Grass Channel

Description: Limited application structural control intended for small drainage areas. Open channels that are vegetated and are designed to filter stormwater runoff through settling and biological uptake mechanisms, as well as to slow water for treatment by another structural control.

Advantages/Benefits:

- Provides pretreatment if used as part of runoff conveyance system
- Cost effective – less expensive than curb and gutter
- Good for small drainage areas
- Generally used in conjunction with downstream practices to increase runoff reduction

Disadvantages/Limitations:

- Must be carefully designed to achieve low, non-erosive flow rates in the channel
- May re-suspend sediment
- Due to potential standing water in channels increased maintenance may be required.
- Will not receive additional runoff reduction credit if more than one grass channel is used in a series

Selection Criteria:

10% – 20% Runoff Reduction Credit for HSG soils C and D

20% – 30% Runoff Reduction Credit for HSG Soils A and B

Land Use Considerations:

- X **Residential**
- X **Commercial**
- X **Industrial**

Maintenance:

- Monitor sediment accumulation and periodically clean out
- Inspect for and correct formation of rills and gullies
- Remove debris from inlet and outlet structures
- Maintain side slopes/remove invasive vegetation
- Ensure that vegetation is well-established

L **Maintenance Burden**
L = Low M = Moderate H = High

SECTION 1. DESCRIPTION

Grass channels are conveyance channels that are designed to provide some treatment of runoff, as well as to slow down runoff velocities for treatment in other structural controls. Grass channels are appropriate for a number of applications including treating runoff from paved roads and from other impervious areas.

Grass channels can provide runoff filtering within the stormwater conveyance system resulting in the delivery of less pollutants than a traditional system of curb and gutter, storm drain inlets and pipes. The performance of grass channels will vary depending on the underlying soil permeability as shown in **Table 7.1**. Grass channels, however, are not capable of providing the same stormwater functions as water quality swales as they lack the storage volume associated with the engineered soil media. Their runoff reduction performance can be increased when compost amendments are added to the bottom of the channel (See **Appendix 7-A**). Grass channels are a preferable alternative to both curb and gutter and storm drains as a stormwater conveyance system, where development density, topography and soils permit.

SECTION 2. PERFORMANCE

Table 7.1. Runoff Volume Reduction Provided by Grass Channels[1]				
Stormwater Function	**Level 1 HSG Soils C and D**		**Level 2 HSG Soils A and B**	
	No CA[2]	**With CA**	**No CA[2]**	**With CA[3]**
Runoff Volume Reduction (RR)	10%	20%	20%	30%[3]
Will not receive additional runoff reduction credit if more than one grass channel is used in a series				

[1] CSN (2008) and CWP (2007).
[2] CA= Compost Amended Soils, see Appendix 7-A
[3] Compost amendments are generally not applicable for A and B soils, although it may be advisable to incorporate them on mass-graded and/or excavated soils to maintain runoff reduction rates. In these cases, the 30% runoff reduction rate may be claimed, regardless of the pre-construction HSG.

SECTION 3: TYPICAL DETAILS

See Appendix 7-B for required standard applicable details for use in construction plans.

SECTION 4: PHYSICAL FEASIBILITY AND DESIGN APPLICATIONS

Grass channels can be implemented on development sites where development density, topography and soils are suitable. The linear nature of grass channels makes them well-suited to treat highway runoff, low and medium density residential road runoff and small commercial parking areas or driveways. Key considerations for grass channels include:

Soils. Grass channels can be used on most soils with some restrictions on the most impermeable soils. Grass channels situated on Hydrologic Soil Group C and D soils will require compost amendments in order to improve performance.

Available Space. Grass channels can be incorporated into linear development applications (e.g., roadways) by utilizing the footprint typically required for an open section drainage feature. The footprint required will likely be greater than that of a typical conveyance channel (TDOT or equivalent). However, the benefit of the runoff reduction may reduce the footprint requirements for stormwater management elsewhere on the development site.

Accessibility. Grass channels require periodic maintenance and must be accessible to various types of equipment. A path of travel for equipment no less than twelve feet in width with a maximum slope of 3:1 must be provided for the grass channel. The path of travel shall be along no less than 50% of the perimeter of the grass channel and must be accessible by common equipment and vehicles at all times.

Elevation Considerations. Grass channels are best applied when the grade of contributing slopes is less than 4%. Terracing or other inlet controls may be used to slow runoff velocities entering the facility. Grass channels are fundamentally constrained by the invert elevation of the existing conveyance system to which the practice discharges.

Subsurface Constraints. Grass channels subgrade should be separated from the water table and bedrock. A separation distance of 2 feet is recommended between the bottom of the excavated grass channels and the seasonally high ground water table and/or bedrock.

