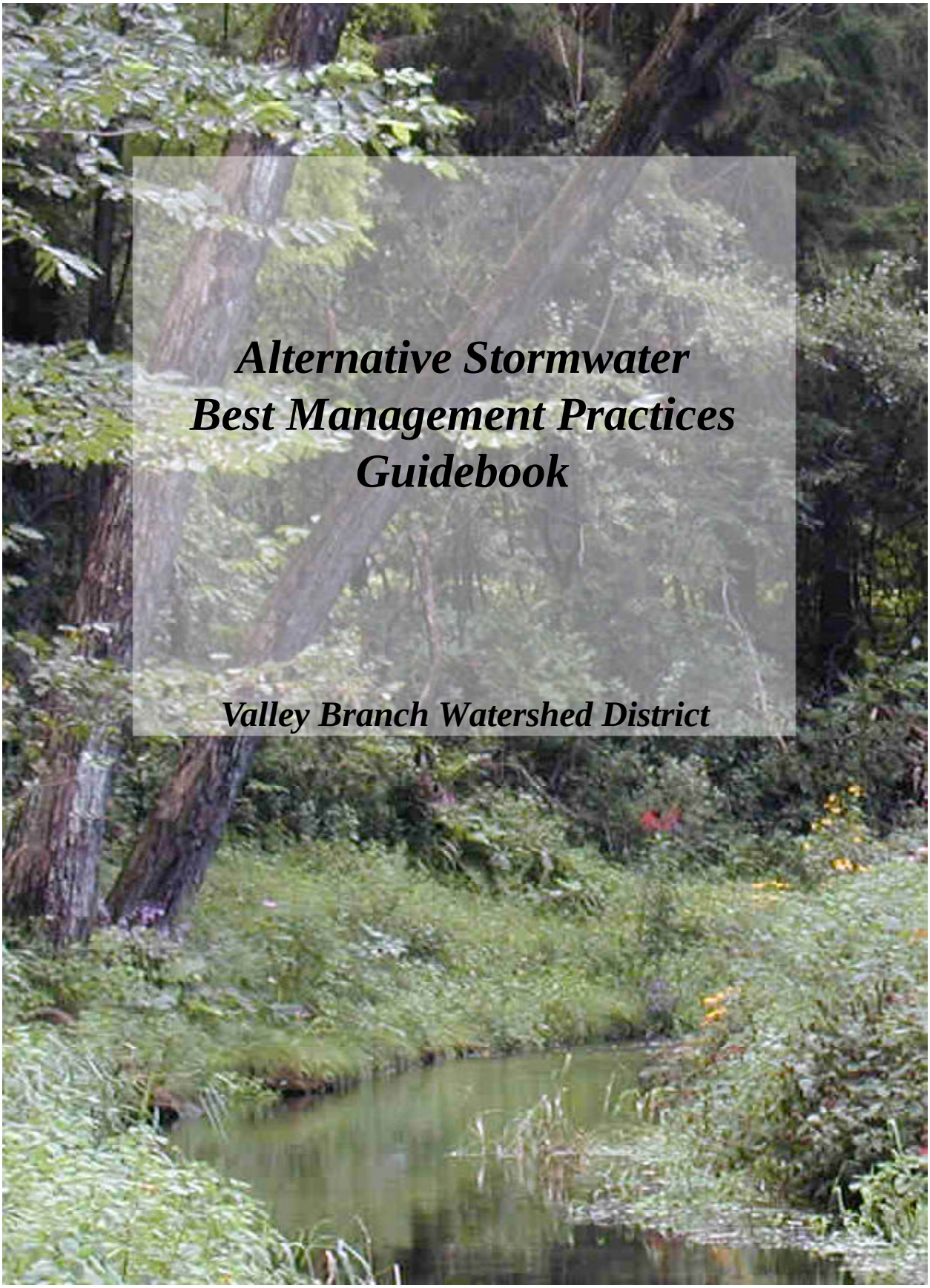

Alternative Stormwater Best Management Practices Guidebook

Valley Branch Watershed District

This guidebook is largely the result of efforts by the Board of Water and Soil Resources and the Valley Branch Watershed District. Members of the Valley Creek Subwatershed Advisory Committee helped to edit the document. Printed April 2000

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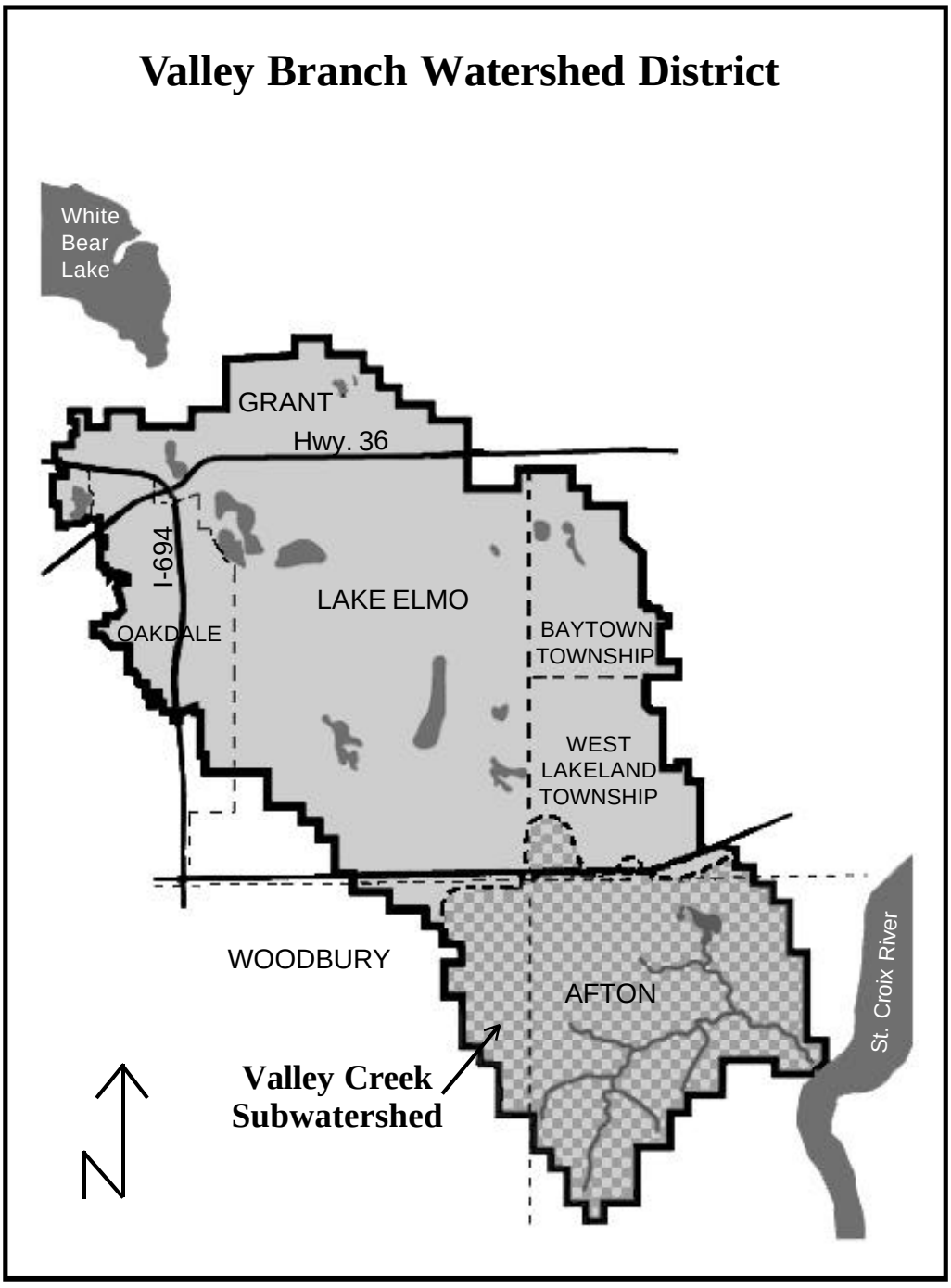
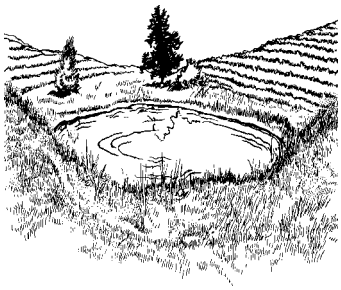
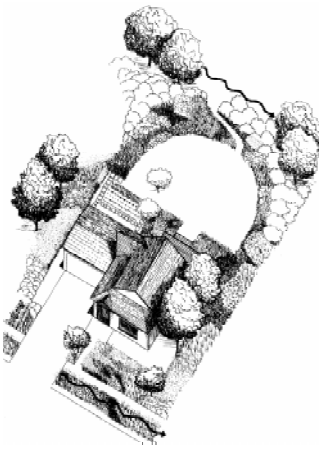
Valley Branch Watershed District



Introduction

The purpose of this document is to provide technical recommendations to Valley Branch Watershed District (VBWD), the cities of Afton and Woodbury, and local watershed residents on alternative stormwater management techniques. Traditional stormwater management tends to drain stormwater from the land as quickly as possible. Large volumes of stormwater piped from roads, parking lots, and buildings creates significant problems for downstream natural water bodies. The goal of this document is to introduce best management practices (BMPs) that, if implemented, can protect Valley Creek from excessive volumes of stormwater runoff from impermeable surfaces and compacted or poorly vegetated soils. These practices also allow for the cleaning of stormwater.





The alternative BMPs described in this document make two broad recommendations. First, to reduce the amount of water-impermeable surfaces constructed and, second, to encourage stormwater to soak into the ground by implementing infiltration basins and other techniques. These practices will reduce runoff volumes and help protect natural water bodies. This document also presents large-scale planning tools that will aid communities in preserving open space and creating greenways that ultimately help protect watersheds.

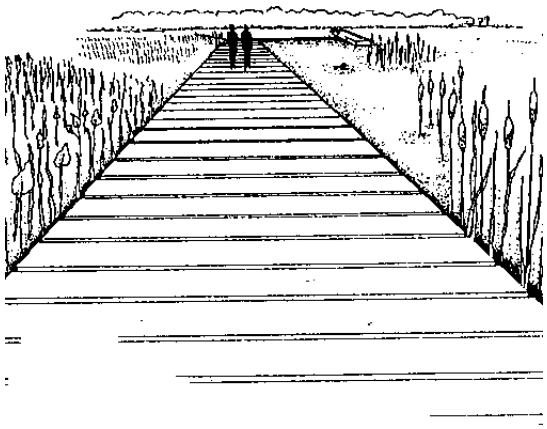
Background

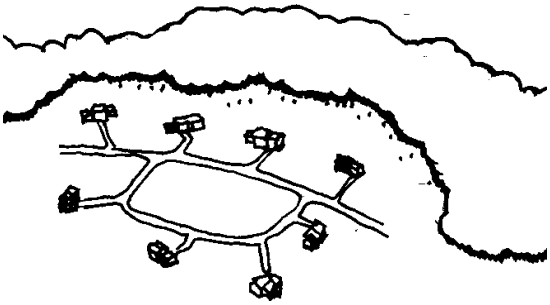
Valley Creek is a high-quality trout stream, one of 15 remaining on the outskirts of the Twin Cities metropolitan area. Although Valley Creek's subwatershed is not yet urbanized, it is beginning to see increased development pressure due to rising land values and construction of transportation linkages. The subwatershed is on the fringe of one of the fastest growing communities in Minnesota and is within one of the fastest growing counties in the country.

