climate at the time of seeding and poor soil conditions.
- Poor soil conditions found at many construction sites can make establishing vegetation challenging. Soil amendments such as organic matter (compost), fertilizer, and lime often need to be added. (See Soil Quality Restoration, page 30)
- Compaction of soils on construction sites inhibits plant growth and the land's ability to absorb rainfall. To relieve compaction, a deep tillage operation will be necessary.
- Success of seed establishment is influenced by the weather (including temperature and rainfall conditions) making supplemental practices essential (compost blankets/mulching/RECP's).

Sediment Control

Sediment control, which is often confused with erosion control, is trapping detached soil particles that are already moving in the erosion process. Slowing the velocity of runoff and providing vegetative filtering helps trap sediment on-site, but typically sediment control is achieved by temporarily impounding flows to allow sediment to settle out. Sediment is the number one pollutant of Iowa's surface waters. It is critical that effective sediment control practices be installed and maintained when soil is exposed to the erosive force of rain and wind.

Sediment Control Practices

Sediment control practices discussed and examined in this section:

- ***Compost Filter Berms***
- ***Compost Socks***
- ***Filter Strips***
- ***GeoRidge™***
- ***Inlet Protection Devices***
- ***Rock Check Dams***
- ***Sediment Control Basins***
- ***Silt Fences***

The rock check dam shown above adds water quality protection to a traditional storm water detention basin by temporarily impounding runoff from frequent, low intensity rainfalls. A traditional detention basin only controls large storms to reduce flooding.

Compost Filter Berms . . . **small triangular structure made of biologically active composted material that slows and filters water to capture sediment and degrade pollutants. In addition to providing sediment control, compost filter berms improve water quality by absorbing pollutants such as hydrocarbons, nutrients and bacteria.**

Design Techniques

- Compost filter berms are small triangular structures of specified blends of composted organic materials installed perpendicular to sheet flows of runoff.
- The width of the berm at its base should be twice that of its height.
- Using a commercially available berm forming device is highly recommended to ensure uniform installation.
- Slope gradient perpendicular to the berm should be five percent or less.
- Drainage areas should be limited to 1/4 acre per 100 lineal foot of berm length, which can be achieved by spacing berms no more than 100 feet apart on a slope.
- Because of compost's ability to absorb pollutants, berms are recommended around water bodies where protecting and improving water quality is a priority.
- If installed with a pneumatic blower truck, compost filter berms can be installed on any terrain, including rocky or hilly ground, and in difficult soil conditions such as frozen or wet ground.
- Compost filter berms do not have to be removed once construction is complete. They can be seeded during installation to become part of the permanent landscape or can be spread out and used a second time as a soil amendment.
- Compost filter berms are most effective if used in conjunction with compost blankets.

Challenges/Limitations

- Compost berms should not be used to control concentrated flows.
- Success is contingent upon the right composition of materials being specific and installed.

Compost Socks . . . **mesh tubes filled with biologically active composted material that slow and filter water to capture and degrade pollutants transported by runoff. Like compost berms, socks filled with compost are placed at the top of slopes and on the contour across slopes to intercept and treat sheet flows.**

Compost socks with a compost blanket protect this slope.

Design Techniques

- Compost socks are mesh-like textile tubes that come in multiple diameters, ranging from 8 to 24 inches.
- Compost socks are filled by pneumatic blower trucks.
- They may be staked at 8 foot intervals for added stability.
- Install socks on the contour no more than 100 feet apart going down the slope.
- Flare the ends uphill to temporarily impound water.
- Compost socks injected with seed can be used to stabilize severe slopes or stream banks.
- Compost socks can be installed on concrete or asphalt for inlet protection.

Challenges/Limitations

- Spacing compost socks too far apart or not placing them on the contour will reduce effectiveness.
- Uneven ground may cause leakage under compost socks. Blowing compost into the joint of the sock and the ground on the uphill side of the sock will help prevent leaks.

Stakes should be installed to hold compost socks in place to prevent movement.