Utilities. Public underground utilities and associated easements should not be located within the grass channel footprint. Local utility design guidance shall be consulted in order to determine clearances required between stormwater infrastructure and other dry and wet utility lines. Private utilities should not be located within the grass channel when possible.

Contributing Drainage Area. The drainage area (contributing or effective) to a grass channel must be 5 acres or less. When grass channels treat and convey runoff from drainage areas greater than 5 acres, the velocity and flow depth through the channel becomes too great to treat runoff or prevent channel erosion.

Floodplains. Grass channels should be constructed outside the limits of the 100-year floodplain.

Setbacks. Grass channels should be set back at least 10 feet down-gradient from building foundations, 50 feet from septic system fields and 100 feet from private wells.

Applications. Grass channels can be used in residential, commercial or institutional development settings. Large commercial site applications may require multiple channels in order to effectively break up the drainage areas and meet the design criteria. Grass channels within the right of way will only receive credit for treating stormwater generated within the right of way. Right of way applications will require Metro Water Services and Metro Public Works approval.

SECTION 5: DESIGN CRITERIA

5.1 Sizing of Grass Channels

5.1.1 Stormwater Quality

Unlike volumetric stormwater practices, grass channels are designed based on a peak rate of flow of the contributing drainage area and achieve a minimum residence time of 5 minutes. The lengths of grass channels vary based on the drainage area imperviousness and slope. Channels must be no less than 25 feet long. **Table 7.2** below gives the minimum lengths for grass channels based on slope and percent imperviousness. Flow being treated by the grass channel must traverse the minimum channel length.

Table 7.2 Grass Channel Length Guidance[1]

Contributing Drainage Area	<=33% Impervious		Between 34% and 66% Impervious		>=67% Impervious	
Slope (max = 4%)	< 2%	> 2%	< 2%	> 2%	< 2%	> 2%
Grass channel minimum length (feet)	25	40	30	45	35	50

[1] Source: ARC (2001)

5.1.2 Geometry

Design guidance regarding the geometry and layout of grass channels is provided below. See Stormwater Management Manual, Volume 2 for channel hydraulic calculations.

Shape. A trapezoidal shape is preferred for grass channels for aesthetic, maintenance and hydraulic reasons. The bottom width of the channel should be between 4 to 8 feet wide. If a channel will be wider than 8 feet, the designer should incorporate benches, check dams, level spreaders or multi-level cross sections to prevent braiding and erosion along the channel bottom. The bottom width is a dependent variable in the calculation of velocity based on Manning's equation.

Side Slopes. Grass channel side slopes should be no steeper than 3 H:1 V for ease of mowing and routine maintenance. Flatter slopes are encouraged, where adequate space is available, to aid in pretreatment of sheet flows entering the channel.

Channel Longitudinal Slope. The longitudinal slope of the channel should ideally be between 1% and 2% in order to avoid scour and short-circuiting within the channel. Longitudinal slopes up to 4% are acceptable; however, check dams will likely be required in order to meet the allowable maximum flow velocities.

Velocity Consideration. The bottom width and slope of a grass channel should be designed such that the flow velocities are minimized to allow for pollutants to settle out. The flow depth for the peak treatment volume should be maintained at 3" or less. The channel should also convey larger storms at non-erosive velocities with at least 6 inches of freeboard. Refer to **Table 7.3** for the maximum velocities per type of turf grass. The analysis should evaluate the flow profile through the channel at normal depth, as well as the flow depth over top of the check dams. Check dams may be used to achieve the 5-minute minimum residence time.

Table 7.3: Maximum Permissible Velocities for Grass Channels

Cover Type	Erosion Resistant Soils (ft./sec.)	Easily Eroded Soils (ft./sec.)
Bermuda grass	6	4.5
Kentucky bluegrass	5	3.8
Grass-legume mixture	4	3
Tall fescue	3	2.3
Red fescue	2.5	1.9

Sources: VADCR (1992), Ree (1949), Temple et al (1987)

Check dams. Check dams must be firmly anchored into the side-slopes to prevent outflanking and be stable during the 10-year storm design event. The height of the check dam relative to the normal channel elevation should not exceed 12 inches. Check dams should be constructed of wood, stone, or concrete. Each impermeable check dam should have a minimum of one weep hole or a similar drainage feature so it can dewater after storms. The orifice equation should be utilized to show that minimum residence time is achieved. If rock check dams are utilized, see TDOT Standard Drawing EC-STR-6 for spacing to meet minimum residence time.

