5.4.1.1 Naturalize Swales and Drainage Channels

Description

Figure 5.4.1.1-1. Typical farm channel.

Figure 5.4.1.1-2. Concrete channel under construction.

Chattanooga neighborhoods have an abundance of open swales and drainage channels. These conveyance channels are generally remnants from agricultural landscapes and Works Progress Administration (WPA) projects designed only to convey stormwater. Constructed swales and open drainage channels are designed primarily for unimpeded conveyance with 3:1 slopes and flat bottoms. Depending on the amount and speed of flow, these channels are traditionally constructed of earth or concrete. Earth banks are frequently stabilized with turf or farm grasses, which are easily eroded as stormwater volume and velocity increase as a result of adjacent development. Traditional maintenance required to maintain flow capacity removes vegetation growing in the channel and returns the ditch to a trapezoidal section to maintain the flow function of the channel. Some remnant channels are allowed to return to forest rather than being reused as a part of new development.

There is considerable opportunity to reshape and naturalize these flow paths to increase their stormwater management performance. This practice reconfigures traditional turf swales and drainage channels to create more naturalistic and effective channel designs to slow stormwater velocity, expand stormwater storage, and provide bank stabilization through reshaping and appropriate plantings. Naturalized channels improve water quality by increasing the removal of nutrients and reducing erosion and sediments.

BMP Functions Table

Grasses and other deep-rooted vegetation established within a drainage channel can filter runoff. Living and decomposing plants with their associated microorganisms trap sediments, take up excess nutrients, and break down chemical compounds. In the southeastern United States, vegetated drainage channels have been particularly successful in reducing sediment, nitrogen, and phosphorous from fertilizers and pesticide concentrations, especially water-soluble pesticides. In addition, modifying the length of a straight ditch by creating meanders, reestablishing a floodplain, and planting with a variety of flood- and drought-tolerant deep-rooted native vegetation provides other important stormwater management functions.

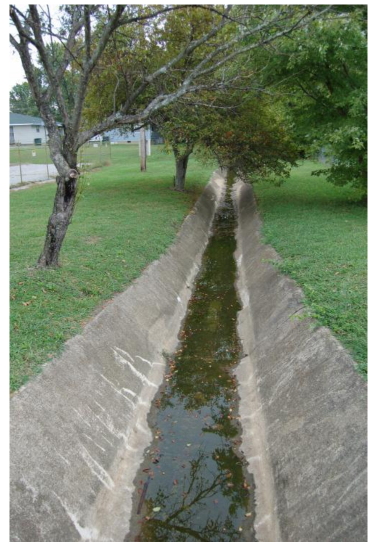

Figure 5.4.1.1-3. Concrete drainage channel in Chattanooga.

BMP	Applicability	Volume Reduction	Water Quality	Peak Rate Reduction	Recharge	Runoff Temperature Mitigation	Heat Island	Habitat Creation	Maintenance Burden	Cost
Naturalize Swales and Drainage Channels	S/R	H	H	M	M	H	H	M	M	L/M/H

KEY: U = Urban; S = Suburban; R = Rural; H = High; M = Medium; L = Low

Key Design Guidelines

- Define site hydrologic context.
- Identify and map natural drainage features (swales, channels, ephemeral streams, depressions, etc.) and any “traditional” drainage channels onsite.
- Evaluate possibilities for improvement, e.g., amount of space available, site context, etc.
- Use local, healthy, intact natural drainage features as a guide for the redesign of existing channels.
- Minimize filling, clearing, or other disturbance of drainage features.

- Use “natural” drainage features instead of heavily structured solutions.
- Where peak flow in large storms is fast and heavy, provide mechanisms within and along the channel to slow water, reduce volume, and reinforce channel sides.
- Design vegetative buffers as well as planting to stabilize the channel.

Advantages

- Improved drainage and ecological function.
- Increased slope stability and channel stability.
- Greater area for flood control.
- Vegetated swales are a first component of a “treatment train” for stormwater runoff before it enters streams and wetlands.
- Vegetated swales can replace more expensive structural drainage systems.
- Naturalized channels can become an aesthetic feature and wildlife habitat.