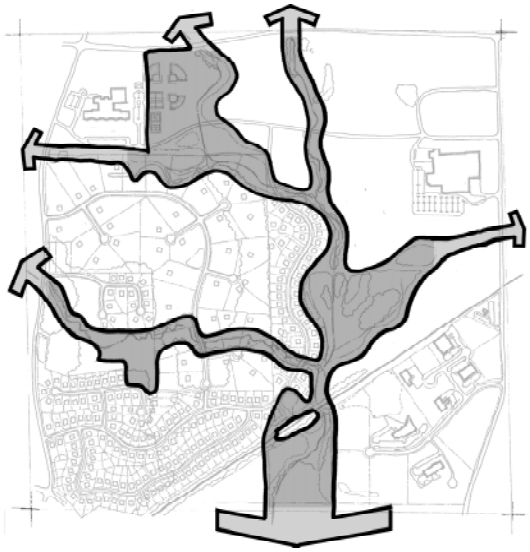
Given these facts, the Valley Creek Subwatershed Project Advisory Committee recognized an important opportunity to manage this high-priority resource. It was determined that a special resource study, led by the Minnesota Department of Natural Resources, the VBWD, and the cities of Afton and Woodbury, would be developed to work in concert with local land use plans. This document is intended to allow cities to directly incorporate specific technical language and design guidelines into relevant local controls. The cities can first identify the appropriate land use for each parcel from their comprehensive plan and then, through an overlay zoning district, implement alternative best management practices for stormwater in those parcels. Finally, for areas that are slated for development but may be appropriate for greenway and open space, the local government should utilize the best management practices listed in the Planning Tools section to allow for permanent protection of those areas. The Valley Creek Subwatershed Advisory Committee will continue to support the local governments by providing the technical support and guidance necessary to ensure implementation of the best management practices.

Planning Tools to Conserve Open Space and Reduce Stormwater Runoff

Introduction

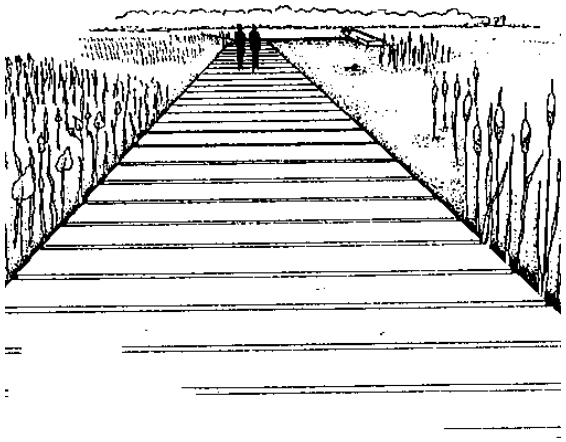






This section describes programs that preserve undeveloped land. These tools can be selectively applied to lands located within a corridor or protected areas that meet planning considerations. There are three main types of land protection techniques listed below, including 1) conservation design that uses local control to manage development, 2) property rights acquisition, and 3) outright purchase of property.

Natural Resource Conservation Plan



A recreational trail system can be overlayed on a natural resource plan connecting environmental amenities together.

Description

A Natural Resource Conservation Plan aggregates the significant resources of an area, creating a patch and corridor system of open space and habitat that will be permanently preserved. Most wildlife species require a large range of habitat and connected habitats to live and reproduce. Planning to preserve these areas in an organized corridor system will direct future planning and development by private landowners and local governments.

In order for a Natural Resource Conservation Plan to succeed and be adopted by a city, community education needs to begin early in the planning process, with all interests represented. Once adopted, education must continue to encourage political and financial support.

Benefits

- Significant existing habitats are preserved in a manner that is most advantageous for wildlife species.
- A variety of planning tools can be used to implement different components of a Natural Resource Conservation Plan.
- Natural stormwater drainage features can be preserved.

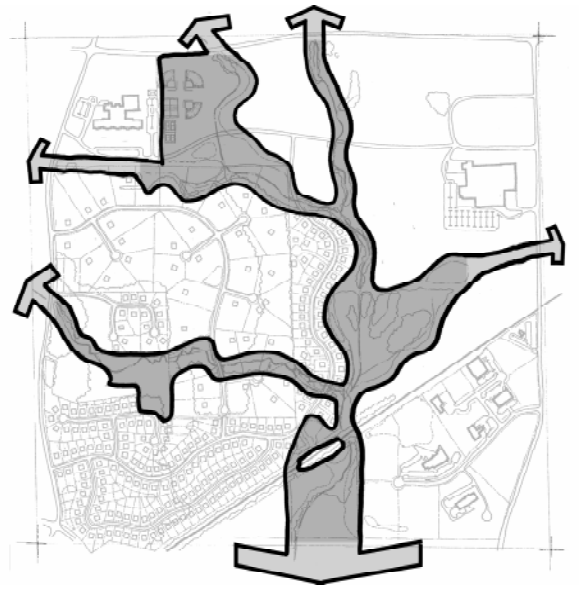
Planning Considerations

- Conduct a natural resources inventory via aerial photographs and site checks to identify significant habitats.
- Identify an ideal network of habitats, such as a stream and complex of wetlands, that can be linked together as a wildlife corridor.
- Evaluate alternatives for land preservation, from public purchase to conservation easements and transfer of development rights (see the remainder of this section).
- Establish a management plan for lands once they are permanently protected.

Additional Information

Contact the Metro Greenways program, Minnesota Department of Natural Resources, (651) 772-7900.

Official Map



This ecological corridor plan includes significant natural areas, parks, and creek corridors.

Description

Areas of land conservation or ecological corridors can be established through a long-range planning tool called the Official Map, which is used in acquiring land as a public resource. This tool has traditionally been used to set aside land for street right-of-ways, parks, and trails. First, a planning study is conducted to identify lands that should be conserved. These areas are documented on a map, which is then adopted through a public process. When the identified properties become available, the city can negotiate to buy the land before it is sold publicly.

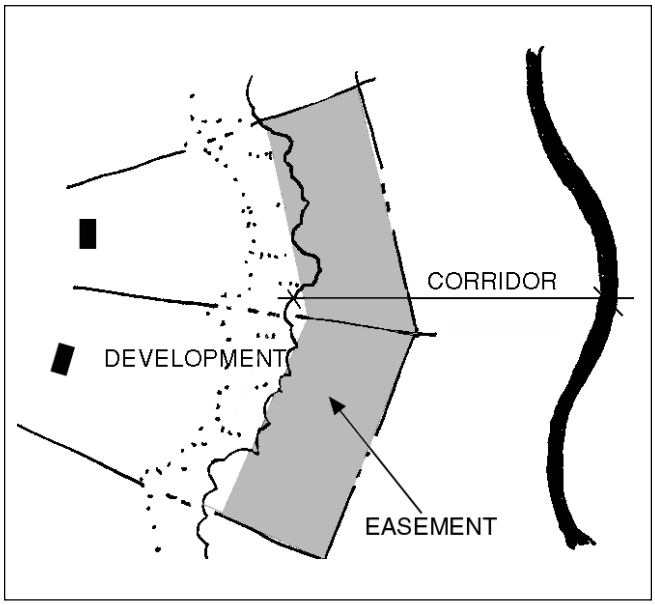
Benefits

- Local government can effectively target lands to be conserved and incrementally create an ecological network of public open space.
- Land put in public ownership is permanently protected from development.
- Landowners are not forced to give up their land, and receive a fair market price for it when they sell.

Planning Considerations

- Assess public support for conserving the land to be included on the Official Map.
- Set clear planning goals.
- Establish Official Map and conduct public process.
- Identify and secure funding for the program.

Donated Conservation Easements



By placing the edge of these back yards in a conservation easement and allowing the landscape to naturalize, the buffer of the stream corridor is widened.

Description

Donated conservation easements are voluntary legal agreements between a landowner and a land trust or local government agency that allow landowners to permanently limit or prohibit development on their property. Conservation easements remain on the property title so that all future owners of the land are bound by the original agreement.

Benefits

- Permanently protects land from development pressures.
- Landowners may receive income, estate, and property tax benefits.
- No or low cost to local government.
- Land remains in private ownership and on the tax rolls.

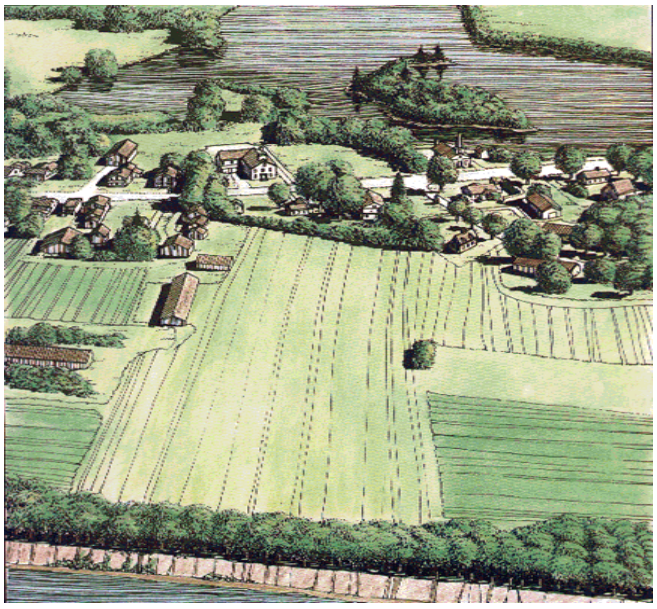
Planning Considerations

- Define eligible property.
- Establish specific restrictions to be placed on the property after development rights are donated.

Additional Information

- Contact The Minnesota Land Trust, (651) 647-9590

Purchase of Development Rights (PDR)



Description

Purchase of development rights (PDR) is a voluntary legal mechanism that allows landowners to sell the right to develop their property to a government agency or nonprofit organization. A conservation easement is then placed on the land. As with a donated easement, the agreement is recorded on the property title to permanently limit the use of the land to agriculture, forestry, or other open space uses.

Benefits

- Permanently protects land from development pressures.
- Landowners are paid to protect their land.
- Landowners may receive estate and property tax benefits.
- Local government can target locations effectively.
- Land remains in private ownership and on the tax rolls.

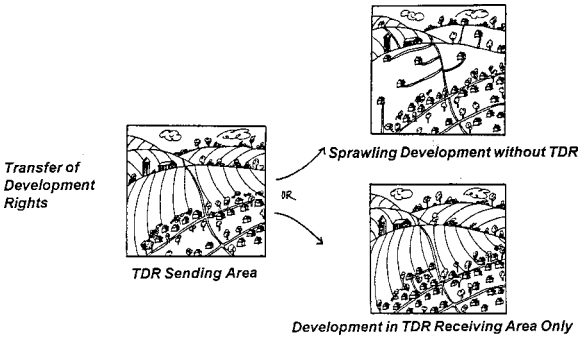
Planning Considerations

- Assess citizen support for PDR.
- Define and map eligible property.
- Create a method for evaluating and prioritizing applications.
- Establish specific restrictions to be placed on the property after development rights are purchased.
- Determine a method for valuing the development rights.
- Consider methods of payment for the development rights.
- Design program administrative structure, staffing structure and duties.
- Identify and secure funding for the program.

Additional Information

- Contact 1000 Friends of Minnesota, (651) 312-1000.

Transfer of Development Rights (TDR)



Land Stewardship Project

Description

Transfer of development rights (TDR) is enabled by local ordinances that create "sending areas" (areas to be preserved) and "receiving areas," where communities encourage additional growth and development. Landowners in the sending area receive development right credits which they can sell in exchange for not developing their land. Real estate developers, speculators, or the local unit of government can then purchase the development right credits and use them to increase existing or planned densities in receiving areas.

Benefits

- Permanently protects land from development pressures.
- Landowners are paid to protect their land.
- Landowners may receive estate and property tax benefits.
- Local government can target locations effectively.
- Low cost to local unit of government.
- Utilizes free market mechanisms.
- Land remains in private ownership and on the tax rolls.

