City of Charlottesville – Stream Buffer Mitigation Manual for the Water Protection Ordinance

The purpose of this manual is to provide guidance to the City of Charlottesville staff and affected landowners on implementing the stream buffer requirements of the Water Protection Ordinance.

This manual contains the following sections:

1. Stream Buffers – What They Are & Why it is Important to Protect Them
2. Mitigation – What it is & Why it's Required in Certain Circumstances
3. Mitigation Plan Approval Process
4. Mitigation Options
5. Standard Details & Design Guidance
6. Sample Plans for Residential Mitigation

1. Stream Buffers – What They Are & Why It is Important to Protect Them

Stream buffers are areas of vegetation along waterways that perform important functions by being a barrier between a particular land use (house, lawn, commercial area) and the water. Ideally, a stream buffer consists of three levels of vegetation: (1) trees, (2) shrubs, and (3) ground cover. Together, these three layers of vegetation function as a system to protect ecological values and water quality.

The Water Protection Ordinance defines "stream buffer" as follows:

An area of land at or near a tributary streambank and/or nontidal wetland that has an intrinsic water quality value due to the ecological and biological processes it performs or is otherwise sensitive to changes which may result in significant degradation to the quality of state waters (Section 10-5).

The Water Protection Ordinance specifies that stream buffers shall be retained or established for the purposes of retarding runoff, preventing erosion, and filtering nonpoint source pollution from runoff (Section 10-71). Other values of stream buffers include:

- Protecting aquatic and terrestrial habitats by provided food, shade, and structural habitat features.
- Holding streambanks in place and protecting property owners from damage from streambank erosion.
- Providing natural flood control and protection by functioning as a giant sponge to absorb and slow down flood waters.
- Providing areas of refuge and recreation within an urban setting. The Rivanna Trails Foundation paths and City of Charlottesville greenbelt are excellent examples.
- Helping to improve air quality by filtering dust and absorbing airborne pollutants.

Stream buffers are not just a local issue, but are important objectives of the Chesapeake Bay Program (Chesapeake 2000 Agreement, http://www.chesapeakebay.net/c2k.htm), Virginia's Chesapeake Bay Preservation Act (http://www.cblad.state.va.us/), and the

Virginia Department of Forestry (http://www.dof.virginia.gov/rfb/index.shtml), among, other agencies and programs.

2. Mitigation – What it is & Why it's Required in Certain Circumstances

Stream buffers are valued for the functions they provide to landowners, the community, and the environment, as described above. In certain circumstances, development activities may be permitted to encroach into a stream buffer, as authorized by the Department of Neighborhood Services (NDS) in accordance with criteria in the Water Protection Ordinance (Section 10-74). In these circumstances, a mitigation plan is required that spells out measures to replace, protect, or preserve the functions that are being lost due to the encroachment (Section 10-75). For example, if vegetation is proposed to be removed from the buffer, then the plan can specify how similar vegetation will be planted elsewhere in the buffer. It is important that the mitigation plan address how the functions of the buffer are being replaced or mitigated for.

3. Mitigation Plan Approval Process

Mitigation Plans must be approved BEFORE an encroachment or disturbance to the stream buffer takes place. Otherwise, the activity would be considered a violation of the Water Protection Ordinance and appropriate penalties pursued. Section 10-73 specifies particular activities that are exempt from the requirement to maintain or establish a stream buffer. Section 10-74 outlines activities that may be authorized by NDS, and a mitigation plan is required is certain cases.

The process for having a mitigation plan approved is as follows:

- For development activities, the applicant should confer with NDS staff during project planning (pre-project meeting) to see if a proposed activity can be authorized under the WPO. In making this determination, NDS staff should determine whether the proposed activity is listed in Section 10-74 AND whether the evaluation criteria for mitigation plans in Section 10-75(d) can be satisfied (e.g., whether development in the buffer is the "minimum necessary"). For individual building permits, NDS staff may not know about a planned encroachment until the permit application is received. In this case, NDS staff should contact the applicant to explain the buffer requirements and whether the encroachment can be authorized. An onsite or office meeting may be needed to make the proper evaluation of the proposed encroachment, existing condition of the buffer, and other factors.
- If the encroachment can be authorized for a subdivision plat or site plan, then the preliminary plat or plan should show conceptual mitigation features – this step ensures that the mitigation is feasible, will fit on the site, and will address the mitigation requirements of Section 10-75. For building permits, after conferring with NDS about whether the encroachment can be authorized, the applicant should prepare a mitigation plan to submit as part of the building permit application (see Sample Plans in Section 6 of this document).
- For subdivision plats and site plans, the final plan should show all the mitigation details. NDS may approve this plan with the final plat or plan after undergoing a

review/revision process. All structural stormwater measures and plantings should be bonded as a site improvement. For building permits, NDS may approve the mitigation plan with the building permit application. If a bond is not appropriate for an individual lot, then NDS should ensure that the plan is implemented prior to issuing a C.O. or by another schedule or milestone.

- All bonds can be released when NDS staff confirms that the plan has been implemented. Periodic inspections can be scheduled thereafter to ensure that mitigation measures are in place and functioning as designed.

4. Mitigation Options

Table 1: Stream Buffer Mitigation Matrix provides a guide for selecting an appropriate mitigation strategy for specific circumstances. The matrix can be used by following the steps outlined below:

- Go to Column #1 to determine whether a proposed project is for a development project (subdivision plat or site plan) or for an individual lot improvement (building permit application).
- Go to Column #2 to determine whether the activity that impacts the stream buffer is new development or redevelopment (redevelopment may include modifications to an already developed site or improvements to an existing structure, such as an addition or deck).
- Go to Column #3 to ascertain the existing condition of the stream buffer on the subject property. The existing condition may be developed (the stream buffer already has some impervious cover or improvement); forest (in general, mature canopy and understory trees with a shrub and ground cover layer); open lawn, meadow, or turf; or scrub (small pioneer species trees, shrubs, grasses, and ground cover). The existing condition will influence which mitigation options are appropriate for the site.
- Column #4 states the preferred mitigation option, and Column #5 lists some other mitigation options that can be considered by NDS staff.

All terms that have **bold font** in the matrix are further explained by descriptions and guidance following the matrix.

Table 1: Stream Buffer Mitigation Matrix

Type of Project	Status	Existing Buffer Condition	Preferred Mitigation	Other Mitigation Options
Site Plan or Subdivision Plat	New Project See Section 10-71.c and Section 10-74.d.1.	Forest	**Preserve** full buffer (100 feet); provide **upslope stormwater controls** to prevent erosive flows through buffer; provide **signage** to mark buffer; provide **optic orange fencing** during construction.	Encroachments for new development should be strongly discouraged, and can only be allowed in accordance with Section 10-74(d). Encroachments should be the **minimum necessary** and mitigation should include **advanced stormwater controls** upslope of remaining buffer plus **signage.**
		Open Lawn, Meadow	**Restore** & **preserve** full buffer; provide **upslope stormwater controls** to prevent concentrated flows through buffer; provide **signage** to mark buffer; provide **optic orange fencing** during construction.	See above. Mitigation should include **compensatory plantings**, **signage**, and **advanced stormwater controls** to prevent erosive flows through buffer.
		Scrub	**Enhance** & **preserve** buffer with plantings based on site conditions; provide **upslope stormwater controls** to prevent concentrated flows through buffer; provide **signage** to mark buffer; provide **optic orange fencing** during construction.	See above. Mitigation should include **compensatory plantings** (depending on site conditions) and/or upslope **advanced stormwater controls**, plus **signage**.

Type of Project	Status	Existing Buffer Condition	Preferred Mitigation	Other Mitigation Options
Site Plan or Subdivision Plat (cont)	Redevelop-ment See Section 10.74.d.1.	Developed (existing impervious cover or improvement within buffer)	Remove existing **impervious cover** and other development from at least inner 50 feet of buffer (more if practical); **Restore** at least inner 50 feet of buffer with **compensatory plantings**; provide **upslope stormwater controls** to prevent erosive flows through buffer; provide **signage** to mark remaining buffer; provide **optic orange fencing** during construction.	• Allow redevelopment on existing footprint within buffer. Provide **advanced stormwater controls** for site impervious cover; protect and/or restore inner 25 feet of buffer. • Provide design that does not exceed existing encroachment and that protects water quality and habitat, and prevents damaging runoff velocity.
		Forest	Same preferred and other mitigation options as for "New Project" described above	
		Open Lawn, Meadow		
		Scrub		
Individual Lot	New Construction See Section 10.74.d.1.	Forest	**Preserve** full buffer; provide 25 foot setback from **principal structure** to buffer line; provide **optic orange fencing** during construction.	Allow **encroachment** that is the **minimum necessary** in accordance with Section 10-74.d.1; provide **on-lot runoff practice**.
		Open Lawn, Meadow	**Preserve** full buffer; mark buffer line with **plantings**, **signage**, or other means; provide 25 foot setback from **principal structure** to buffer line; provide **optic orange fencing** during construction.	Allow **encroachment** that is the **minimum necessary** in accordance with Section 10-74.d.1; provide **compensatory plantings**.
		Scrub	**Preserve** full buffer; mark buffer line with **plantings**, **signage**, or other means; provide 25 foot setback from **principal structure** to buffer line; provide **optic orange fencing** during construction.	Allow **encroachment** that is the **minimum necessary** in accordance with Section 10-74.d.1; provide **compensatory plantings** and/or **on-lot runoff practice**, depending on site.

Type of Project	Status	Existing Buffer Condition	Preferred Mitigation	Other Mitigation Options
Individual Lot (cont)	Improvement to Existing Structure (e.g., addition, shed, deck) See Section 10-74.d.1.	Existing Structure or Improvement	Remove existing improvement if practical (e.g., dilapidated shed) to reduce buffer encroachment; provide **compensatory plantings** for area of buffer to be restored.	Allow existing structure and additional improvement (up to 400 square feet) within the 50 landward feet of the buffer (Section 10-74.d.1); Provide **compensatory plantings** or **on-lot runoff practice**, depending on site.
		Forest	**Minimize** disturbance to the buffer. If allowed **encroachment** into buffer < 200 square feet, **preserve** remaining buffer. If allowed **encroachment** > 200 square feet (up to 400 square foot maximum), **preserve** remaining buffer and provide **on-lot runoff practice**.	N/A
		Open Lawn, Meadow	**Minimize** disturbance to the buffer. If allowed **encroachment** into buffer < 200 square feet, **preserve** remaining buffer and mark buffer line with **plantings**, **signage**, or other means. If allowed **encroachment** > 200 square feet (up to 400 square foot maximum), **preserve** remaining buffer and provide **compensatory plantings**.	N/A

Type of Project	Status	Existing Buffer Condition	Preferred Mitigation	Other Mitigation Options
Individual Lot (cont)	Improvement to Existing Structure (e.g., addition, shed, deck) (cont)	Scrub	**Minimize** disturbance to the buffer. If allowed **encroachment** into buffer < 200 square feet, **preserve** remaining buffer and mark buffer line with **plantings**, **signage**, or other means. If allowed **encroachment** > 200 square feet (up to 400 square foot maximum), **preserve** remaining buffer and provide **compensatory plantings** or **on-lot runoff practice**, depending on site.	N/A

Type of Project	Status	Existing Buffer Condition	Preferred Mitigation	Other Mitigation Options
Storm-water manage-ment facilities and erosion control measures	To serve new development or to modify existing structures. See Section 10-74.b.	Variable to site	In general, keep these facilities outside of the buffer. If such measures must encroach into the buffer due to site conditions, then additional measures should include **compensatory plantings** to restore and/or enhance buffer vegetation after the E&S measures are removed (Section 10-72.a). Permanent facilities within the buffer should be **advanced stormwater controls** and should discharge in a manner that spreads water across the buffer and/or does not erode the buffer (see specifications for **upslope stormwater controls**).	N/A

Type of Project	Status	Existing Buffer Condition	Preferred Mitigation	Other Mitigation Options
Paved Pathways & Trails Exceeding 3 feet in Width	New Construction or Renovation or Existing Facilities See Section 10-74.d.4. Also see 10-72.b.5 and 10-72.c.4 for conditions related to pathways and trails.	Variable to site	Pathways and trails should avoid the inner 25 feet of the buffer, except for rare occasions to gain access to the water or where topography prevents the trail being outside of this zone (such as a steep slope along a narrow floodplain). General design guidance for trails is contained in the *Riparian Buffers Modification & Mitigation Manual* (DCR, Chesapeake Bay Local Assistance, 2003, pages 71-81). Some of the regulatory guidance in this document does not pertain to the City's WPO. The document can be found at: http://www.cblad.state.va.us/ripbuffstat.cfm. In addition to this guidance, the design for paved pathways and trails exceeding 3' in width shall include **compensatory plantings** and low-tech runoff controls, such as vegetated swales and biofiltration, in places where runoff may produce erosive conditions.	

Definitions & Guidance For Terms in Bold From Table 1:

Advanced Stormwater Controls – Measures used to control runoff that address water quality, downstream channel protection, and water quantity (detention) if needed. These measures may also be used to meet the requirements of Article III of the Water Protection Ordinance. Advanced stormwater controls should be designed to be upslope from the protected buffer area in such a way that runoff is filtered, infiltrated, slowed down (made non-erosive), or otherwise treated. Examples include biofiltration, extended detention, some manufactured BMPs, or upslope low-impact development designs. The Virginia Stormwater Management Handbook is a design source (http://www.dcr.virginia.gov/sw/stormwat.htm#handbook).

Compensatory Plantings – Planting within the buffer for the purpose of compensating for an encroachment. The intent of the planting is to maintain the natural functions of the buffer, including water quality protection, erosion and sediment control, runoff control, flood control, and habitat protection. Compensatory plantings should be specified in a planting plan. This plan should include the approximate location of the plantings, species, size, root condition (type of stock), planting specifications (e.g., time of year), and maintenance requirements. The plan can be a buffer reforestation plan or a more formal landscape plan using native species. The former is an informal plan to promote the ultimate creation of a riparian forest, while the latter is more a designed plan (by a landscape architect or horticulturalist) that also promotes the natural functions of the buffer. In either case, plant materials can be balled and burlap, container stock, bare root stock, container grown seedlings, bare root seedlings, and/or seeds and plugs. For bare root stock and seedlings, tree tubes and brush mats should be used to reduce browsing and competition during the initial years.

Encroachment – Any *development, land development, or land development project* as defined by the Water Protection Ordinance that occurs or is authorized by the program authority to occur within the stream buffer.

Minimize – See below under “Minimum Necessary.”

Minimum Necessary – This term occurs in the Water Protection Ordinance and the Chesapeake Bay Preservation Regulations. The Chesapeake Bay Local Assistance Department (CBLAD) provides the following guidance on administering projects to adhere to this standard:

> *The terms “minimum necessary to afford relief” is inherently a subjective standard that must be considered on a case-by-case basis, taking into account the specifics of a particular request. When considering the minimum necessary to afford relief, things such as the size of the structure, the types of proposed structures, and the placement of the structures in relation to the size, layout and location of the lot or parcel are important considerations. Some examples of requests that would not be the minimum necessary to afford relief could include an application for an extremely large structure on a given lot or parcel, especially*

when compared to the size of the structures in the adjacent lots. Another example would be a request for a house that would be located outside of the RPA, but with a large attached deck with a pool that would be located within the RPA. In this instance, the sole reason for the exception request relates, not to a use of the property, but to the extent that the applicant wishes to use the property. In this example, consideration of relocation of the house on the lot or resizing the deck and pool are all potential solutions that may result in the property owner achieving their desired use without the need for an exception. Should alternative location, sizing, or orientation options to avoid the need for an exception be available, and the applicant chooses to continue with the exception request, then the finding of "minimum necessary to afford relief" would not be present. (Excerpted from: "Exceptions – Guidance on the Chesapeake bay Preservation Area Designation and Management Regulations," September 16, 2002, Chesapeake Bay Local Assistance Department).

On-Lot Runoff Practice – Practices that address roof, yard, and driveway runoff in a way that the runoff does not impair or even enhances the natural functions of the downslope buffer. These practices may collect/reuse runoff water, filter or infiltration runoff, or use landscaping to treat and slow down the water. Examples are rain gardens (also known as "bioretention planting bed"), dry wells, french drains, rain barrels, or specific landscaping techniques to conserve and protect water (e.g., Bayscapes: http://www.acb-online.org/project.cfm?vid=85)

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Optic Orange Fencing -- High visibility safety or tree protection fencing that is used as a temporary measure during construction to keep construction equipment and activities out of a protected area.