Figure 5.4.1.1-4. Highly urbanized, vegetated drainage swale.

Disadvantages

- May require additional space.
- Regrading and planting are an additional cost.
- Periodic maintenance of plants.
- Special city and state regulations for some existing drainage channels.

Applications

- Any size or type of property, from residential to commercial (including highly urbanized sites), containing formal or channel ditches that could be reconfigured and/or replanted

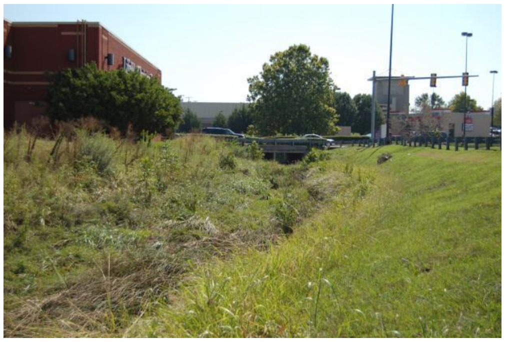

Figure 5.4.1.1-5. Drainage channel at Hamilton Place Mall that could easily become an amenity.

Naturalizing existing drainage channels to increase stormwater management performance is appropriate for a wide variety of settings. These opportunities include large-scale commercial and industrial properties (shopping centers and manufacturing sites) as well as residential developments and institutional or corporate campuses. Drainage channels often form boundaries between properties and are opportunities for preservation of right-of-way and for joint improvement projects. Many drainage channels are city owned and located in a public right-of-way or utility easement.

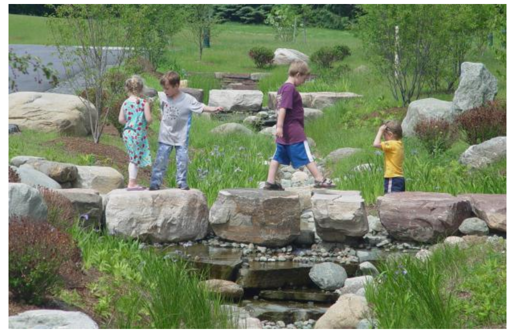

Figure 5.4.1.1-6. Vegetated swale with check dams in a residential neighborhood.

Applicable Protocols and Specifications

- Protocol 2 Coordination with Other Utilities
- Protocol 3 Soil Testing
- Protocol 5 Planting Guidelines

Design Considerations

This BMP is eligible for SOV credits as defined in Chapter 7. A Criteria Checklist is provided at the end of this section as summary of design and establishment considerations.

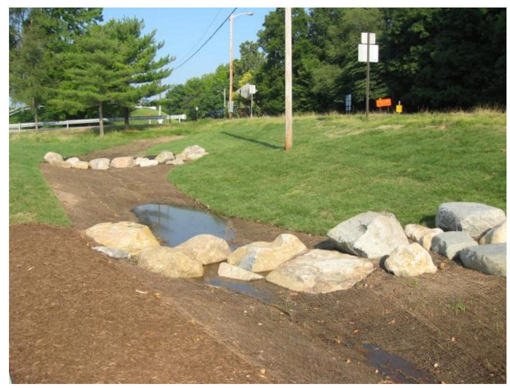

Figure 5.4.1.1-7. Vegetated swale retrofit with meadow seeding and check dams along roadside.

<u>Overview</u>

Underground pipes have been the dominant method of conveyance in most development and redevelopment projects. However, open drainage channels still exist within much of Chattanooga. Concern regarding healthy water and the effective and multipurpose management of stormwater has returned open channels to the status of a cutting-edge BMP. For example, formalized planted open channels are now important components of “complete streets.”

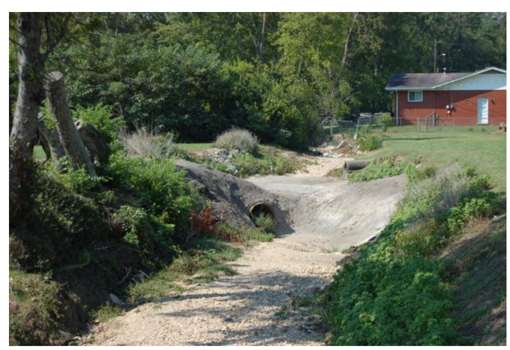

Figure 5.4.1.1-8. Drainage channel running behind a residential area in Chattanooga, Tennessee.