Armoring may be needed behind the check dam to prevent erosion. The check dam must be designed to spread runoff evenly over the grass channel, through a centrally located depression with a length equal to the bottom width. In the center of the check dam, the depressed weir length should be checked for the depth of flow, sized for the appropriate design storm (see **Figure 7A.3**). The ponded water at a downhill check dam should not touch the toe of the upstream check dam.

5.2 Pretreatment

Pretreatment measures should be designed to evenly spread runoff across the entire width of the grass channel. Several pretreatment measures are feasible, depending on the scale of the grass channel and whether it receives sheet flow, shallow concentrated flow or deeper concentrated flows.

5.3 Compost Soil Amendments

Soil compost amendments serve to increase the runoff reduction capability of a grass channel. The compost-amended strip should extend over the length and width of the channel bottom, and the compost should be incorporated to a depth as outlined in **Appendix 7-A**. The amended area will need to be rapidly stabilized with grass. Depending on the slope of the channel, it may be necessary to install a protective biodegradable geotextile fabric to protect the compost-amended soils. Care must be taken to consider the erosive characteristics of the amended soils when selecting an appropriate geotextile. For redevelopment or retrofit applications, the final elevation of the grass channel (following compost amendment) must be verified as meeting the original design hydraulic capacity.

5.4 Planting Grass Channels

Designers should choose grass species that can withstand both wet and dry periods as well as relatively high-velocity flows within the channel. Taller and denser grasses are preferable, though the species of grass is less important than good stabilization. Grass channels should be seeded at such a density to achieve a 90% turf cover after the second growing season. Performance has been shown to fall rapidly as vegetative cover falls below 80%. Grass channels should be seeded and not sodded. Seeding establishes deeper roots and sod may have muck soil that is not conducive to infiltration (Storey et. al., 2009).

5.5 Grass Channel Material Specifications

The basic material specifications for grass channels are outlined in **Table 7.4** below.

Table 7.4. Grass Channel Material Specifications

Material	Specification	Notes
Surface Cover	• Bermuda grass • Grass-legume mixture • Kentucky bluegrass • Tall fescue • Red fescue	Where velocities dictate, use woven biodegradable erosion control matting durable enough to last at least two growing seasons.
Compost Soil Amendment	See App. 7-A for additional requirements	
Check Dams	• Wood[1] • Gabions • Rock[2] • Concrete	[1]Wood used for check dams shall consist of pressure treated timers or water-resistant tree species. [2]See TDOT Standard Drawing EC-STR-6.

SECTION 6: SPECIAL CASE DESIGN ADAPTATIONS

6.1 Steep Terrain

Grass channels are not practical in areas of steep terrain, although terracing a series of grass channel cells may work on slopes from 5% to 10%. The drop in elevation between check dams should be limited to 18 inches in these cases, and the check dams should be armored on the down-slope side with suitably sized stone to prevent erosion.

SECTION 7: CONSTRUCTION

7.1 Construction Erosion Prevention and Sediment Control

Construction Stage EPSC Controls. Grass channels should be fully protected by check dams. Ideally, grass channels should remain *outside* the limits of disturbance during construction to prevent soil compaction by heavy equipment.

Excavation. The proposed site should be checked for existing utilities prior to any excavation. It is very important to minimize compaction of both the base of the grass channel and the amended soils. When possible, excavators should work from the sides to remove original soil.

7.2 Construction Sequence

The following is a typical construction sequence to properly install a grass channel, although steps may be modified to reflect different site conditions.

Step 1. The designer and the installer should have a preconstruction meeting, checking the boundaries of the contributing drainage area and the actual inlet elevations to ensure they conform to original design. Since other contractors may be responsible for constructing portions of the site, it is quite common to find subtle differences in site grading, drainage and paving elevations that can produce hydraulically important differences for the proposed grass channel. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the plan review/inspection authority.

Step 2. Grass channel installation may only begin after the entire contributing drainage area has been stabilized with vegetation. Any accumulation of sediments that does occur within the channel must be removed during the final stages of grading to achieve the design cross-section. EPSC for construction of the grass channel should be installed as specified in the erosion and sediment control plan. Stormwater flows must not be permitted into the grass channel until the bottom and side slopes are fully stabilized.

Step 3. Grade the grass channel to the final dimensions shown on the plan.

Step 4. Install check dams and pretreatment features as shown on the plan.

Step 5 (Optional). Incorporate compost amendments according to **Appendix 7-A**.

Step 6. Hydro-seed the bottom and banks of the grass channel, and peg in erosion control fabric or blanket where needed. After initial planting, a biodegradable erosion control fabric should be used, conforming to soil stabilization blanket and matting requirements found in the Tennessee Erosion and Sediment Control Handbook.