Preserve -- Measures taken to ensure that a buffer area (or remaining buffer area after an allowed encroachment) is protected from further disturbance. For a subdivision plat, this can include placing the buffer area in open space or a buffer easement, restrictive language in covenants or deeds, donation of the buffer to an easement holding entity, and/or providing signs that clearly mark the buffer boundary and explain that the vegetation is to be protected. The management of vegetation is in accordance with Section 10-72 of the Water Protection Ordinance.

Principal Structure – The Chesapeake Bay Local Assistance Department provides the following guidance on principal structures:

Webster's Dictionary (9th edition) defines "principal" as "…a matter or thing of primary importance." Using this definition, a principal structure would be one primary structure. Furthermore, the principal structure would be one that is necessary to use the land in the manner permitted by the underlying zoning classification. Necessary utilities includes such things as electric and telecommunication lines, water and onsite or public sewage disposal facilities. (Excerpted from: "Resource Protection Area: Buffer Area Encroachments, Guidance on the Chesapeake Bay Preservation Area Designation and

Management Regulations, September 16, 2002, Chesapeake Bay Local Assistance Department).

Restore – Plantings within the buffer that help maintain the natural functions of the buffer, including water quality protection, erosion and sediment control, runoff control, flood control, and habitat protection. See the guidance and standards for **compensatory plantings**.

Signage -- Any signs, posts, etc. approved by the City that mark the boundary of the buffer and state that the vegetation is protected. Signs should also include contact information in case someone has questions about the restrictions.

Upslope Stormwater Controls -- Measures employed to prevent damage to a buffer area from concentrated runoff. These measures can also be used to comply with Section 10-52 of the Water Protection Ordinance. In general, measures are designed to slow down and spread out runoff, and may include energy dissipators, level spreaders, check dams, or detention facilities designed in accordance with Section 10-52.

5. Standard Details & Design Guidance

Standard details and design guidance contain the recommended content and guidelines for mitigation plans using various techniques. Each section also contains relevant Internet links for interested parties to find more information. The following are addressed in this section:

- **Compensatory Plantings** – Guidance on vegetative replacement standards for encroachments, planting details, preparing sites and choosing plants for various applications, invasive species to avoid, and nurseries that sell native plants.

- **On-Lot Runoff Practices** – Details and guidance for rain gardens (bioretention planting beds), dry wells, swale infiltration trenches, and innovative small-scale on-lot practices

- **Upslope Stormwater Controls** – Standards and details for level spreaders and energy dissipators that can help prevent erosive flows from stormwater conveyance systems through the stream buffer.

- ***Advanced Stormwater Controls*** *are addressed in the Virginia Stormwater Management Handbook: http://www.dcr.virginia.gov/sw/stormwat.htm#handbook.*

  The Handbook is a comprehensive design manual for stormwater practices. The City may utilize and adapt the standards in the Handbook based on sound engineering and planning judgment.

COMPENSATORY PLANTINGS

Compensatory Planting Plan Content:

- Vicinity Map, North Arrow
- Property Owner, address, contact and number for plan preparer if different than owner
- Schematic of vegetation in buffer, vegetation to be removed, and vegetation to be added. Landscape plan if appropriate
- Planting details: species, type of stock (B&B, container, bare root), size, spacing, number, and planting schedule
- Installation procedures, protection measures (e.g., tree tubes, brush mats, etc.)
- Maintenance plan & schedule

COMPENSATORY PLANTING CONTENT

COMPENSATORY PLANTING LINKS

Chesapeake Bay Local Assistance Department (DCR), *Riparian Buffers Modification & Mitigation Guidance Manual* (September 2003) – This manual is the State's latest guidance to localities that must implement and enforce the Chesapeake Bay Preservation Act and Regulations ("Tidewater" localities).
http://www.cblad.state.va.us/ripbuffstat.cfm

Virginia Department of Forestry, Riparian Forest Buffers – This site contains many additional links to information about forest buffers, including their functions, plants, restoration around the State, and other programs.
http://www.dof.virginia.gov/rfb/index.shtml

Chesapeake Bay Program, Riparian Forest Buffers – Another site with information on the functions of buffers and other links.
http://www.chesapeakebay.net/ripar1.htm

Table 2: Vegetation Replacement Standards for Small Encroachments:

These standards were developed by the Chesapeake Bay Local Assistance Department (CBLAD). The standards are applicable to situations where small stream buffer disturbances are taking place and the number and type of plants removed is known. Such cases may include construction of decks, sheds, and additions, and minor lot improvements, such as removing invasive species or creating access paths to the water.

VEGETATION REPLACEMENT RATES

VEGETATION REMOVED	PREFERRED REPLACEMENT VEGETATION	ACCEPTABLE ALTERNATIVE VEGETATION
1 tree or sapling 1/2"-2 1/2" caliper	1 tree @ equal caliper or greater	**Or** 2 large shrubs @ 3'-4' **Or** 10 small shrubs or woody groundcover *@ 15"-18"
1 tree ≥ 2 1/2" caliper	1 tree @ 1 1/2" - 2" caliper,or 1evergreen tree @ 6' min. ht., per every 4" caliper of tree removed (ex: a 12" cal. tree would require 3 trees to replace it)	**Or** 75% trees @ 1 1/2" - 2" and 25% large shrubs @ 3'-4' per every 4" caliper of tree removed. (ex: a 16" cal. tree removed would require 3 trees and 1 large shrub) **Or** 10 small shrubs or woody groundcover @ 15"-18" per 4"caliper of tree removed (ex: a 8" caliper tree removed requires 20 small shrubs)
1 large shrub	1 large shrub @ 3'-4'	**Or** 5 small shrubs or woody groundcover @ 15"-18"

* Woody groundcover is considered to be a woody, spreading shrub that remains close to the ground, to 18" high, such as a shore juniper, *juniperus conferta*. Vines may not be considered "woody groundcover" for the purpose of vegetation replacement.

Source: Chesapeake Bay Local Assistance Department, *Riparian Buffers Modification & Mitigation Guidance Manual*, Appendix D, September 2003 http://www.cblad.state.va.us/ripbuffstat.cfm

Table 3: Stream Buffer Restoration for ¼ Acre or Less:

This table is also from CBLAD's *Riparian Buffers Modification and Mitigation Guidance Manual*. It contains stream buffer restoration planting goals for areas larger than those addressed in Table 2. Table 3 is applicable for more substantial encroachments into the buffer for allowable development, replacement of invasive species, or encroachments of ¼ acre or less.

RESTORATION / ESTABLISHMENT TABLE A

Definitions:

Canopy tree: a tree that reaches 35 feet in height or larger when mature
Understory tree: a tree that matures to a height of 12 feet to 35'
Large shrub: a shrub that reaches 10 feet of height or greater at maturity
Small shrub: a woody plant that can reach up to 10 feet of height at maturity

¼ acre or less of buffer

Up to 10,890 square feet or less

For every 400 square-foot unit (20'x20') or fraction thereof plant:

one (1) canopy tree @ 1½" - 2" caliper or large evergreen @ 6'
two (2) understory trees @ ¾" – 1 ½" caliper or evergreen @ 4'
or *one* (1) understory tree and *two* (2) large shrubs @ 3'-4'
three (3) small shrubs or woody groundcover @ 15" – 18"

Example:
A 100-foot wide lot x 100-foot wide buffer is 10,000 square feet.
Divide by 400 square feet (20'x20' unit) to get:
25 units

Units x	plant/unit	Number of plants
25 units x	1 canopy tree	25 canopy trees
	2 understory trees	50 understory trees
	3 small shrubs	75 small shrubs
		150 plants

Source for Tables 3 & 4: Chesapeake Bay Local Assistance Department, *Riparian Buffers Modification & Mitigation Guidance Manual*, Appendix D, September 2003.
http://www.cblad.state.va.us/ripbuffstat.cfm

Table 4: Stream Buffer Restoration for Greater Than ¼ Acre:

This table is also from CBLAD's *Riparian Buffers Modification and Mitigation Guidance Manual*. It contains stream buffer restoration planting goals for areas larger than ¼ acre. Table 4 is applicable for similar but more substantial projects than addressed in Table 3.

RESTORATION / ESTABLISHMENT TABLE B

Greater than ¼ acre of buffer

More than 10,890 square feet

A. Plant at the same rate as for ¼ acre or less.

B. The waterside 50% of the buffer (from the waterline inland for the first 50 feet):
For every 400 square-foot unit (20'x20') or fraction thereof plant:

one (1) canopy tree @ 1½" - 2" caliper or large evergreen @ 6'
two (2) understory trees @ ¾" – 1 ½" caliper or evergreen @ 4'
or *one* (1) understory tree and *two* (2) large shrubs @ 3'-4'
three (3) small shrubs or woody groundcover @ 15" – 18"
AND

The landward 50% of buffer (from 50 feet inland to 100 feet inland):
either plant
Bare root seedlings or whips at 1,210 stems per acre[1], approximately 6'x6' on center (Minimum survival required after two growing seasons: 600 plants)
or
Container grown seedling tubes at 700 per acre approximately 8'x 8' on center (Minimum survival required after two growing seasons: 490 plants)

C. If the applicant is willing to enter into a five year maintenance and performance guarantee:
100% of buffer planted with:
Bare root seedlings or whips at 1,210 per acre, approximately 6'x 6' on center (Minimum survival required after two growing seasons: 600 plants)
or
Container grown seedling tubes at 700 per acre approximately 8'x 8' on center (Minimum survival required after two growing seasons: 490 plants)

1 acre or more of buffer

With an evaluation from an arborist or forester or other professional, natural regeneration may be an acceptable method of buffer establishment, however, a forestry management plan must be in place prior to any vegetation being removed. A minimum of 35 feet next to the water must be left in forest and protected prior to any vegetation being removed. If over 20 percent of the vegetation must be removed for the health of the woodlot, within the 35 feet closest to the shoreline, vegetation must be reestablished by seedling plantings at the rates above.

[1] Palone, Roxanne S., and Al Todd, *Chesapeake Bay riparian handbook: A guide for establishing and maintaining riparian forest buffers.* May 1977. p. 7-20.

Table 5: Site Preparation Guidance for Buffer Restoration
Source: Thomas Jefferson Soil & Water Conservation District, *Riparian Protection Handbook*, pg. A-15

Pasture Preparation

Again, technical assistance should be sought before preparing a site for planting.

On sites of relatively non-erosive soils where concentrated runoff is not likely to occur: The sod can be plowed and disked in early spring following an application of the herbicides Oust, Escort and Arsenal to control turf grasses. The site should then be immediately seeded with a warm-season grass mixture to stabilize the soil, and trees can be planted.

On sites where concentrated runoff and erosion occur: Extensive mechanical preparation is not recommended. Instead, a combination of Roundup and Oust can be applied in a 4-foot-diameter circle at each planting location to control sod forming grasses. A square piece of geotextile mesh can also be used at the base of each vegetative planting to control undesirable species.

Abandoned Field Preparation

Abandoned fields are covered with shrubs and vines, interspersed with tree saplings.

Where many seedlings of native or pioneer species occur, basal bark sprays noninvasive exotic species during the dormant season are very selective and will provide effective control.

dbh = diameter at breast height or 4.5 feet from the ground on the up-hill side of a tree.

Another viable approach is to cut shrubs and vines after they are completely leafed-out, but prior to hardening off in the spring. The stumps can subsequently be treated with Compadre herbicide after cutting to prevent re-sprouting.

Early-Successional Site Preparation

Early-successional sites occur where tree saplings are well enough established to begin canopy closure. This stage occurs when saplings are at least 2-4 inches dbh and have a crown height of 12-20 feet.

In general, site preparation strategies are similar to those involved in abandoned field sites, although to a lesser degree. Cutting and subsequent use of herbicides is recommended.

It is important to remember that a pesticide permit is needed before any herbicide recommendations are made to landowners.

The local Cooperative Extension office may also be able to make herbicide recommendations.

Table 6: Choosing Plant Stock
Source: Thomas Jefferson Soil & Water Conservation District, *Riparian Protection Handbook*, pg. A-22

How To Choose The Size Of The Plants?

150 stems per acre can be planted.

Balled and Burlap and/or Container Stock
Although the most expensive to utilize in a buffer project, this size of plant material will attain the highest canopy height in the shortest amount if time. It is most appropriate in riparian forests where intensive multiple uses are anticipated, as in an urban park system.

240 stems per acre can be planted.

Bare Root Stock
A more cost-effective approach is to use bare root stock material. These plants are usually several feet tall, and can be hand-planted with mattocks, although root spread may be compromised. The use of power augers to dig planting holes will be more expensive, but the plants will have a higher rate of survival.

350 stems per acre can be planted.

Container Grown Seedlings
These types of seedlings are commonly grown in paper pots that disintegrate when planted. This increases the survival rate because the plant never loses contact with its soil and suffers less stress. In addition, container grown seedlings have roots that are more developed than bare root plants and are more drought tolerant.

1,210 stems per acre can be planted.

Bare Root Seedings and Year Transplants
This size of plant material is acceptable where a longer time to attain canopy closure is acceptable, and they are relatively inexpensive. Tree shelters will accelerate growth and increase the survivability of these seedlings, although the use of shelter will significantly raise the cost of the buffer project.

Seeds and Plugs
For certain riparian species with large seeds, such as walnuts and oak, seed planting is a viable alternative. While the plant material may be the least expensive, tree shelters are required to obtain acceptable survivability. Seed material is also the material of choice for establishing grasses and forbs.

Overview of Considerations When Selecting Plant Material Sizes

	Estimated Cost/Plant	Estimated Number/Acre	Average Survival Rate	Average Installation Cost	Average Cost/Acre
Balled and Burlap/Container	HIGH	LOW	HIGH	HIGH	HIGH
Bare Root Stock	↑	↑	↑	↑	↑
Container Seedlings					
Bare Root Seedlings	↓	↓	↓	↓	↓
Seeds	LOW	HIGH	LOW	LOW	LOW

Figure 1: Three-Zone Stream Buffer Concept
Source: Thomas Jefferson Soil & Water Conservation District, *Riparian Protection Handbook*, pg. A-16

Note: The Water Protection Ordinance specifies two management zones in Section 10-72: Zone 1 (undisturbed zone, closest to the water) and Zone 2 (managed zone, landward to 100'). The 3-Zone Concept is promoted by the Chesapeake Bay Program, and is offered here as design guidance for development activities adjacent to streams and stream buffers.

What Is The 3-Zone Forest Buffer Concept?

- Zone 1's minimum width is 15 to 35 feet.
- Zone 2's width can vary from 25 to 200 feet.
- Zone 3's common width is 20 to 30 feet.

Zone 1: This zone stretches upland from the edge of the stream. The permanent mature forest along the edge of the water maintains habitat, provides food, cools water temperature, helps stabilize streambanks, reduces flood impact and removes nutrients. Tree harvesting is not recommended in this zone.

Zone 2: Zone 2 is located immediately upslope from Zone 1. This managed forest removes sediment, nutrients and other pollutants from the surface and groundwater. It also provides wildlife habitat and economic benefits to the landowner from management of the forest resource.

Zone 3: This zone is located on the outer edge of the buffer closest to the adjacent land use with potential to impact the stream. This zone may contain grass filter strips, terraces or other features useful in slowing runoff, infiltrating water and helping to filter sediment and its associated chemicals.