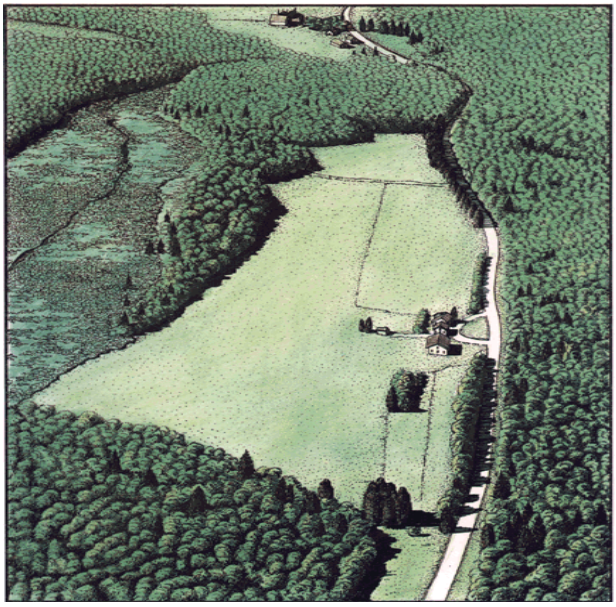
Planning Considerations

- Assess citizen support for TDR.
- Set clear program goals.
- Establish sending and receiving zones.
- Establish the number of development rights to be sent and received.
- Define landowner participation in the sending zone.
- Develop a system to track the transfer of the development rights.
- Decide how to restrict properties after developments rights are sold.
- Choose whether to create a development rights "bank."
- Define administrative structure and staffing duties.
- Identify and secure funding for the program.

Additional Information

- Contact 1000 Friends of Minnesota, (651) 312-1000.

Land Acquisition



Land Stewardship Project

Description

Land acquisition is used in select cases when willing landowners want to conserve their land by selling or donating it outright to a public agency or land conservation organization. This mechanism allows the public agency to have full control over a property's future.

Benefits

- Provides maximum flexibility for local unit of government to determine future use of land.
- Financial incentive for landowner.
- Local government can target locations effectively.

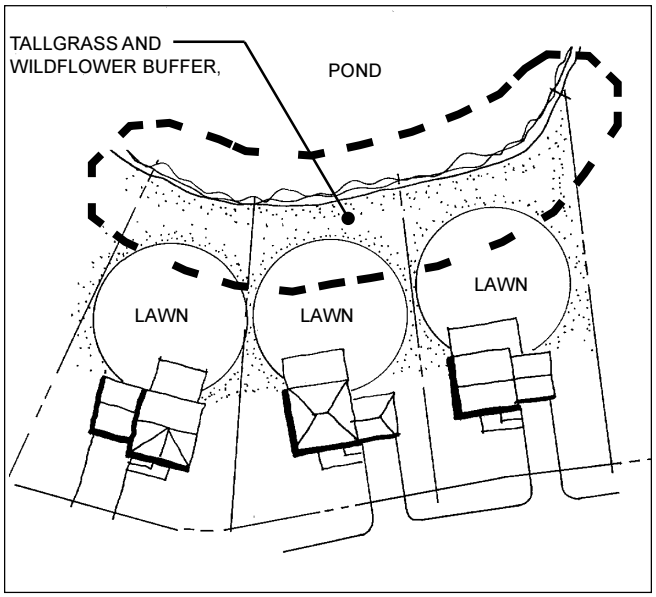
Planning Considerations

- State a clear set of goals.
- Establish community upport.
- Create a method for prioritizing parcels.
- Map targeted areas and priority parcels.
- Inform people of the program's voluntary nature, and educate to encourage sales and donation of priority lands.
- Identify funding.
- Consider a variety of ways to pay for purchased land.
- Commit to long-term management of the land.

Additional Information

Contact The Trust for Public Land, (612) 338-8494,
the Minnesota Land Trust, (651) 647-9590,
or the Parks and Trails Council of Minnesota, (651) 281-0508 or (800) 944-0707.

Overlay District



An overlay district can be used to define guidelines for landscaping development adjacent to natural areas.

Description

An overlay district can be used to create a set of regulations for a specific area of land slated for development. These regulations are in addition to existing ordinances for the described district.

Utilize an overlay district ordinance to reduce impermeable surfaces, reduce stormwater runoff, and require stormwater infiltration BMPs.

Other suggested overlay district requirements include:

- Reduce front and side setbacks for residential development.
- Reduce road widths.
- Encourage cluster development.
- Reduce parking requirements (provide economic incentives to encourage shared parking).
- Establish tree preservation rules.
- Encourage the preservation of open space where significant natural features, such as groves of trees or wetlands, occur.

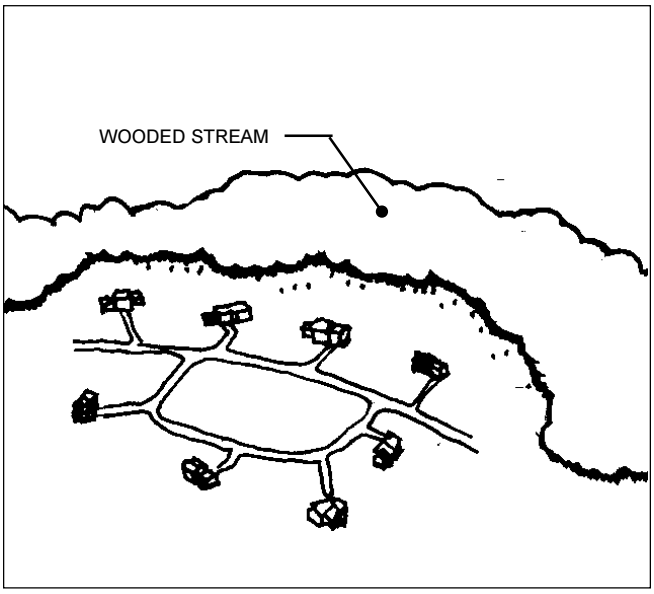
Benefits

- Allows for development and establishment of tax base without extensive damage to habitat.
- Helps to preserve natural areas as open space.
- Reduces stormwater runoff and impacts to downstream water bodies.
- Local government can effectively target locations for preservation.
- Low cost to local units of government.

Planning Considerations

- Assess public support.
- Set clear planning goals.
- Establish overlay district and conduct public process of approval.

Transfer of Density (TOD)



Design of smaller lots in this subdivision preserves the wooded stream corridor from development and establishes it as permanent open space.

Description

Transfer of density (TOD) can be used in tandem with the Official Map, prior to the platting of land or when a property owner plans to subdivide. Allowing higher-than-permitted density in one area of a development frees up land in another area of the development for permanent open space.

Stormwater infiltration BMPs should be implemented in the areas of increased density.

Benefits

- Allows for development and tax base establishment without extensive damage to habitat.
- Preserves natural areas as open space.
- Reduces stormwater runoff and related impacts on downstream water bodies.
- Local government can effectively target locations for preservation.
- Low cost to local units of government.

Planning Considerations

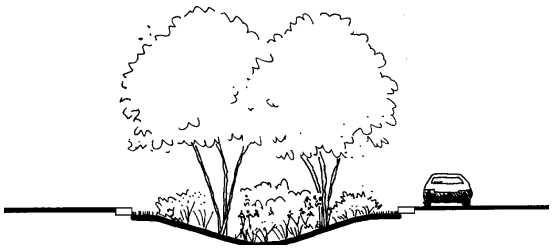
- Utilize an Official Map to identify significant natural resources to be preserved.
- Design the development to accommodate increased density outside the natural area.
- Initiate city and public review process.
- Establish a management plan for lands once they are permanently preserved.

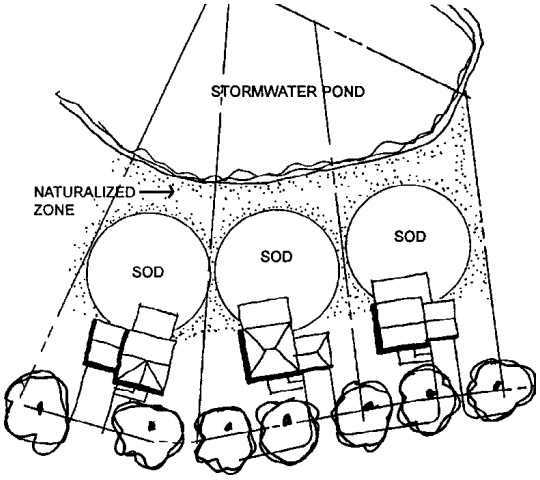
Examples

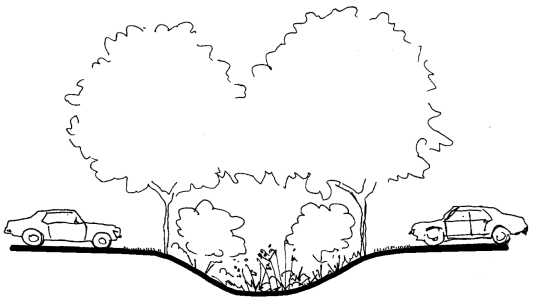
Local developments that employed TOD include the Fields of St. Croix in Lake Elmo and Jackson Meadows in Marine-on-St.-Croix.

Site Design to Reduce Stormwater Runoff

Introduction

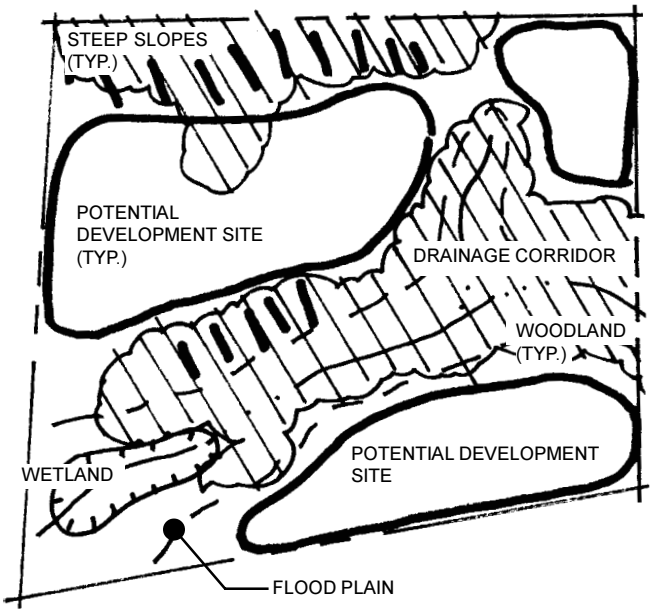






The primary source of water-borne pollutants and high runoff volumes in urban areas comes from impermeable surfaces such as roofs, driveways, parking lots, and roads. Design that reduces the extent of these surfaces before they are built will reduce runoff's impact on downstream water bodies. This section of the guidebook provides a general overview of ways that hard surfaces can be reduced.

Building Locations



Map drainage paths, the flood plain, steep slopes, and other natural resources to determine where development can occur with the least amount of impact.

In early design stages, developments can be arranged to help preserve natural drainageways, swales, and ravines. Strategies include placing buildings "high and dry" to preserve areas of natural stormwater infiltration and conveyance, limiting impermeable surfaces, and building infiltration basins to reduce impact to natural waterways.

Buildings can be arranged so that drainageways and areas of undisturbed vegetation fall along back lot lines between clusters of buildings.

Buildings should not occur on long slopes steeper than 18%, and a 40-foot setback should be established at the top of these slopes. Follow local ordinances when they are stricter than these guidelines.

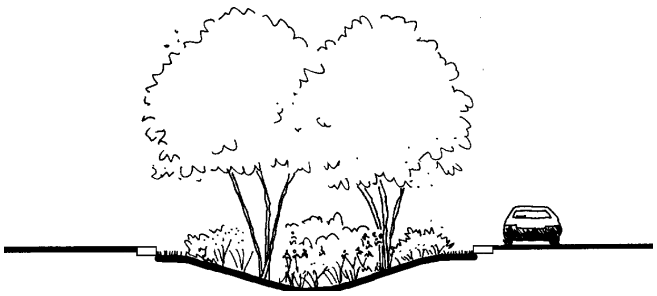
Benefits

- If natural drainageways are strictly preserved in the site planning process, flood volumes, peak discharges, and base flows will be held closer to their pre-development levels. Trace metals, hydrocarbons, and phosphorus will have a much greater opportunity to become bound to the underlying soil, thus reducing their movement to groundwater, lakes, and streams.
- Natural habitats are preserved and remain physically connected, resulting in better wildlife viability.

Design Guidelines

- Do not disturb natural drainageways.
- Building should not occur on slopes greater than 18% and a 40-foot setback should be established at the top of these slopes. Follow local ordinances when they are stricter than these guidelines.