Step 7. Conduct the final construction inspection and develop a punch list for facility acceptance. Then log the GPS coordinates for each grass channel and submit them to MWS.

SECTION 8: AS-BUILT REQUIREMENTS

After the grass channel has been constructed, the owner/developer must have an as-built certification of the grass channel conducted by a registered Professional Engineer. The as-built certification verifies that the GIP was installed per the approved plan. The following items shall be provided in addition to the as-built requirements found in SWMM Volume 1.

1. The Engineer shall include a copy of the GIP summary table found in Appendix 7-C.
2. Supporting documents such as invoices and compost certification.

SECTION 9: MAINTENANCE

9.1 Maintenance Document

The requirements for the Maintenance Document are in Appendix C of Volume 1 of the Manual. They include the execution and recording of an Inspection and Maintenance Agreement or a Declaration of Restrictions and Covenants, and the development of a Long-Term Maintenance Plan (LTMP) by the design engineer. The LTMP contains a description of the stormwater system components and information on the required inspection and maintenance activities. The property owner must submit annual inspection and maintenance reports to MWS.

Maintenance requirements for grass channels include the following:

1. Maintain grass height of 3 to 4 inches.
2. Remove sediment build up in channel bottom when it accumulates to 25% of original total channel volume.
3. Ensure that rills and gullies have not formed on side slopes. Correct if necessary.
4. Remove trash and debris build up.
5. Replant areas where vegetation has not been successfully established.

All grass channels must be covered by a drainage easement to allow inspection and maintenance. If a grass channel is located in a residential private lot, the existence and purpose of the grass channel shall be noted on the deed of record.

9.2 Ongoing Maintenance

Once established, grass channels have minimal maintenance needs outside of the spring cleanup, regular mowing, repair of check dams and other measures to maintain the hydraulic efficiency of the channel and a dense, healthy grass cover.

Table 7.5 Suggested Spring Maintenance Inspections/Cleanups for Grass Channels[1]

Activity
Add reinforcement planting to maintain 90% turf cover. Reseed any dead vegetation.
Remove any accumulated sand or sediment deposits behind check dams.
Inspect upstream and downstream of check dams for evidence of undercutting or erosion, and remove and trash or blockages at weepholes.
Examine channel bottom for evidence of erosion, braiding, excessive ponding or dead grass.
Check inflow points for clogging and remove any sediment.
Inspect side slopes and grass filter strips for evidence of any rill or gully erosion and repair.
Look for any bare soil or sediment sources in the contributing drainage area and stabilize immediately.

[1] Source: VADCR (2011)

Figure 7.1: Typical Grass Channel
Rosa Parks Boulevard, Nashville, TN

SECTION 10: REFERENCES

Atlanta Regional Commission (ARC). 2001. *Georgia Stormwater Management Manual.* Atlanta, GA.

Chesapeake Stormwater Network (CSN). 2008. *Technical Bulletin 1: Stormwater Design Guidelines for Karst Terrain in the Chesapeake Bay Watershed.* Version 1.0. Baltimore, MD. Available online at: http://www.chesapeakestormwater.net/all-things-stormwater/stormwater-guidance-for-karst-terrain-in-the-chesapeake-bay.html

Claytor, R. and T. Schueler. 1996. *Design of Stormwater Filtering Systems.* Center for Watershed Protection. Ellicott City, MD.

CWP. 2007. *National Pollutant Removal Performance Database Version 3.0.* Center for Watershed Protection, Ellicott City, MD.

Haan, C.T., Barfield, B.J., and Hayes, J.C. *Design Hydrology and Sedimentology for Small Catchments.* Academic Press, New York, 1994.

Lantin, A., and M. Barrett. 2005. *Design and Pollutant Reduction of Vegetated Strips and Swales.* ASCE. Downloaded September, 2005.

Maryland Department of Environment (MDE). 2000. *Maryland Stormwater Design Manual.* Baltimore, MD. Available online at: htp:/www.mde.state.md.us/Programs/WaterPrograms/SedimentandStormwater/stormwater design/index.asp

Northern Virginia Regional Commission (NOVA). 2007. *Low Impact Development Supplement to the Northern Virginia BMP Handbook.* Fairfax, Virginia

Ree, W. 1949. *Hydraulic characteristics of vegetation for vegetated waterways.* Agricultural Engineering.

Schueler, T., D. Hirschman, M. Novotney and J. Zielinski. 2007. *Urban Stormwater Retrofit Practices.* Manual 3 in the Urban Subwatershed Restoration Manual Series. Center for Watershed Protection, Ellicott City, MD.