The stormwater management goal in naturalizing existing drainage channels is not only to slow flow but also to remove pollutants, encourage infiltration and filtration, and increase storage opportunities. Other BMPs such as check dams or ponds can be used to supplement the functions of naturalized drainage channels. These areas can also provide site amenity if incorporated into the site design.

Figure 5.4.1.1-9. Drainage channel street side in residential area in Chattanooga, Tennessee.

<u>Design Strategies</u>

- If retrofitting an existing swale or drainage channel that is part of a larger system, safe conveyance for larger storms must be a priority.
  - Evaluate existing swales or structured drainage features to determine their volume requirements within the larger system's hydrologic engineering (i.e., provide adequate cross-sectional area to pass design storms through the site).
  - Avoid obstructions or constrictions that will cause flooding or create erosion problems.
  - Note: Agreements must be made between the owner and the City before naturalization of existing swales can be incorporated into the stormwater management plan for a site and before volume or water quality credits can be received. Some existing conveyances might also require an Aquatic Resource Alteration Permit (ARAP) from TDEC or possible permitting from the U.S. Army Corps of Engineers before work can be performed.
- Where space allows, redesign the sides of trapezoidal channels to create a meandering swale with a broad floodplain on one side. A linear depression adjacent to one side of the channel bank will store water from larger storms, reducing peak flows.
  - Remove any fill and regrade channel to meander if there is space to increase the length or width of the channel.

Figure 5.4.1.1-10. Vegetated swale in apartment complex in Portland, Oregon.

Figure 5.4.1.1-11. Meandering vegetated swale in subdivision, street side, in Philadelphia, Pennsylvania.

- Use natural drainage patterns in the area surrounding the site as a model.
- Plant both sides of the bank with occasional trees and shrubs and a ground layer of deep-rooted, low-maintenance, flood- and drought-tolerant plants. Native grasses are particularly well suited to this regimen. If applicable, plants can be selected to remove specific pollutants.

- Check dams located within the channel are recommended for vegetated swales with longitudinal slopes greater than 3 percent. Check dams create a series of small, temporary pools along the length of the swale to:
  - Enhance infiltration capacity;
  - Decrease runoff volume, rate, and velocity; and,
  - Provide filtering of nutrients and pollutants, and settling of sediments in the pools.

  The frequency of check dams within the swale will depend on swale length and degree of slope as well as on the desired amount of storage volume.
  - Care must be taken to avoid erosion around the ends of the check dams.
  - Check dam pools should be designed to prevent mosquito breeding.
  - River-rock should be used in lieu of rip-rap.

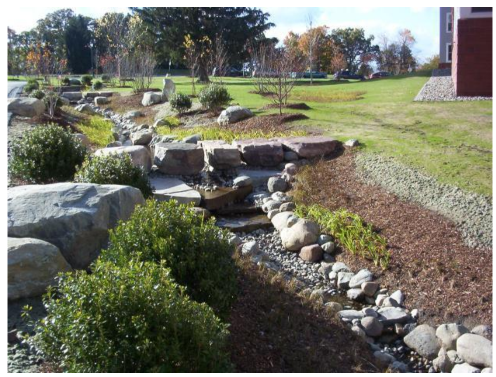

Figure 5.4.1.1-12. Naturalized swale with check dams and river-rock reinforced channel.

- Energy Dissipation

  Provide erosion protection or energy dissipation measures if the flow into the channel or swale can reach an erosive velocity.
  - The higher the design velocity of the flow, the greater the need to stabilize the banks. Consider stabilization of naturalized channels with bioengineering techniques.
  - Design the channel with carefully placed obstructions to slow flow and to provide additional habitat. In general, use local materials such as boulders and preserve tree trunks to help manage, convey, and dissipate the energy of runoff during high flows.
  - Stabilize the entire swale with jute netting as necessary to establish vegetation and prevent erosion.
  - When possible, allow seeds to establish (germinate) before allowing water into the swale. Sods (of both wetland grasses and wildflowers) will establish more reliably.

