

An aerial rendering of a highway interchange with a stormwater management system. The highway has multiple lanes with cars and a truck. A concrete structure with an arched opening is visible, leading to a stream. The surrounding area is lush with green trees and grass. The sky is blue with some clouds.

SESWA Regional Stormwater Seminar

SWM Field Quality Control and Quality Assurance

Doug Beisch, P.E.

April 15, 2016



Agenda

- 1 Background and Overview
- 2 QA/QC Program and Process
- 3 BMP Functional Components
- 4 Lessons Learned
- 5 Q&A/Open Discussion

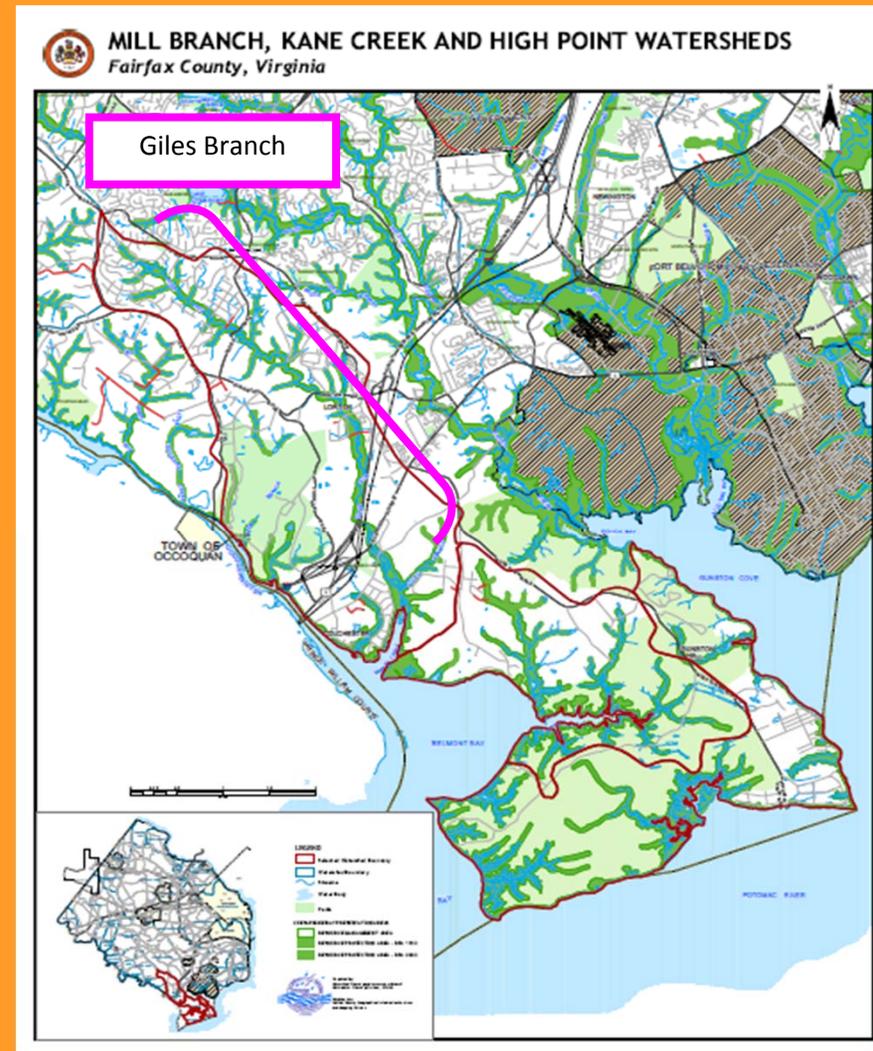
Demonstration Project

"It is easier to resist at the beginning than at the end."

-Leonardo da Vinci

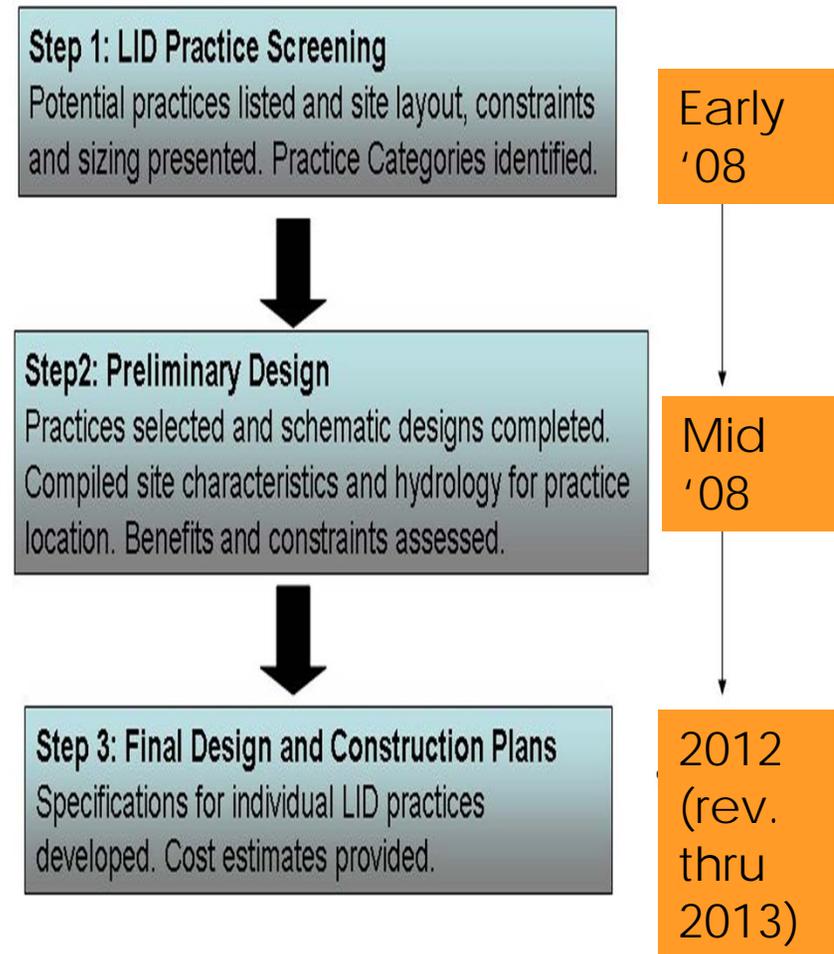
Lorton Road LID Demonstration Project

- Outgrowth of Fairfax SPS
- Watershed Plans
- Steering Committee
- Demonstration Project



Planning Stages

- Early Conceptual Report
- Significant Stakeholder Review
- Commissioned Design
 - Conceptual
 - Preliminary
 - Intermediate
 - Final



Practice Screening Results

- Swales
- Bioretention
- Bioslopes
- Compost Soil Amendments
- Enhanced Detention Facilities
- Natural Dispersion

Swales



Bioretention



Bioslopes



Compost Soil Amendments



Enhanced Detention Facilities



Natural Dispersion



QA/QC Program and Process

|  Low Impact Development Facility Field Inspection Checklist Natural Dispersion | | | |
|---|--|----------------------|--|
| Project Name | | Project Number | |
| Project Location | | Inspector Name | |
| Contractor | | Inspection Date | |
| Contractor Representative | | Last Inspection Date | |
| <small>Checklist to be completed at each stage of construction. This sheet to be accompanied with copy of any field notes taken during inspection. Photographic documentation of each stage should be made and a copy attached (with captions) to this checklist.</small> | | | |
| Stage of Construction | | | |
| <input type="checkbox"/> | Layout/Staking <ul style="list-style-type: none"> • Correct location/placement? • General dimensions of facility with tape: L = _____ W = _____ • Layout/shape per plan? • Describe any visible, previously unknown conflicts: | | |
| | <ul style="list-style-type: none"> • Any field modifications requested? Describe & provide sketch (attach sheets as needed). | | |
| <input type="checkbox"/> | Rough Grading/Excavation <ul style="list-style-type: none"> • Proper erosion & sediment controls installed? • Surface Area rough & scarified? • Describe any visible, previously unknown conflicts: | | |
| | <ul style="list-style-type: none"> • Any field modifications requested? Describe & provide sketch (attach sheets as needed). | | |
| <input type="checkbox"/> | Gravel Diaphragm/Engineered Level Spreader <ul style="list-style-type: none"> • Constructed per details in plan? • Spot elevations to ensure gravel diaphragm/ELS is completely level? Correct design elevation? • Geotextile fabric installed per plan? • Proper size/class of riprap, rock, and/or stone incorporated per details? • Final dimensions in accordance with plan? L = _____ W = _____ H/D = _____ | | |
| | Surface Preparation <ul style="list-style-type: none"> • Protected from Compaction during construction? • Topsoil applied? • Surface Slope: s = _____ | | |
| <input type="checkbox"/> | Final Landscaping/Stabilization <ul style="list-style-type: none"> • Inspect seed mix ticket(s) for compliance with planting specifications in plan. • Proper placement of stabilization matting/blanketing and seeding per plan? • Proper plant species and quantities per plan? • Any substitutions requested? Describe. | | |

“Quality means doing it right when no one is looking.”

Henry Ford

Overall Quality Control Program



NOTE:

CONTRACTOR SHALL COORDINATE WITH DESIGN ENGINEER FOR INSPECTIONS OF ALL LID MEASURES DURING :

- A. STAKEOUT**
- B. TRENCH/PIT GRADING**
- C. UNDERDRAIN/GRAVEL BED INSTALLATION**
- D. ENGINEERED SOIL PLACEMENT**
- E. FINAL STABILIZATION AND PLANTING**

CONTRACTOR IS RESPONSIBLE FOR GIVING SUFFICIENT NOTICE TO ENGINEER PRIOR TO INSPECTION AND FOR PROVIDING DOCUMENTATION INCLUDING:

- A. PHOTOS**
- B. MATERIALS TICKETS**
- C. SOILS TESTING**
- D. AS BUILT DRAWINGS**

DOCUMENTATION SHALL DEMONSTRATE PROPER WORKMANSHIP CONSISTENT WITH PLANS, SPECIFICATIONS, AND REFERENCE STANDARDS, TO THE SATISFACTION OF THE ENGINEER AND OWNER.