Schueler, T. 2008. Technical Support for the Baywide Runoff Reduction Method. Chesapeake Stormwater Network. Baltimore, MD. www.chesapeakestormwater.net

Storey, B.J., Li, M., McFalls, J.A., Yi, Y. 2009. *Stormwater Treatment with Vegetated Buffers.* Texas Transportation Institute. College Station, TX.

Temple, D.M., Robinson, K.M., Ahring, R.M., and Davis, A.G. 1987 "Stability design of grass-lined open channels." Agric. Handbook 667, Agric. Res. Service, U.S. Department of Agriculture, Washington, D.C.

Virginia Department of Conservation and Recreation (VADCR). 2011. Stormwater Design Specification No. 3: Grass Channel, Version 2.3, March 1, 2011. http://vwrrc.vt.edu/swc/NonProprietaryBMPs.html.

Virginia Department of Conservation and Recreation (VADCR). 1992. *Virginia Erosion and Sediment Control Handbook*

Virginia Department of Conservation and Recreation (VADCR). 1999. *Virginia Stormwater Management Handbook. Volumes 1 and 2*. Division of Soil and Water Conservation. Richmond, VA.

Wisconsin Department of Natural Resources. "Vegetated Infiltration Swale (1005)." *Interim Technical Standard, Conservation Practice Standards*. Standards Oversight Council, Madison, Wisconsin, 2004. Available online at: http://dnr.wi.gov/org/water/wm/nps/pdf/stormwater/techstds/post/InterimInfiltrationSwale100 5. pdf.

APPENDIX 7-A
DESIGN CRITERIA FOR AMENDING SOILS WITH COMPOST

SECTION 1: DESCRIPTION

Soil restoration is a practice applied after construction, to deeply till compacted soils and restore their porosity by amending them with compost. These soil amendments can reduce the generation of runoff from compacted urban lawns and may also be used to enhance the runoff reduction performance.

SECTION 2: DESIGN CRITERIA

2.1 Determining Depth of Compost Incorporation

Table 7-A.1 presents some general guidance for compost amendments and incorporation depths.

Table 7-A.1. Compost and Incorporation Depths

	Level 1	Level 2
Compost (in)	6	12
Incorporation Depth (in)	12	24
Incorporation Method	Tiller	Subsoiler

Once the area and depth of the compost amendments are known, the designer can estimate the total amount of compost needed using the following estimator equation:

Equation 7.1. Compost Quantity Estimation

$$C = A * D * 0.0031$$

Where: C = compost needed (cu. yds.)

A = area of soil amended (sq. ft.)

D = depth of compost added (in.)

2.2 Compost Specifications

The basic material specifications for compost amendments are outlined below:

- Compost shall be derived from plant material and provided by a member of the U.S. Composting Seal of Testing Assurance (STA) program. See www.compostingcouncil.org for a list of local providers.
- The compost shall be the result of the biological degradation and transformation of plant-derived materials under conditions that promote anaerobic decomposition. The material shall be well composted, free of viable weed seeds, and stable with regard to oxygen consumption and carbon dioxide generation. The compost shall have a moisture content that has no visible free water or dust produced when handling the material. It shall meet the following criteria, as reported by the U.S. Composting Council STA Compost Technical Data Sheet provided by the vendor:
    a. 100% of the material must pass through a half inch screen
    b. The pH of the material shall be between 6 and 8
    c. Manufactured inert material (plastic, concrete, ceramics, metal, etc.) shall be less than 1.0% by weight
    d. The organic matter content shall be between 35% and 65%
    e. Soluble salt content shall be less than 6.0 mmhos/cm
    f. Maturity should be greater than 80%
    g. Stability shall be 7 or less
    h. Carbon/nitrogen ratio shall be less than 25:1
    i. Trace metal test result = “pass”
    j. The compost must have a dry bulk density ranging from 40 to 50 lbs./cu.ft.