Filter Strips . . . **strips of vegetation left as a buffer between construction sites and stream corridors. Filter strips reduce the velocity of runoff leaving a construction site, filter sediment and enhance infiltration of runoff. Filter strips should be maintained as permanent buffers to protect urban streams, ponds and wetlands after construction is completed.**

Iowa farmers have installed 18,223 miles of filter strips along rural streams. Urban filter strips are increasingly being installed to buffer urban streams.

Design Techniques

- Filter strips are buffer zones of grasses along the edges of streams. They absorb runoff, stabilize the soil and trap pollutants. Trees and shrubs can be strategically planted for habitat value.
- Surface runoff should be evenly distributed and enter the filter strip as a sheet flow.
- Areas of existing vegetation can be maintained or new vegetation can be established prior to the onset of land disturbing activities.
- Many communities are encouraging or requiring ponds and stream buffers. Installing or maintaining buffers is a storm water management practice that helps communities protect water quality and comply with Phase I and II of NPDES regulations.

Challenges/Limitations

- Private ownership in stream corridors can prevent the installation and maintenance of a comprehensive filter strip system.
- Dedicated linear green space is needed to buffer urban streams. Trails can be installed to provide a community amenity.
- When planting new filter strips, use native vegetation to build soil quality and enhance infiltration.

Buffering urban stream corridors protects water quality, stabilizes stream banks and provides linear green space for recreational activities.

GeoRidge™. . . low profile, porous berms installed perpendicular to the direction of flow. The GeoRidge™ system is designed to complement the performance of erosion control blankets in channel and slope applications.

This GeoRidge™ system has trapped sediment. Maintenance should be performed to maintain its effectiveness.

Design Techniques

- Recommended spacing of GeoRidge™ is directly related to the channel grade. The steeper the grade, the closer the spacing.
- Prepare the channel by forming the shape and grade of the channel. Install the erosion control blankets before installing the GeoRidge™ system.
- Place GeoRidge™ berms perpendicular to the direction of the flow. Overlap panels by a minimum of 2 inches. Cut a slot in the crest of the overlapping berm to allow contact between the foot of the berm and the soil.
- Secure berms with pins or staples. The pin/staple spacing across the width of the panel should be ten inches on center for the upstream leg and 20 inches on center for the downstream leg.
- GeoRidge™ can be removed after the site is stabilized and used over again.

Challenges/Limitations

- Silt deposited behind GeoRidge™ must be removed periodically to maintain permeability.
- Allowing excessive sediment to build up behind the berm will create a non-porous check structure which causes overflow and scouring on the downhill side of the structure. This can lead to failure of the system.

A GeoRidge™ system complements erosion control blankets to protect areas of concentrated flow on this site in Iowa's fragile Loess Hills region.

Inlet Protection . . . **traps and filters sediment from runoff before it enters storm sewer inlets. Inlet protection serves as a last line of defense for keeping sediment on site. Construction sites will always generate some sediment-laden runoff, making inlet protection an important practice. A variety of products and techniques are available to provide inlet protection.**

A geotextile fabric is installed beneath the grate of this storm sewer inlet. Runoff will receive one last filtering before moving off-site.

Design Techniques

- Inlet protection techniques can vary from covering inlets with geotextile (above) to placing silt fence, compost socks or rock filter dams around the inlet. A host of other options are available.
- The key is to install a protective device that filters storm water runoff one last time before it enters the storm sewer.
- Traditional flood control detention basins can be retrofitted with an inlet protection system to provide water quality benefits while maintaining flood control functions.

A rock check dam serves as an inlet protection device on this site.

Challenges/Limitations

- Since inlet protection devices impede the direct flow into the storm drain, streets may become temporarily flooded or covered with deposited sediment.
- Designers should provide a plan for dealing with impounded water. Deposited sediment should be cleaned promptly. Sediment can also clog the filtering medium, requiring regular maintenance to prevent extended ponding of runoff water.
- Inlet protection techniques should not be subjected to large sediment loads. The vast majority of sediment should be trapped upland from inlets. Inlet protection should provide a final filtering of runoff, after other components of a pollution prevention plan have done their job.