Cul-de-Sac Design

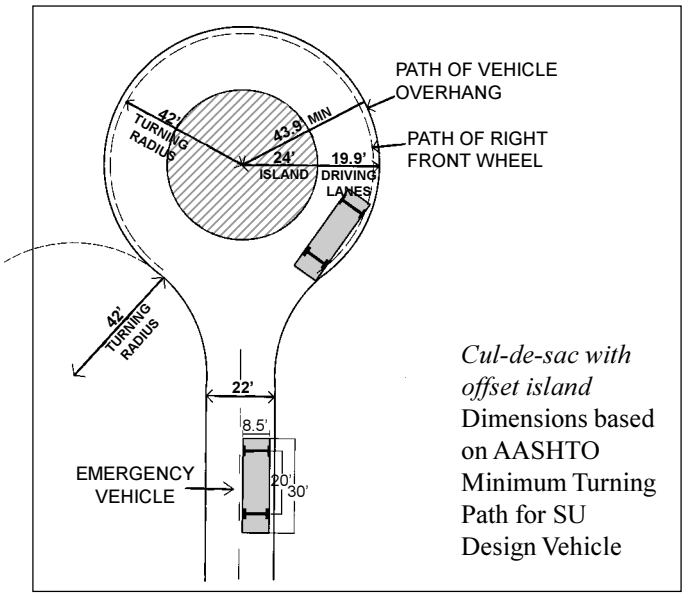


Cul-de-sac infiltration island accepts stormwater from surrounding pavement.

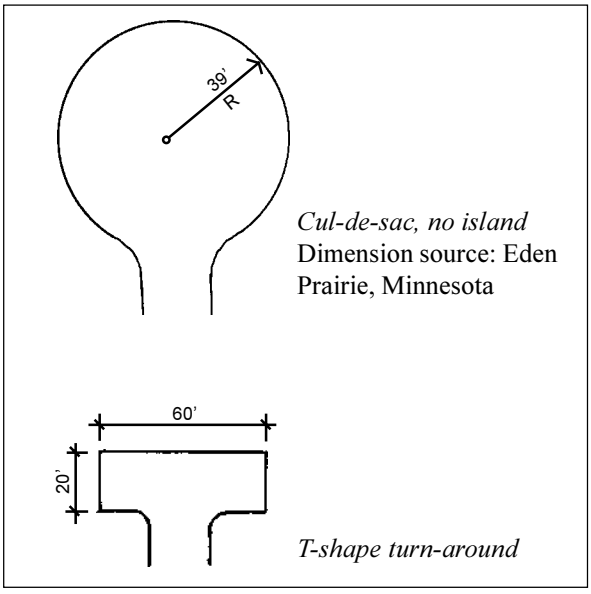
Reducing the size or changing the shape of cul-de-sacs can reduce the amount of impervious surface in subdivisions. Cul-de-sacs should be designed using the minimum radius that accomodates turning of emergency, service, and maintenance vehicles. Changing the radius from 40 feet to 30 feet can reduce the impervious coverage by about 50% (Schueler 1995).

Using turnaround options such as a T-shape can also greatly reduce impervious surface.

A landscaped island in the center of the cul-de-sac removes impervious surface where driving does not occur. This island can also be designed as a depression to accept stormwater runoff from the surrounding pavement. A flat apron curb will stabilize roadway pavement and allow for runoff to flow from pavement into the cul-de-sac's open center.



Cul-de-sac with offset island
Dimensions based on AASHTO Minimum Turning Path for SU Design Vehicle



Cul-de-sac, no island
Dimension source: Eden Prairie, Minnesota

T-shape turn-around

Drawings adapted from Schueler 1995.

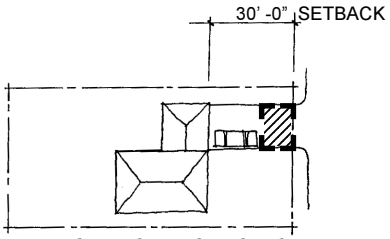
Benefits

- With less impervious surface, less stormwater runoff will require management. Reducing stormwater runoff protects downstream water bodies. Less paved surface also means lower development and maintenance costs.
- Reducing pavement lessens the urban heat island effect, the increase in air temperature that can occur when highly developed areas are exposed to the sun.
- Planted cul-de-sac islands are more attractive than wide expanses of pavement.

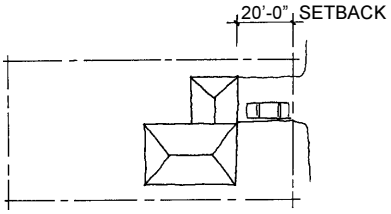
Design Guidelines

- Design cul-de-sacs with a radius of 39 feet or less.
- Include an unpaved, depressed island with a minimum radius of 20 feet.

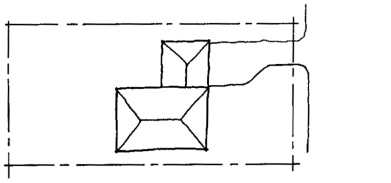
Driveway Design



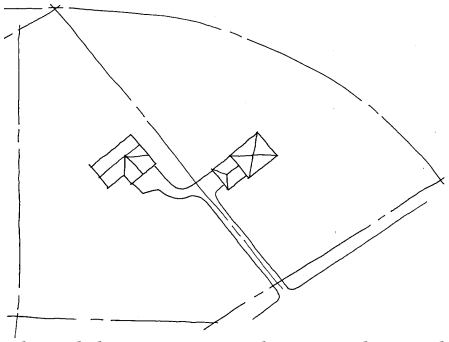
Typical residential setback creates excess driveway paving.



Reduce setback to provide one car length in driveway.



For longer driveways, narrow driveway to one lane at the street.



Shared driveways can eliminate the need for two long driveways.

Impervious surfaces in housing developments can be reduced by 1) changing building setback codes, 2) reducing driveway widths, and 3) implementing alternative driveway layouts.

1. Driveways are shortened when codes allow buildings to be placed closer to the street. Side setback codes can also be changed to allow developers to design a single driveway between two dwellings. (This can then branch into two driveways closer to the garages.)

2. New houses commonly have two- or three-stall garages with driveway widths ranging from 24 to 36 feet. An alternative is to design driveways full-width in front of the garage (one car deep), then narrowed to a single lane where they meet the street.

3. Other design alternatives include concrete wheel track driveways, which are unpaved in the center. These are commonly found in such old neighborhoods such as Crocus Hill in St. Paul. Residents there can attest to their ease of maintenance, both in mowing and snow removal.

When site conditions permit, pervious surfacing such as compacted aggregate or dry-set pavers can be used. Turfed geotextile grids may be appropriate in front of a third garage or for driveway overflow parking in summer.

Many driveways can be graded to drain toward front and side yards, rather then directly into the street.

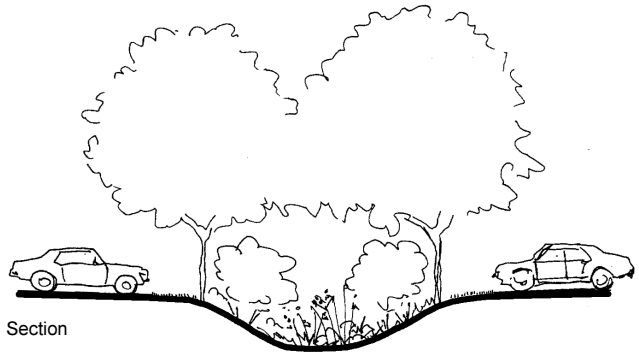
Benefits

- Reducing impervious surface reduces the need for stormwater management because runoff is reduced.
- Less paved surface means lower costs for development and driveway maintenance.
- Snow removal is also reduced.

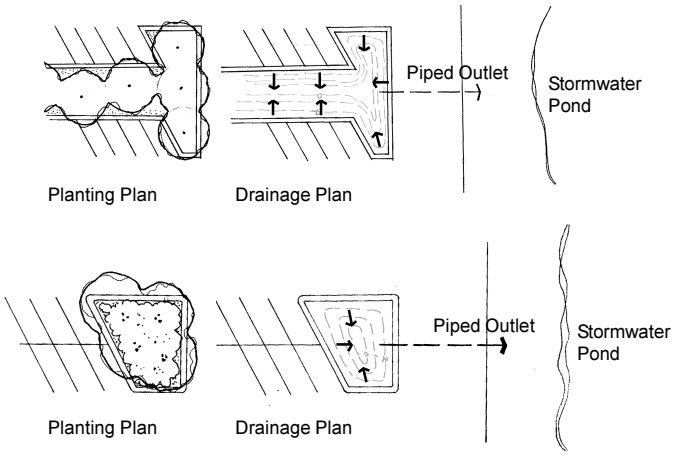
Design Guidelines

- Reduce front yard setback to 20 feet from the property line.
- For long driveways, narrow the driveway to one lane as it approaches the street.
- Use turfed geotextile pavers for temporary overflow parking along driveways.

Parking Lot Design



Infiltration island within parking lot.



Two alternative designs for parking lot infiltration islands. Parking lot sheet flow is directed to depressed islands, overflow drains to stormwater pond.

The impervious surface of parking lots can be reduced by: 1) changing municipal codes to reduce parking requirements, 2) reducing stall dimensions, and 3) promoting shared parking lots.

1. To avoid excess parking lot development, codes should set a minimum and maximum number of spaces a development can provide. Parking demand ratios should be based on site-specific parking generation studies.

2. Create dedicated compact car spaces and spillover parking areas with pervious surfaces. Determine the most space-efficient design for the site, which may be angle parking (to reduce driving lane width), or conventional stalls.

3. Allow shared parking between businesses with peak parking demand at different times of the day or week. For example, a restaurant that requires parking primarily on evenings and weekends could share parking with an office building with weekday parking needs.

Making parking lots smaller may free up space for landscaping. Planted materials in parking areas can then help treat stormwater runoff. (See *Infiltration Islands, Vegetated Filter Strips.)*

Benefits

- Reducing parking surface reduces the need for stormwater runoff management.
- Less paving means lower development and maintenance costs.
- Trees and shrubs hold water that is then evaporated. Shading also reduces the urban heat island effect and makes the area more comfortable for people.

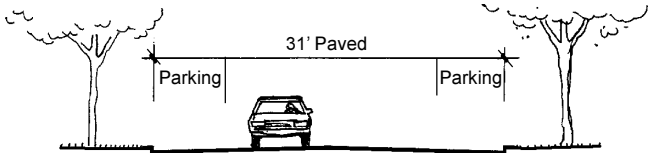
Design Guidelines

- Use minimum stall dimensions.
- Use the most space-efficient stall configuration for the site.
- In larger commercial parking lots, design 30% of the spaces for compact cars only.
- Use pervious surfacing in summer spillover parking areas.
- If soils are suitable, drain parking lot runoff into infiltration islands using curb cuts or flat curbs.

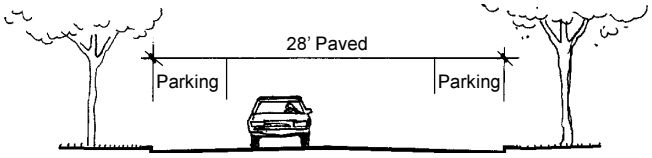
Examples

A local example of innovative parking design can be found at H.B. Fuller World Headquarters, Vadnais Heights.

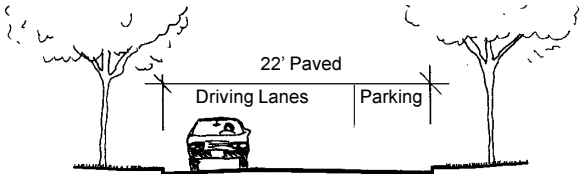
Street Design



Standard width for residential collector streets, with parking on both sides. Dimension Source: Maple Grove, Minnesota.



Standard width for residential minor streets, with parking on both sides. Dimension Source: Eden Prairie, Minn.