Anatomy of BMP QC Inspections

|  Low Impact Development Facility Field Inspection Checklist Bioretention Filter/Type III Swale | |
|---|---|
| Project Name | Project Number |
| Project Location/Facility ID | Inspector Name |
| Contractor | Inspection Date |
| Contractor Representative | Last Inspection Date |
| <small>Checklist to be completed at each stage of construction. This sheet to be accompanied with copy of any field notes taken during inspection. Photographic documentation of each stage should be made and a copy attached (with captions) to this checklist.</small> | |
| Stage of Construction | |
| <input type="checkbox"/> | Layout/Staking <ul style="list-style-type: none"> • Correct location/placement? • General dimensions of facility with tape: L = _____ W = _____ • Layout/shape per plan? • Describe any visible, previously unknown conflicts: • Any field modifications requested? Describe & provide sketch (attach sheets as needed). |
| | <input type="checkbox"/> Rough Grading/Excavation <ul style="list-style-type: none"> • Proper erosion & sediment controls installed? • Sides and bottom of excavated area rough & scarified? • Depth of excavation (top of excavated area from crest of berm to bottom): D = _____ • Liner required? Installed per plan? • Describe any visible, previously unknown conflicts: • Any field modifications requested? Describe & provide sketch (attach sheets as needed). <u>Armored Berm Construction</u> <ul style="list-style-type: none"> • Cutoff trench constructed per details in plan? • Geotextile fabric installed per plan? • Proper size/class of riprap, rock, and/or stone incorporated per details? • Final dimensions in accordance with plan? L = _____ W = _____ H/D = _____ • Conveyance culverts installed per plan? |
| | <input type="checkbox"/> Subsurface Drainage <p><u>Sump Stone</u></p> <ul style="list-style-type: none"> • Proper size/class of stone incorporated per details? • Depth of sump stone layer: D = _____ • Any field modifications requested? Describe & provide sketch (attach sheets as needed). <p><u>Drainage Connection/Underdrain</u></p> <ul style="list-style-type: none"> • Proper size/type of underdrain pipe? • Perforations? • Layout per plan? • Cleanouts per plan? • Connected properly to SWM structure or daylighted per design? • Water-tight connections? |

Typically we recommend inspections at five milestones

May adjust frequency and/or role dependent on comfort level

Step 1 – Layout/Staking

Stage of Construction

Layout/Staking

- Correct location/placement?
 - General dimensions of facility with tape: L = _____ W = _____
 - Layout/shape per plan?
 - Describe any visible, previously unknown conflicts:
-
- Any field modifications requested? Describe & provide sketch (attach sheets as needed).

- Verify appropriate location
- Review grade busts or shifts
- Identify critical tie-ins
- Generally review dimensions (non-survey)
- Identify Conflicts or Adjustments for Resolution

Milestone Picture



Step 2 – Rough Grading/Excavation

Rough Grading/Excavation

- Proper erosion & sediment controls installed?
- Sides and bottom of excavated area rough & scarified?
- Depth of excavation (top of excavated area from crest of berm to bottom): D = _____
- Liner required? Installed per plan?
- Describe any visible, previously unknown conflicts:



- Any field modifications requested? Describe & provide sketch (attach sheets as needed).

Armored Berm Construction

- Cutoff trench constructed per details in plan?
- Geotextile fabric installed per plan?
- Proper size/class of riprap, rock, and/or stone incorporated per details?
- Final dimensions in accordance with plan? L = _____ W = _____ H/D = _____
- Conveyance culverts installed per plan?

- General Depths verified
- Scarification or bottom treatment applied
- Liners or other membranes
- Cutoff trenches
- Deep drainage
- Unanticipated soil conditions

Milestone Picture



Step 3 – Subsurface Drainage

| | |
|--------------------------|--|
| <input type="checkbox"/> | <p>Subsurface Drainage</p> <p><u>Sump Stone</u></p> <ul style="list-style-type: none">• Proper size/class of stone incorporated per details?• Depth of sump stone layer: D = _____• Any field modifications requested? Describe & provide sketch (attach sheets as needed). <p><u>Drainage Connection/Underdrain</u></p> <ul style="list-style-type: none">• Proper size/type of underdrain pipe?• Perforations?• Layout per plan?• Cleanouts per plan?• Connected properly to SWM structure or daylighted per design?• Water-tight connections? |
|--------------------------|--|

- Sump stone properly installed
- Drains proper size/type
- Connections watertight where needed
- Tees or wyes for cleanouts and obs wells
- Udrain daylight
- Choker stone OK

Milestone Picture



Step 4 – Media Installation

| | |
|--------------------------|---|
| <input type="checkbox"/> | Soil Media Installation/Incorporation |
| | <ul style="list-style-type: none">• Inspect material ticket for compliance of soil media with specifications in plan.• Soil media well mixed?• Depth of soil media: D = _____ |

- Media in compliance with spec
- Procedures for installation OK
- Well mixed – homogeneous
- Proper depths of incorporation

Milestone Picture



Step 5 – Landscaping and Stabilization

| | |
|--------------------------|---|
| <input type="checkbox"/> | <p>Final Landscaping/Stabilization</p> <ul style="list-style-type: none">• Inspect seed mix ticket(s) for compliance with planting specifications in plan.• Proper placement of stabilization matting/blanketing and seeding per plan?• Any substitutions/modifications requested? Describe. |
|--------------------------|---|

- Seeding
- Planting
- Stabilization
- Blanketing/matting
- Riprap
- Level spreaders
- Other surface treatments required
- Procedures for warranty (if any)
- Watering (seasonal)

Milestone Picture



Available Resources

- [Field QC Guidelines](#)
- [Specifications](#)
- [Drawings and Details](#)

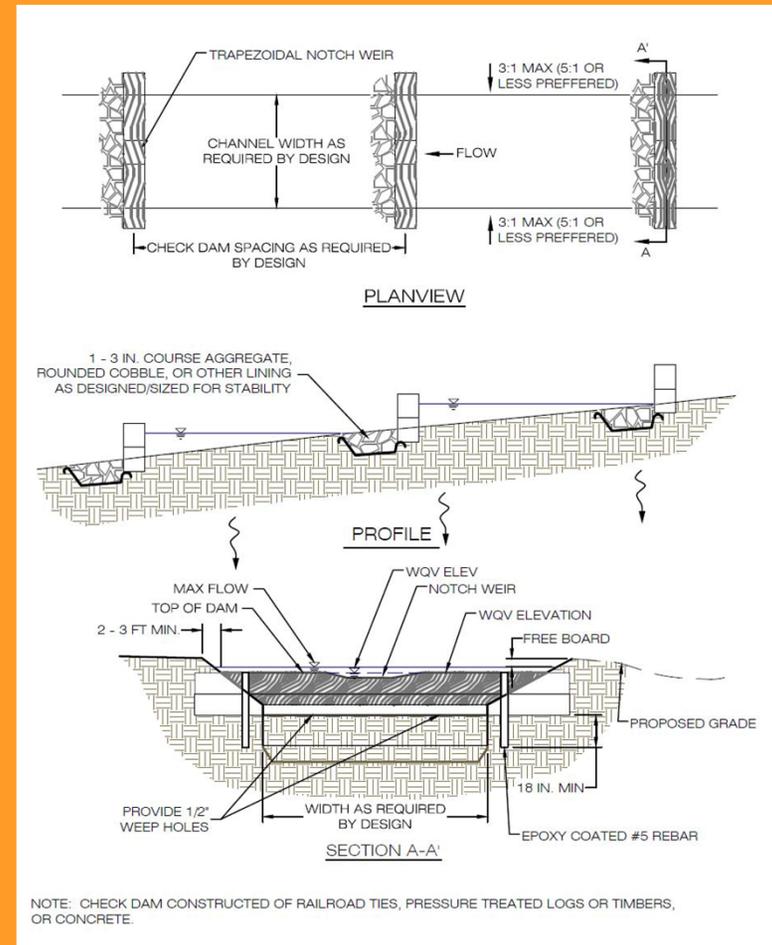
BMP Construction

“It is not the beauty of a building you should look at; its the construction of the foundation that will stand the test of time.”