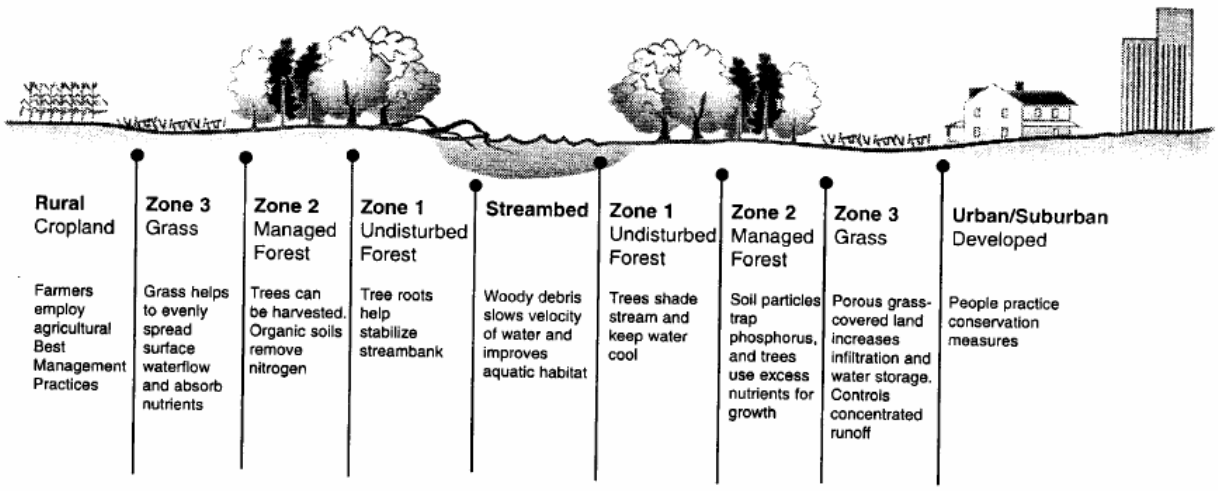


Table 7: Selecting Plant Species
Source: Thomas Jefferson Soil & Water Conservation District, *Riparian Protection Handbook*, pg. A-17

Recommended in Zone 1

Silver Maple
Sycamore
Black Willow
Eastern Cottonwood

Recommended in Zone 2

Red Oak
Black Walnut
Green Ash
Sycamore
River Birch
Pin Oak
Shad Bush
Black Haw
Redbud
Winterberry
Virginia Sweetspire
Maple-Leaf Viburnum

Recommended in Zone 3

Arrowwood
Silky Dogwood
Azalea
Elderberry
Gray Dogwood
Grasses and Forbs

Zone 1

Trees that are best suited to conditions of frequent inundation should be planted in this zone. The fast growth rate and brittle habit of these species withstand the periodic trauma of heavy floods. Instead of washing away and exposing unstabilized streambanks, these species shed branches and regrow from the remaining trunk. Due to their fast growth rate, they are established relatively easily and rapidly reach canopy closure.

Along the stream, understory trees and shrubs tolerant of flooding and wet soils should be densely interplanted among canopy species to provide additional structure and shading of the riparian area.

Zone 2

This zone can include commercially viable canopy species such as red oak and black walnut where site conditions permit. More flood and wet soil tolerant species may be necessary in this zone.

An understory will provide additional shade and structure to Zone 2. Shade tolerant shrubs will grow in the deeper shade further inland and shade the forest floor to inhibit competition from invasive edge species.

Zone 3

As the transition zone between the forested buffer and adjacent land uses, Zone 3 must be carefully designed to meet management objectives. For structural diversity, the transition across this zone should be as densely planted as possible with shrubs to reduce light penetration into Zone 2 and recolonization by invasive exotic species.

Where sediment filtering is a primary objective, this zone should be planted with a dense herbaceous cover. No trees or shrubs should be located where sediments will accumulate. For control of channelized flows, a diversion should be installed to retard water flow and settle out sediments.

A forb layer of warm season grasses and annuals may be planted in all Zones. Cold season grasses should be included in open sites, along with raspberry, dewberry, and thimbleberry. These plants will effectively compete with undesired invasive plants until canopy closure is reached.

Table 8: Riparian Plant List
Source: Thomas Jefferson Soil & Water Conservation District, *Riparian Protection Handbook*, pgs. A-18 – A-20.

Ecological and Silvicultural Characteristics of Riparian Plants

x = Characteristic/Preference o = Tolerance

PLANT NAME	REGION			WILDLIFE VALUE				SHADE TOLERANCE				GROWTH RATE				SIZE			ROOTING
COMMON NAME	COAST	PIED.	MTNS.	V. HI	HIGH	MED.	LOW	LOW	MED	HIGH	V. HI	V. FAST	FAST	MED.	SLOW	>75'	50-75'	<50'	
RIPARIAN CANOPY																			
Swamp white-cedar	x					x		x						x	x		x		shallow
Baldcypress	x	x					x	x	o					x		x			shallow
Black willow	o	x	x		x			x				x					x		shallow
Eastern cottonwood		x	x				x	x					x			x			shallow
Red maple	x	x	x	x				x	x	o			x	x			x		v. shallow
Swamp white oak	x	x			x			x	o	o			x	x		x			shallow
Blackgum	x	x	x			x		x	o						x			x	taproot
Green ash	o	x	x				x	x				x					x		shallow
Silver maple	x	x	x	x				x	x	o		x		x		x			v. shallow
Sycamore	x	x					x	x	o	o		x					x		shallow
River birch	x	x	x	x				x	o				x				x		shallow
Pin oak	x	x			x			x	o				x	x		x			shallow
Willow oak	x	x			x			x	o				x	x		x			shallow
Hackberry	x	x	x	x				x	o	o			x	x		x			deep lateral
Pitch pine	x						x	x						x	x			x	shallow
American beech	x	x			x			o	x	x	x			x	x	x			shallow
Sweetgum	x	x					x	x	o					x			x		deep taproot
Black walnut	o	x	x				x	x	o				x			x			taproot
Bitternut hickory	x	x	o			x		x	x	o				x	x	x			deep taproot
Persimmon	x	x			x			x	o						x			x	deep taproot
White ash	o	x	x				x	x	x	x				x		x			shallow
Yellow-poplar	x	x	x				x	x	x	o			x	x		x			shallow/deep
White oak	o	x	x	x				x	o	o					x	x			deep taproot
Red oak	o	x	x		x			x	x	o				x		x			deep lateral
Basswood		x	x				x	x	x	x	o			x			x		deep lateral

Table 8 (continued, page 2 of 3)

PLANT NAME	REGION			WILDLIFE VALUE				SHADE TOLERANCE				GROWTH RATE				SIZE			ROOTING
COMMON NAME	COAST	PIED.	MTNS.	V. HI	HIGH	MED.	LOW	LOW	MED	HIGH	V. HI	V. FAST	FAST	MED.	SLOW	>75'	50-75'	<50'	
RIPARIAN UNDERSTORY																>40'	40-30'	<30'	
Boxelder	o	x	x	x				x				x				x			deep lateral
Hazel alder		x	x			x		x					x					x	shallow
Sweet bay	x	x					x	o	x	o				x				x	deep lateral
Blackhaw		x	x		x			x	x	o				x				x	shallow
Possumhaw	o	x	x		x			x	x					x	x			x	shallow
Witch-hazel		x	x				x	o	x	x	x			x			x		deep lateral
Shad bush		x	x		x			o	x	x	x				x		x		shallow
Pawpaw		x		x				x	x	o					x		x		deep lateral
Hornbeam		x	x	x					o	x	x				x		x		deep lateral
Redbud		x	x				x	o	x	x			x	x			x		shallow
Flowering dogwood		x	x			x		o	x	x	x				x		x		shallow
RIPARIAN SHRUBS																			
Buttonbush	x	x	x				x	x	o					x			x		shallow
Pussy willow		x	x		x			x					x			x			shallow
Sweet pepperbush	x	x			x			x	x	x				x	x		x		shallow
Swamp azalea	x	x					x	x	x	o				x		x			shallow
Winterberry	x	x			x			x	x	o					x	x			shallow
Arrowwood	x	x	x		x			x	x					x		x			shallow
Highbush blueberry	x	x		x				x	x						x		x		shallow
Elderberry	x	x	x	x					o	x	x		x			x			shallow
Virginia sweetspire		x	x				x	x	x	x	o			x	x			x	shallow
Inkberry	x	o			x			x	x	o					x			x	shallow
Swamp leucothoe	x	x					x		o	x	x				x			x	shallow
Pinxterbloom	x	x					x		o	x	x				x		x		shallow
Bayberry	x				x			x	o					x			x		shallow
Silky dogwood		x	x	x				x	o	o			x				x		shallow
Common ninebark	x	x				x		x	o				x					x	shallow
Red chokeberry	x					x		x	x	o					x			x	shallow

Table 8 (continued, page 3 of 3)

PLANT NAME	REGION			WILDLIFE VALUE				SHADE TOLERANCE				GROWTH RATE				SIZE			ROOTING
COMMON NAME	COAST	PIED.	MTNS.	V. HI	HIGH	MED.	LOW	LOW	MED	HIGH	V. HI	V. FAST	FAST	MED.	SLOW	>75'	50-75'	<50'	
RIPARIAN SHRUBS, CONT.																			
Spicebush	x	x	x	x					o	x	x				x		x		deep laterals
Gray dogwood		x	x	x				x	x	o				x			x		shallow
Rosebay rhododendron	x	x	x				x		o	x	x				x	x			shallow
Maple-leaf viburnum		x	x		x				o	x	x			x	x		x		shallow
FORBS AND FERNS																			TYPE
Jewelweed	x	x	x		x			x	o					x			x		annual
Smartweed	x	x			x			x					x					x	annual
Royal fern		x	x				x	x	x	o			x					x	fern
Sensitive fern		x	x				x	x	x	x	o		x					x	fern
Joe-Pye weed	x	x	x			x		x					x				x		perennial
Swamp dewberry	o	x	x		x			x	o				x					x	perennial
Thimbleberry	o	x	x		x			x	o				x				x		perennial
Raspberry	o	x	x		x			x	o				x				x		perennial
GRASSES																>6'	3-6'	<3'	
Switchgrass	o	x	x	x				x	o				x				x		warm, clump
Eastern gamagrass	x	x		x				x	o	o			x				x		warm, clump
Field bromegrass	o	x	x		x			x					x					x	w. annual
Fowl meadow grass	o	x	x		x			x					x					x	cold, sod
Deertongue	o	x	x		x			x	x	o			x					x	warm, clump
Tall fescue	o	x	x			x		x	o				x					x	cold, sod
Indiangrass	o	x	x		x			x	x				x			x			warm, sod
Purpletop	o	x	x		x			x	o				x				x		warm, clump
Big Bluestem	o	x	x		x			x						x		x			warm, clump
Little Bluestem	o	x	x		x			x						x				x	warm, clump

Source: Chesapeake Bay Riparian Handbook ...

Table 9: Invasive Alien Plant List
Source: Chesapeake Bay Local Assistance Department, *Riparian Buffers Modification & Mitigation Guidance Manual*, Appendix B, September 2003. http://www.cblad.state.va.us/ripbuffstat.cfm

COMMON NAME	SCIENTIFIC NAME
Highly Invasive Species	
Tree-of-heaven	*Ailanthus altissima*
Garlic mustard	*Alliaria petiolata*
Alligator weed	*Alternanthera philoxeroides*
Porcelain-berry	*Ampelopsis brevipedunculata*
Asiatic sand sedge	*Carex kobomugi*
Oriental bittersweet	*Celastrus orbiculata*
Short-fringed knapweed	*Centaurea dubia*
Spotted knapweed	*Centaurea maculosa*
Canada thistle	*Cirsium arvense*
Chinese yam	*Dioscorea oppositifolia*
Autumn olive	*Elaeagnus umbellata*
Winged burning bush	*Euonymus alata*
Hydrilla	*Hydrilla verticillata*
Cogon grass	*Imperata cylindrica*
Chinese lespedeza	*Lespedeza cuneata*
Chinese privet	*Ligustrum sinense*
Japanese honeysuckle	*Lonicera japonica*
Morrow's honeysuckle	*Lonicera morrowii*
Standish's honeysuckle	*Lonicera standishii*
Purple loosestrife	*Lythrum salicaria* & *L. virgatum*
White sweet clover	*Melilotus alba*
Yellow sweet clover	*Melilotus officinalis*
Japanese stilt grass	*Microstegium vimineum*
Anellima	*Murdannia keisak*
Parrot feather	*Myriophyllum aquaticum*
European water-milfoil	*Myriophyllum spicatum*
Common reed	*Phragmites australis*
Japanese knotweed	*Polygonum cuspidatum*
Mile-a-minute	*Polygonum perfoliatum*
Kudzu vine	*Pueraria lobata* (*P. montana*)

Table 9 (continued, page 2 of 4)

Lesser celandine	*Ranunculus ficaria*
Multiflora rose	*Rosa multiflora*
Wineberry	*Rubus phoenicolasius*
Johnson-grass	*Sorghum halepense*

Moderately Invasive Species

Norway maple	*Acer platanoides*
Quack grass	*Agropyron repens*
Rhode Island bent-grass	*Agrostis tenuis*
Five-leaf akebia	*Akebia quinata*
Wild onion	*Allium vineale*
Mugwort	*Artemisia vulgaris*
Jointed grass	*Arthraxon hispidus*
Giant reed	*Arundo donax*
Japanese barberry	*Berberis thunbergii*
Balloon vine	*Cardiospermum halicacabum*
Musk thistle	*Carduus nutans*
Sickle pod	*Cassia obtusifolia*
Brown knapweed	*Centaurea jacea*
Bull-thistle	*Cirsium vulgare*
Field-bindweed	*Convolvulus arvensis*
Cut-leaf teasel	*Dipsacus laciniatus*
Common teasel	*Dipsacus sylvestris*
Brazilian water-weed	*Egeria densa*
Wintercreeper	*Euonymus fortunei*
Tall fescue	*Festuca elatior* (*F. pratensis*)
Fennel	*Foeniculum vulgare*
Gill-over-the-ground	*Glechoma hederacea*
English ivy	*Hedera helix*
Velvet-grass	*Holcus lanatus*
Japanese hops	*Humulus japonicus*
Ivy-leaved morning-glor	*Ipomoea hederacea*
Common morning-glory	*Ipomoea purpurea*
Yellow flag	*Iris pseudacorus*
Shrubby bushclover	*Lespedeza bicolor*
Blunt-leaved privet	*Ligustrum obtusifolium*
Amur honeysuckle	*Lonicera maackii*
Tartarian honeysuckle	*Lonicera tatarica*
Moneywort	*Lysimachia nummularia*
China-berry	*Melia azedarach*
Princess tree	*Paulownia tomentosa*
Timothy	*Phleum pratense*
Golden bamboo	*Phyllostachys aurea*
Canada bluegrass	*Poa compressa*
Rough bluegrass	*Poa trivialis*

Table 9 (continued, page 3 of 4)

Bristled knotweed	*Polygonum cespitosum*
White poplar	*Populus alba*
Jointed charlock	*Raphanus raphanistrum*
Red sorrel	*Rumex acetosella*
Curled dock	*Rumex crispus*
Giant foxtail	*Setaria faberi*
Japanese spiraea	*Spiraea japonica*
Common chickweed	*Stellaria media*
Ivy-leaved speedwell	*Veronica herderifolia*
Chinese wisteria	*Wisteria sinensis*
Common cocklebur	*Xanthium strumarium*

Occasionally Invasive Species

Redtop	*Agrostis gigantea*
Bugleweed	*Ajuga reptans*
Mimosa	*Albizia julibrissin*
Oatgrass	*Arrhenatherum elatius*
Common dayflower	*Commelina communis*
Poison hemlock	*Conium maculatum*
Crown-vetch	*Coronilla varia*
Orchard grass	*Dactylis glomerata*
Russian olive	*Elaeagnus angustifolia*
Thorny elaeagnus	*Elaeagnus pungens*
Weeping lovegrass	*Eragrostis curvula*
Leafy spurge	*Euphorbia esula*
Red morning-glory	*Ipomoea coccinea*
Nipplewort	*Lapsana communis*
Sweet breath of spring	*Lonicera fragrantissima*
Bell's honeysuckle	*Lonicera x bella*
Birdsfoot trefoil	*Lotus corniculatus*
Silver grass	*Miscanthus sinensis*
White mulberry	*Morus alba*
Wild parsnip	*Pastinaca sativa*
Beefsteak plant	*Perilla frutescens*
Black pine	*Pinus thunbergii*
Sawtooth oak	*Quercus acutissima*
Water chestnut	*Trapa natans*
Siberian elm	*Ulmus pumila*
Linden viburnum	*Viburnum dilatatum*
Periwinkle	*Vinca minor* & *V. major*
Japanese wisteria	*Wisteria floribunda*

Table 9 (continued, page 4 of 4)

"About the List" This advisory list is published by Virginia Department of Conservation and Recreation (VDCR) to inform land managers of potential risks associated with certain plant species know to exhibit invasive behavior in some situations. It should also be noted the list is not regulatory in nature, and thus does not prohibit the use of the listed plant species. VDCR Natural Heritage and Virginia Native Plant Society use detailed criteria to assess the invasiveness of a plant. Factors used to rank each species include: culmulative impacts on natural areas; potential to disperse and invade natural landscapes; distribution and abundance; difficulty to manage; and impacts on other species. The list is periodically reviewed and updated by land managers, nurserymen, landscape architects, horticulturalists, botantists, wildlife biologists, and other conservation partners. **"Invasiveness Ranking"** Each species on the list is assessed according to its cumulative effects on natural areas and native plant habitats where it typically occurs. The A-ranked species exhibit the most invasive tendancies in natural areas and native plant habitats. they may disrupt ecosystem processes and cause major alterations in plant community composition and structure. They establish readily in natural systems and spread rapidily. The B-ranked species exhibit moderate invasiveness in natural areas. They may have minor influence on ecosystem processes, alter plant community composition and affect community structure in at least one layer. They may become dominant in the understory layer without threatening all species found in the community. These species usually require a minor disturbance to become established. The C-ranked species generally do not affect ecosystem processes but may alter plant community composition by outcompeting one or more native plant species. They often establish in severely disturbed areas. The disturbance may be natural or human origin, such as ice- storm damage, windthrow, or road construction. These species spread slowly or not at all from disturbed sites. **"Regions"** For purposes of this list, the state has been divided into three regions. Coastal Plain and Piedmont follow conventional boundaries. Blue Ridge, Ridge and Valley, and Cumberland Plateau and grouped together into one region called Mountain. **"Habitat Requirements"** The categories for light and soil requirements are very broad and are meant only to give general indication of habitat adaptations for these plants.