Rock Check Dams . . . **rip rap grade stone placed perpendicular to concentrated flows in ditches or swales. Rock check dams serve as sediment trapping structures by slowing flows and allowing sediment to drop out of runoff. This practice is used to prevent gully erosion from scour caused by concentrated flows.**

Design Techniques

- Maximum height of rock check dams should be three feet. The top of the rock check dam should be a minimum of one foot below the top of the ditch or swale to prevent out or bank flows.
- Front and back slopes should extend three feet out for every foot of height (3:1 slopes).
- Temporary ponding must not cause damage to adjacent areas or structures.
- The top of the dam should be level across the entire length to provide a “level spreader” affect, should the dam overtop.

Challenges/Limitations

- Trapped sediment needs to be removed after every erosive rain to maintain the capacity of the structure until vegetation is established.
- Dams are typically not removed after a site is stabilized, which could cause problems with future maintenance, such as mowing.
- Pores between rocks can become plugged, reducing the filtering ability of the structure.

These rock check dams complement RECP’s and trap sediment in concentrated flows.

Sediment Control Basins . . . **basins are commonly used on construction sites to retain sediment by impounding and slowly releasing runoff. Sediment settles out of standing water, so maximizing the time water is impounded increases the amount of sediment retained on site. Basin outlets can be wrapped in geotextile or bedded in gravel to enhance trap efficiency.**

Design Techniques

- Basins can be placed strategically throughout the construction site and be temporary in nature. For instance, a basin can be installed as part of a phased grading plan and removed as one phase is completed.
- Often, a large basin is installed as a perimeter protection practice. Large volumes of water can be captured and retained with this approach.
- Perimeter basins can be removed and the site landscaped after grading is completed and the site is stabilized.
- In many cases, sediment basins can be multi-functional. They can serve as sediment traps during construction and as water features that helps manage storm water after development is completed.

Challenges/Limitations

- Trapped sediment should be cleaned out regularly to maintain storage capacity and maximize time of impoundment.
- Sediment basins are not trap efficient for very fine silts and clay sized soil particles that stay in suspension for extended periods.
- Bed outlets in gravel or wrap them with geotextile to help trap fine particles. Coagulating agents are also available, which cause fine particles to clump together and fall out of suspension.

Basin Outlet

Silt Fences . . . **temporary sediment barriers of geotextile fabric anchored in the ground and supported by posts on the downstream side of the fabric. Silt fences temporarily impound runoff and retain sediment on-site, often as perimeter control. They are most effective when designed to provide comprehensive water and sediment control throughout a construction site and if used in conjunction with erosion control practices.**

Design Techniques

- Silt fences can be sliced or trenched into the ground. Slicing normally creates a more secure system as the ground can be compacted more fully to prevent undercutting of the fence.
- Install silt fences on the contour, and no more than 100 feet apart going down a slope.
- Flare the ends of silt fence runs uphill to temporarily impound water.
- Silt fence should always be used with rolled erosion control products when used as ditch checks to control concentrated flows. Space silt fence so that the elevation at the bottom of an upstream fence is equal to the elevation of the top of the next fence downstream, creating a stair-step effect.
- Inspect and clean out or replace silt fence after every one-half inch rain. (This is the most crucial and difficult aspect of an effective silt fence system.)
- Silt fence systems must be removed after a site is stabilized.

Challenges/Limitations

Conditions that limit the effectiveness of silt fences include:

- Not placing on the contour
- Spacing too far apart
- Ends not curved uphill, allowing water to bypass the fence
- Not entrenching deeply enough to prevent undercutting
- Not maintained/cleaned out after a storm event
- Used as perimeter control devices or ditch checks without supporting practices

A series of silt fence ditch checks. Note how concentrated flows have caused gullying between the checks. A rolled erosion control product is recommended to enhance the effectiveness of silt fence checks.