David Allan Coe

BMP Functional Components

- Compost Soil Amendments
- Biofilters
- Grassed Swales
- Bioslopes



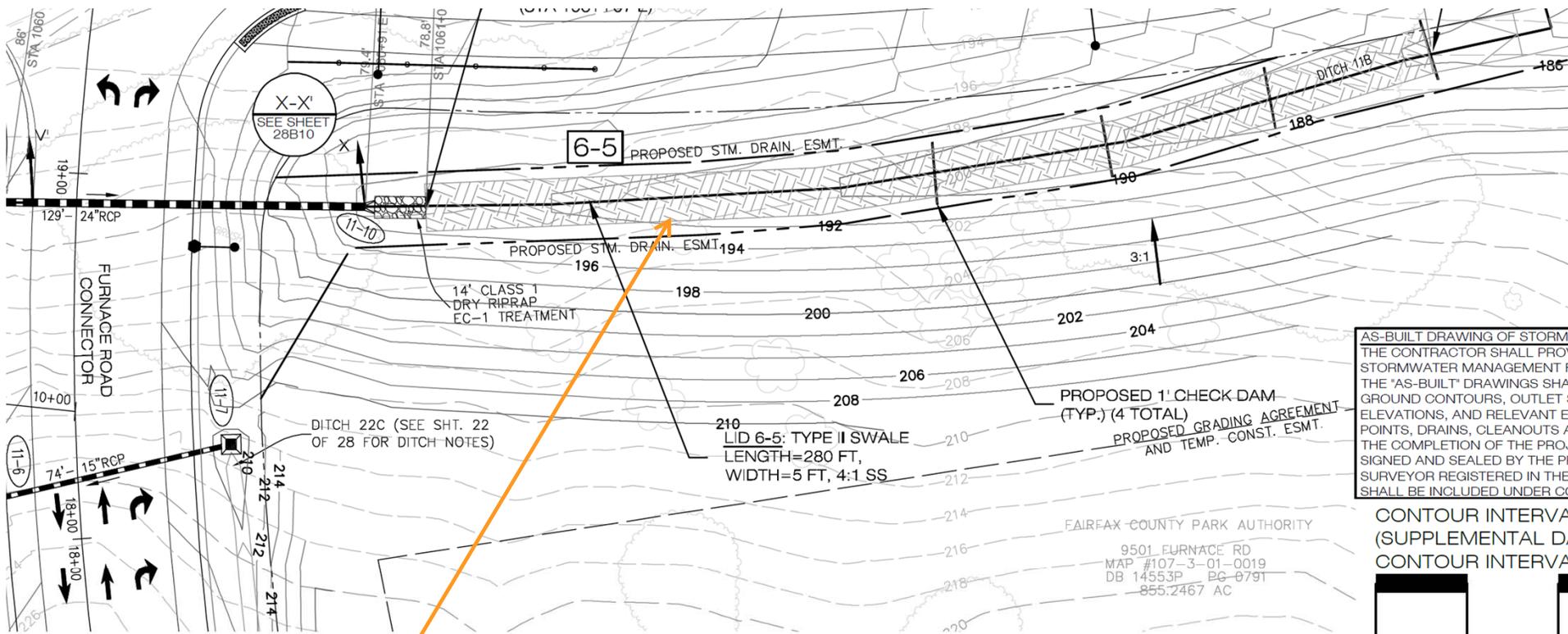
Compost Soil Amendments



Compost Soil Amendments – Critical Issues

- Compost Source and Testing
- Stakeout of Compost Areas
- Proper Topsoiling/soil prep for stabilization
- Documentation during steps
- Testing of soils if in-situ used
- Rototill or rip (before application)
- Apply surface compost
- Re-rototill
- Rake and stabilize
- Protective coverings or mulch

Compost Soil Amendments



END:

-  ENGINEERED SOIL MEDIA/BIOFILTER BED
-  PROPOSED STORM SEWER SYSTEM (SHOWN FOR INFORMATION ONLY)
-  PROPOSED COMPOST SOIL AMENDMENTS
-  PROPOSED WATERMAIN AND EASEMENT

EMERGENCY POLICE - FIRE - RESCUE

FAIRFAX COUNTY

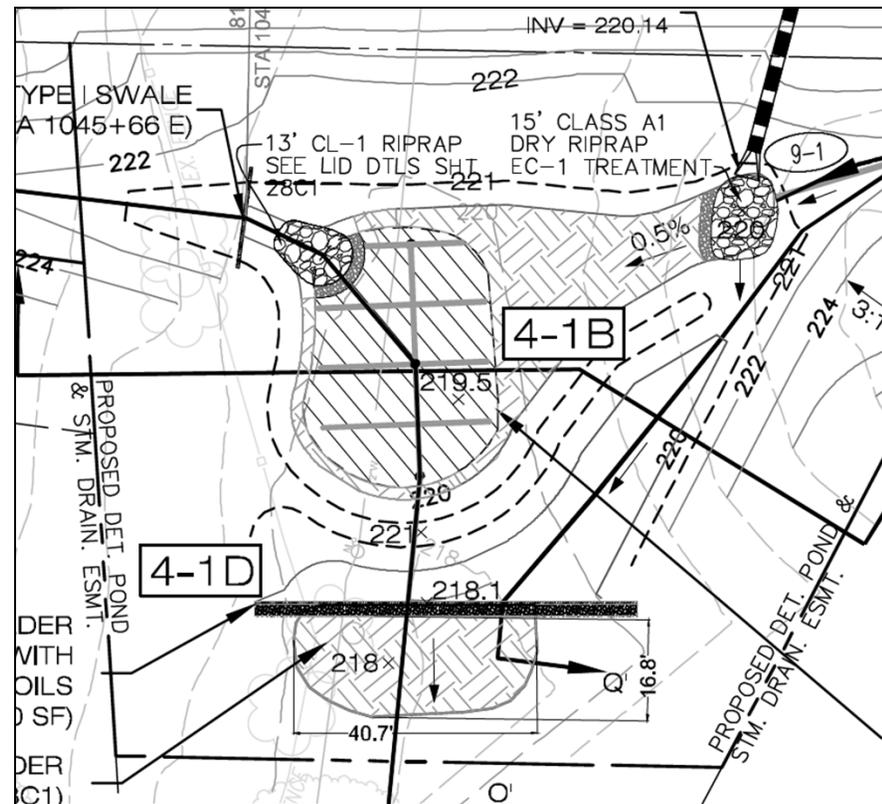
DEPARTMENT OF PUBLIC WORKS AND ENVIRONMENTAL SERVICES
12000 GOVERNMENT CENTER PARKWAY, SUITE 500
FAIRFAX, VA 22031

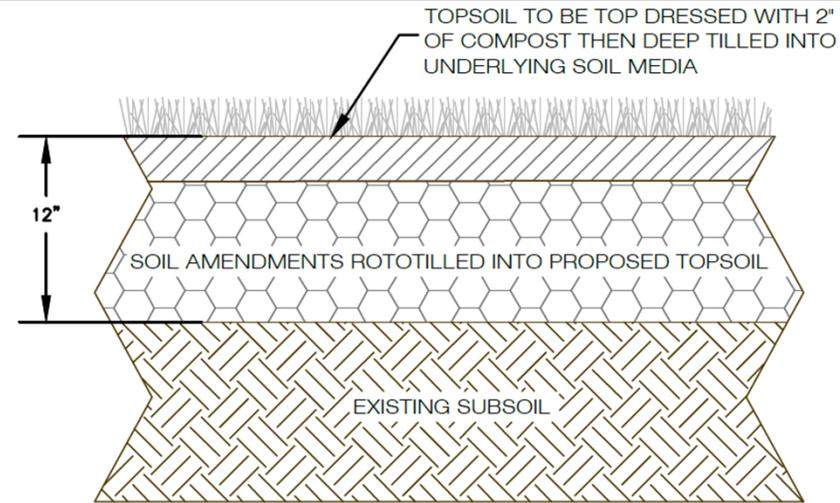
| | | | | |
|---|--|--|--|--|
| R | | | | |
| E | | | | |



Areas of Incorporation

- Perimeter areas around bioretention beds
- Type II Swales
- Adjacent to Type III Swales
- Filter Strip Areas



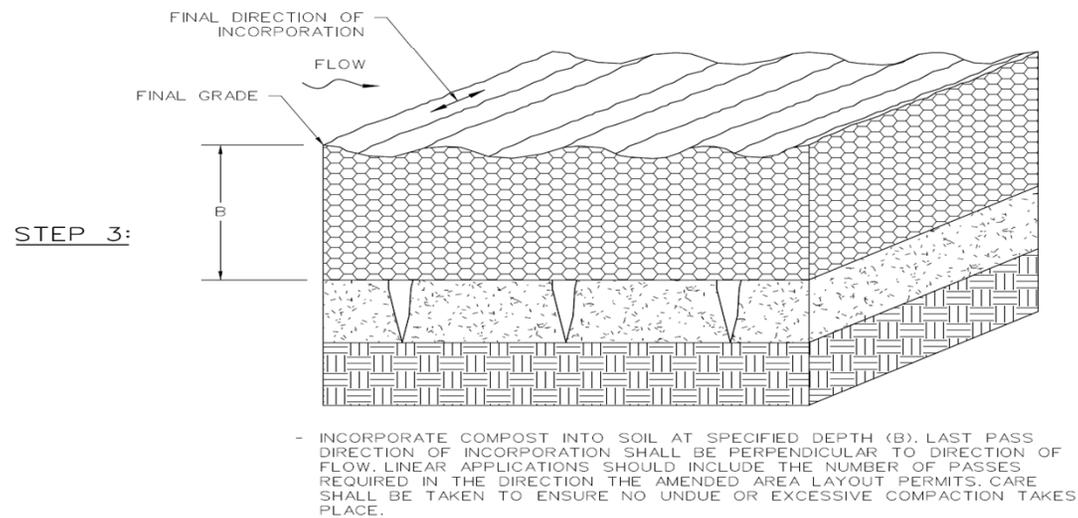
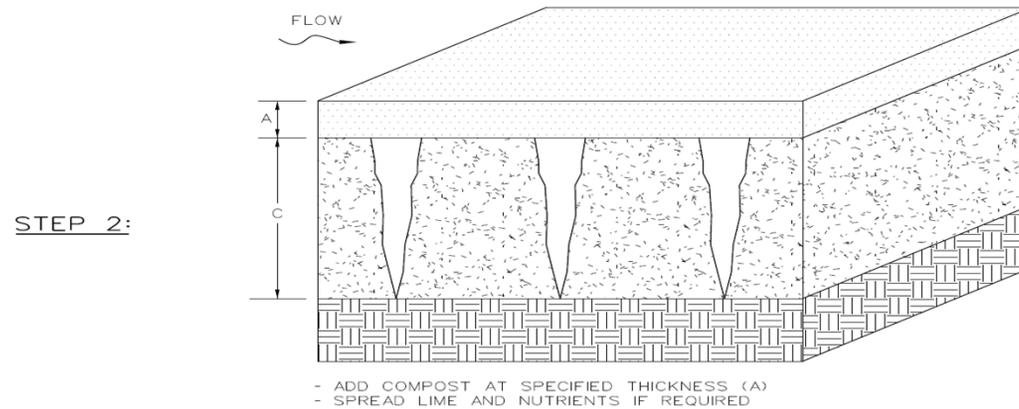
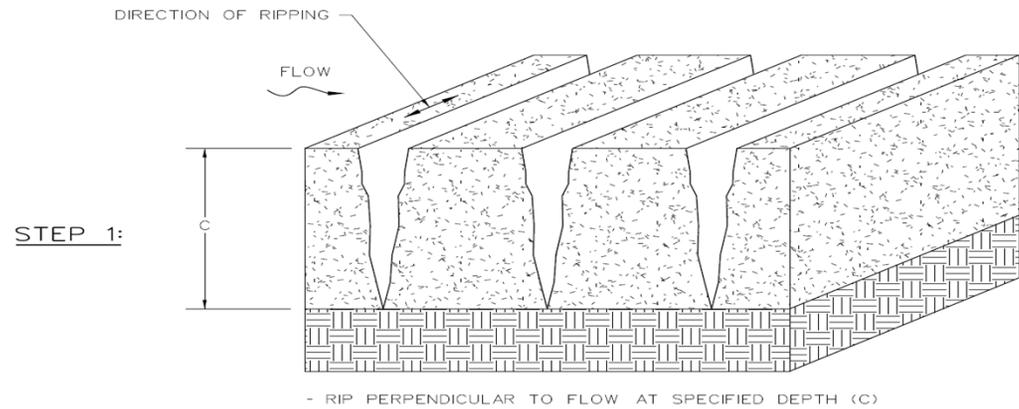