Table 10: Nurseries for Native Plants
Source: Chesapeake Bay Local Assistance Department, *Riparian Buffers Modification & Mitigation Guidance Manual*, Appendix E, September 2003. http://www.cblad.state.va.us/ripbuffstat.cfm

(Compiled by Nancy Arrington, former Horticulture Chair, Virginia Native Plant Society.)

Key: **C** Carnivorous Plants, **F** Ferns, **G** Grasses, **H** Herbaceous Plants, **O** Orchids, **S** Seed, **W** Woody Plants

[This is a list of nurseries whose stock is partially or entirely made up of native plants. It is not intended to be exclusive. There may be other nurseries stocking native plants as well. This is a list of suppliers and is not to be construed as an endorsement of those suppliers.]

Botanique
387 Pitcher Plant Ln.
Stanardsville, VA 22973
E-mail: botanique@pitcherplant.com
Catalog $1 (as a courtesy, not required); C, F, H, O

Edible Landscaping
361 Spirit Ridge Lane
Afton, VA 22920
434-361-9134
Free catalog; W

Meadowview Biological Research Station
8390 Fredericksburg Turnpike
Woodford, VA 22580
phone/fax: (804) 633-4336 / (804) 633-5056
E-mail: meadowview@pitcherplant.org
Catalog on-line; C

The Salt and The Earth
P.O. Box 560
Deltaville, VA 23043
804-776-6985, 804-776-6324
E-mail: alor@inna.net
Call for availability; G, H

Sassafras Farm
7029 Bray Rd.
Hayes, VA 23072
804-642-0923
E-mail: sasafras@3bubbas.com
SASE for list; F, G, H

Table 10 (continued, page 2 of 2)

Virginia Natives
P.O. Box D
Hume, VA 22639-0903
phone & fax:540-364-1665
E-mail: vanatvs@erols.com
Mailorder catalog $1.50
retail by appointment
C, F, G, H, W

Lists of plants suggested for conservation, restoration and landscaping in Virginia and lots of other relevant information can be found care of Virginia's Natural Heritage Program. < http:// www.dcr.state.va.us/dnh/>

List of Nurseries for Native Plants from the Maryland Native Plant Society

Bobtown Nursery
16212 Country Club Rd.
Melfa VA 23410
(757) 787-8484

Joseph Brown Native Seeds & Plants
7327 Hoefork Lane
Gloucester Point VA 23062
(804) 642-0736

Pinelands Nursery
8877 Richmond Rd.
Toano, VA 23168
(800)667-2729
Contact: Don Knezick
sales@pinelandsnursery.com
www.pinelandsnursery.com

WaterWays Nursery
Sally Kurtz, 13015 Milltown Road, Lovettsville, VA 20180
(540) 822-5994
http://members.aol.com/wwnursery/index.html
(herbaceous only)

Figure 2: Planting Details

Source: Chesapeake Bay Local Assistance Department, *Riparian Buffers Modification & Mitigation Guidance Manual*, Appendix C, September 2003. http://www.cblad.state.va.us/ripbuffstat.cfm.

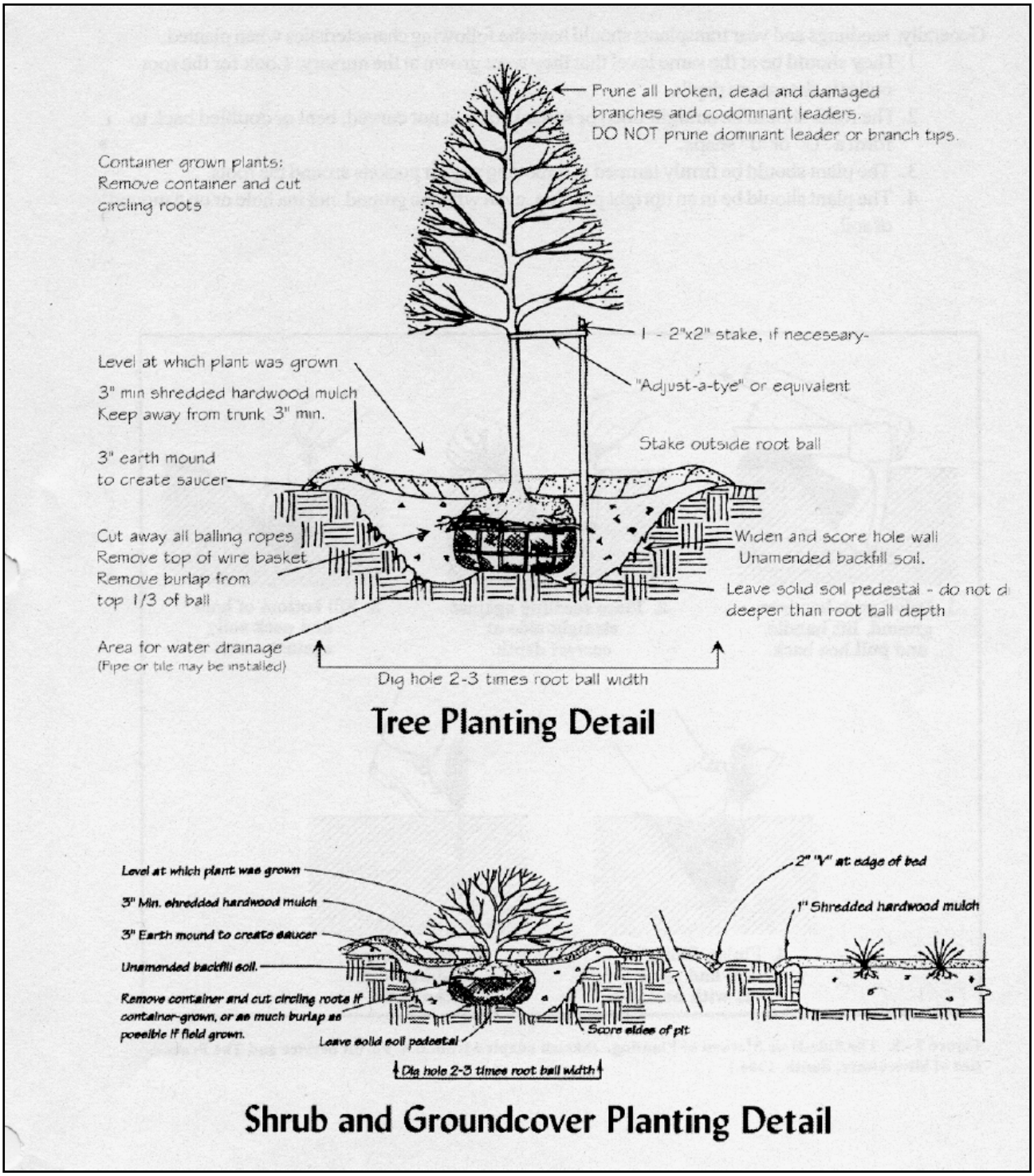


Figure 3: Planting Details for Bare Root Seedlings & Year Transplants

Two methods are illustrated for planting bare root seedlings and year transplants. The first is the Side-Hole Method, and the latter is Slit Method.

BARE ROOT SEEDLINGS AND YEAR TRANSPLANTS

(Taken from Section VII of *The Chesapeake Bay Riparian Handbook.* Palone, Roxanne S. and Albert H todd, eds. 1998)

Generally, seedlings and year transplants should have the following characteristics when planted:

1. They should be at the same level that they were grown at the nursery. Look for the root collar to determine depth.
2. The roots should be straight doen or spread out, but not curved, bent or doubled back to form a "U" or "J" shape.
3. The plant should be firmly tamped in removing any air pockets around the roots.
4. The plant should be in an upright position, even with the ground, not ina hole or on a mound of soil.

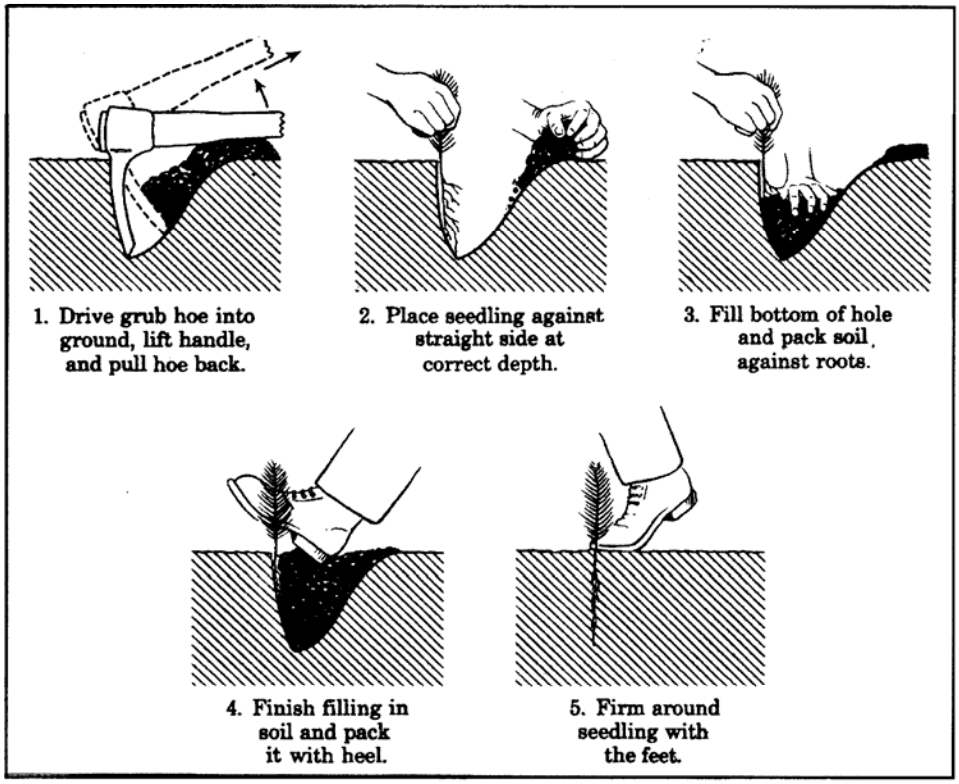


Figure 7 - 8. The Side-Hole Method of Planting. (Sketch adapted from U.S. Forest Service and The Practice of Silviculture, Smith, 1986.)

Figure 3 (continued, page 2 of 2)

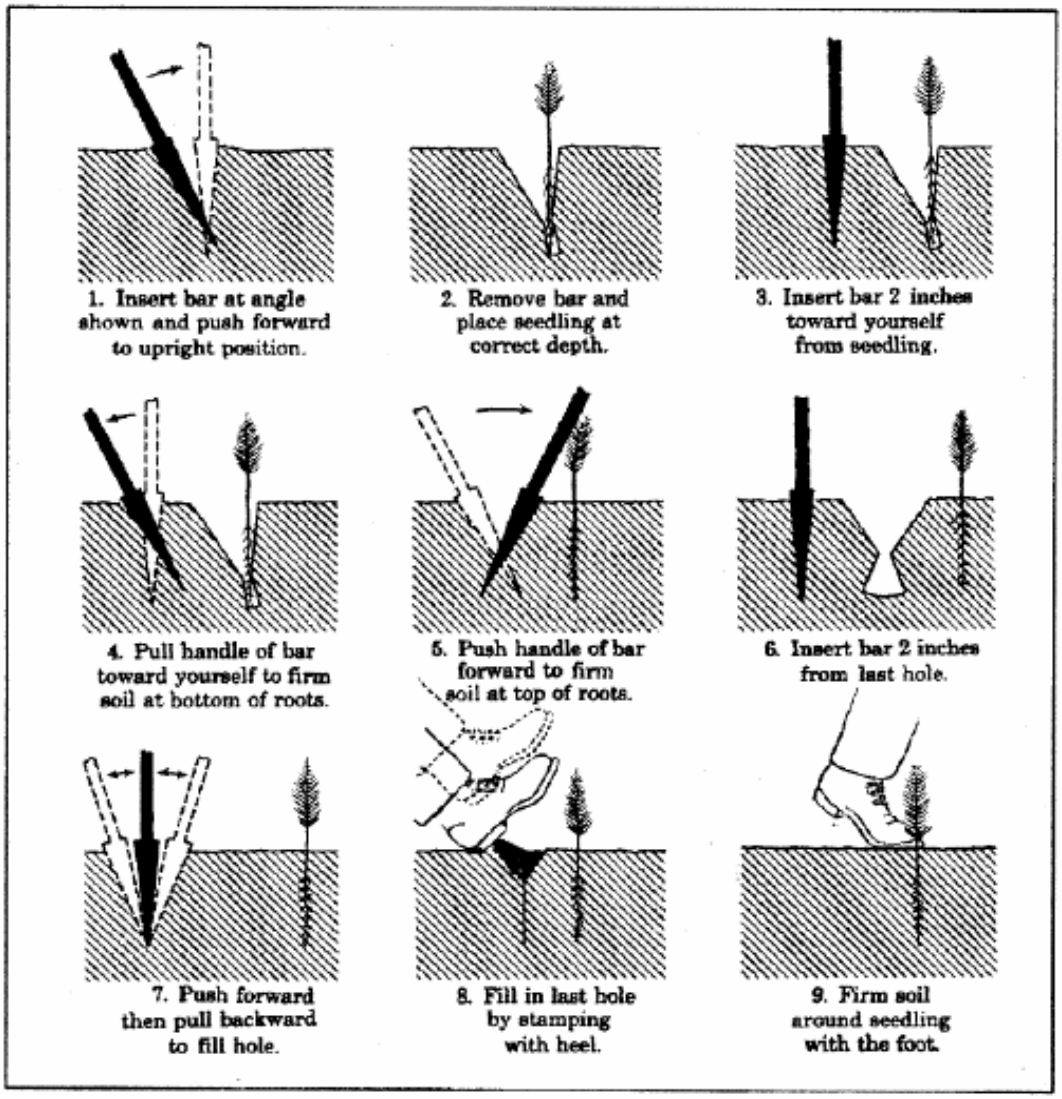


Figure 7 - 7. Slit Method. Steps in the use of the slit method of planting seedlings in sandy soil. (Sketch by U.S. Forest Service.)

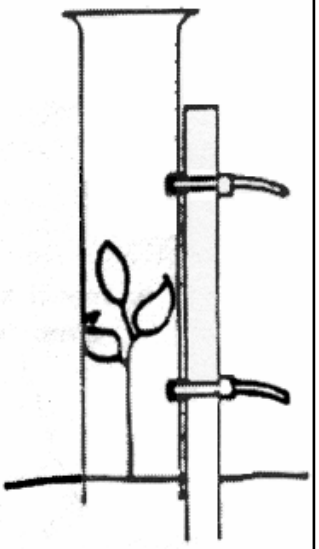
Source: Chesapeake Bay Local Assistance Department, *Riparian Buffers Modification & Mitigation Guidance Manual*, Appendix C, September 2003. http://www.cblad.state.va.us/ripbuffstat.cfm

Figure 4: Installing Tree Protection Tubes

Installing Tree Protectors

3) **The flared end of a Supertube is the top.** Gently guide the Supertube down over the seedling, making sure the seedling doesn't get caught under the ties.

4) Fasten the ties loosely around the stake. Do not tighten them yet.



5) Place your gloved hand over the top of the Supertube and push down until the base of the tube sits ½ - 1" deep in the soil.

This is easiest to do right after planting when the soil is loose, or when the soil is moist.

If the soil is packed or dry, try this: Place a board on top of the Supertube (the board should be at least 6" x 6"). Pound the board with a mallet or hammer, to push the base of the Supertube ½ - 1" into the soil.