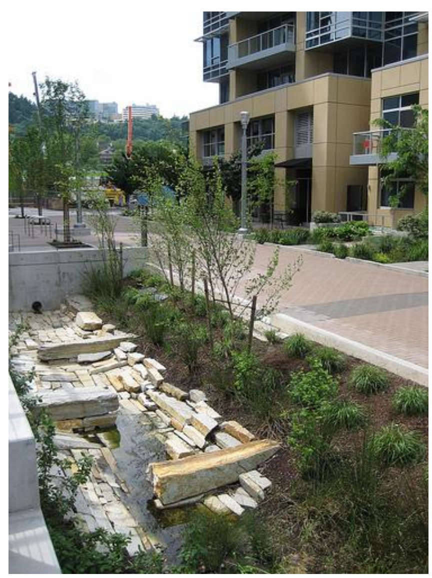

Figure 5.4.1.1-13. Energy dissipation at outfall structure.

Construction Issues

- At the start of construction, identify drainage features on the site plans and construction drawings and stake existing and proposed channel configuration in the field.
- Protect newly created or modified drainage features from excessive sediment and stormwater loads during reestablishment and while they remain in a disturbed state.
- Be careful that site designs do not burden recreated drainage features from upstream stormwater loads. Key strategies for protecting the site's drainage ways during construction include:
  - Control stormwater discharged into the drainage way under construction.
  - Dissipate energy in swales with check dams, boulders, and channel configuration.
  - Restrict construction access, especially on steep slopes.
  - Use small machines to work in tight spaces and minimize damage to the soil by keeping machines on already compacted areas (e.g., small cranes operated from a nearby roadway can deliver materials to the construction area).
  - Do not drive construction vehicles across a swale unless a stabilized crossing is provided.

Operations and Maintenance

Natural drainage features that are properly protected and integrated as part of a site's development should require minimal maintenance after establishment. Periodic inspections and targeted maintenance actions are critical. Evaluate erosion, bank stability, sediment/debris accumulation, and the presence of invasive species. Problems should be corrected in as timely a manner as possible to avoid compounding effects.

During establishment of vegetation, watering, weeding, mulching, replanting, etc. are required. Undesirable species should be removed and desirable replacements planted.

Consider an easement, deed restriction, or other legal measures to protect swales from future disturbance or neglect. In some cases, depending on the location, the City may require these legal measures.

References

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Criteria Checklist BMP 5.4.1.1

ITEM DESCRIPTION	YES	N/A
The following checklist provides a summary of design guidance for the owner/applicant for successful implementation.		
• Identify existing "traditional" ditches on the Existing Conditions and Site Protection Plan.	☐	☐
• Identify and map stormwater flow into and out of the site, including overland flow as well as underground flow (where possible). Use current topographic maps to calculate the size and location of drainage area flowing to and within the project site.	☐	☐
• Delineate and label current conceptual design on the appropriate plans as outlined in Chapter 4, General Design and Review Process for New Development and Redevelopment. Note how they relate to known historic flow patterns.	☐	☐
• Evaluate possibilities for improvement. Where possible, identify and use the site's existing and historic hydrologic patterns in the proposed design.	☐	☐
• Minimize filling, clearing, or other drainage feature disturbance.	☐	☐
• Provide mechanisms to reduce velocity and volume, and reinforce channel sides where peak flow may be erosive.	☐	☐
• Avoid obstructions or constrictions that will cause flooding or create erosion problems.	☐	☐
• Where space allows, redesign the sides of trapezoidal channels to create a meandering swale with a broad floodplain on one side.	☐	☐
• Plant both sides of the bank with occasional trees and shrubs and a ground layer of deep-rooted, low-maintenance flood- and drought-tolerant plants.	☐	☐
• Check dams located within the channel are recommended for vegetated swales with longitudinal slopes greater than 3 percent.	☐	☐
• Protect newly created or modified drainage features from excessive sediment and stormwater loads during reestablishment and while they remain in a disturbed state.	☐	☐