PHYSICAL REQUIREMENTS FOR COMPOST:

| PARAMETER | RANGE | TESTING METHOD |
|---|--|----------------|
| PH | 5.0-8.5 | TMECC 4.11A |
| SOLUBLE SALT CONCENTRATION | < 10DS/M | TMECC 4.10-A |
| MOISTURE | 30-60% WET WEIGHT BASIS | SMEWW 2540B |
| ORGANIC MATTER | 30-65% DRY WEIGHT BASIS | TMECC 5.07-A |
| PARTICLE SIZE | 98% PASS THROUGH 3/4" SCREEN OR SMALLER | TMECC 2.02-B |
| STABILITY (CARBON DIOXIDE EVOLUTION RATE) | >80% RELATIVE TO POSITIVE CONTROL | TMECC 5.08-B |
| MATURITY (SEED EMERGENCE AND SEEDLING VIGOR) | >80% RELATIVE TO POSITIVE CONTROL | TMECC 5.05-A |
| PHYSICAL CONTAMINANTS (MAN MADE INERTS) | <1% DRY WEIGHT BASIS | TMECC 3.08-A |
| CHEMICAL CONTAMINANTS | MEET OR EXCEED US EPA CLASS A STANDARD, 40 CFR § 503.13, TABLES 1 AND 3 LEVELS: | |
| ARSENIC | < 41PPM | TMECC 4.06-AS |
| CADMIUM | < 39 PPM | TMECC 4.06-CD |
| COPPER | < 1,500 PPM | TMECC 4.05-CU |
| LEAD | < 300 PPM | TMECC 4.06-PB |
| MERCURY | < 17 PPM | TMECC 4.06-HG |
| MOLYBDENUM | < 75 PPM | TMECC 4.05-MO |
| NICKEL | < 420 PPM | TMECC 4.06-NI |
| SELENIUM | < 100 PPM | TMECC 4.06-SE |
| ZINC | < 2,800 PPM | TMECC 4.06-ZN |
| BIOLOGICAL CONTAMINANTS (PATHOGENS) | MEET OR EXCEED US EPA CLASS A STANDARD, 40 CFR § 503.32(A) LEVELS: | |
| FECAL COLIFORM | < 1,000 MPN PER GRAM, DRY WEIGHT BASIS | TMECC 7.01 |
| SALMONELLA | < 3 MPN PER 4 GRAMS, DRY WEIGHT BASIS | TMECC 7.02 |

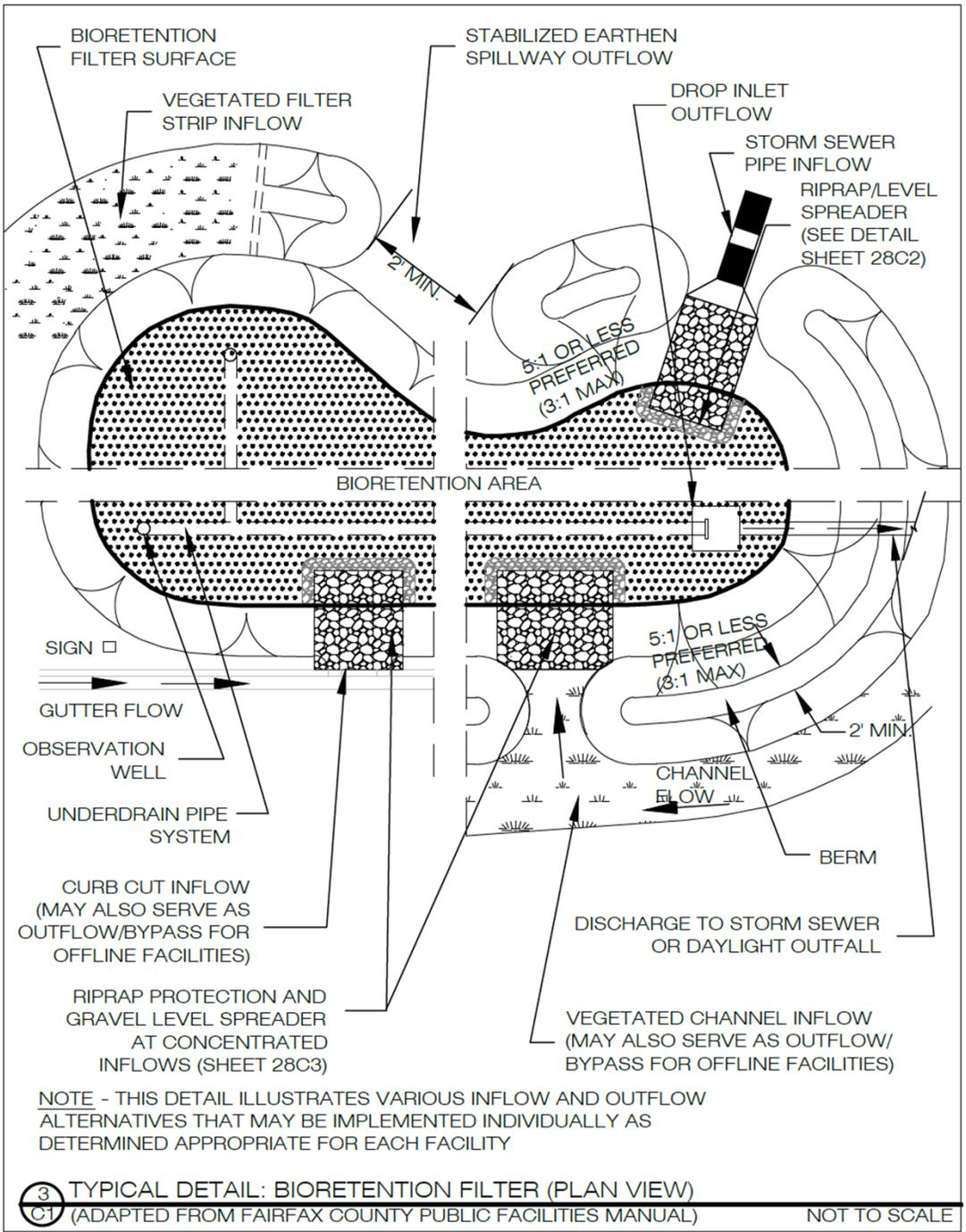
6 DETAIL: COMPOST AMENDED SOILS
C2 (ADAPTED FROM LOW IMPACT DEVELOPMENT CENTER)