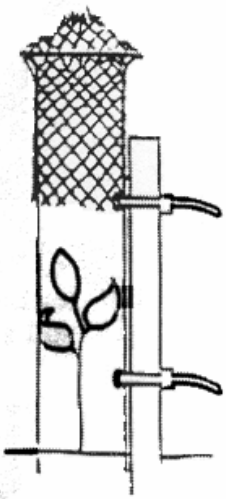
It is critical that the base of every Supertube be well seated in the soil.

6) Cinch the ties tight.

Installing Protective Net

The plastic net included with your shipment of Supertubes (2' and taller) prevents birds from entering the Supertube and harming themselves or the tree.

The net breaks down over 18 months in the sun. It is designed to allow buds to grow through. However, buds can get caught on the net. Each time you are checking your trees, remove the net from those Supertubes where the tree is a few inches from the top or has already emerged. Bird entry is not a problem after the tree emerges.



1) Expand the bottom of the net.

2) Pull the net 7-8" down the Supertube.

3) Adjust the net so that the ends of the net are just touching.

Source: Chesapeake Bay Local Assistance Department, *Riparian Buffers Modification & Mitigation Guidance Manual*, Appendix C, September 2003. http://www.cblad.state.va.us/ripbuffstat.cfm

ON-LOT RUNOFF PRACTICES

On-Lot Runoff Practice Plan Content:

- Vicinity Map, North Arrow
- Property Owner, address, contact and number for plan preparer if different than owner
- Proposed encroachment into the stream buffer (use, square footage, vegetation to be removed).
- Type of mitigation practice to be used. Manufacturers literature if appropriate
- Details on size, materials & installation
- Cross-section sketch with dimensions
- Maintenance plan & schedule

ON-LOT RUNOFF PRACTICES CONTENT

ON-LOT RUNOFF PRACTICES LINKS

Low Impact Development Center – Downloadable fact sheets and information on low impact development plus many valuable links for rain gardens, bioretention, and other stormwater sites.
http://www.lowimpactdevelopment.org/index.htm

Rain Gardens of West Michigan, West Michigan Environmental Action Council – A very detailed site about planning and building rain gardens.
http://www.raingardens.org/Index.php

Virginia Department of Forestry, Rain Garden Site -- Basic information on the considerations of building a rain garden.
http://www.dof.virginia.gov/rfb/rain-gardens.shtml

Prince George's County, Maryland, Department of Environmental Resources, Bioretention – Detailed information on the design of bioretention areas, including a design guidelines, worksheets, and plant lists.
http://www.goprincegeorgescounty.com/Government/AgencyIndex/DER/PPD/LID/bioretention.asp?h=20&s=40&n=50&n1=160

Virginia Stormwater Management Handbook, Department of Conservation & Recreation – The Handbook is a comprehensive design manual for multiple stormwater practices. Standard 3.11 addresses bioretention, and contains detailed design guidelines and a plant list.
http://www.dcr.virginia.gov/sw/stormwat.htm#handbook

Thomas Jefferson Soil & Water Conservation District, Rooftop Runoff Collection – Our local soil and water district is a state leader in promoting the harvesting of rooftop runoff through rain barrels, cisterns, and other devices.
http://www.avenue.org/tjswcd/programsandprojects/page14.html

Alliance for the Chesapeake Bay, Bayscapes Site – The Alliance promotes a landscaping approach that conserves water, is beneficial for wildlife, and protects water quality. The "Bayscapes" page contains information and many publications to download.
http://www.acb-online.org/project.cfm?vid=85

Figure 5: Rain Garden Schematics from Prince George's County, Maryland
Source: *How Does Your Garden Grow: A Reference Guide to Enhancing Your Rain Garden*, Prince George's County Department of Environmental Resources.

These schematics provide a sense of what a rain garden is and how rain gardens can fit into the overall lot landscaping. More specific rain garden design information can be found in the "Links" section, particularly the raingardens.org site.

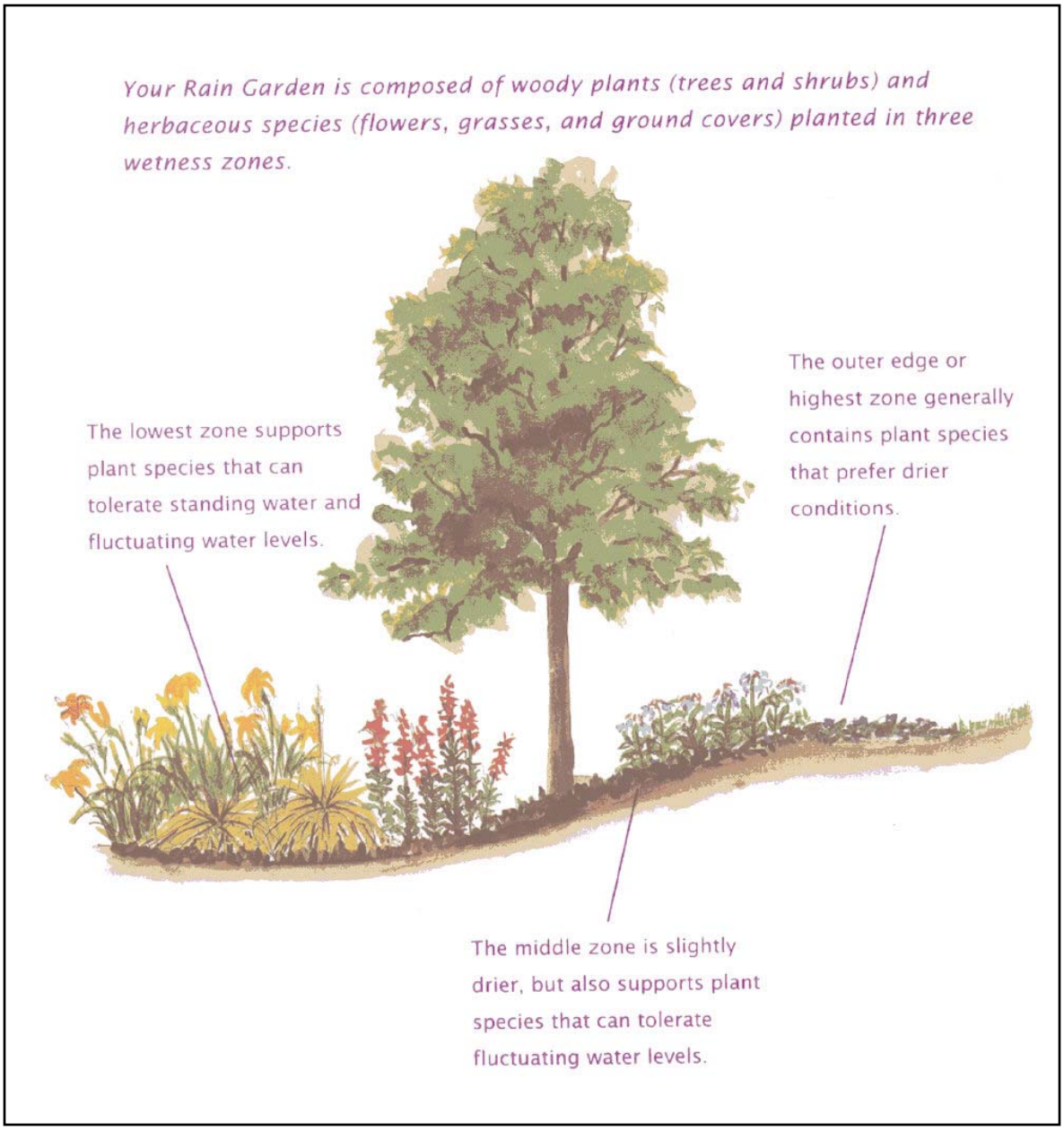


Figure 5 (continued, page 2 of 3)

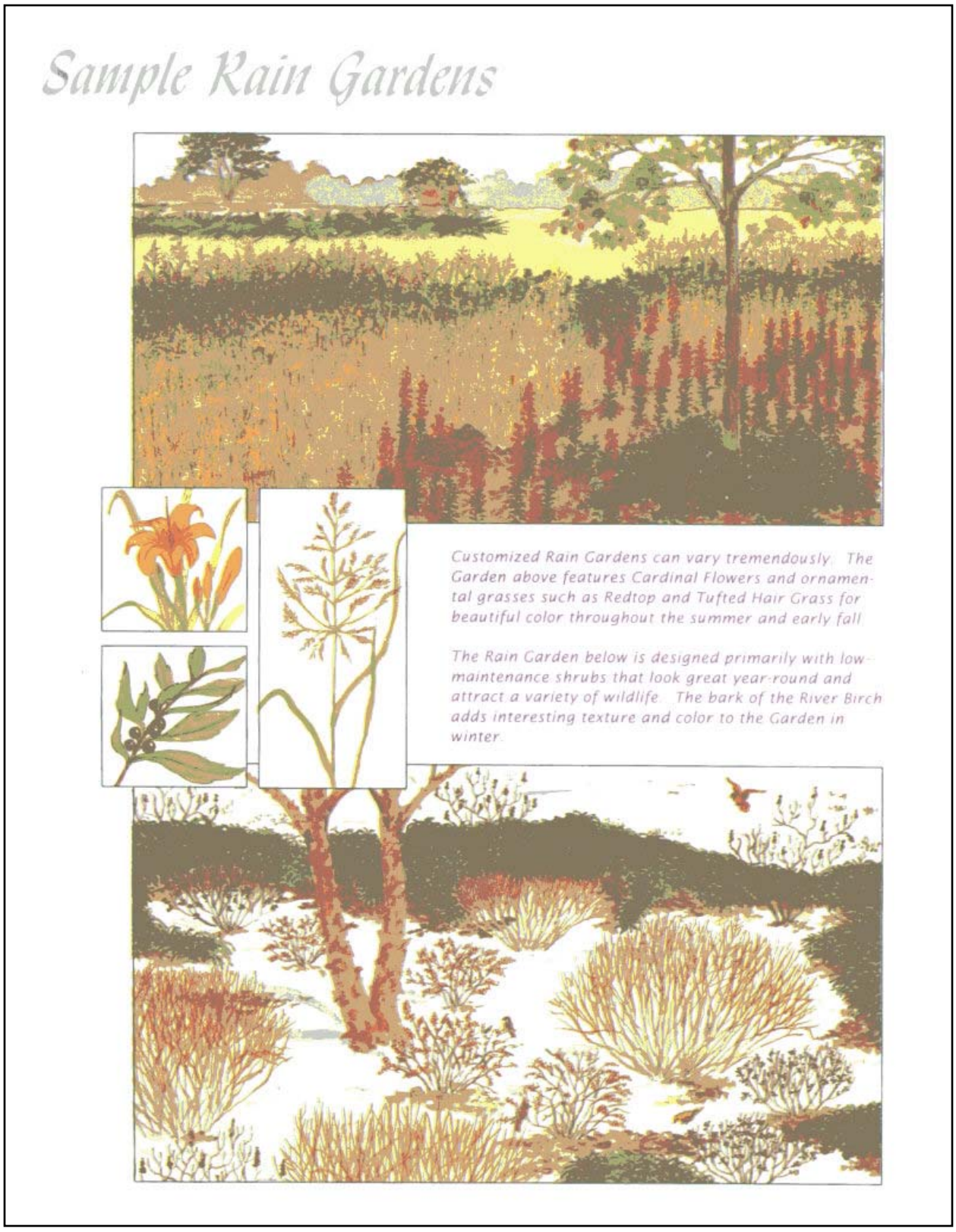


Figure 5 (continued, page 3 of 3)

Figure 6: Rain Garden Detail – Also Known as Bioretention Planting Bed
Source: City of Virginia Beach, Public Works, as modified by D. Hirschman
This detail can be used in conjunction with a landscape plan for an on-lot rain garden (bioretention planting bed).

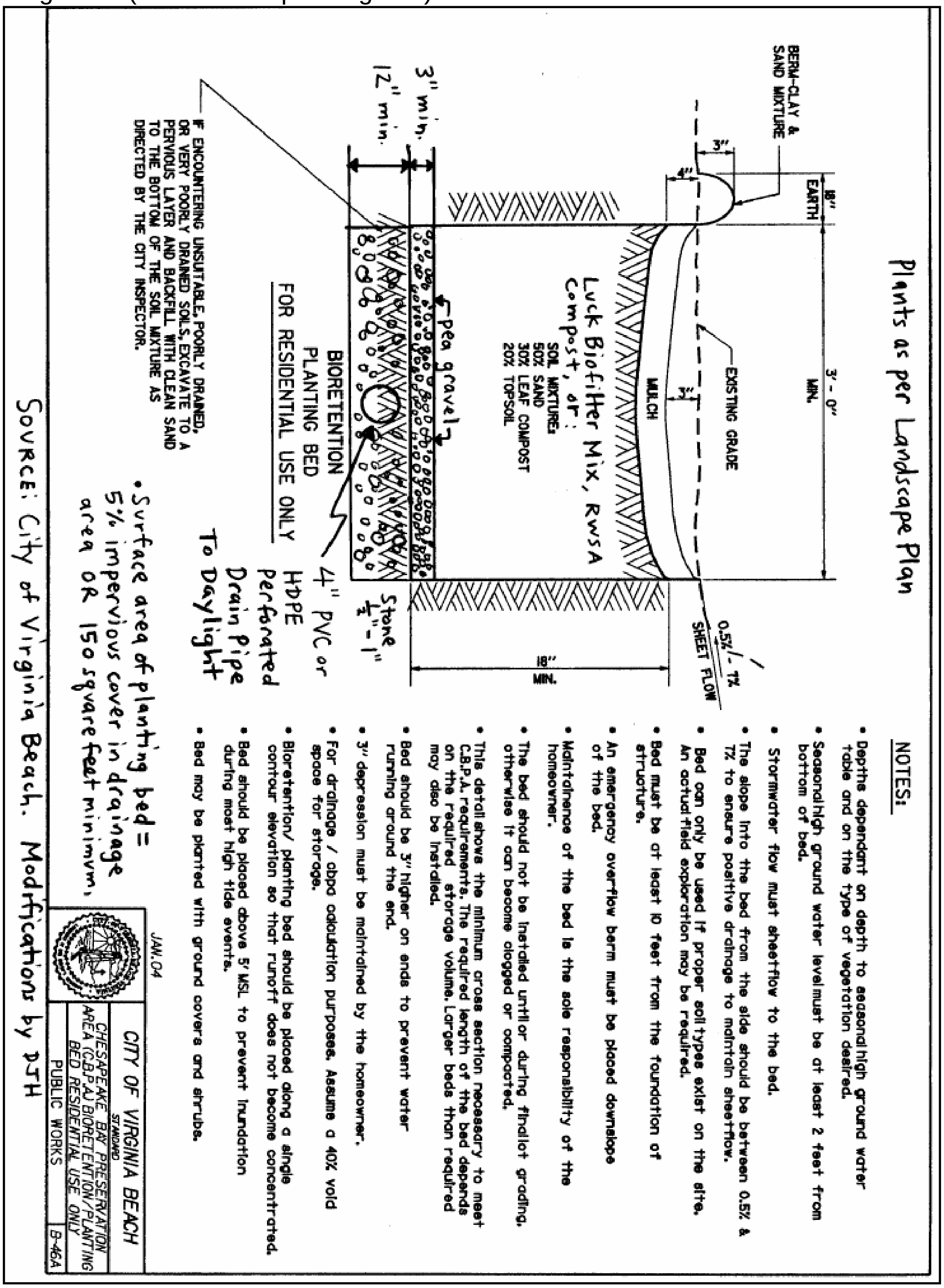


Figure 7: Dry Well Detail
Source: City of Richmond, Chesapeake Bay Preservation Program, Public Information Manual, 1994

The dry well can be used to temporarily store and infiltrate rooftop runoff. Concerns with this design include: clogging (limited longevity) and difficulty of maintenance, especially compared to a surface feature such as a rain garden. Underlying soils are very important, and must be capable of exfiltrating the water. Also, the underground stone reservoir concept can be made into a “french drain” (long, narrow stone filled trench with perforated drainage pipe to daylight). The same concerns exist with longevity and maintenance, but these measures can be very helpful to correct drainage problems near a structure.