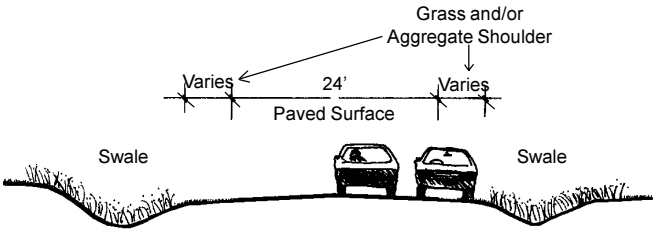


Allowing parking on only one side can further reduce the width of low-volume residential streets. Dimension Source: Robert Engstrom Companies (Fields of St. Croix, Lake Elmo, Minn.).

Many residential streets are wider than necessary. They should be designed with the minimum pavement width that will support the area's traffic volume; on-street parking needs; and emergency, maintenance, and service vehicles. For example, consider creating one parking lane rather than two for suburban residential streets.

In new subdivisions, reduce impervious surface by reducing the total length of residential streets. (See *Open Space Subdivision Design.)*

Encourage stormwater infiltration through the use of curbless road designs and overland drainage conveyance systems. On low-traffic streets, narrow the pavement and allow grass shoulders to function as an occasional parking lane.



Crowned, curbless road drains to roadside swales. Grass shoulders function as occasional parking lanes. Dimension Source: Afton, Minn.

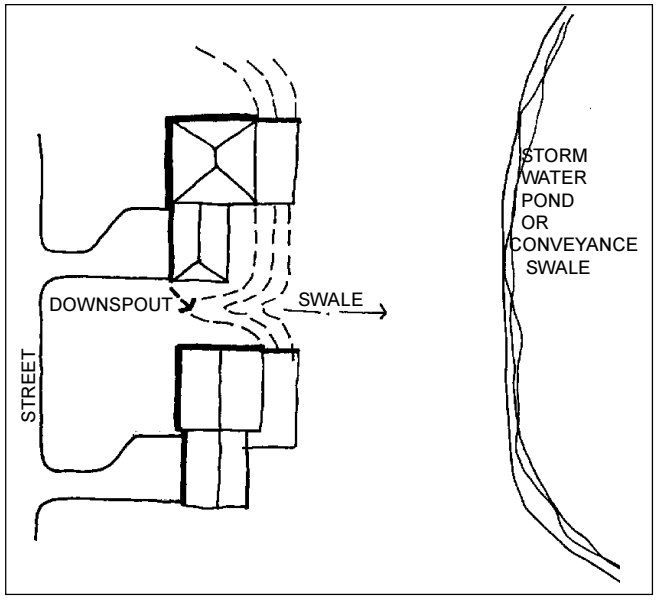
Benefits

- Reducing impervious surface results in less stormwater runoff and less infrastructure to accommodate it.
- Less pavement means lower costs for development and maintenance.
- Narrower streets discourage fast driving speeds and create a more pedestrian-friendly environment.

Design Guidelines

- Design residential streets with the minimum pavement width necessary to support: the traffic volume; on-street parking needs; and emergency, maintenance, and service vehicles.

Rooftop Runoff Management



Direct downspouts to grassy swales and infiltration areas, not to driveways and streets.

Description

In general, connections between impervious surfaces should be eliminated. Rooftop runoff, for example, should be directed to yards and other vegetated areas, not to the roadway and storm sewer system. Downspouts, too, should be designed to discharge over grassed areas, not the driveway.

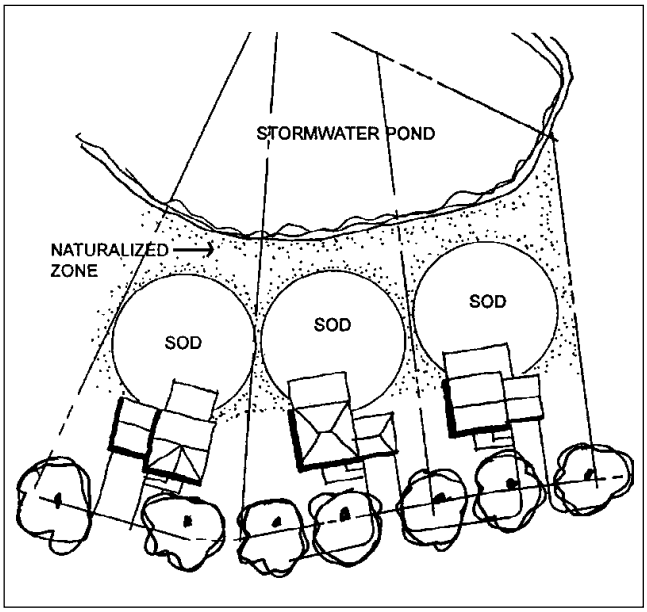
Benefits

- A considerable amount of phosphorus accumulates on hard surfaces in the form of wind-blown dust particles. When washed from roofs and then carried via storm sewers into lakes and streams, water quality can significantly diminish. Directing roofwater onto land allows phosphorus to bind to soil particles.
- Directing roof water onto permeable surfaces increases on-site infiltration and reduces flooding and icing on walkways and driveways.
- Groundwater is recharged and landscape plants receive additional water.

Design Guidelines

- 100% of roof water should be directed to permeable surfaces.
- Bottom of swale must be a minimum of three feet above water table to prevent groundwater contamination.

Planting Design



Frame large yards with naturalized plantings such as tallgrass and wildflowers. Shade streets and driveways wtih trees.

Description

Shallow-rooted turf grass does not facilitate as much water infiltration as deep-rooted native grasses and wildflowers. Substitute native plantings for sod in areas where stormwater will accumulate, as well as in other areas not used for active recreation.

Vegetation reduces runoff by holding water on leaves, stems, and branches from where it then evaporates. A significant amount of stormwater can evaporate from beds of tall grasses, wildflowers, shrubs, and trees. Trees that canopy paved surfaces will also reduce runoff.

Soil compaction is a serious problem where heavy equipment has been used during construction. Compacted soil impedes stormwater infiltration and inhibits plant growth. Before final grading on a construction project's planting areas, fracture or rip soils to a minimum depth of 24 inches. Before planting, till the upper 10 inches.

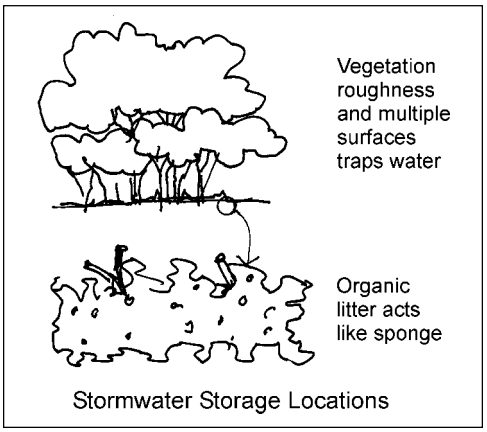
Benefits

- Vegetation facilitates stormwater infiltration and increases evaporation, reducing stormwater runoff volumes. Channels created by deep roots encourage deep infiltration.
- Planting native vegetation creates wildlife habitat.
- A variety of vegetation creates a more interesting and aesthetically pleasing environment.
- Trees shade impermeable surfaces, keeping stormwater cool and reducing urban heat island effect.

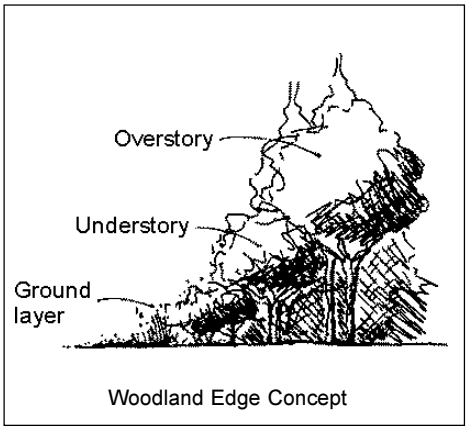
Design Guidelines

- After construction, soils in planting areas should be loosened to a depth of 24 inches to a maximum compaction of 85% standard proctor density, and the upper 10 inches should be tilled.
- Vegetation should cover as much of non-paved surfaces as possible; where it is unfeasible, use pervious mulches.
- Canopy trees should cover at least 50% of paved surfaces at maturity.
- Plant deep-rooted trees, shrubs, wildflowers, and grasses over at least 25% of a lot's green space.

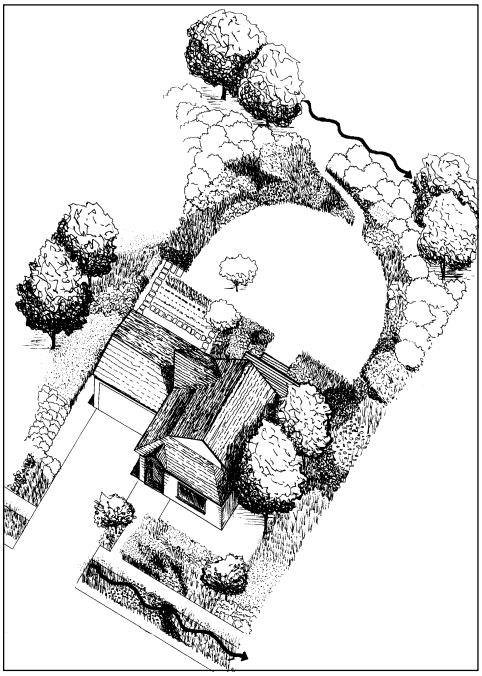
Site Design to Reduce Stormwater Runoff



A planting design can encourage stormwater evaporation and infiltration by providing tree canopy, understory, and groundlayer vegetation to trap rainwater. The layer of organic plant debris, or litter, acts as a sponge to absorb rainwater.

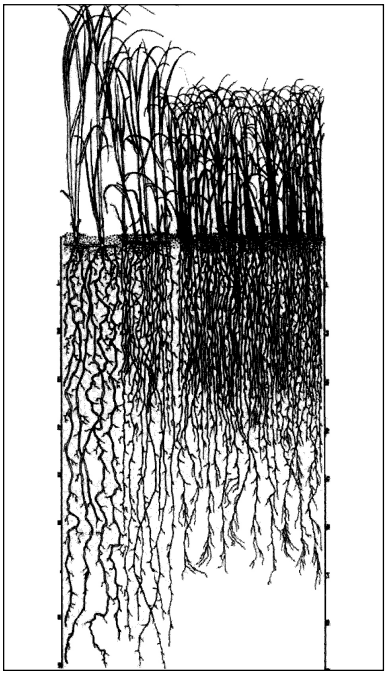


Design a natural woodland edge at the fringe of developments to increase habitat and stormwater storage areas and to improve aesthetic appeal.



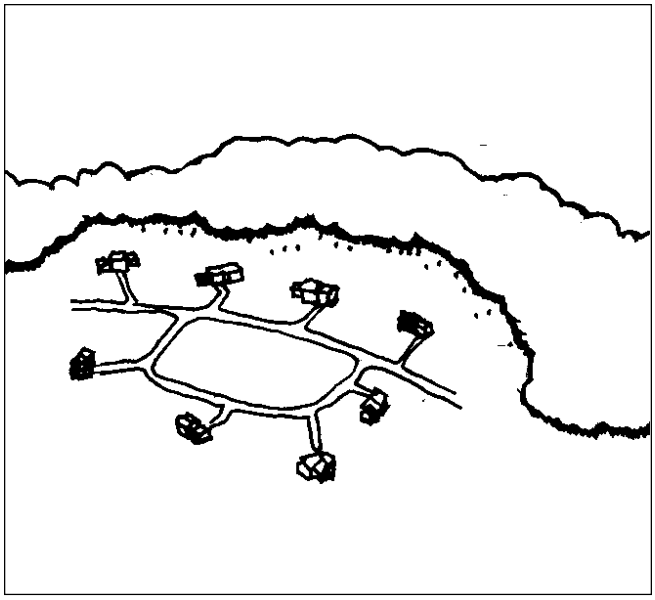
T. Olson (in Nassauer)

Naturalized plantings aid in water infiltration, evaporation, and habitat creation, while offering aesthetic benefits as well.



Deep-rooted prairie plants create channels for quick water infiltration. They also hold up to a half-inch of stormwater on their leaves and in the thatch they create.

Open Space Subdivision Design



Preserve greenway corridors and utilize as amenity for neighborhoods.

Description

An alternative to the typical suburban subdivision, open space design preserves 50% or more of a residential development as natural open space.