Storm Water Management

Land development can have profound impacts on surface and ground water resources. Roads, parking lots, rooftops and compacted turf areas inhibit water from infiltrating the ground and recharging streams with slowly released groundwater. Rainwater flows off impervious and compacted surfaces into storm drains which discharge into streams, wetlands, rivers or lakes, polluting these receiving waters. Low Impact Development (LID) is an ecologically friendly approach to land development and storm water management. The goal of the LID approach is to mitigate development's impacts on land, water and air. The LID approach emphasizes site design and planning techniques that retain water on-site and mimic the natural infiltration-based, ground water-drive hydrology of our historic landscape. Low Impact Development infiltrates more rain and sheds less runoff, to protect water quality and reduce flood peeks.

Low Impact Development (LID)

Traditionally, storm water management has involved the rapid conveyance of water via storm sewers to surface waters. Where storm water management is required, it has focused on flood control, but not water quality protection. Low Impact Development is a different approach that retains and infiltrates rainfall on-site. Infiltration-based storm water management practices associated with LID may include the following:

- ***Bioretention Cells***
- ***Bioswales***
- ***Infiltration Trenches***
- ***Native Landscaping***
- ***Permeable Paving Alternatives***
- ***Rain Gardens***
- ***Soil Quality Restoration***

Bioretention cells manage runoff from impervious surfaces that dominate commercial, institutional and industrial sites.

Bioretention Cells . . . **shallow, landscaped depressions that can handle large volumes of water from extensive impervious surfaces found in commercial, institutional, industrial or residential settings. Bioretention cells generally have an engineered substratum, due to altered and compacted soil conditions.**

Design Techniques

- The subgrade of a bioretention cell will usually include a tile drain bedded in gravel and a soil matrix that is amended with sand and compost to ensure at least 40 percent pore space is maintained.
- Bioretention cell size can be up to 30 percent of the square footage of the impervious surface draining to the cell, but usually will be less than ten percent. The depth of the amended subgrade affects the surface area of the bioretention cell.
- Native trees and shrubs can be planted to provide shading for parking surfaces.
- Bioretention cells should be strategically located to capture roof runoff or segment impervious surfaces to intercept runoff before the volume becomes too large.
- The underlying tile drain should be below frost lines to keep the soil matrix drained.

Challenges/Limitations

- There is potential for fine particles to accumulate in the surface layer of bioretention cells, which could impede the percolation of water through the soil profile.
- Maintain a mowed turf border around the perimeter of the cell to trap fine particles and prevent this potential problem.

A turfed island was converted into a bioretention cell at this site. Curb cuts allow runoff to enter the bio-cell for pollutant removal. Large runoff events can still enter storm sewers.

Bioswales . . . **vegetated conveyance systems that provide an alternative to storm sewers. They incorporate some of the design features of rain gardens and bioretention cells that facilitate infiltration. Bioswales convey large runoff events to storm sewer inlets or directly to surface waters, infiltrating the first flush of runoff and providing vegetative filtering to flows that cannot be infiltrated.**

Design Techniques

- Bioswales allow frequent, low intensity rains that account for the majority of annual precipitation to infiltrate. The infiltrated water from bioswales helps recharge groundwater. Recharging groundwater will supply receiving waters with a slow, purified seep rather than surges of polluted surface runoff.
- Infiltration trenches, subgrade drains and amended soils may be needed to facilitate infiltration.
- Bioswales will safely convey large storm flows that exceed infiltration capacity.
- Enhance and utilize existing natural drainage swales whenever possible to absorb and convey storm water runoff.

Challenges/Limitations

- Compacted soil conditions usually require subgrade enhancement to facilitate infiltration.
- Ordinances often require curbs and gutters on urban streets, making it necessary to obtain variances to use swales in conveying road runoff in urban areas (as shown above).

A bioswale featuring native vegetation showing its fall colors.

Infiltration Trenches . . . excavated trenches backfilled with a coarse stone aggregate and biologically active organic matter. Infiltration trenches allow temporary storage of runoff in the void space between the aggregate and help surface runoff infiltrate into the surrounding soil.