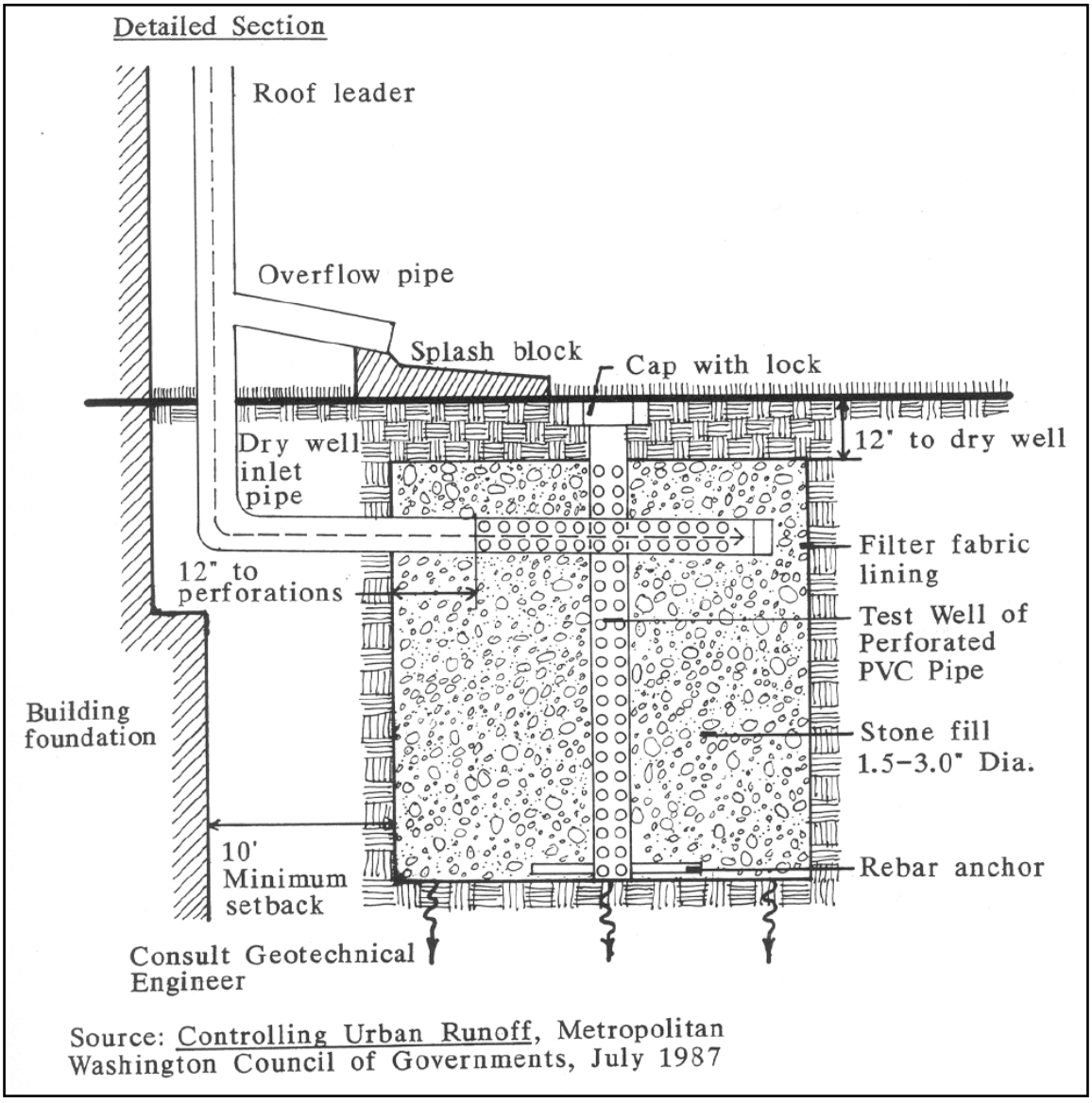
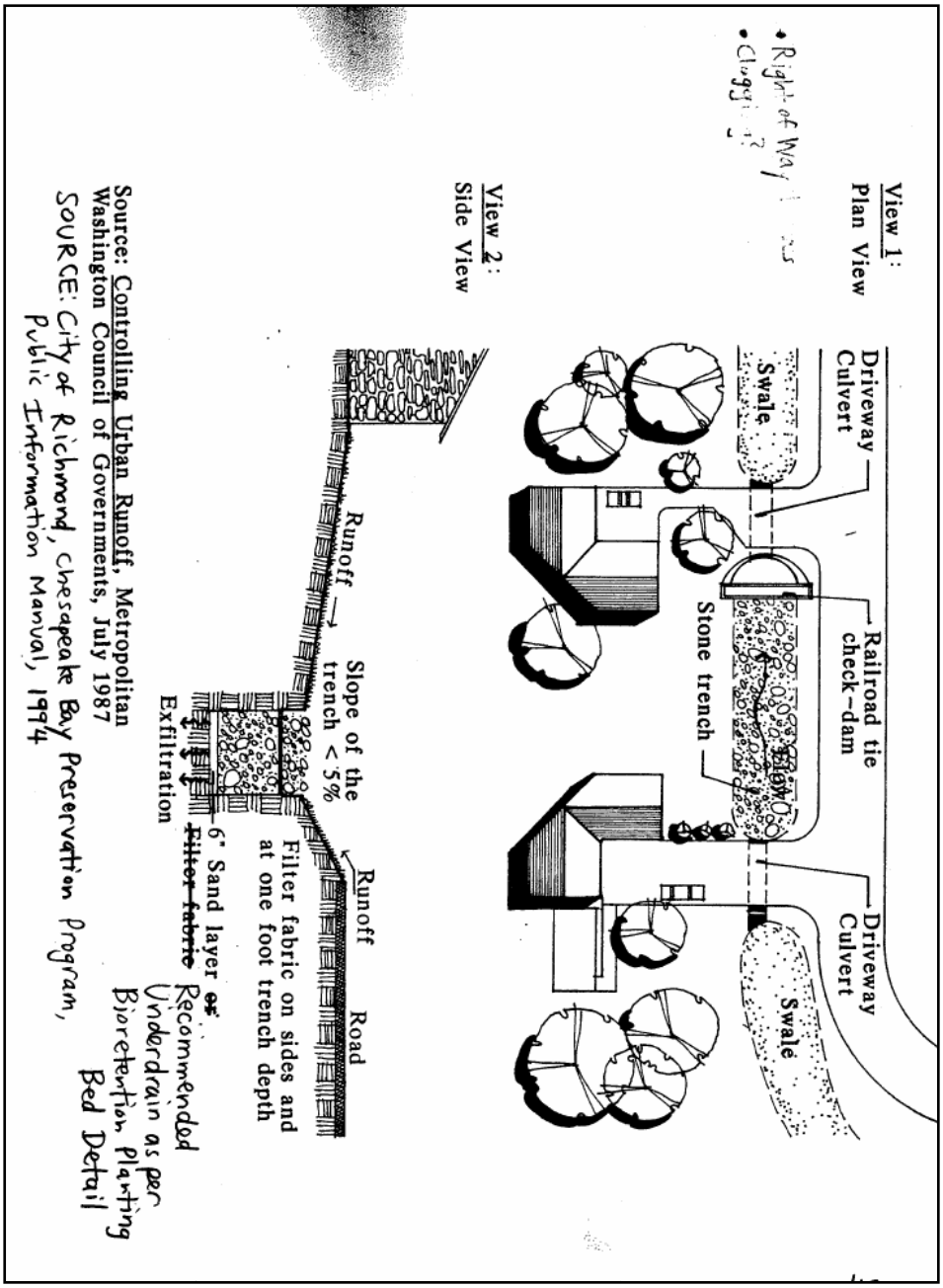


Figure 8: Swale Infiltration Trench
Source: City of Richmond, Chesapeake Bay Preservation Program, Public Information Manual, 1994

This design is another stone reservoir for storing and exfiltrating runoff water. It is designed to be placed strategically in the yard to intercept runoff from driveways, rooftops, and yards. Again, the underlying soils are critical, and must be able to percolate enough water to prevent the trench from clogging. Filter fabric under the trench should be replaced with approximately 3" of pea gravel (less prone to clogging).



On lot run off practices:
'zero discharge; water dispersal for small scale high density sites'

low tech, plants not necessary approach to water dispersal on small sites

Contributed by Amy Ransom Arnold, ASLA
Member of the Charlottesville Planning Commission City Streams Task Force
Principle of land + form, llc
Albemarle County Landscape Planner

On lot run off practices:

'zero discharge; water dispersal for small scale high density sites'

Rain gardens, dry wells, large stone trenches typically serve as single collection points for concentrated volumes of storm water run off. The intimacy of detail in a residential yard can also allow for a more dispersed approach to managing run off that depends primarily on multiple points of infiltration that may or may not include plantings. This system of allowing a large portion of total site run off to soak back into the earth in multiple locations, rather than a few areas and can be directly tied to the driveways, sidewalks, hedges, terraces on a small scale property and integrated into garden / yard detail. Each place of infiltration becomes a part of the design vocabulary of the yard. Rather than creating a single area to treat and absorb the total volume of site run off, the overall volume is dispersed through out the site in smaller areas, drainage details become yard details.

Engineering details can be scaled down and used very locally to manage water on site. Every impermeable surface has its own infiltration area sized to handle its specific volume of run off in a matrix of trenches and drainage areas that are scattered throughout the site to absorb surface flow. The surface area of the infiltration area equals five percent (5%) impervious cover in drainage area. Water loving indigenous plants can be included as part of the system to help absorb water. The presence of plants in the system is determined by the interest of the resident in the maintenance of the plantings.

With or without heavy planting, the goal is to create an overall absorbent matrix, increasing permeability across the entire site, compensating integrally for every impermeable element:

*a driveway can have an integral infiltration area, sized for area of impermeable surface (see swale infiltration trench cross section in Figure 8)

*a concrete terrace becomes stone pavers set in stone dust (permeable compensates for impermeable)

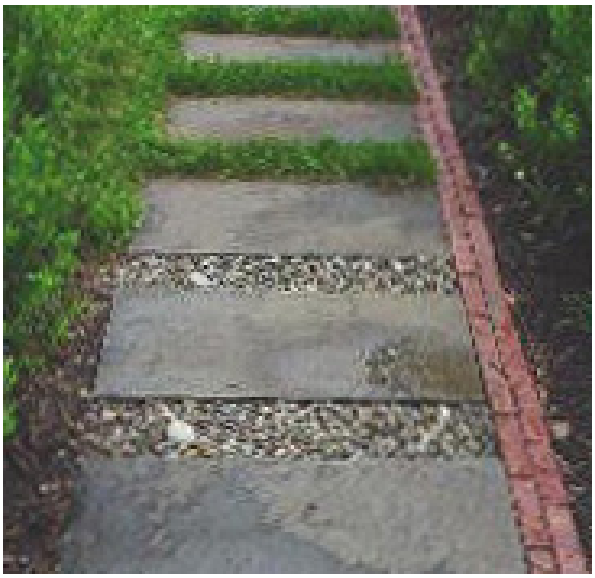
*lawn is converted into a meadow planting (increase permeability, decrease sheet flow)

*soil pockets for water loving plants are dispersed among less permeable elements

*tree plantings increase (decrease sheet flow)

*garden beds replace turf (decrease sheet flow)

*concrete walkways become segmented paths alternating planting and paving (decrease sheet flow)



*****stone filled trenches are placed to line pavement, flower beds, hedges and in circles or mounds around trees (see infiltration trench cross section)

*drainage details become garden details (small scale sand filter / rainwater rill carries roof downspout water)

Hedges and hedgerows of water loving plants that are slightly lower than the rest of the yard can be used to collect run off when they are made up of plant species that are adaptable to a variety of conditions, withstand both drought and wet soils. (refer to the recommended plant lists for rain gardens) Your rain garden can become a hedge serving as rain water management and formal garden element simultaneously. The same applies to tree groves, lines of trees or drifts of water loving perennials and grasses. Local stone and soil suppliers now carry bioretention (rain garden) soil media for use in rain gardens or in an overall integrated infiltration matrix.

By far the greatest source of storm water run off in a residential context is roofs. Green roofs have long been a part of design / construction vocabulary in Europe and are the most effective way to decrease roof water run off. The technology for green roof construction is surprisingly accessible. The internet provides multiple web sites that provide detailed information about the use of green roofs. Local soil and stone companies now carry multiple types of green roof media (soil).

Rain water valves installed in downspouts can collect run off from a green or conventional roof to storage tanks or a cistern, directing any overflow into a gravel trench filled with river stone, or a hedge that is slightly lower than its context and contains water loving plants (refer to the recommended plant lists for rain gardens). Gravel infiltration trenches and 'wet hedges' can be combined for maximum effect. Submersible pumps are an efficient way to make use of your collected water, saving money on watering your garden in the long run. With proper filtering, collected water can be used in drip irrigation systems.

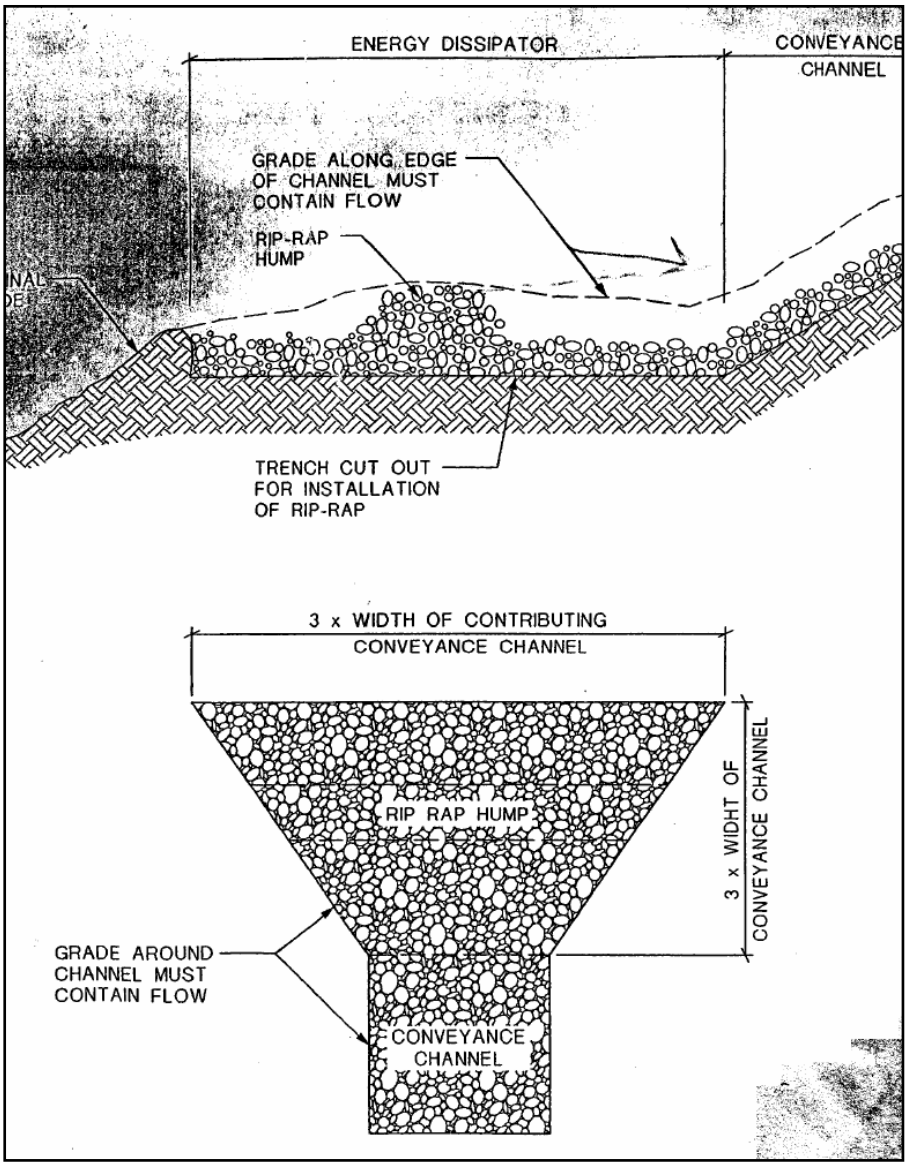
By allowing for the integration of a matrix of infiltration and collection, planned as an overall system, the goal of zero discharge (run off) from a small lot or residential property is close to attainable. Certainly the run off contributed to the stream watershed becomes closer to the pre development conditions of the surrounding area and begins to compensate for the impact of a densely populated urban environment on our streams and rivers.

UPSLOPE STORMWATER CONTROLS

The purpose of upslope stormwater controls is to prevent concentrated flow from eroding, damaging, and/or short-circuiting the stream buffer area. Techniques may include energy dissipators, level spreaders, check dams, or detention facilities. Proper construction of these measures can be difficult, and construction oversight by the City is important.