First identify desirable and/or vulnerable natural features, such as groves of trees, fields, farmsteads, wetlands, and steep slopes. Preserve these as open space amenities, and let them be the central organizing element driving the design. This is similar to the process of golf course community design, where the course is designed first and housing placed around it. Individual lots can be designed adjacent or otherwise overlooking a variety of open spaces, from formal "greens" to prairies, fields, woodlands, or wetlands.

Aggregating housing in clusters of smaller lots can also help reduce road and driveway lengths.

Benefits

- Infrastructure construction costs are reduced.
- The construction of less impervious surface reduces stormwater runoff and results in a smaller area of soil compacted by heavy equipment.
- Marketing and sales advantages occur when realtors capitalize on the open space amenity values. Buyers actually gain the use of many acres of land even when buying a small lot. Passive and active recreation activities are located right out the door.
- Homes in open space developments tend to appreciate faster than their counterparts in conventional subdivisions.
- Wildlife habitat is preserved.

Design Guidelines

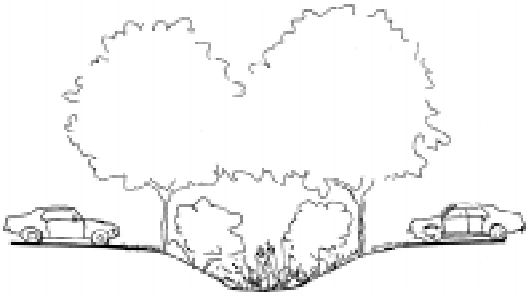
- Fifty percent or more of the site should be preserved as natural area.
- Each home should back onto or face open space.
- A 100-foot minimum buffer zone should be established along streams, wetlands, and lakes.
- Building should not occur on slopes steeper than 18% and a setback of 40 feet should be established at the top of the slope. Follow local ordinances when they are stricter than these guidelines.

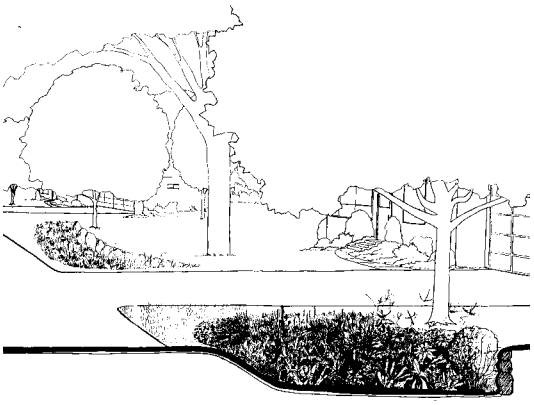
Examples

Local examples include Fields of St. Croix in Lake Elmo and Jackson Meadow in Marine-on-St. Croix.

Best Management Practices for Use in Development

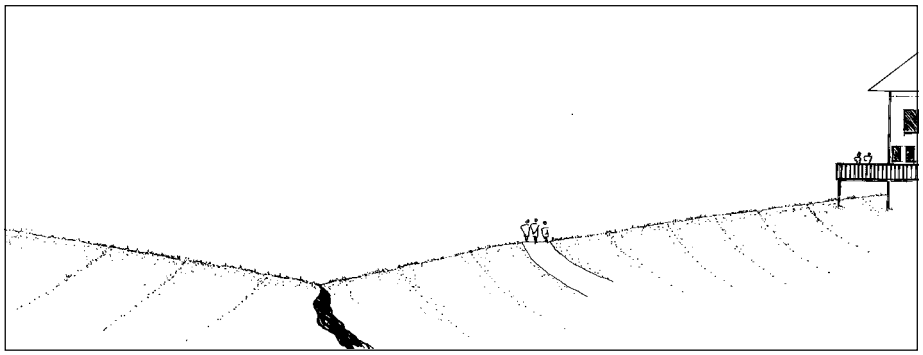
Introduction



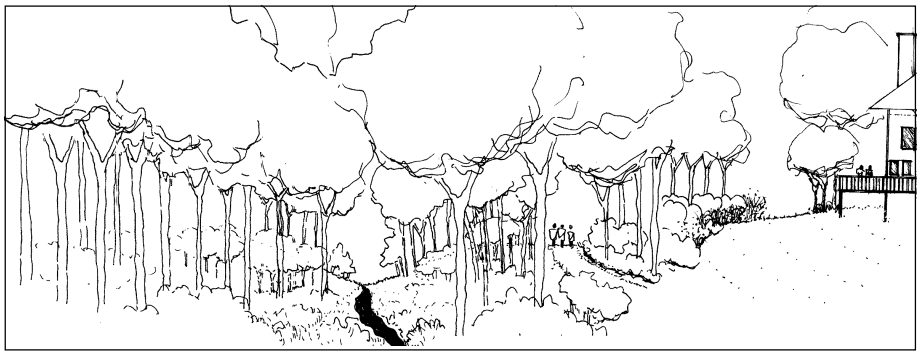


Reducing the volume of stormwater runoff through infiltration and evaporation and slowing the rate of runoff are primary goals in protecting natural water bodies. Infiltration is accomplished by running stormwater over the vegetated ground surfaces rather than pavement and by creating shallow depressions where water can soak into the ground. Infiltration BMPs remove some of the most common stormwater pollutants and encourage groundwater recharge, helping to maintain stream baseflow and colder water temperatures, which are important to trout and other wildlife. This section presents common stormwater infiltration practices in use today. These practices should be employed in conjunction with other pollution prevention and stormwater management techniques to provide comprehensive site treatment.

Buffer



No buffer, runoff from lawns goes directly to creek.



Woodland buffer slows runoff, creates opportunity for infiltration, stabilizes banks, shades water, and creates habitat.

Description

A buffer is an area of land abutting a stream, wetland, or lake that serves to protect water quality and aquatic habitat by limiting human activities. It also serves to slow and filter stormwater runoff. Ideally, a buffer zone is a vegetated area that excludes buildings, roads, and parking lots. Vegetation is preserved within the buffer to stabilize banks, shade water, and create habitat.

Benefits

- Stabilizes soils and prevents erosion along streams, lakes, and wetlands.
- Filters out suspended solids, nutrients, and other harmful substances in stormwater runoff.
- Enhances aquatic ecosystems by moderating water temperature and providing habitat.
- Creates upland habitat and provides wildlife migration corridors.
- Increases infiltration and evaporation of stormwater runoff.
- Enhances aesthetic quality.
- Creates opportunities for recreational trails.

Design Guidelines

- Buffers should be a minimum of 100 feet wide.
- Include 100-year floodplain in buffer area.
- Include slopes greater than 25% and contiguous wetlands where they occur. For instance, if a 100-foot buffer is specified along a stream and a steep slope is 200 feet wide, include the entire system. Depending on soils and local ordinances, a lower slope threshold may be appropriate.
- Preserve all vegetation within the buffer, especially trees growing along streams.

Vegetated Swales

Robert Sykes

The tall grasses and wildflowers growing within vegetated swales slow stormwater flow and trap some pollutants.

Description

A vegetated swale is a shallow ditch with gentle side slopes, planted in vigorous ground covers such as native grasses and wildflowers. It collects stormwater runoff and allows for infiltration while it carries runoff toward bioretention areas, retention ponds, or stormwater wetlands. Swales perform best when they are long, with broad, shallow-sloped sides, and when characterized by permeable subsoils and dense vegetation.

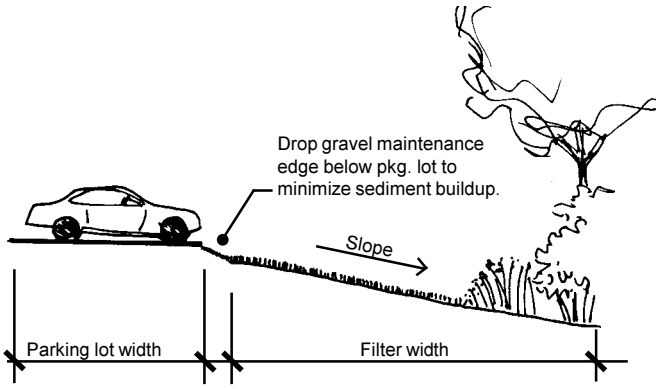
Benefits

- Natural water bodies are protected from sudden stormwater surges that erode banks and destroy vegetation.
- Directing stormwater to vegetated swales allows for infiltration, reducing the volume of runoff and recharging groundwater.
- Vegetation filters runoff, allowing some contaminants to drop out.
- Heavy metals and nutrients will bind with soil particles and be taken up by vegetation.
- Road oils can be broken down by naturally occurring soil bacteria.

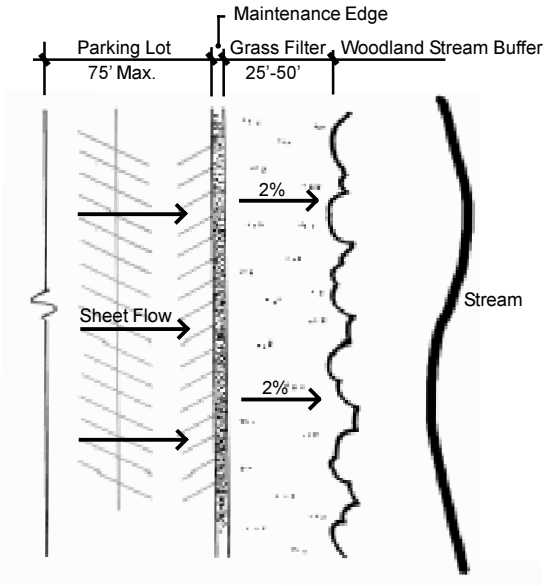
Design Guidelines

- Swales should be 100% vegetated, ideally with native species that provide some habitat value.
- Provide emergency overflow for large storm events.
- Pets must not be allowed to defecate in vegetated swales to prevent bacterial contamination of downstream water bodies.
- If soil within swale is compacted during construction, soil fracturing or ripping to a depth of three feet should be done to accommodate infiltration.
- Bottom of swale must be a minimum of three feet above the water table to prevent groundwater contamination.

Vegetated Filter Strips



The width of the filter strip is dependant on the roughness of its vegetation, its slope, and the width of the parking lot contributing the runoff.



The Center for Watershed Protection suggests directing the sheet flow from a maximum 75-foot wide impervious surface over a 25- to 50-foot-wide grass filter strip at a 2% slope.

Description

A vegetated filter strip is intended to slow stormwater runoff by intercepting sheet flow from impervious surfaces. The multiple stems and thatch of the vegetation creates friction and slows the water velocity. The roughness of the vegetation will determine the flow length and slope necessary to effectively remove sediment and other pollutants from a given area. The Center for Watershed Protection suggests directing sheet flow from a maximum 75-foot wide impervious surface over a 25- to 50-foot-wide grass filter strip at a 2% slope.

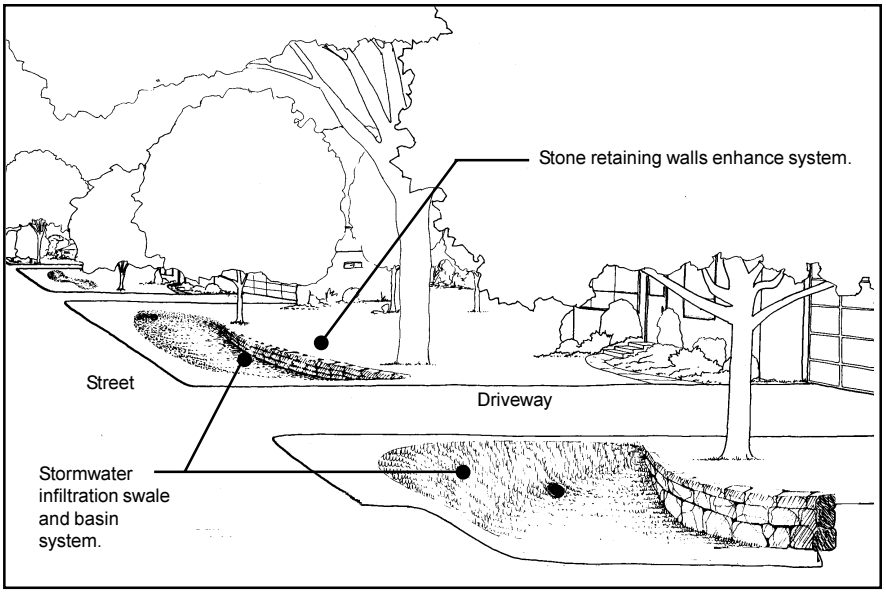
Benefits

- Filter strips trap trash and sediments.
- Water is cooled as it moves through a filter strip.
- Filter strips reduce the rate of runoff.