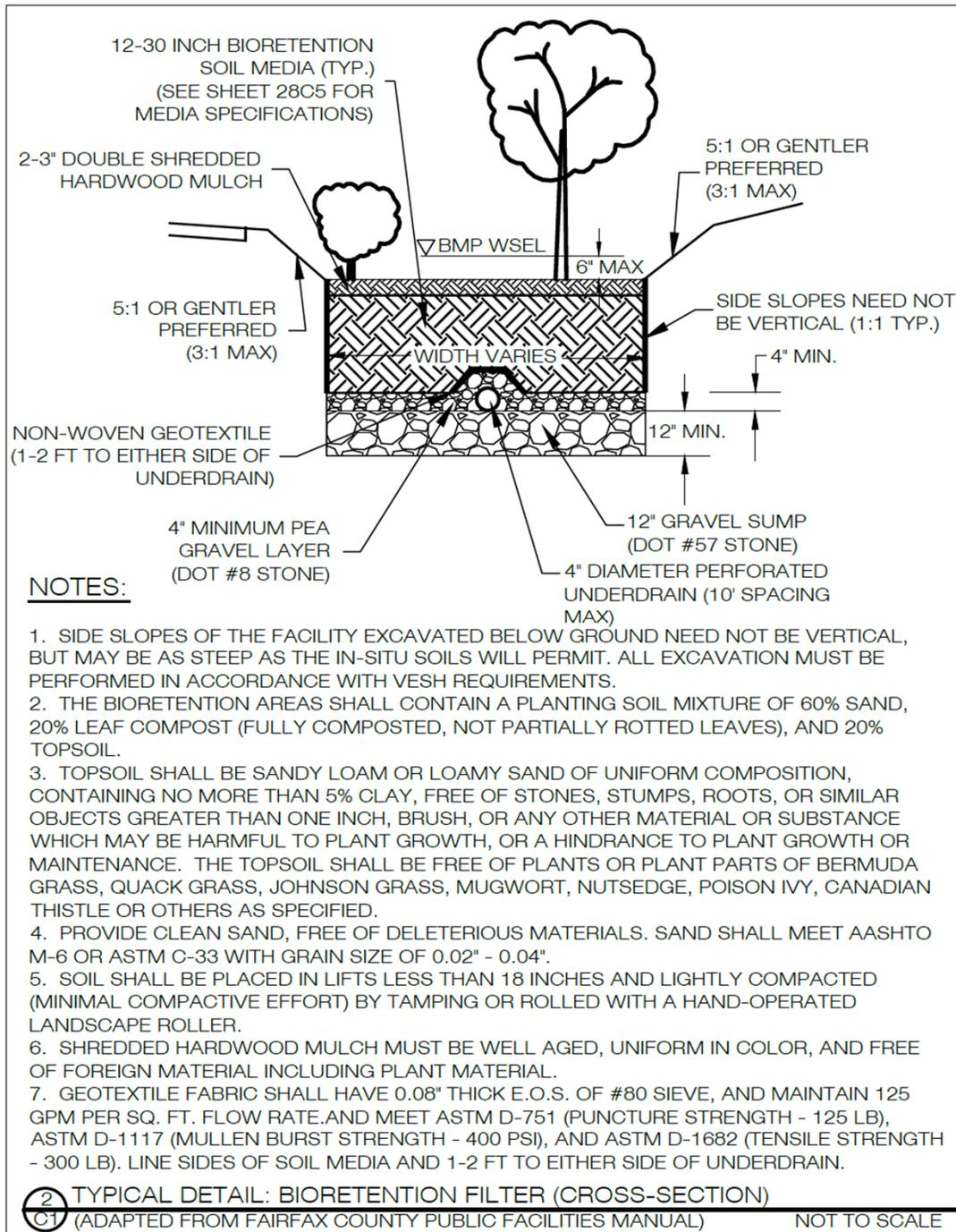
NOT TO SCALE

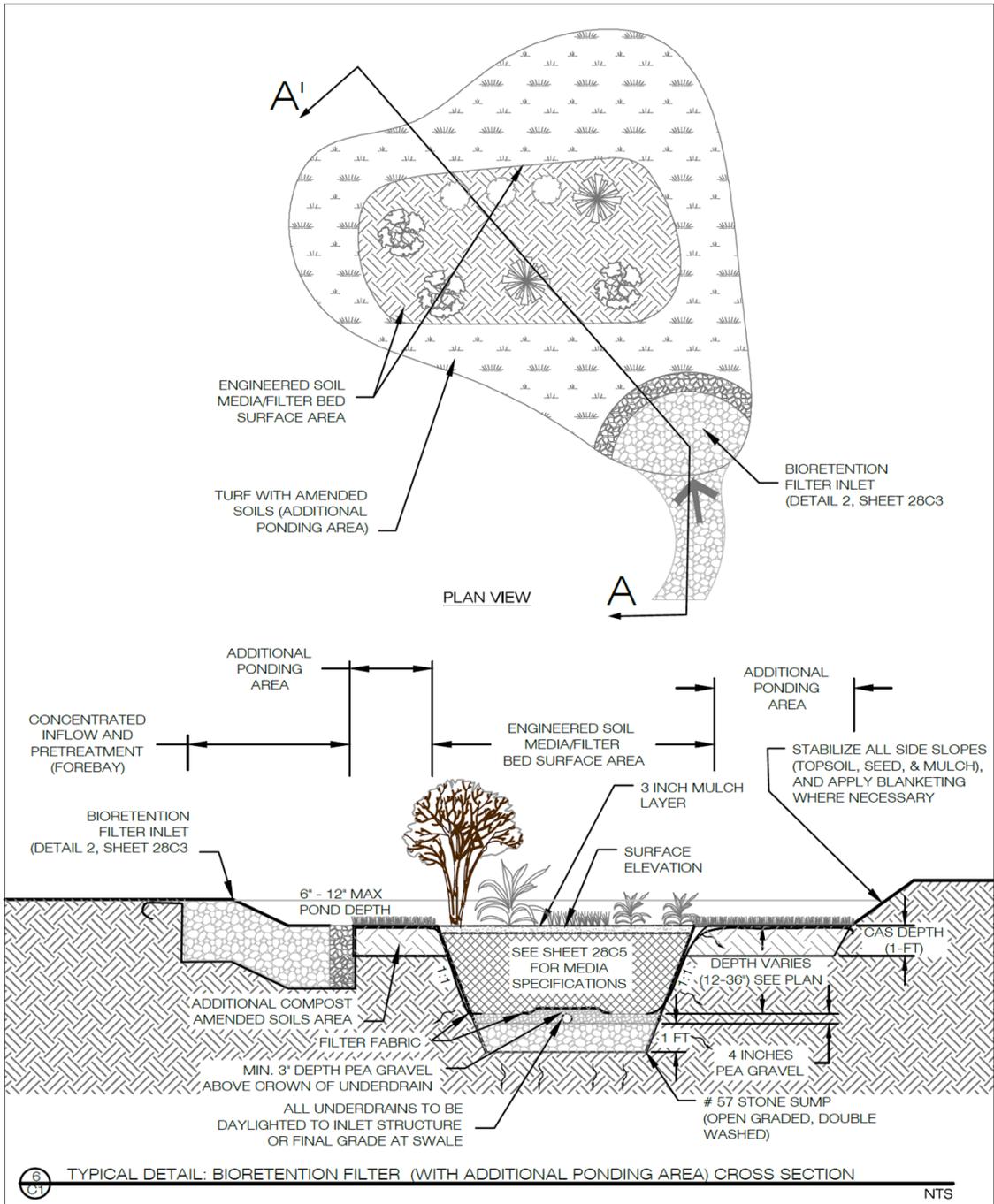


Bioretention/Biofilter

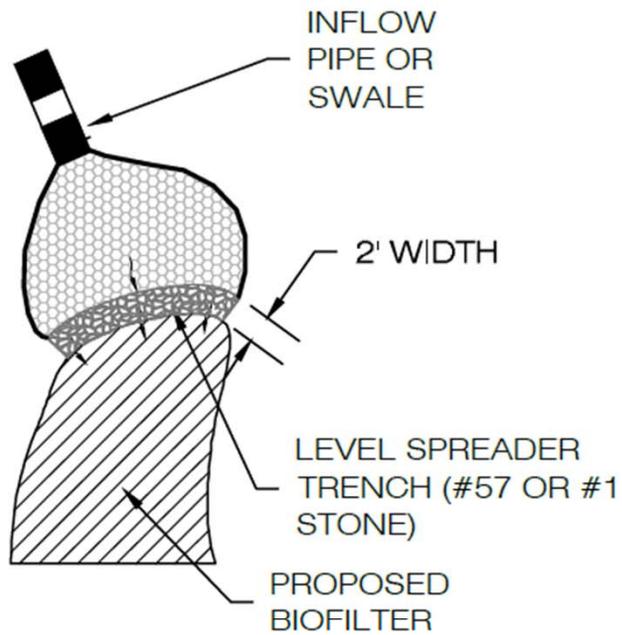




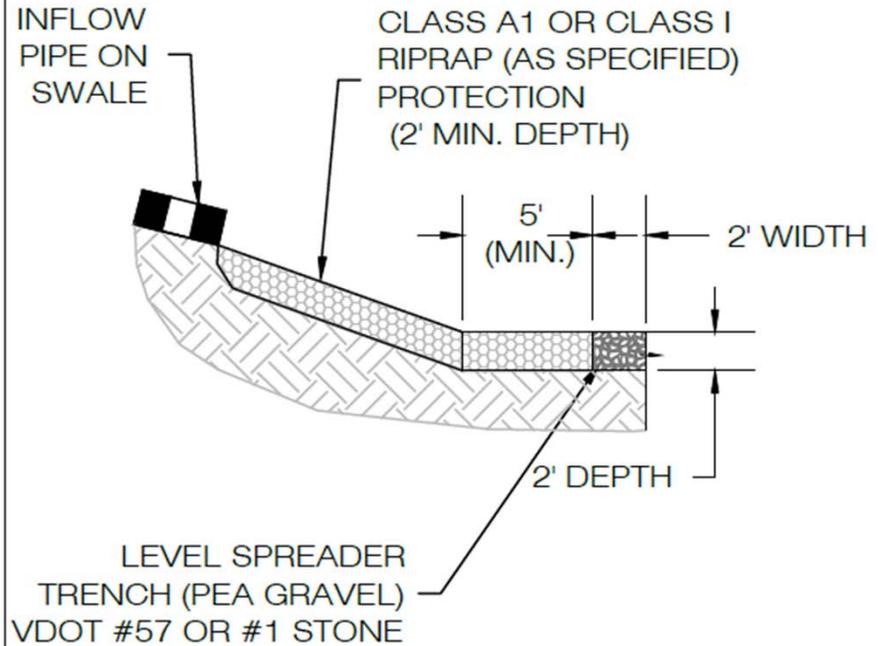




PLAN VIEW



PROFILE VIEW

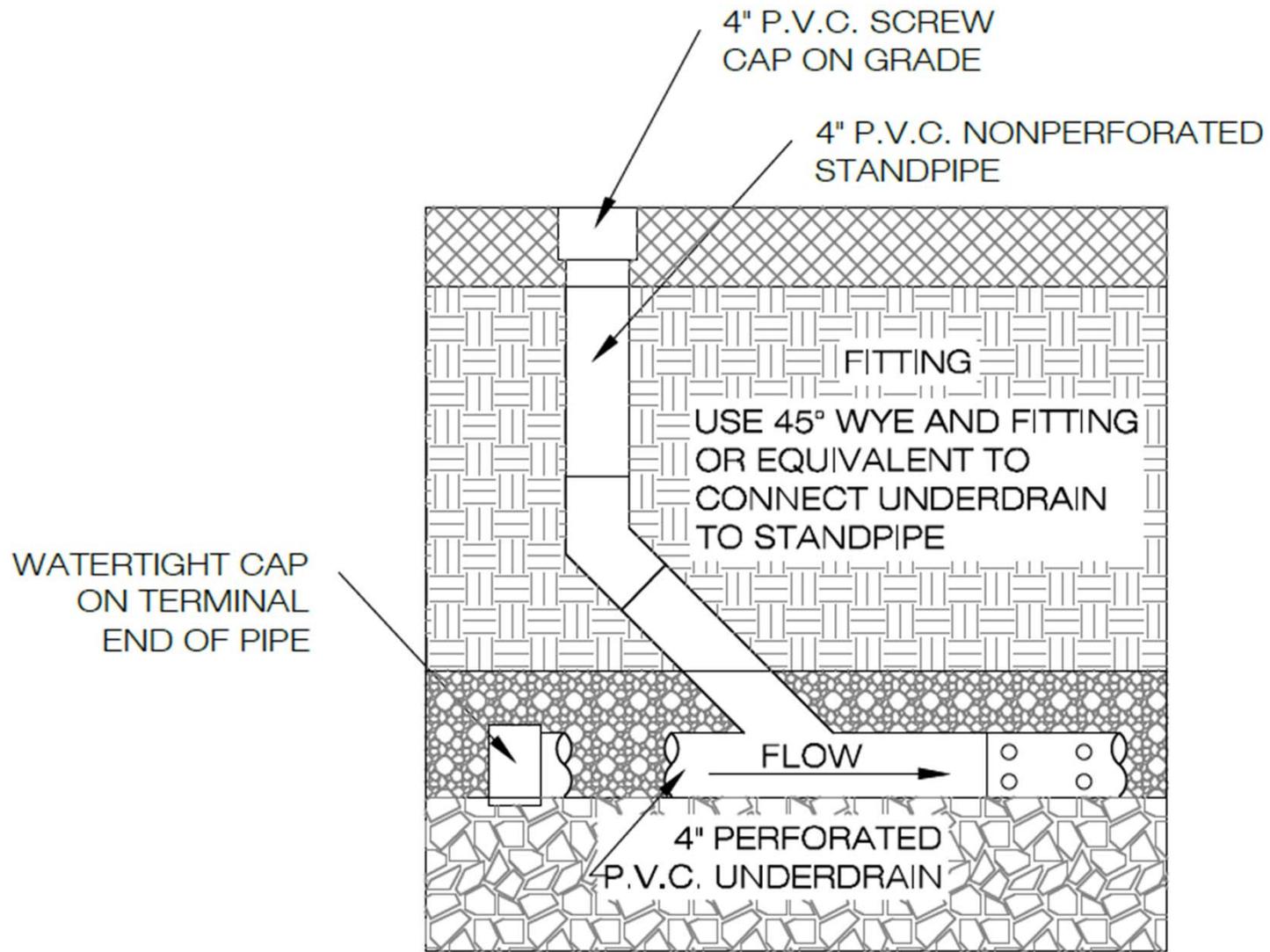


NOTE: LEVEL SPREADER TRENCH TO BE INSTALLED PARALLEL TO CONTOUR AND TO MATCH THE PROPOSED GRADE. TOP LIP ELEVATION TO BE UNIFORM TO WITHIN 1".

2
C3

DETAIL: TYPICAL GRAVEL LEVEL SPREADER

NTS



8
C2

DETAIL: 4" P.V.C. CLEANOUT AND UNDERDRAIN (TYP.)

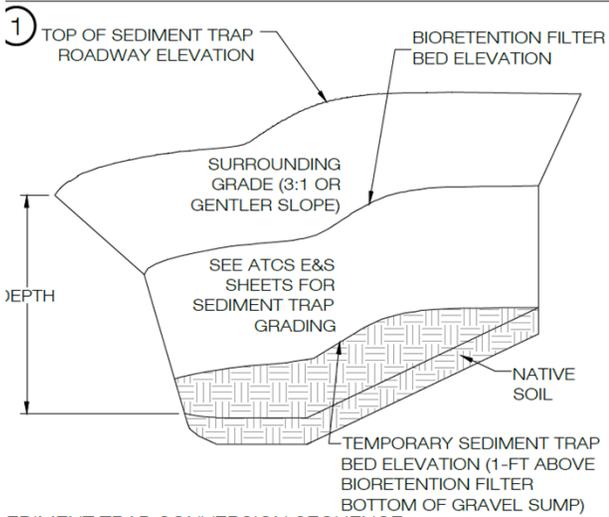
NTS

Biofilters – Critical Issues

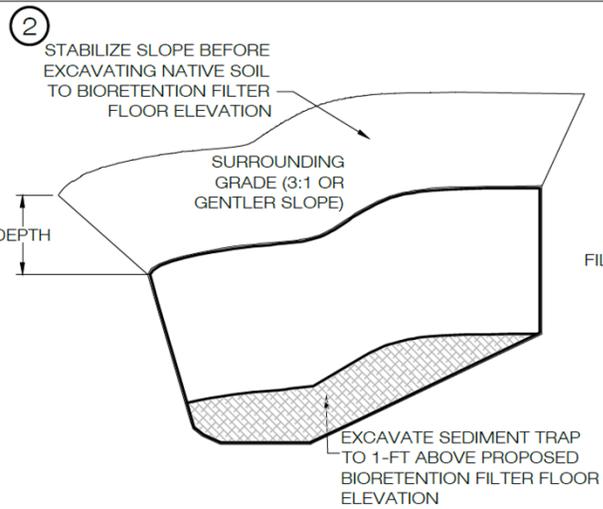
- Materials Source and Testing
 - Must be good biosoil mix or will be rejected
- Stabilization/Dissipation at Flow Inputs
 - Will require attention after initial installation
- Proper subdrainage and cleanouts
 - Plug all weep/lift holes and drains
 - Ensure all connections are watertight
 - Proper choker stone
 - Proper gravel
- Proper Media Application
 - Applied in lifts and watered/settled
 - Watered in and topped off
 - Soil bridging if needed
- Proper elevations
 - No low spots
 - No pocketed water
 - Tolerances