Two measures are presented: (1) Level Spreader/Energy Dissipator detail used in Albemarle County (Figure 9), and (2) Energy Dissipator design from the Henrico County Environmental Program Manual (Section 9.01-1; Figures 10 and 11)

Figure 9: Level Spreader/Energy Dissipator



ENERGY DISSIPATOR

Excerpted From: Henrico County Environmental Program Manual, Minimum Standard 9.01,
http://ntit6new.co.henrico.va.us/works/newdpwweb/enviromanual.htm

*Henrico County's Energy Dissipator design can be used for **upslope stormwater controls** in order to avoid erosive flows from a storm sewer through the stream buffer. The City may adapt this design to specific site conditions based on sound engineering judgment.*

Definition

An energy dissipator is a device that is used to convert concentrated stormwater runoff to sheet flow and is constructed at the end of all storm sewers or channels that outfall into a buffer.

Purpose

The purpose of an energy dissipator is to introduce storm flows into the buffer at a slower rate and spread the flow over a larger area than would normally occur with a storm sewer outfall. The energy dissipator allows for more efficient use of the buffer by spreading the storm flow over a wider area of the buffer.

Design Criteria

Energy dissipators are required at the end of all storm sewers and constructed/altered channels that outfall into Stream Protection Areas. The energy dissipators must be designed and constructed according to the following design criteria. All appropriate details must be included in the approved plans.

- As indicated in the following table, either Design A (**Figure 10**) or Design B (**Figure 11**) (refer to sketches) will be provided based on the pipe size and discharge (10-year storm) or the channel's discharge (10-year storm).

Pipe Diameter (in)	10-Year Peak Discharge (cfs)									
	10	20	30	40	50	60	70	80	90	100
15	A	A								
18	A	A	A	A						
21		A	A	A	B					
24			A	A	B	B	B	B		
27			A	A	A	B	B	B	B	B
30				A	A	A	B	B	B	B
36						A	A	B	B	B
42									A	B

- The sides and bottom of the plunge pool excavation shall be lined with filter fabric underlining and Class AI rip rap in accordance with the Virginia Erosion and

Sediment Control Handbook, Third Edition, 1992, State Minimum Standards and Specifications Number 3.19.

- The spreader weir section shall be constructed by excavating a trench to the depth and configuration shown, laying down hardware cloth and backfilling with VDOT No. 3 aggregate. The hardware cloth shall be galvanized steel, ½ inch mesh, 19 gauge. The hardware cloth shall be wrapped around the aggregate and timber as shown and the edges stapled to the top of the timber every 12" with ¾ inch galvanized steel staples.

- The 6" x 6" treated timber shall be level.

- Special considerations shall be made where a cross slope exists in the area of construction and outfall, and where there is a possibility that storm water may flow around and bypass the spreader weir. The contractor shall construct an additional timber and aggregate weir section as shown that ties back into existing grade.

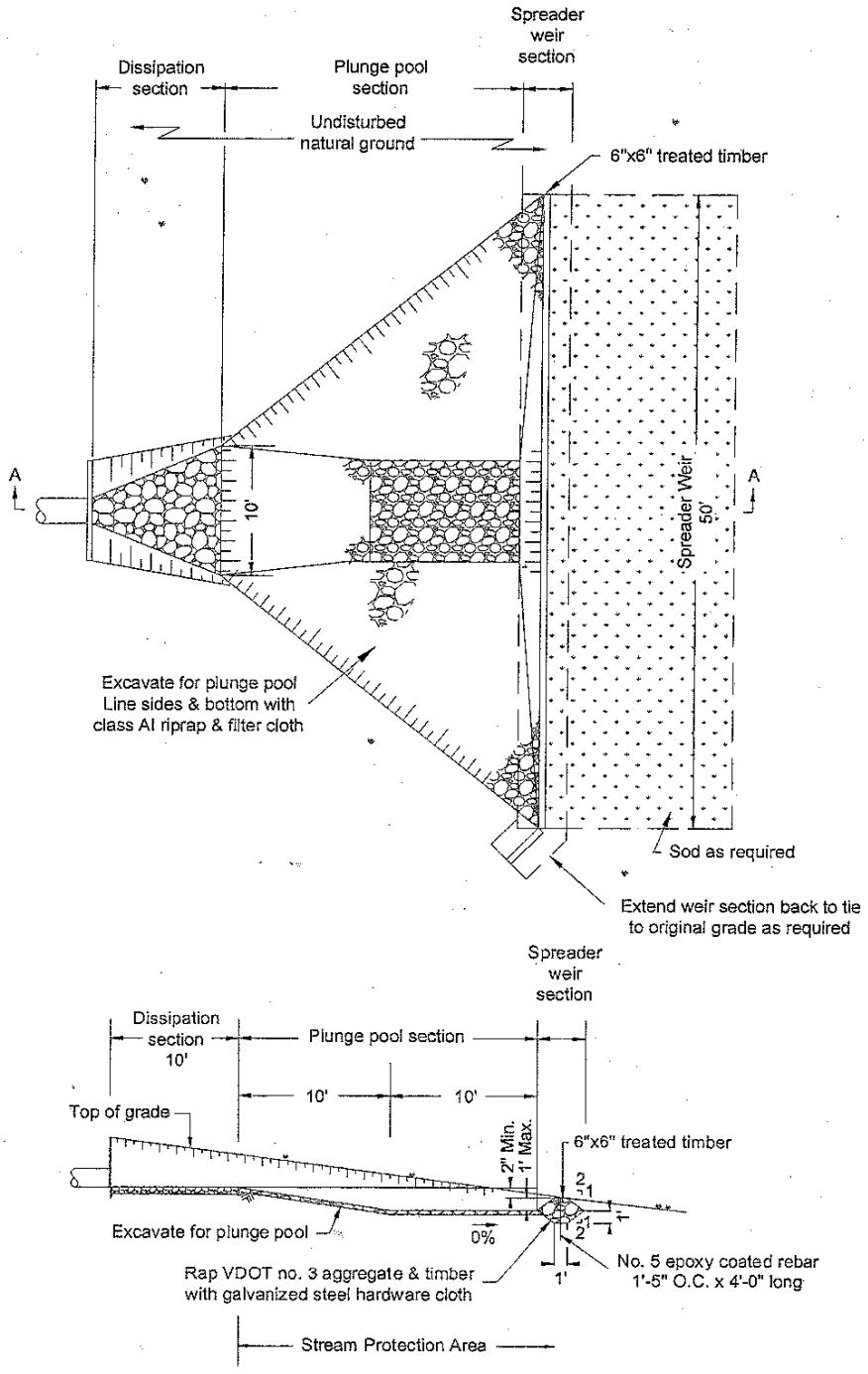
- A minimum of clearing and grading may be required downstream of the spreader weir section to insure free overflow of storm water over the weir. Generally, all clearing and grading shall be kept to a minimum, but where required, the disturbed area shall be planted with sod in accordance with the Virginia Erosion and Sediment Control Handbook, Third Edition, 1992, State Minimum Standards and Specifications Number 3.33. The sod shall be secured with netting and staples in accordance with Plate 3.33-2.

- If installed at the end of county maintained storm sewer, the drainage easement must encompass the entire energy dissipator (dissipation section, plunge pool section, and spreader weir section) and provide an area 10 feet wide around the entire energy dissipator to provide for maintenance.

- As indicated in the details, the dissipation section of the energy dissipator is outside the Stream Protection Area (SPA). The remaining components (plunge pool section and spreader weir section) of the energy dissipator will be in the upper twenty (20) feet of the SPA unless site constraints dictate otherwise and the Department of Public Works concurs.

Pollutant Removal

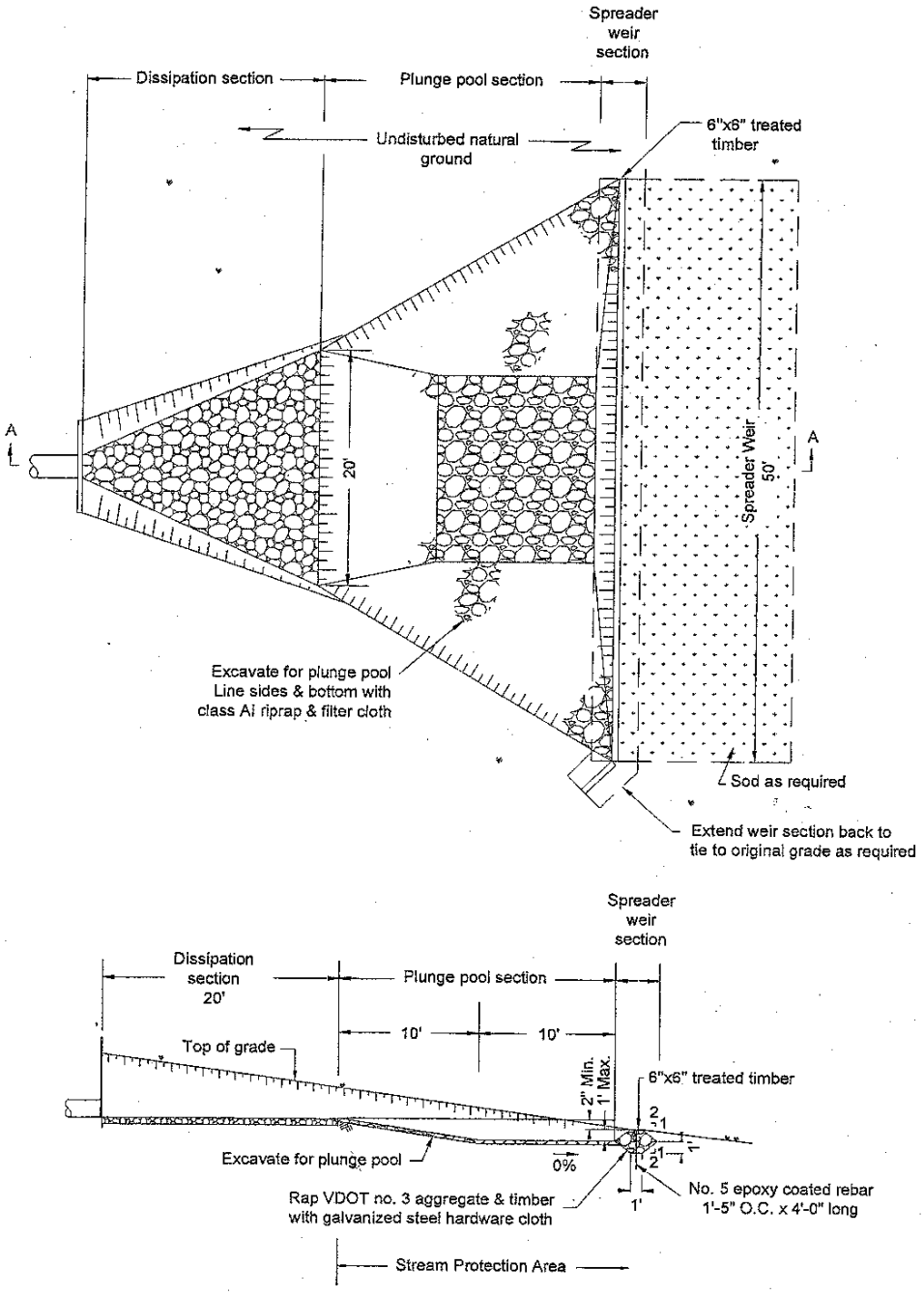
Each energy dissipator that is installed in conjunction with the SPA is assumed to result in 0.10 pound of pollutant removal.



Section AA

Storm Water Outflow Spreader Device
Design A
N.T.S.

Figure 10



Section AA

Storm Water Outflow Spreader Device
Design B
N.T.S.

Figure 11

6. Sample Plans

Two sample plans are included in this section: one for an on-lot runoff practice (bioretention planting bed) and the other for compensatory plantings. Both are for small-scale encroachments resulting from residential activities. These sample plans are only offered as examples. Plan preparers may use discretion in plan layout, as long as the minimum content is included, as listed in the Standard Details & Design Guidance (see page 14 for compensatory planting and page 37 for on-lot runoff practices).

On-Lot Runoff Practice Sample Plan

Proposed House Addition at 117 Meadowcreek Lane

Narrative
Owner: Betty & Ralph
Address: 117 Meadowcreek Lane, Charlottesville, VA 22901
Phone: 293-XXXX
Email: bettyandralph@meadowcreek.com
Tax Map & Parcel: 15-72-B(1)

Existing Conditions: Our existing house is right at the 100 foot stream buffer line, as measured from the top of the bank of Meadow Creek. The house was built in 1974, and the lot was platted in 1970. This lot was recorded prior to the City's adoption of the Water Protection Ordinance. The existing buffer vegetation consists of woods with large, mature trees, generally within the first 50 feet of the buffer (closest to Meadow Creek), and lawn in the remaining buffer up to the house. The treeline extends beyond the 100 foot buffer line west of the house, where a steep slope drops down from the neighboring lot. This slope is approximately 25%. The backyard slopes to the northeast. These features are shown on the enclosed plan.

Proposed Use in the Stream Buffer: We are proposing to build a modest addition to our house for a study and den. The addition will have a footprint of 370 square feet. No more land will be disturbed than is necessary for the construction of this addition. The existing vegetation in the area of the proposed addition is grass and foundation plantings. Theoretically, the addition could be built on the west side of the house outside of the stream buffer. However, the steep slope and existing woods along that side would necessitate much more clearing, grading, and tree cutting (and much more damage to the buffer and its functions) than at the proposed location behind the house. The addition can be authorized by the City in accordance with the Water Protection Ordinance, Section 10-74(d)(1), as long as a mitigation plan is approved.

Proposed Mitigation: The proposed use in the stream buffer is quite small. We are proposing a bioretention planting bed with a minimum square footage of 150 square feet. The existing house and driveway all drain through the backyard, and this runoff is currently untreated. The new addition and as much of the existing house and driveway as practical will flow to the bioretention area. This is an area where we want to do some landscaping anyway, and the planting bed will fit into our yard landscape plans and allow us to continue to enjoy our backyard. We have no intention of cutting or encroaching into the existing forest that lines the banks of Meadow Creek (except for our son's tree house). The bioretention planting bed will constructed based on the attached diagram and plan. We will also place silt fence at the construction limits during construction to ensure that silt and sediment do not run towards the creek.

Maintenance: We will ensure that the bioretention planting bed will be maintained along with our other landscaping. Maintenance will generally include adding and replacing plants, annual mulching, and making sure that the bed does not pond water for long periods of time (more than 2 days).