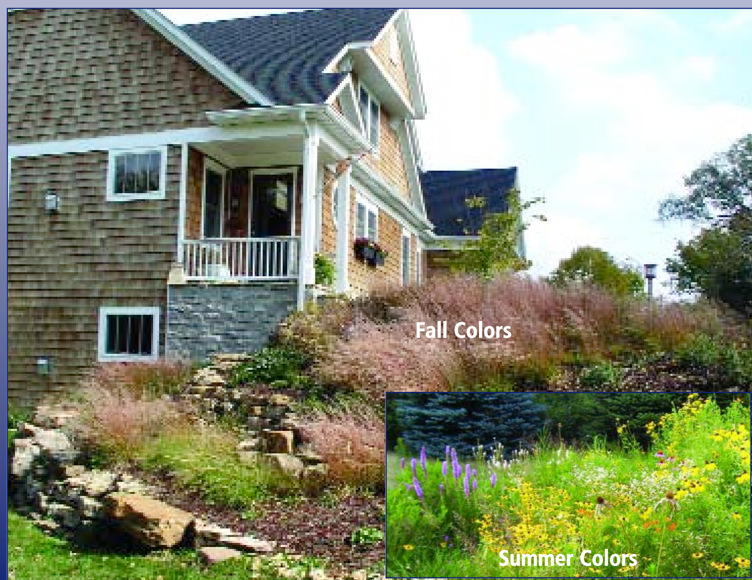
Design Techniques

- Different design techniques will be needed for different site conditions. Deep, narrow trenches work well in parking lots (above). Wider, more shallow trenches (below) work on the perimeter of a site or down the center line of a swale.
- Trenches should be lined with geotextile fabric before placing gravel.
- The grated trench shown above has a layer of granular material covering the folded fabric. This top layer of granular material will need to be replaced periodically as fines accumulate.
- Fabric will be folded over to cover the top of the trench (shown at right) to prevent fines from migrating into pore space of the gravel. Cover the trench with compost amended soil and plant native vegetation.
- An underdrain may be needed to decant water that is unable to percolate into the soil profile.

Challenges/Limitations

- The trench should be inspected after the first few runoff events and then at least annually thereafter. An observation port can be installed to monitor percolation rates.
- Clogging of trenches could occur over time due to accumulation of fine particles. If an infiltration trench becomes clogged, replace the top layer of the trench where fines have concentrated.

Native Landscaping . . . native plants have a tremendous root architecture that builds soil quality and increases organic matter content. High organic matter content helps soil hold water like a sponge and infiltrate most rain. Native landscaping is a key component of infiltration-based storm water management practices.



Design Techniques

- Use native plants in landscaping designs in conjunction with other soil quality restoration techniques (i.e. addressing compaction, enhancing organic matter content).
- Devote at least 30 percent of green space (yards, parks, campuses) to native landscaping and direct runoff toward native landscaped areas.
- Always maintain a mowed turf border around native landscape in an urban setting to enhance aesthetics.
- Design plantings to provide season long color displays.
- Some native plants grow as tall as 8 feet high. Selecting lower growing species (3-4 feet) may provide the best design for urban sites.

Challenges/Limitations

- Weed ordinances could make native landscaping "illegal" in some communities, as some ordinances place limitations on the maximum height vegetative cover can be. Variances can usually be obtained.
- A strong bias exists for mowed turf and a well-groomed appearance. Perceptions of native landscaping as "wild" or "unkept" have caused problems.
- Develop an educational campaign to help people understand that native landscaping helps create hydrologically functional landscapes.

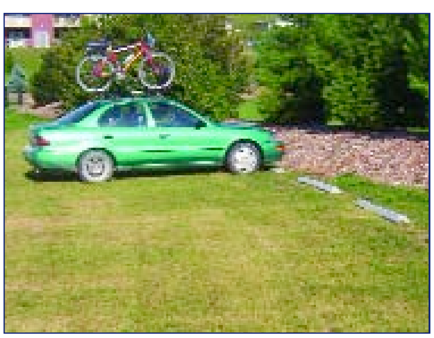
A mix of native grasses and forbs are featured around the perimeter of Coral Ridge Mall in Coralville, Iowa.