Design Guidelines

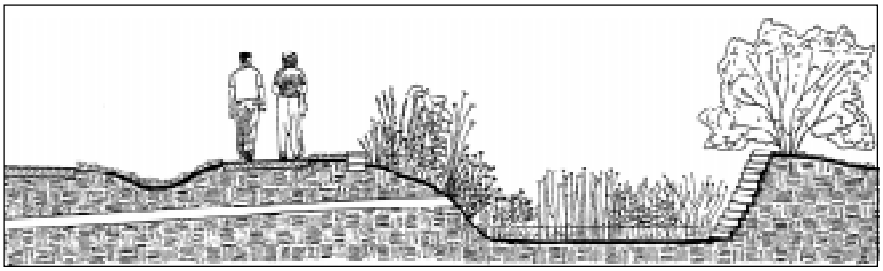
- Filter strips can accept *sheet* drainage (not channel flow) from adjacent surfaces.
- Drop the maintenance strip below the parking lot elevation to reduce sediment buildup.
- Cover 100% of the filter strip with vegetation, primarily grasses.
- Soils within a filter strip should be tilled to a depth of 24 inches after construction of any adjacent hard surfaces.

Infiltration Basin



Brady Halverson (in Nassauer)

Roadside infiltration basins can also function as a swale to allow large storm events a way to drain off site.



Brady Halverson (in Nassauer)

Infiltation basin designed as boulevard garden of native grasses, wildflowers and shrubs.

Benefits

- Infiltrating stormwater allows groundwater recharge.
- When used in combination with vegetated swales, infiltration basins can eliminate the need for expensive curb-and- gutter storm sewer systems.
- Basins allow for stormwater infiltration, while the vegetation holds water, allowing some of it to evaporate.
- Contaminants such as heavy metals and excess nutrients bind with soil particles and can be taken up by vegetation, while road oils can be broken down by naturally occurring soil bacteria.

(Infiltration Basins continued on next page)

Description

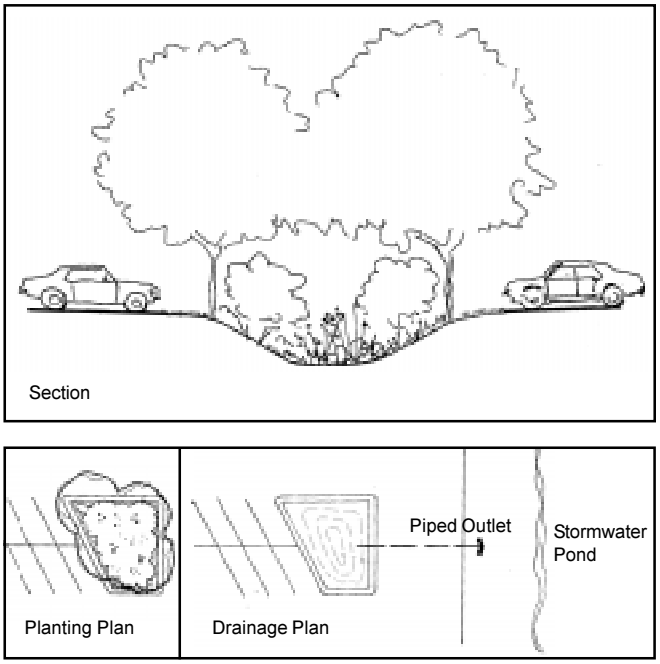
Infiltration basins are shallow depressions in the land that accept stormwater runoff from surrounding surfaces. They are capable of storing incoming runoff while infiltrating water through the bottom and sides.

To function effectively over the long term, infiltration basins require a small tributary area and vigorous vegetative growth. Plants should be well maintained for a neat, attractive appearance. Shrubs and trees can be used to provide screening and shade.

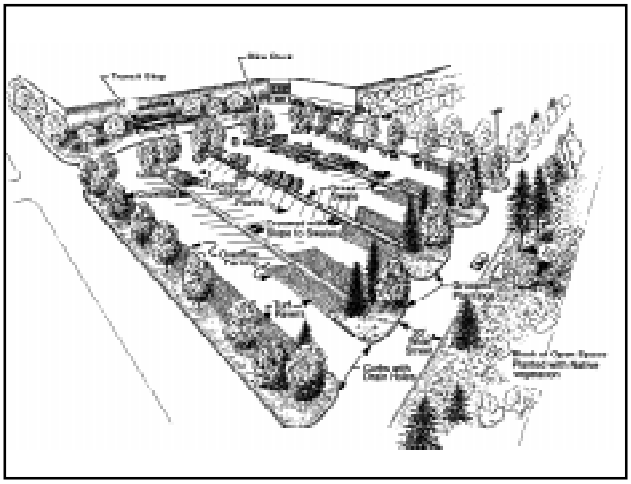
The soils within infiltration basins must be loose and friable. If compacted during construction, they must be fractured or ripped to a depth of two feet. If soils are heavy, they should be excavated to a depth of four feet and replaced with a sandy planting soil in order for plants to survive and water to infiltrate.

Infiltration basins in parking lots and cul-de-sacs are called infiltration islands. They receive runoff from the surrounding pavement over flattened curbs or via curb cuts. See *Parking Lot Design* and *Cul-de-Sac Design.*

Infiltration Basin (continued)



Paved surfaces are graded to drain into basin where stormwater can pool and soak into the ground. An overflow pipe permits large events to drain to stormwater pond on site.



Robert W. Droll (in Wells)

Infiltration islands within a parking lot.

Benefits (continued)

- Trees within infiltration islands reduce urban heat island effect by shading pavement. They also make parking areas more comfortable for people.
- The basins can be attractive features in the landscape.

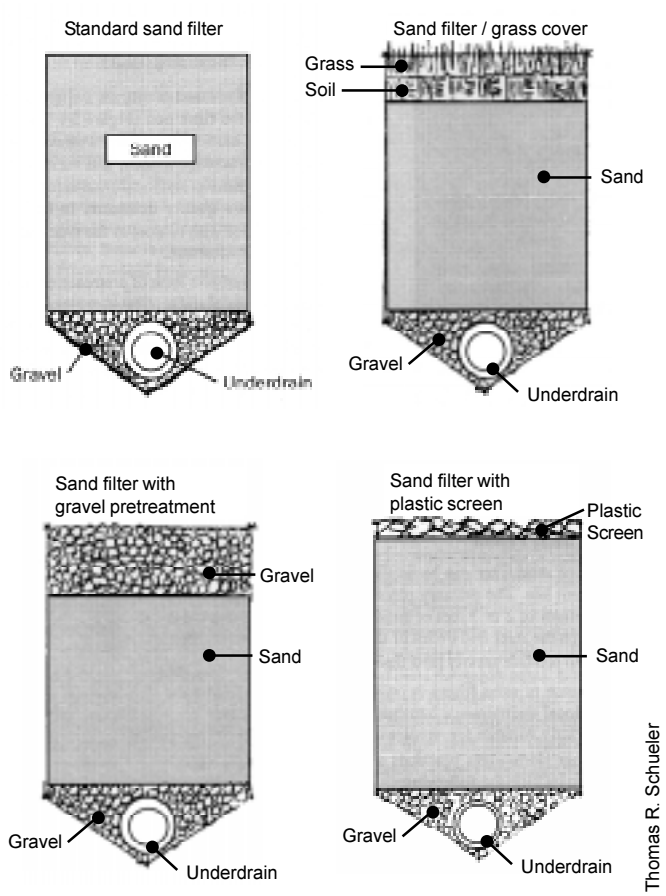
Design Guidelines

- Evaluate soil suitability; avoid using on clay soils.
- Determine depth to bedrock, water table, or impermeable layer. Seasonal high water table must be three feet below basin bottom.
- Grade side slopes to a maximum of 25%.
- 100% vegetation is essential.
- Protect from compaction during construction. Soils within infiltration basin should be either tilled to a minimum of three feet or excavated and replaced with planting soils to a depth of four feet.
- Plantings should be neat and showy and undergo regular mainatainance.
- Design basins to hold runoff from adjacent surface for a 3/4-inch storm event and to infiltrate that stormwater within 72 hours.
- Construct for a maximum depth of two feet of standing water for best plant survival.

Examples

Local examples include Maplewood's rainwater gardens and a parking lot at H.B. Fuller World Headquarters, Vadnais Heights.

Sand Filter



Thomas R. Schueler

Cross-sections of sand filters.

Description

Sand filters, engineered devices for treating runoff at the source, are usually placed along the downstream edge of parking lots. Sand filters are particularly suited for parking lots because they are installed underground and consume little usable land.

Runoff flows over the surface of the lot into a shallow depression that has been excavated and filled with sand. Water soaks into the filter area, where it is cleaned and then captured in a drain tile below. Alternative designs route stormwater from the parking lot into a grated sedimentation chamber where coarse sediments are trapped. The runoff is then spread over a filter bed and pollutants are captured as the runoff flows down through the sand filter. The treated runoff is collected at the bottom and returned to the storm sewer or discharged to a receiving stream.

The most effective sand filters allow for easy removal of coarse sediments from the surface. To remain effective, filters must be changed as they fill with contaminants. Regular maintenance is essential.

Benefits

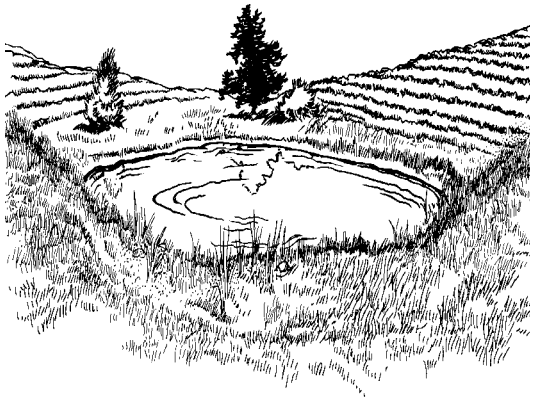
- Sand filters occupy minimal space.
- Pollutants such as heavy metals and phosphorus bind to sand particles.
- Rate of runoff is reduced.
- Stormwater is cooled as it flows through the underground sand.

Design Guidelines

- Regular maintenance is essential for sand filter effectiveness.
- Sand filters should be sized to accommodate 3/4-inch of precipitation from adjacent paving.
- Vegetation should cover at least 80% of the sand surface.
- Bottom of filter must be no closer than three feet from the water table.

Best Management Practices for Agricultural Lands

Introduction



Much of western Afton is still in agricultural production. Given the soil and geography of the area, it would be preferable if it retained its rural character. This section provides basic information on preserving soil and managing stormwater on agricultural land. To preserve a permanent agricultural area, these best management practices could be complemented by the land protection techniques suggested in the Planning Tools section of this document.

The following agricultural BMPs are meant to supplement a total farm management plan. When designing a management plan, it is important to consider water quality in relation to the other natural and economic resources on a farm. Agencies such as the Natural Resources Conservation Service and County Soil and Water Conservation District are available to help design, implement, and maintain a BMP plan.

Stream Protection

Description

Bioengineering is a way to buffer banks from heavy stream flow and seasonal flooding, and thus reduce erosion. Willows, grasses and other native plants with deep roots and multiple stems help stabilize banks. Other materials, such as large rocks placed strategically in the stream bed and root wads from overblown trees, may also be used to help direct stream flow away from the bank and toward the center of the stream.

Additional measures include fencing to prevent cattle from trampling banks, destroying vegetation, and stirring up sediment in the streambed. A buffer zone of vegetation along the stream bank also filters runoff and may also absorb excess nutrients. This is further discussed on the next page.