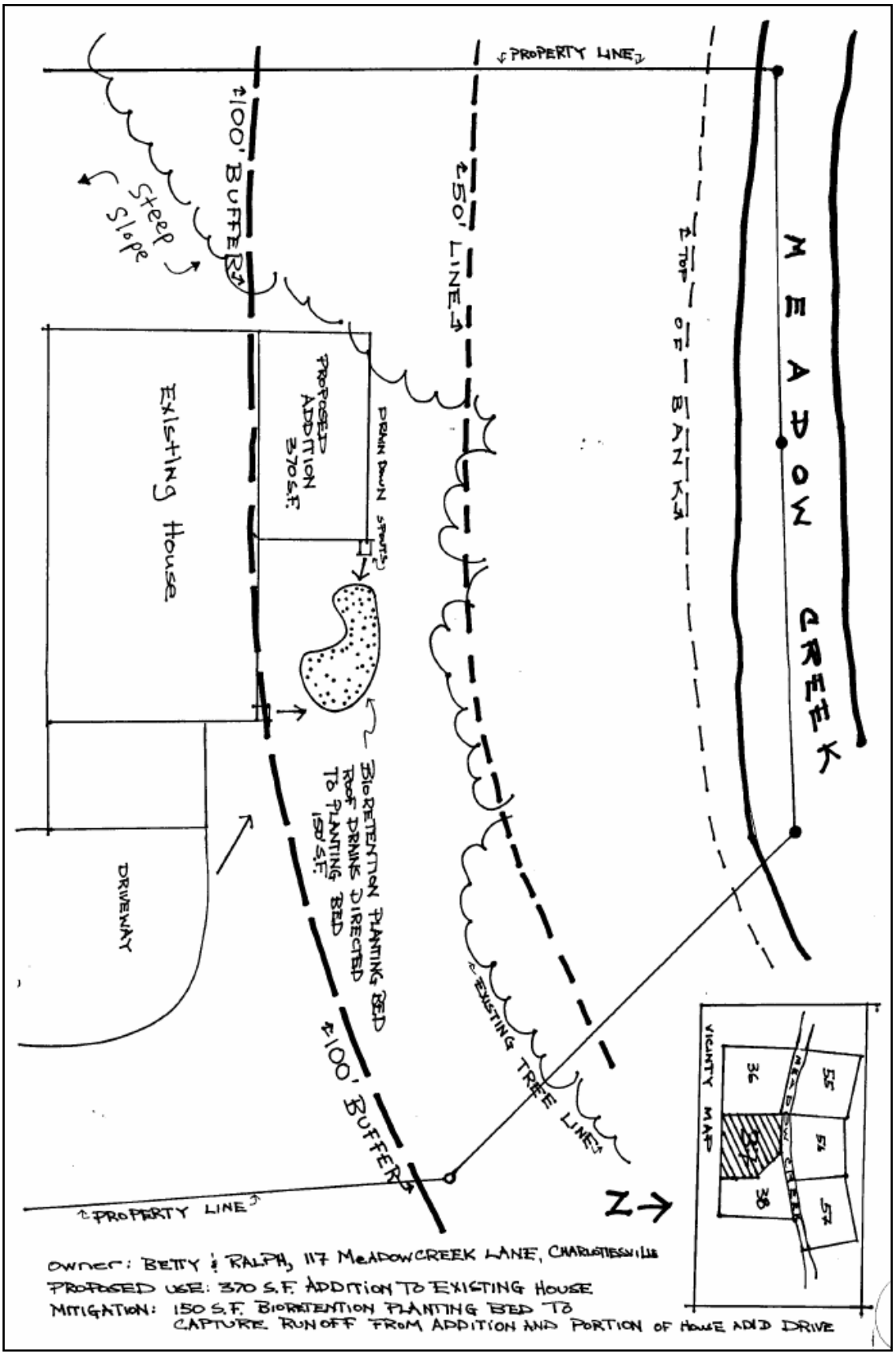


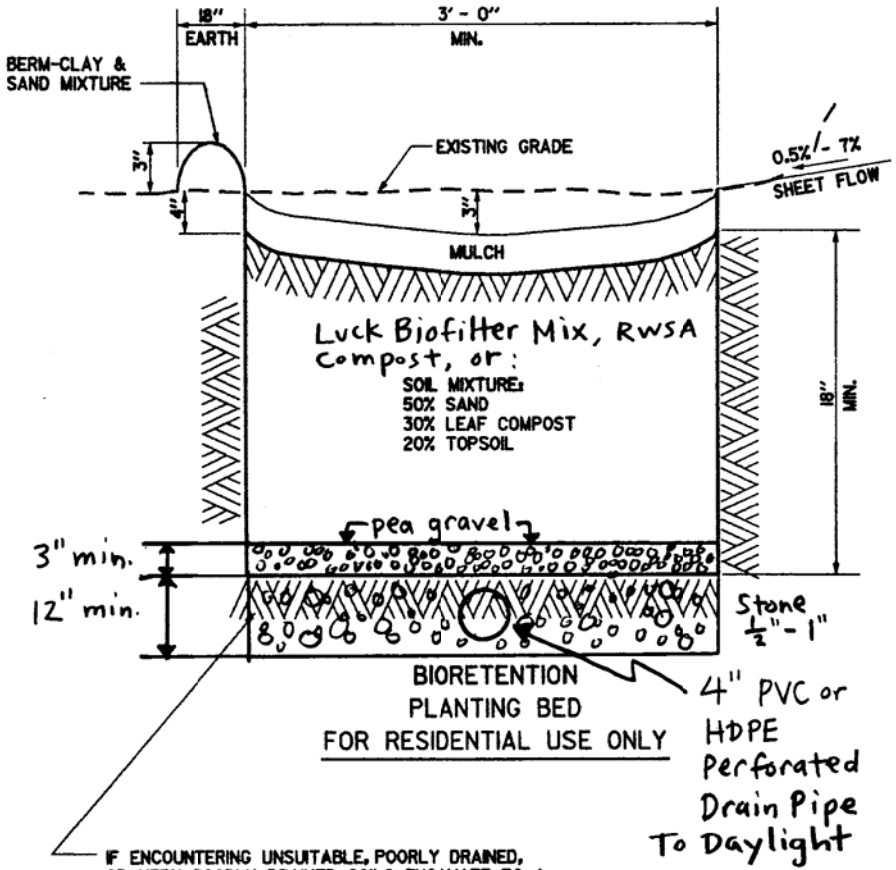
Figure 12: Sample Plan for On-Lot Runoff Practice (page 2 of 4)

Bioretention Planting Bed Plant List

Quantity	Botanical Name	Common Name	Size & Root Condition	Remarks
TREES				
1	*Betula nigra*	River Birch	1 – 1-1/2” cal., B&B	
SHRUBS				
2	*Cornus stolonifera*	Red Twig Dogwood	18 – 24” CONT.	
2	*Hypericum densiflorum*	St. John’s Wort	18” CONT.	
1	*Hamamelis virginiana*	Witch Hazel	18 – 24” CONT	
PERENNIALS				
5	*Lobelia cardinalis*	Cardinal Flower	½ gallon cont.	
5	*Hemerocallis spp.*	Daylilly	Transplants	
5	*Rudbeckia laciniata*	Green-headed Coneflower	6” pot	
GROUNDCOVER				
50	*Liriope spp.*	Lily-turf	Plugs	18” o.c.

Note: Plants may be substituted based on availability. Additional plants may be added at the owner’s discretion.

Sample Plan for On-Lot Runoff Practice (page 3 of 4)



NOTES:

- Depths dependant on depth to seasonal high ground water table and on the type of vegetation desired.
- Seasonal high ground water level must be at least 2 feet from bottom of bed.
- Stormwater flow must sheetflow to the bed.
- The slope into the bed from the side should be between 0.5% & 7% to ensure positive drainage to maintain sheetflow.
- Bed can only be used if proper soil types exist on the site. An actual field exploration may be required.
- Bed must be at least 10 feet from the foundation of structure.
- An emergency overflow berm must be placed downslope of the bed.
- Maintainence of the bed is the sole responsibility of the homeowner.
- The bed should not be installed until or during final lot grading, otherwise it can become clogged or compacted.
- This detail shows the minimum cross section necessary to meet C.B.P.A. requirements. The required length of the bed depends on the required storage volume. Larger beds than required may also be installed.
- Bed should be 3" higher on ends to prevent water running around the end.
- 3" depression must be maintained by the homeowner.
- For drainage / cbpa calculation purposes. Assume a 40% void space for storage.
- Bioretention/ planting bed should be placed along a single contour elevation so that runoff does not become concentrated.
- Bed should be placed above 5' MSL to prevent inundation during most high tide events.
- Bed may be planted with ground covers and shrubs.

• Surface area of planting bed = 5% impervious cover in drainage area OR 150 square feet minimum.

JAN. 04

CITY OF VIRGINIA BEACH
STANDARD
CHESAPEAKE BAY PRESERVATION AREA (C.B.P.A.) BIORETENTION/PLANTING BED RESIDENTIAL USE ONLY
PUBLIC WORKS | B-46A

SOURCE: City of Virginia Beach. Modifications by DJH

Sample Plan for On-Lot Runoff Practice (page 4 of 4)

Compensatory Planting Sample Plan

Proposed Deck at Buffet Residence

Narrative
Owner: Ryan Buffet
Address: 843 Riparian Way, Charlottesville, VA 22901
Phone: 293-XXXX
Email: ryan@moorescreek.com
Tax Map & Parcel: 50-12-A(1)

Existing Conditions: This lot has frontage on Moores Creek. The existing house, built in 1984, is within the 100 foot buffer line, measured from the top of the bank. Most of the existing buffer is currently grass, with scattered trees and shrubs. A narrow band of trees lines the bank of Moores Creek and extends up the northern property line.

Proposed Use in the Stream Buffer: A 400 square foot deck is proposed, as shown on the attached plan. Roughly half of the deck will be within the 100 foot stream buffer. No more land will be disturbed than is necessary for the construction of this addition. The existing vegetation in the area of the proposed addition is grass, except that the corner closest to the creek has some trees and shrubs that will need to be removed. These include 2 red oaks (10" and 12" caliper) and 4 spicebushes (5' high). An additional red maple (8" caliper) will be removed, but is outside of the buffer (however, we are counting this as part of the vegetation that must be mitigated).

The proposed deck is no closer to Moores Creek than the existing house.
The addition can be authorized by the City in accordance with the Water Protection Ordinance, Section 10-74(d)(1), as long as a mitigation plan is approved.

Proposed Mitigation: The construction of the deck within the buffer and removal of the trees and shrubs mentioned above will be mitigated through creating a compensatory buffer planting area closer to Moores Creek. This replanted buffer area will consist of 8 trees and 12 shrubs, as noted on the attached plan. The replanted area is currently turf and is only a few feet from the top of the streambank. In this regard, the compensation area will better aid the functions of the stream buffer to protect Moores Creek than the area to be impacted. All plant materials will be nursery stock and will be installed in accordance with the attached specifications. Planting will take place sometime between October 15 and December 15 of 2004.

Maintenance: All plants will be watered during the first growing season. Any plants that die during the first year will be replaced (during the fall of 2005). Otherwise, the area will be left to nature so that it can blend into the existing vegetation along Moores Creek.

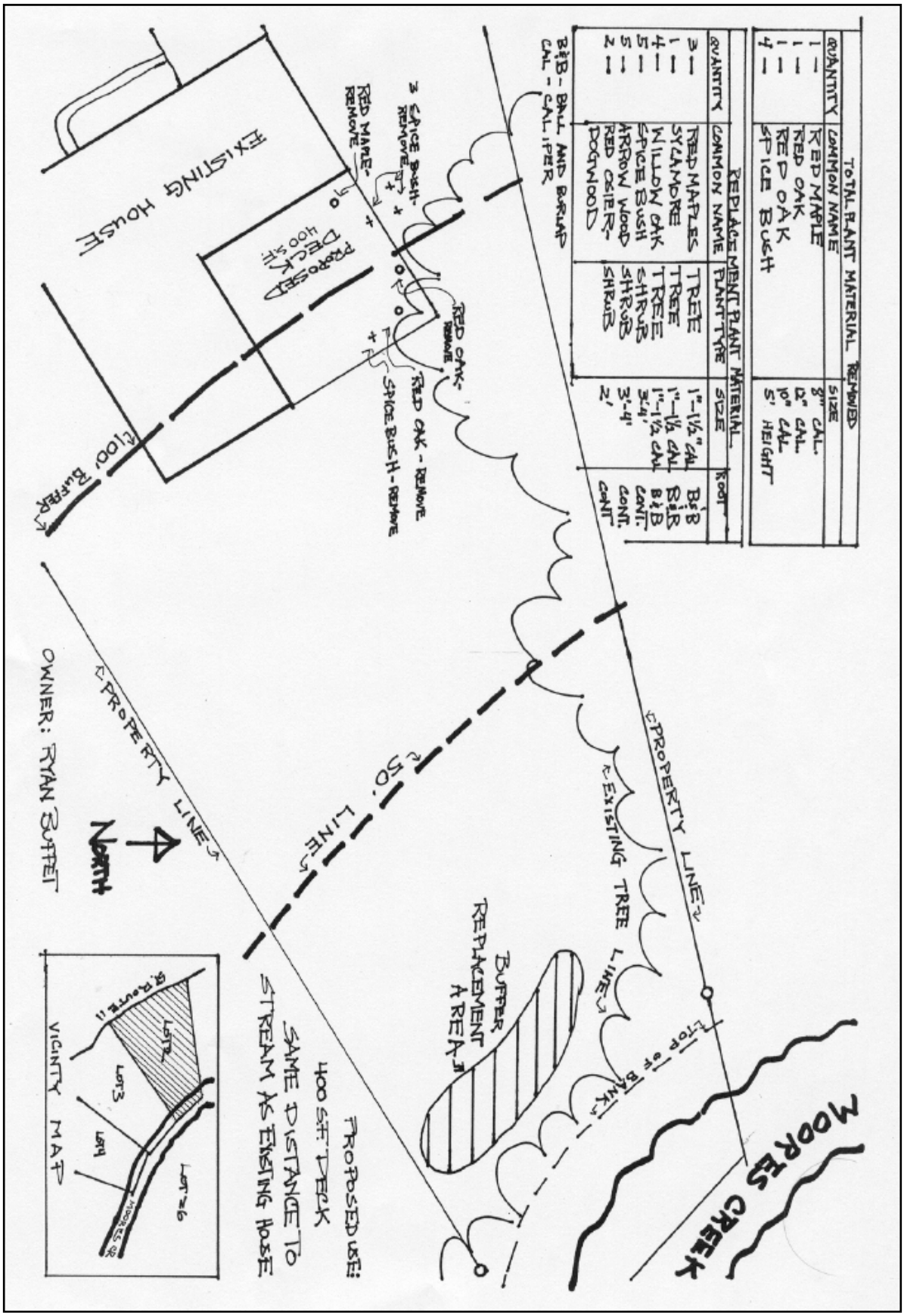
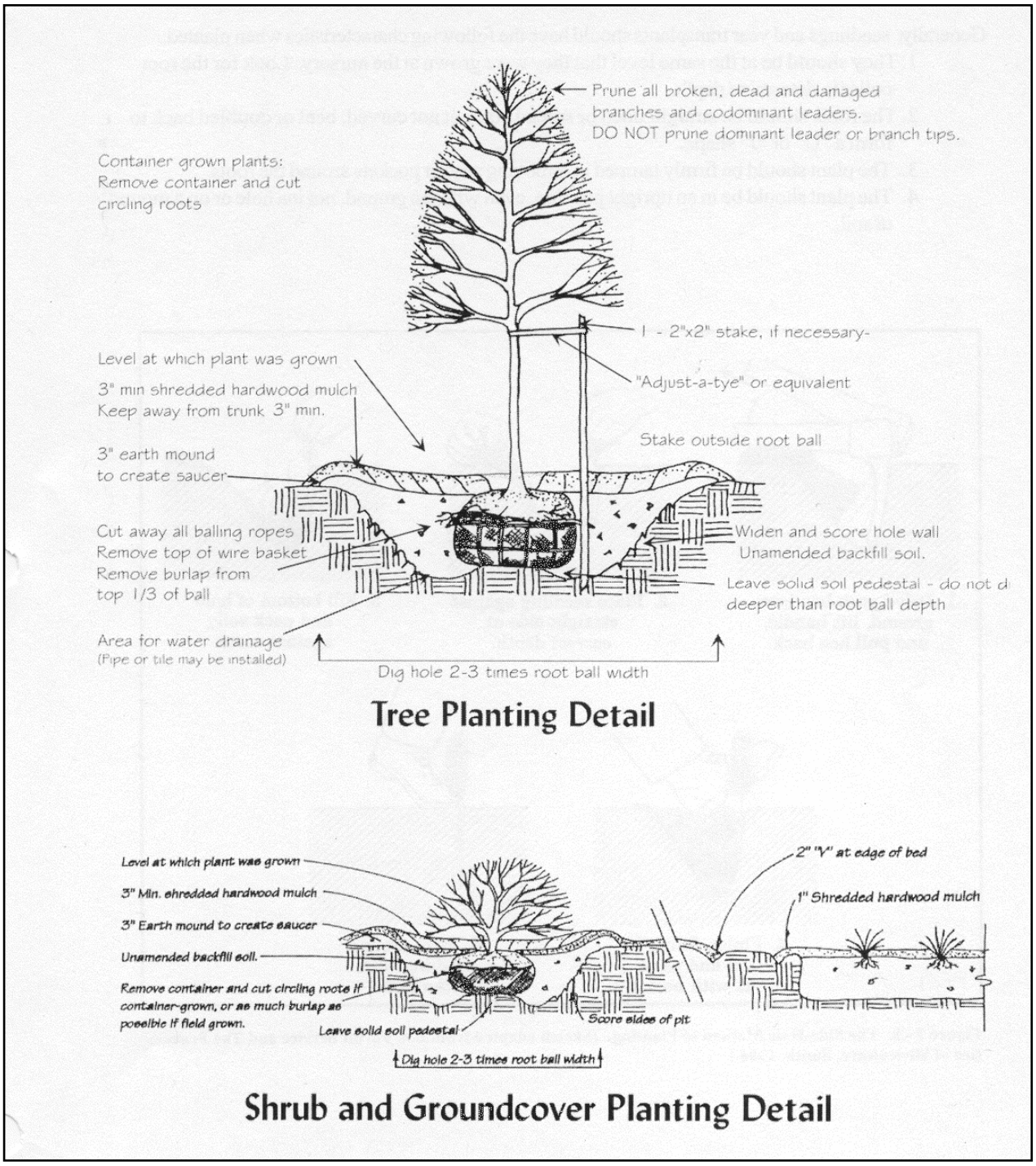


Figure 13: Sample Plan for Compensatory Planting (page 2 of 3)



Sample Plan for Compensatory Planting (page 3 of 3)