Permeable Paving Alternatives . . .

paver blocks, geoweb reinforced gravel and grassed surfaces are permeable paving surfaces. All of these options provide the support of traditional impervious parking surfaces while allowing water to infiltrate. Subgrade can be designed to hold varying storm sizes. Subdrains can be used to facilitate water movement through these systems.

Design Techniques

- Permeable paving systems can be designed to infiltrate virtually any design storm, including the 100-year storm.
- Permeable systems can be used strategically with impervious surfaces to capture the high frequency-lower intensity storms and the first flush of large storms.
- Potential sites for these paving alternatives include: parking lots, fire lanes, off-street parking aprons in residential neighborhoods, camping area parking pads, driveways, bike paths and private roads.



Grass as a permeable paving alternative.

Challenges/Limitations

- This practice should be used with caution in areas underlain with highly permeable soils (i.e., sandy soils) where infiltrated pollutants may reach groundwater without the opportunity for adequate filtering and processing of pollutants.
- The grassed paver alternatives should not be used for high volume traffic areas. These systems are best suited to fire lanes, overflow parking areas, or for infrequently used facilities that require large parking capacity (i.e. churches, stadiums, malls).

Sub-structure of grass paving.

Rain Gardens . . . **popular, new perennial gardens featuring native vegetation strategically located to capture runoff from impervious surfaces such as roofs, driveways, and patios. Rain gardens are landscaping features used by homeowners to create beautiful yards able to absorb water, reduce runoff, protect water quality, and prevent flooding. They perform essentially the same function as bioretention cells.**

Design Techniques

- Determine soil quality and percolation rates with a soil investigation.
- Designs can be as simple as a shallow excavation and organic matter enhancement, if good soil quality exists. Detailed engineering of the substrate may be necessary, depending on soil quality and site conditions.
- Choose a location that is at least ten feet, but preferably 30-40 feet, from the house. Utilize natural depressions, if possible.
- If poor soil quality exists, soil should be excavated and amended with compost (and possibly sand).
- If a high water table and/or poor percolation rates exist, a subdrain tile should be installed. The tile will lower the water table and allow water to percolate through the amended soil profile.
- Plant with colorful native flowers and grasses. Native plants improve soil quality to help restore infiltration capacity.
- The surface should be 5-10 percent the size of impervious surfaces that drain into them.
- Rain gardens create functional landscapes by infiltrating rainwater and by processing pollutants. Deep rooted natives can also "de-water" the soil profile by "breathing" water vapor into the atmosphere.
- Rain barrels can store rainfall for watering rain garden plants until they are established. Rain barrel overflows should be directed to rain gardens.

Challenges/Limitations

- Urban soils are often extensively altered and heavily compacted during development. Compacted soils should be excavated and replaced with a mixture of 30 percent sand/30 percent compost/40 percent soil.
- In some cases, outlets for a drain tile may not be easily accessible.
- French drains (holes drilled through compacted layers and filled with porous material) can sometimes substitute for drain tiles.

For more information about rain gardens, visit:
www.mninter.net/~stack/rain/
www.raingardens.org

Soil Quality Restoration . . .

key to restoring soil quality is reducing soil compaction and increasing organic matter content. In urban communities the soils are often disturbed and severely compacted. Topsoil is generally thin with low organic matter.

"I think the biggest problem caused by construction is compaction. If planners were to develop pre-plans that address controlling traffic and unnecessary soil disturbance, runoff would be reduced." -Mike Sucik, State Soil Scientist, Iowa NRCS

Design Techniques

- Restoring soil quality is a water quality management practice. A healthy soil profile has high organic matter content and 50 percent pore space. High organic matter content allows water to be absorbed and infiltrated. Adequate pore space in the soil profile allows water to be stored on-site.
- Compacted soils lack pore space which prevents infiltration and storage of water. Minimize land disturbing activities to prevent compaction.
- Where compaction can't be avoided, perform deep tillage before establishing vegetative cover (see photo at right).
- Add compost to achieve higher organic matter content. Organic matter absorbs rainfall and facilitates infiltration.