- Proper use of filter fabric

Biofilters – Critical Issues

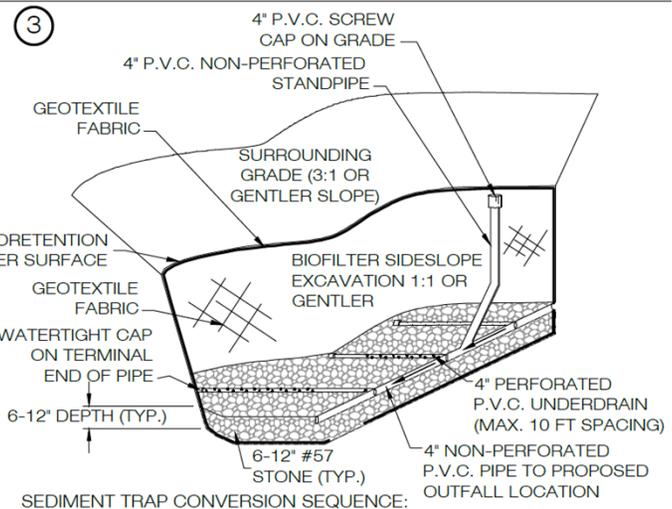
- **Construction Sediment**
- Final Landscaping
 - Materials/Seed
 - Sequence of Installation
 - Plant Material Warranty
- Maintenance During Construction
 - Prohibit construction traffic/equipment
 - Block inlets (if feasible)
 - Improve stabilization
- Sump Stone
 - Must be clean
 - Choker stone
 - Fabric overlay only (not a wrap of full covering)
- Monitor for settlement/erosion
 - Construction defects (settlement)
 - Erosion requires proactive stabilization



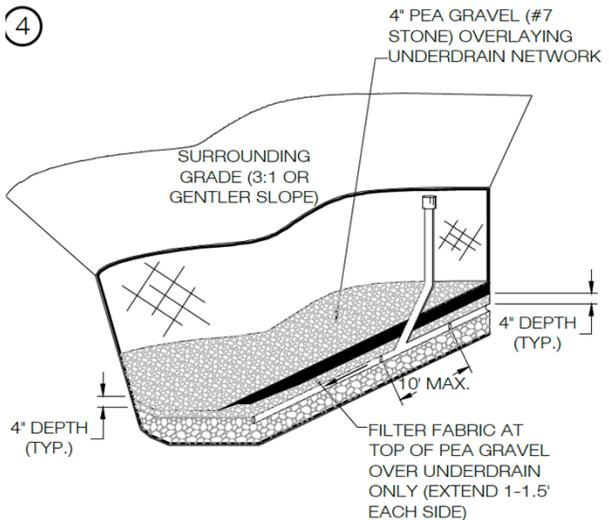
1. SEDIMENT TRAP CONVERSION SEQUENCE:
1. GRADE SEDIMENT TRAP.



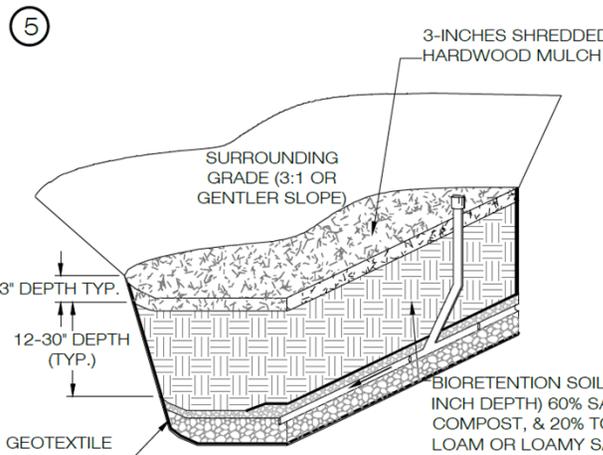
2. SEDIMENT TRAP CONVERSION SEQUENCE:
2. TO CONVERT THE SEDIMENT TRAP TO A BIORETENTION FILTER, FIRST STABILIZE ALL AREAS DRAINING TO THE BIORETENTION FILTER AND ENSURE A SLOPE OF 3:1 H:V OR GENTLER TO THE BIORETENTION FILTER SURFACE. EXCAVATE THE SEDIMENT TRAP TO AN ELEVATION CORRESPONDING TO THE BIORETENTION FILTER FLOOR ELEVATION, AND DISPOSE OF EXCAVATED SOIL. INSTALL IMPERMEABLE GEOTEXTILE LINER AROUND SIDE SLOPES AND ON BOTTOM OF BIOFILTER AS NEEDED.