APPENDIX 7-B
STANDARD DETAILS

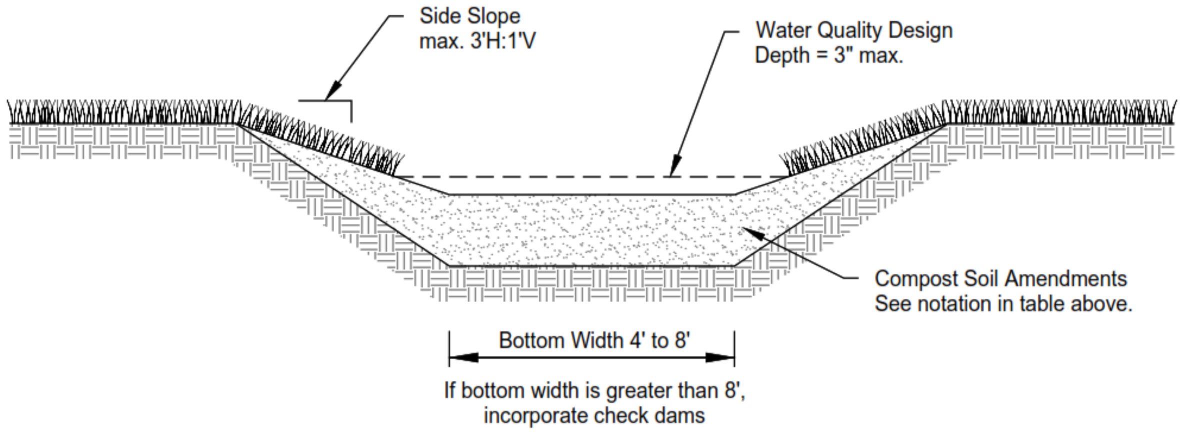

Figure 7A.1. Grass Channel – Typical Section

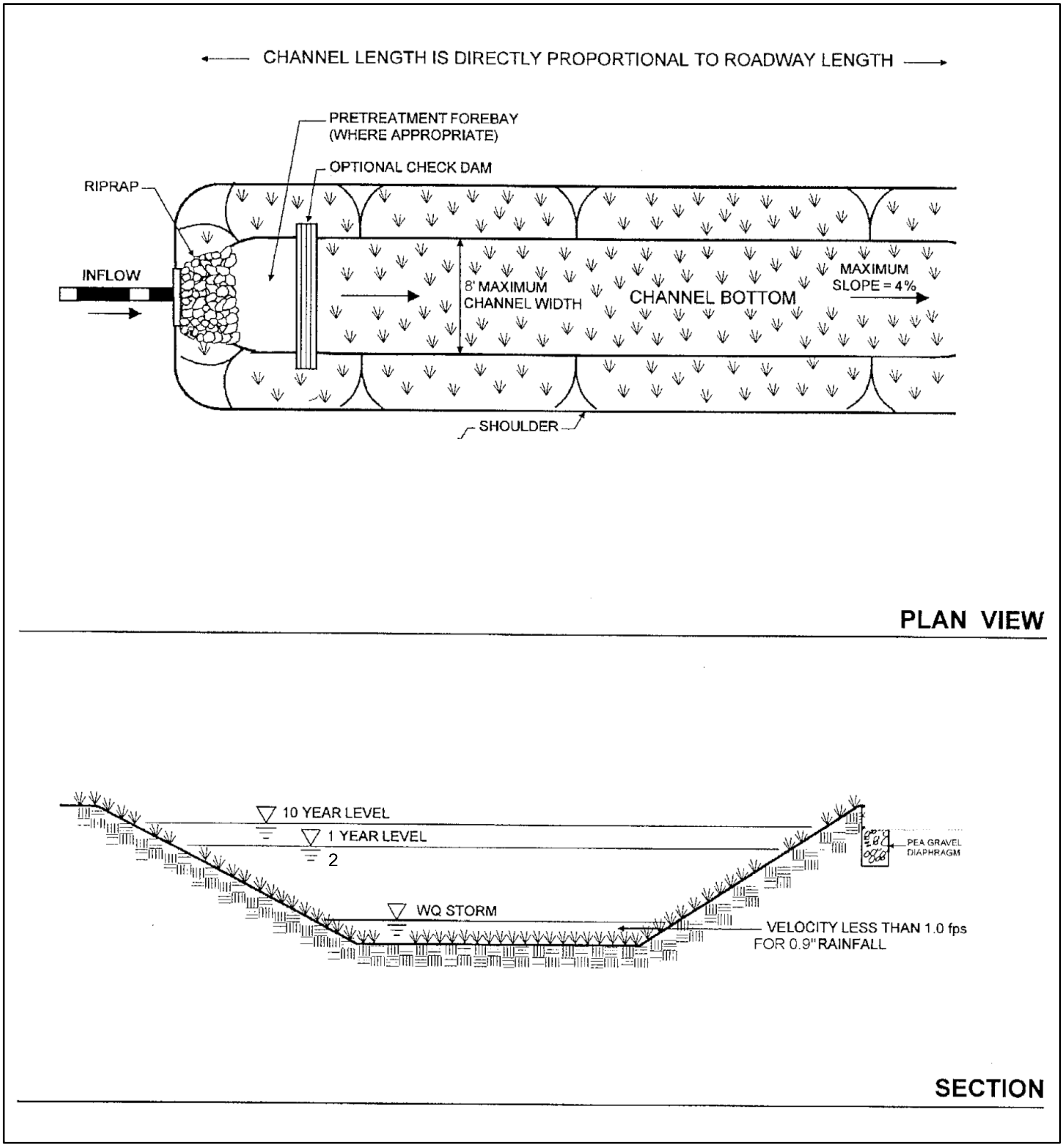

Figure 7A.2. Grass Channel – Typical Plan, Profile and Section (Source: VADCR, 2011, MWS edited 2020)