Benefits

- Stream bank erosion is reduced.
- Better water quality results from reducing amounts of nutrients, chemicals, animal waste, and sediment entering the stream.
- Buffer zones provide cover and habitat for birds and other small animals.

Design Guidelines

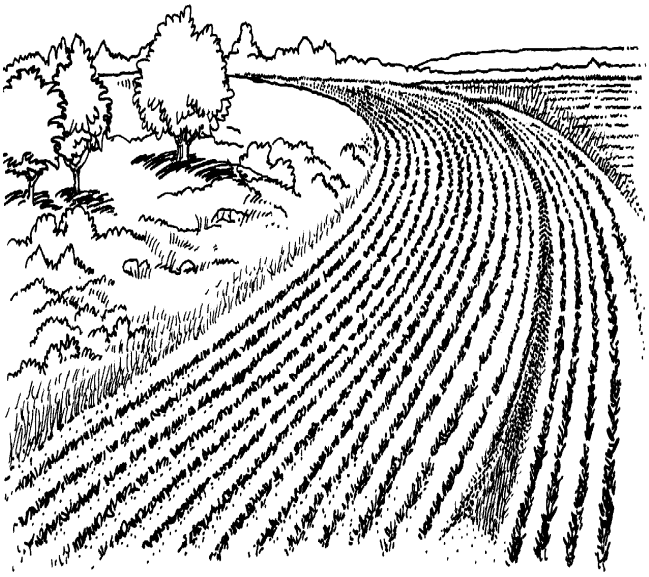
- Plant native species to help stabilize stream banks.
- The vegetated buffer zone along streams should be at least 20 feet wide.
- Fence livestock out of the buffer zone.

Additional Information

Contact the Washington County Soil and Water Conservation District (SWCD) or the Natural Resources Conservation Service (NRCS), both at (651) 430-6820.

Source:
National Resource Conservation Service. 1994. *Conservation Choices*, USDA Washington, D.C.

Filter Strips



Description

Strips of grass, trees, and/or shrubs planted adjacent agricultural fields slow water flow and intercept sediment, chemicals, and nutrients. Collected nutrients are then used by the vegetation, rather than contaminating natural water bodies. Soil eroding from adjacent fields also will deposit in a filter strip rather than wash into lakes and streams.

Benefits

- Perennial ground cover reduces soil erosion.
- Vegetation filters out contaminants, thus protecting water quality.
- Wildlife habitat is created.

Design Guidelines

- Filter strips for cropland should be at least 15 feet wide.
- Steeper slopes require wider strips.

% Slope	Minimum width
0-10	15 feet
10-20	20 feet
20-30	25 feet

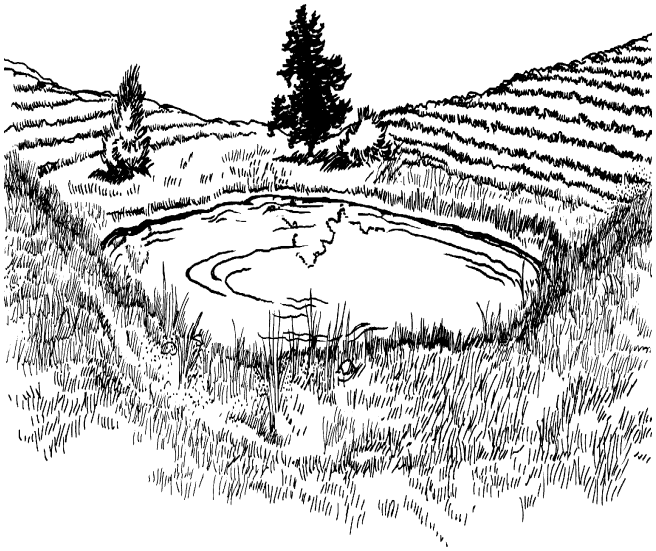
- A minimum 50-foot width is required for filter strips on forest land.

Additional Information

Contact the Washington County Soil and Water Conservation District (SWCD) or the Natural Resources Conservation Service (NRCS), both at (651) 430-6820.

Source:
National Resource Conservation Service. 1994. *Conservation Choices*, USDA Washington, D.C.

Farm Pond



Description

A typical farm pond is formed when a dam is built across an existing gully or low-lying area. Earth for the dam is dug out with heavy machinery to form a bowl, which typically fills with water within a year. An overflow pipe is installed through the dam to control the water level and allow water to escape without causing erosion.

CAUTION: Ponds should *not* be installed near perennial streams, since their overflow may contribute warm water to cold-water fish habitats.

Benefits

- Prevents soil erosion and protects water quality by collecting and storing runoff water.
- Sediment washed from fields can settle in the pond.
- Provides wildlife habitat.

Design Guidelines

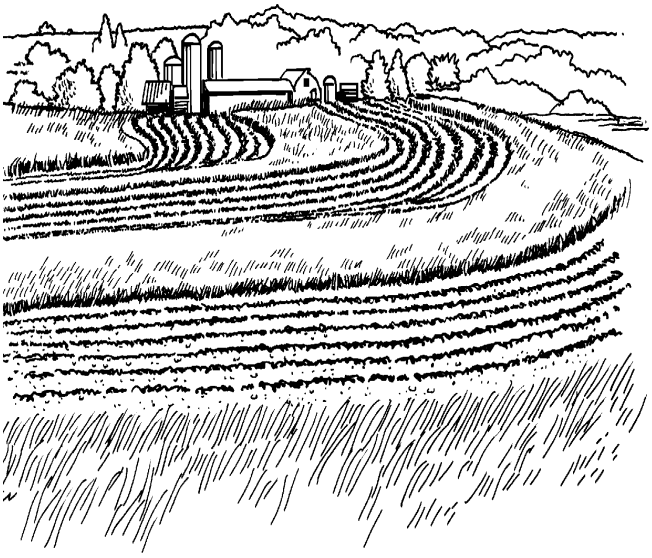
- Generally, for every surface acre of pond there should be at least 10 acres of drainage area.
- Invasive weeds such as purple loosestrife should be eradicated if they establish around the pond.
- Cattle should be fenced away from ponds.

Additional Information

Contact the Washington County Soil and Water Conservation District (SWCD) or the Natural Resources Conservation Service (NRCS), both at (651) 430-6820.

Source:
National Resource Conservation Service. 1994. *Conservation Choices*, USDA Washington, D.C.

Strip Cropping/Contour Farming



Description

Crops are planted in alternate strips, which follow ground contours. Often a perennial crop, such as hay or alfalfa, is alternated with an annual crop, such as oats or corn. Perennial crops slow runoff, increase infiltration, trap sediment, and provide surface cover. Rotating the strips from corn to legumes, for example, allows nutrient-needy crops to benefit from the nitrogen added to the soil by legumes. This practice combines the beneficial effects of contouring and crop rotation.

The crop row ridges resulting from tilling and planting on the contour create what amount to hundreds of small dams. These dams slow water flow and increase infiltration, which reduces erosion.

Benefits

- Contour strip cropping reduces soil erosion and protects water quality. Contouring can reduce soil erosion by as much as 50%, compared to uphill-downhill farming.
- Contour strip cropping may help reduce fertilizer needs and costs.
- Infiltration recharges the water table and sustains stream baseflow.
- Stormwater infiltration is increased, reducing runoff and providing moisture for crops.
- These practices also increase the aesthetic appeal of the landscape.

Design Guidelines

- Alternate annual and perennial crops.
- Strip cropping is not as effective if crop strips become too wide, especially on steep slopes.

Additional Information

Contact the Washington County Soil and Water Conservation District (SWCD) or the Natural Resources Conservation Service (NRCS), both at (651) 430-6820.

Source:

National Resource Conservation Service. 1994. *Conservation Choices*, USDA Washington, D.C.

Grassed Waterway

Description

When sod-forming grasses are planted in natural drainageways in broad strips, runoff water is prevented from flowing over open soil, where erosion can more easily occur. An outlet is often installed at the base of the drainageway to stabilize the waterway and prevent a gully from forming.

Grassed waterways are typically mowed once or twice a year to reduce weed and woody plant invasion.

Benefits

- Sediment collects within the vegetation.
- Grass cover protects the drainageway from gully erosion.
- Vegetation may act as a filter, absorbing some of the nutrients carried in runoff water.
- Vegetation provides cover for small birds and animals.

Design Guidelines

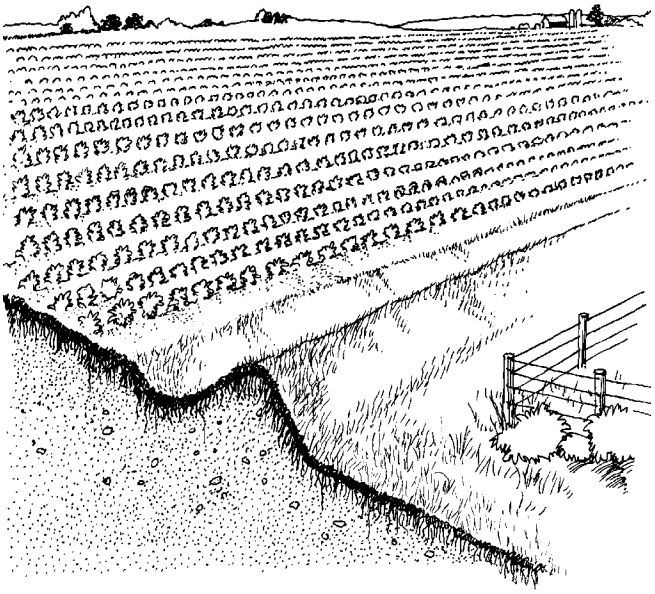
- A waterway should be sufficiently deep and wide to carry the peak runoff from a 10-year frequency, 24-hour storm. Check NRCS design charts.
- The peak water elevation produced by a 100-year storm event should be checked to ensure structures are not susceptible to damage.
- Waterway must be vegetated 100%.

Additional Information

Contact the Washington County Soil and Water Conservation District (SWCD) or the Natural Resources Conservation Service (NRCS), both at (651) 430-6820.

Source:
National Resource Conservation Service. 1994. *Conservation Choices*, USDA Washington, D.C.

Diversion Structure



Description

A diversion is much like a terrace, but its purpose is to direct or divert runoff water from an area. A diversion is often built at the base of a slope to divert runoff away from bottom lands. A diversion may also be used to direct runoff flows away from a feedlot, or to collect and direct water to a pond.

Diversions should be planted with a perennial grass cover.

Benefits

- Reduces soil erosion on lowlands by catching runoff water and preventing it from reaching farmland below.
- Vegetation in the diversion channel filters runoff water, improving water quality.
- Vegetation provides cover for small birds and other animals.

Design Guidelines

- Each diversion must have an outlet, either a grassed waterway, grade stabilization structure, or underground outlet.
- Diversions should not be built in high-sediment-producing areas unless other conservation measures are also installed.
- Diversions must be vegetated 100%.

Additional Information

Contact the Washington County Soil and Water Conservation District (SWCD) or the Natural Resources Conservation Service (NRCS), both at (651) 430-6820.

Source:
National Resource Conservation Service. 1994. *Conservation Choices*, USDA Washington, D.C.

Crop Residue Management

Description

Using low- or no-till practices allows crop residue to remain on fields after harvest. This residue provides cover for the soil at a critical time of the year. Debris from old crops shields soil particles from rain and wind until new crop growth can produce a protective canopy.

Benefits

- Ground cover provided by crop residue helps prevent soil erosion, especially in fall, winter, and early spring.
- Residue improves soil tilth and adds organic matter to the soil as it decomposes.
- Less frequent tilling reduces soil compaction.
- Fewer tillage trips can mean savings of time, energy, and labor.

Design Guidelines

- Reduce the number of unnecessary tillage passes. Every pass buries more crop residue.
- Use straight points and sweeps on chisel plows instead of twisted points. Twisted points can bury 20% more residue.
- Set tillage tools to work at shallower levels.

Additional Information

Contact the Washington County Soil and Water Conservation District (SWCD) or the Natural Resources Conservation Service (NRCS), both at (651) 430-6820.

Source:
National Resource Conservation Service. 1994. *Conservation Choices*, USDA Washington, D.C.

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