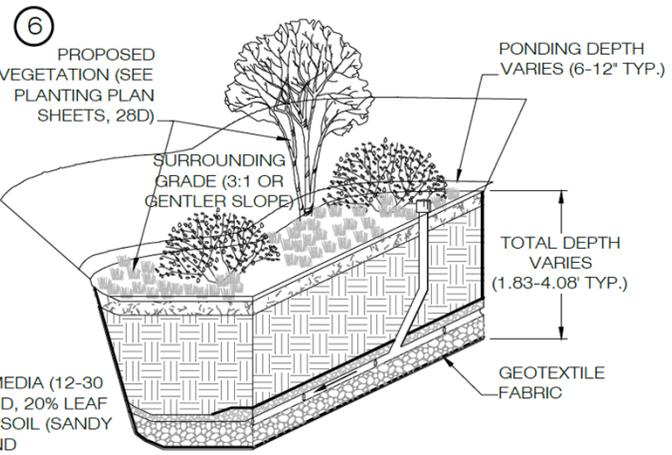
3. SEDIMENT TRAP CONVERSION SEQUENCE:
3. ONCE GEOTEXTILE FABRIC HAS BEEN INSTALLED, PROVIDE A 6-12 INCH LAYER OF VDOT #57 STONE (TYP.). INSTALL UNDERDRAIN NETWORK WITH A MAXIMUM OF 10-FOOT SPACING BETWEEN UNDERDRAIN BRANCHES AND NEST 3-INCHES WITHIN THE #57 STONE LAYER ENSURING THAT PERFORATED PIPES WITH A WATERTIGHT CAP ON TERMINAL END ARE USED FOR UNDERDRAIN BRANCHES AND NON-PERFORATED PIPES ARE USED FOR PRIMARY UNDERDRAIN PIPE. INSTALL 4-INCH NON-PERFORATED CLEANOUT PIPE PER DETAIL ON THIS SHEET.



4. SEDIMENT TRAP CONVERSION SEQUENCE:
4. PROVIDE 4-INCH LAYER OF PEA GRAVEL OVERLAYING UNDERDRAIN NETWORK AND INSTALL FILTER FABRIC 1-1.5 FEET IN TOP OF PEA GRAVEL ON EITHER SIDE OF THE NON-PERFORATED UNDERDRAIN PIPE.



5. SEDIMENT TRAP CONVERSION SEQUENCE:
5. INSTALL 12-30 INCH LAYER OF BIOFILTER SOIL MEDIA (AS SPECIFIED IN DESIGN PLANS) ENSURING THAT ABOVE SPECIFICATIONS ARE OBSERVED. LIGHTLY TAMP BIORETENTION FILTER SOIL MEDIA. ONCE BIORETENTION FILTER SOIL MEDIA IS INSTALLED, INSTALL A 3-INCH LAYER OF SHREDDED HARDWOOD MULCH OVERLYING THE BIORETENTION FILTER SOIL MEDIA.



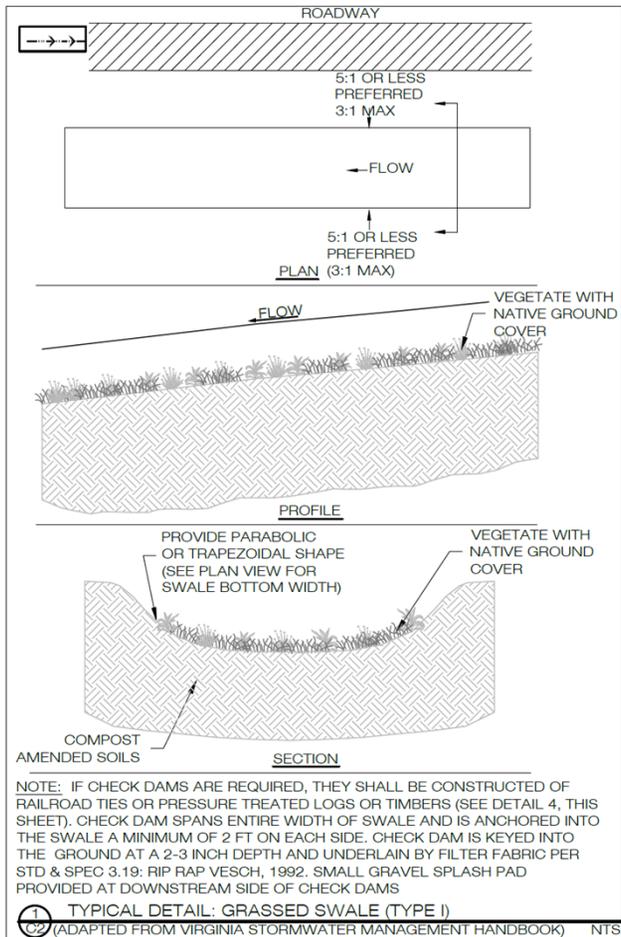
6. SEDIMENT TRAP CONVERSION SEQUENCE:
6. SEED AND PLANT BIORETENTION FILTER SURFACE AREA ACCORDING TO THE PROVIDED PLANTING PLAN (SHEETS 28D).

GENERAL NOTES:
1) CONSTRUCTION OF THE BIORETENTION FILTERS SHALL NOT BE FINISHED UNTIL THE CONTRIBUTING DRAINAGE AREAS HAVE BEEN STABILIZED AND APPROVED BY THE COUNTY. UPON WHICH, THE BASINS SHALL FIRST BE CLEANED AND BROUGHT TO DESIGN GRADE.
2) CONTRACTOR SHALL CONTACT THE COUNTY INSPECTOR AND ENGINEER 24 HOURS PRIOR TO BACKFILLING THE BIORETENTION FILTERS, AND OBTAIN APPROVAL OF THE UNDERDRAIN...

Swales



TYPE 1



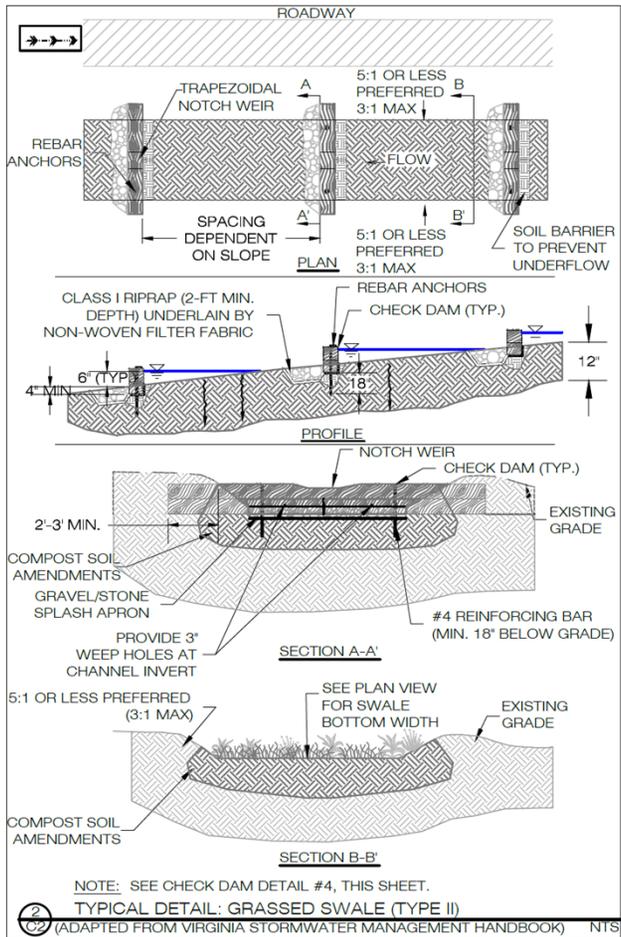
Trapezoidal X-section preferred

Dimensioned per plan

Stable with vigorous dense rooted vegetation

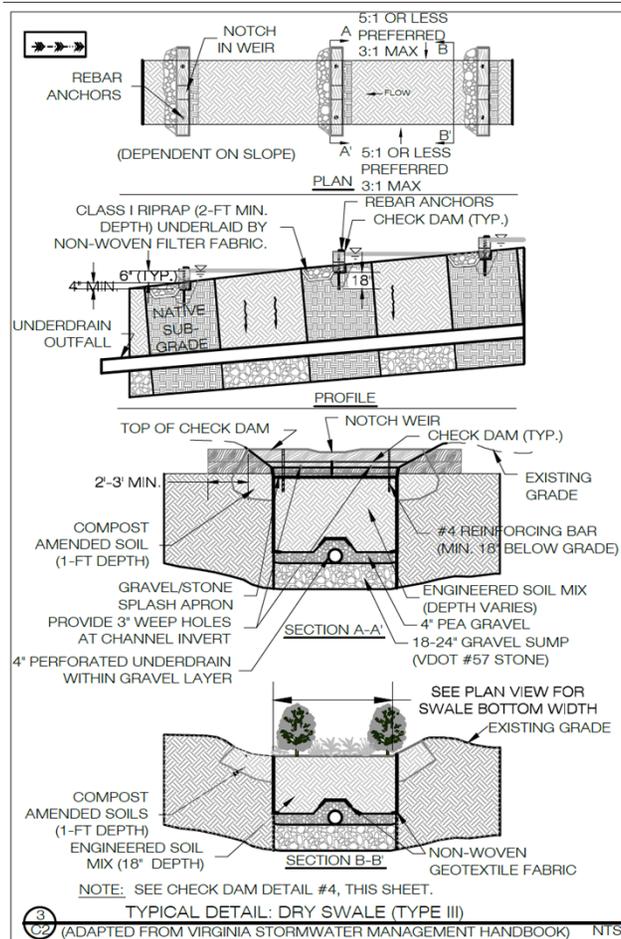
Check Dams Optional (see plan)

TYPE 2



Trapezoidal X-section preferred
Dimensioned per plan
Compost Soil Amendments Included
Check Dams Typical(see plan)