Challenges/Limitations

- Soil quality restoration needs to be recognized as a viable component of a storm water management system. Enhancing soil quality reduces the amount of runoff that is shed and improves water quality by absorbing and processing pollutants moving in the first flush of any runoff event.
- Compaction is generally widespread in urban areas due to grading activities associated with development. Compaction is the most difficult challenge when attempting to restore soil quality.
- Performing deep tillage can be challenging in constrained settings.

Utilize One-Call to locate all utilities prior to performing deep tillage.

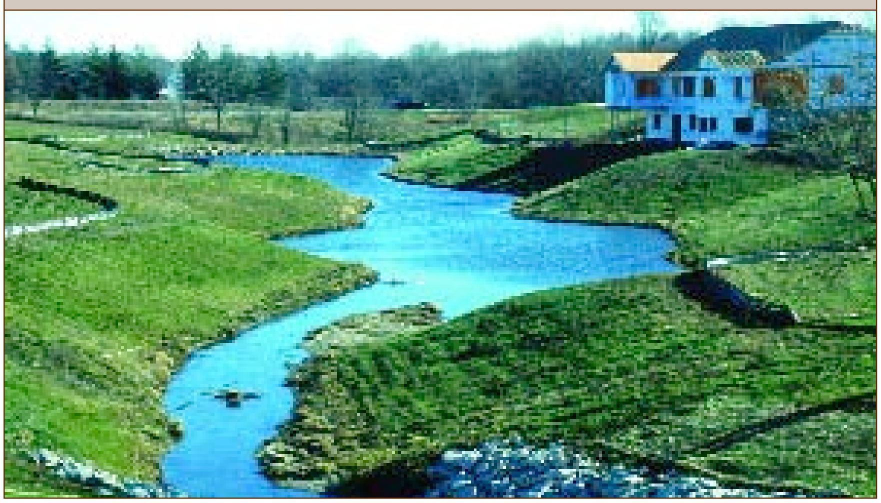
Final Thoughts

Conservation for urbanizing landscapes is a rapidly evolving field. New techniques are emerging and new products are constantly being developed. It is imperative that conservationists, developers, engineers, and municipal officials stay flexible and stay abreast of the changes that will continue to unfold.

This brochure provides a snapshot of the industry as of 2004. Not all practices or products are included in this brochure. However, the most common, effective, and most promising practices are highlighted.

Some of the newest practices may not have design standards and specifications developed yet. NRCS is partnering with a number of entities to update the erosion and sediment control chapter and the storm water management chapter of Iowa's Statewide Urban Design and Specifications (SUDAS) manual. The SUDAS manual will be reviewed annually and include standards and specifications for the newest practices. This manual will give design professionals the tools needed to help communities comply with water quality regulations.

Many different options are available when deciding on a system of practices to enhance construction site erosion and sediment control and improve storm water management. NRCS can provide planning and technical assistance to help meet conservation needs in the urbanizing areas of Iowa.



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Helpful Websites:

www.ia.nrcs.usda.gov
www.iamu.org
www.urbanwaterquality.org
www.epa.gov
www.stormh2o.com
www.cwp.org
www.lowimpactdevelopment.org
www.stormwatercenter.net
www.greeninfrastructure.net
www.rmi.org

NRCS Natural Resources Conservation Service

Developed in cooperation with:

- Environmental Protection Agency (EPA)
- Iowa Association of Municipal Utilities (IAMU)
- Iowa Department of Agriculture and Land Stewardship (IDALS)
- Iowa Department of Natural Resources (DNR)
- Iowa State University Extension Service
- Urban Resources & Borderland Alliance Network (URBAN)