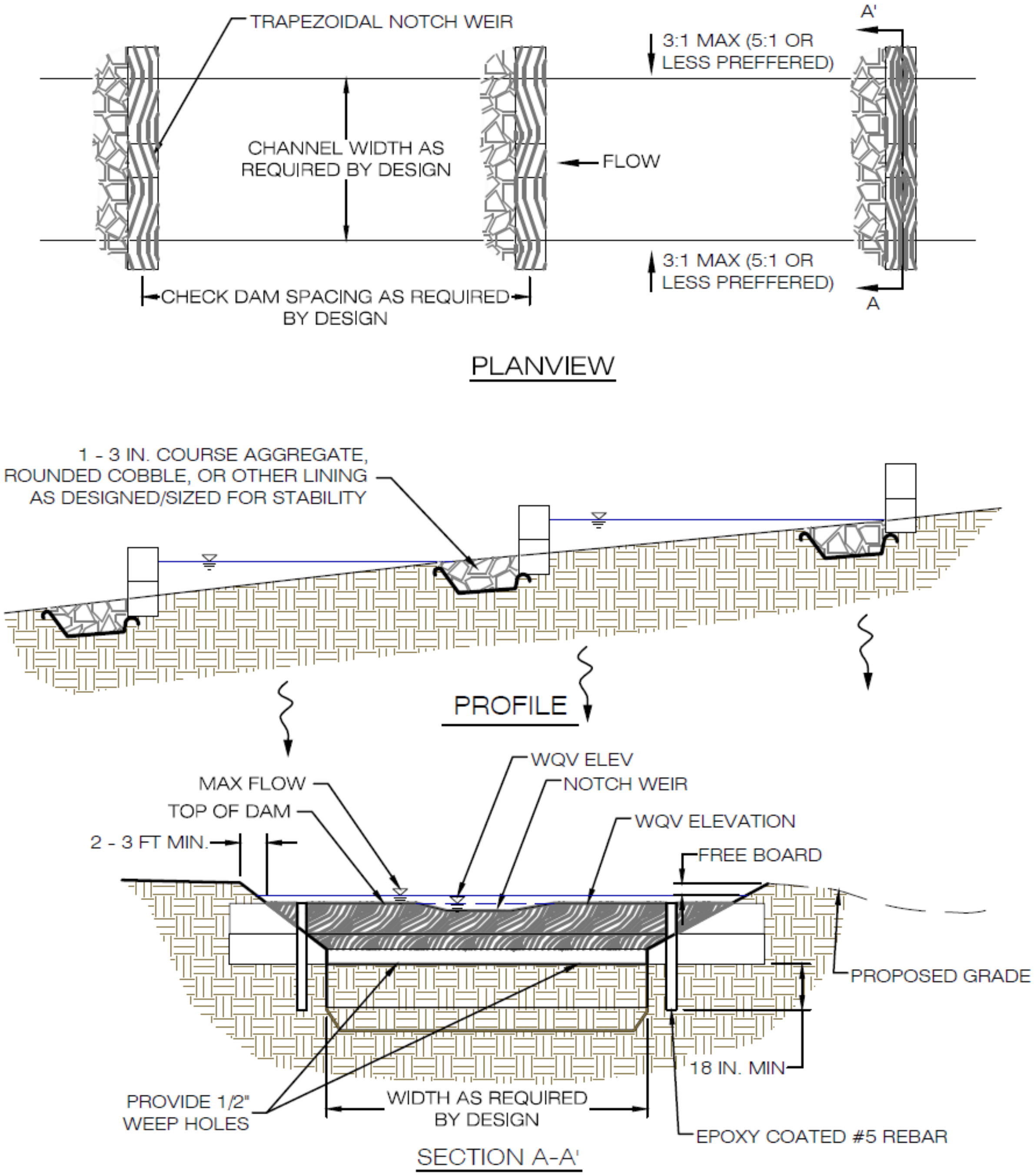

Figure 7A.3 Grass Channel with Check Dams – Typical Plan, Profile, and Section

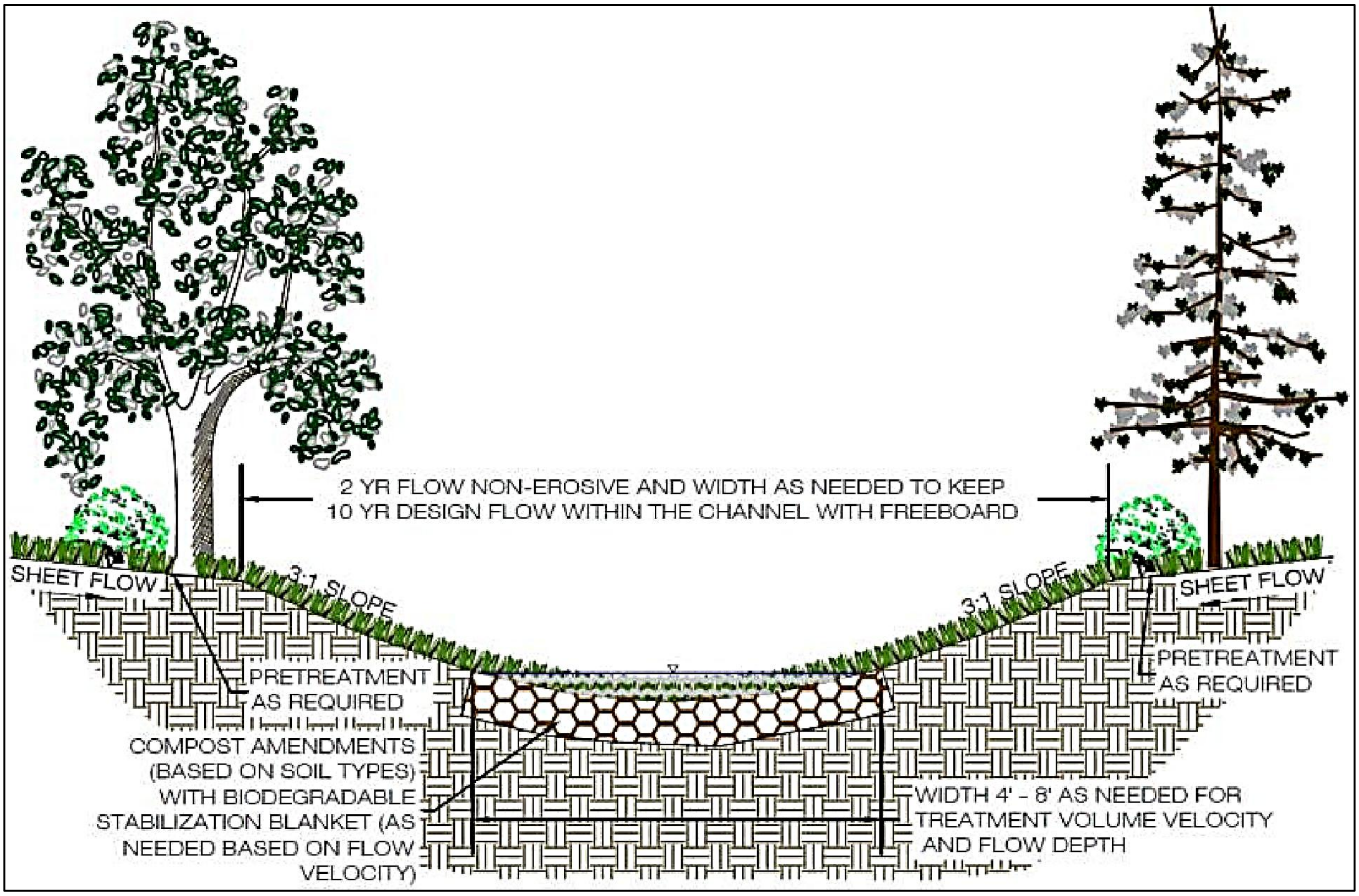

Figure 7A.4: Grass Channel with Compost Amendments - Section

APPENDIX 7-C
AS-BUILT REQUIREMENTS

A printer friendly version of this table can be found on the MWS Development Services website or by request.

Grass Channel Number:

	Design	As-built
Top of Bank Elevation		
Channel Slope		
Invert Elevation (Upstream)		
Check Dam Height, FT		
Channel Drop, FT		
Invert Elevation (Downstream)		
Check dam spacing, FT		
Bottom width, FT		
ALL Elevation shall be NAVD88		

Compost Amendment Requirements (Please check one):
_____ 0” Compost Incorporated
_____ 6” Compost Incorporated @ 12” Depth
_____ 12” Compost Incorporated @ 24” Depth

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