TYPE 3



Linear Bioretention Facility

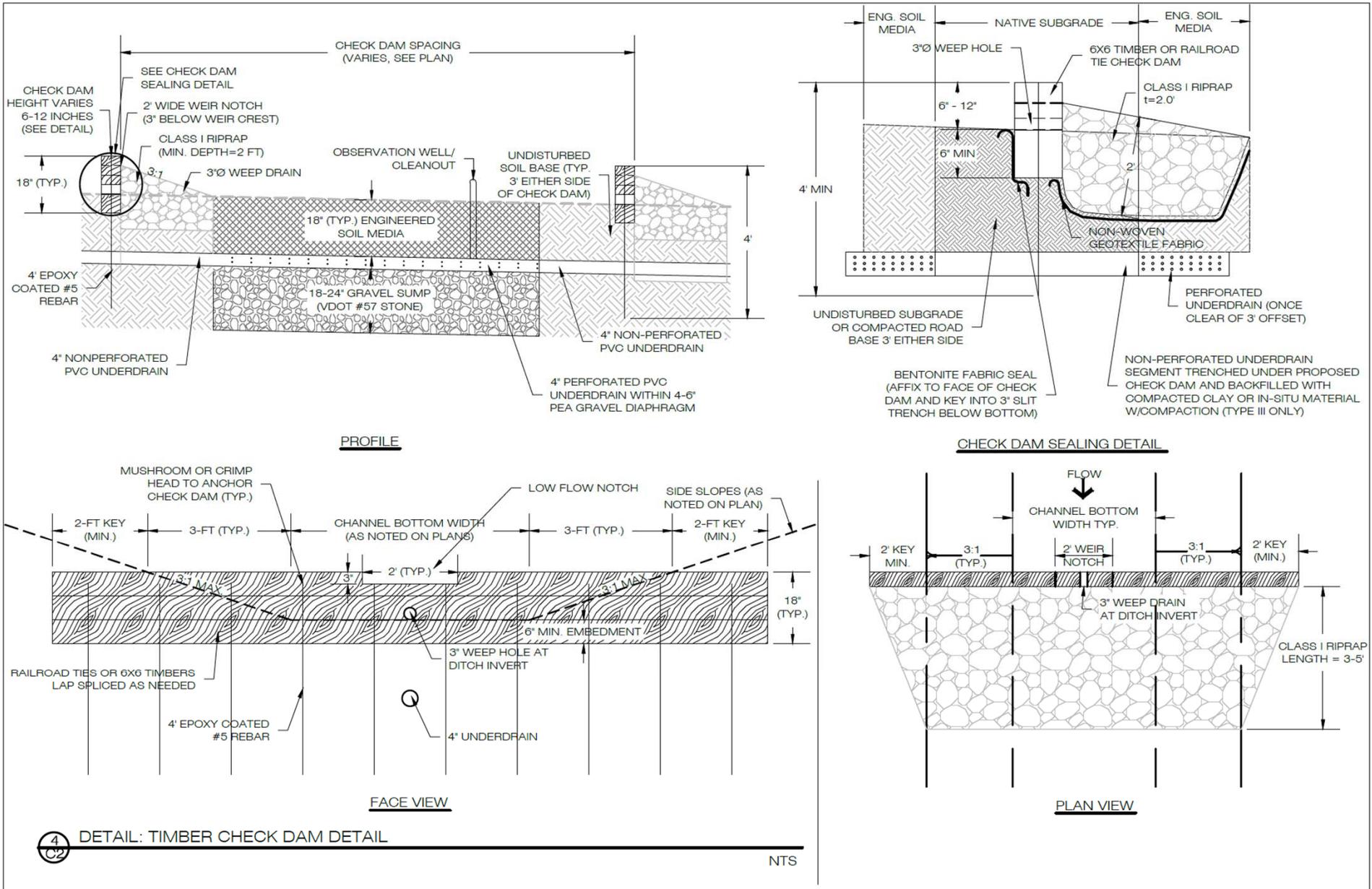
Dimensioned per plan

Compost Soil

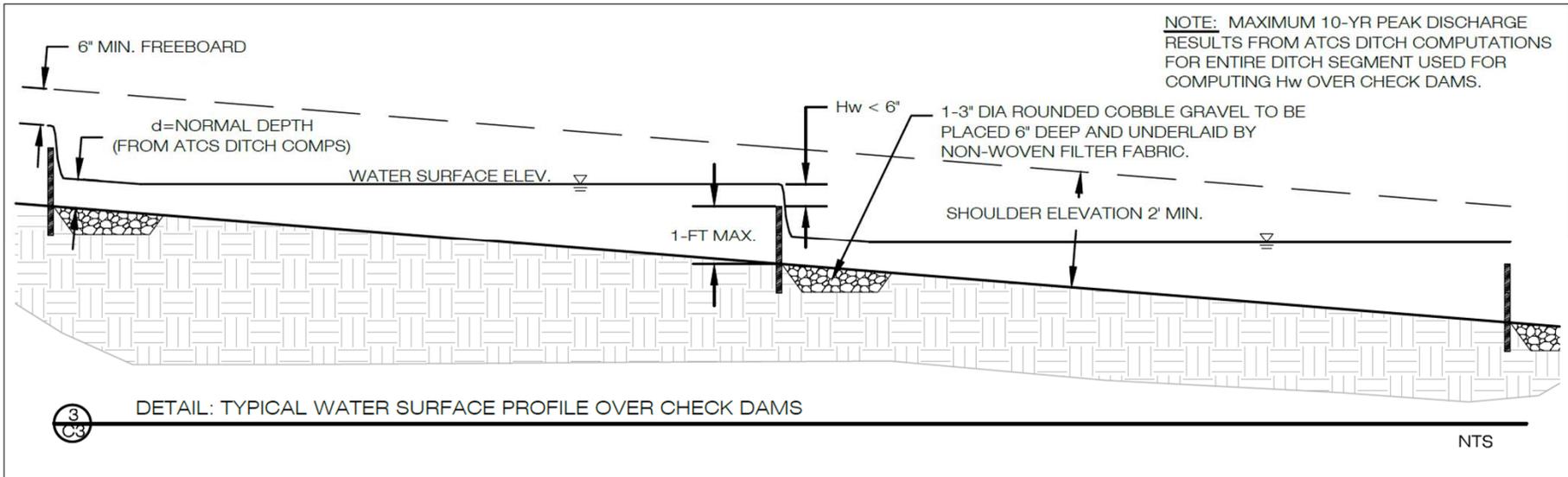
Amendments may be included on perimeter

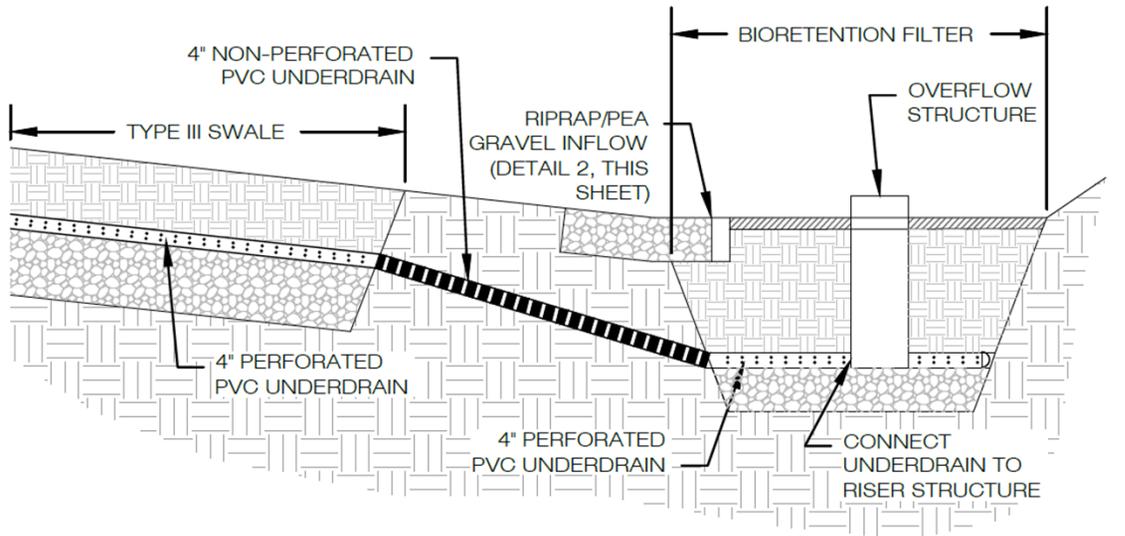
Check Dams

Typical(see plan)

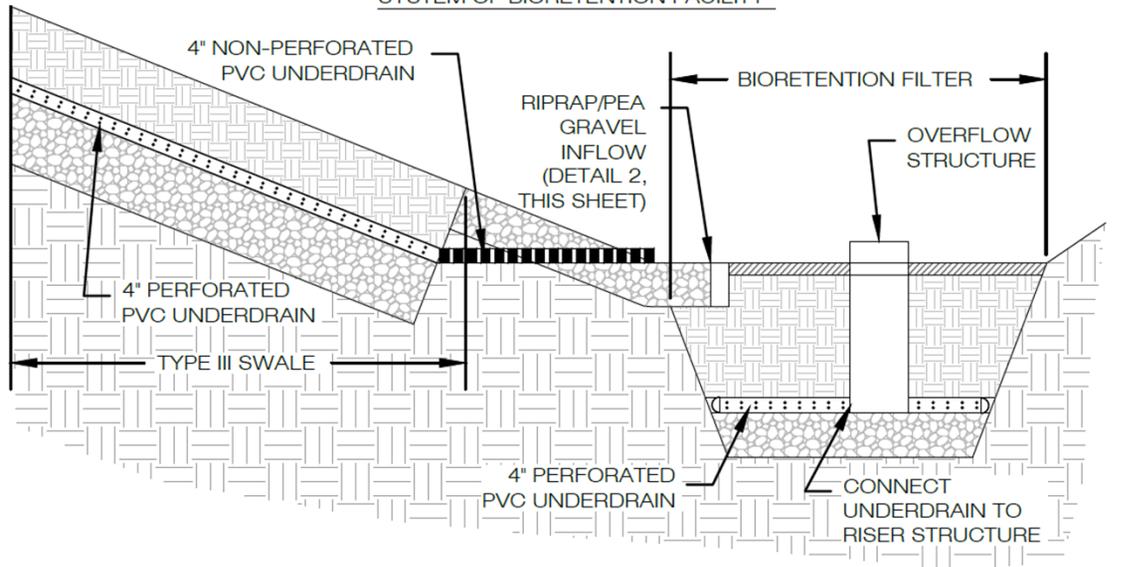


Swale Typ. Profile





CONNECT SWALE UNDERDRAIN TO UNDERDRAIN SYSTEM OF BIORETENTION FACILITY



DAYLIGHT SWALE UNDERDRAIN TO SURFACE OF BIORETENTION FACILITY



DETAIL: TYPE III SWALE/BIORETENTION FILTER COMBINATION

NTS

Swale Construction - Critical Elements

| | |
|--|--|
| Dimensions | Type III – Same issues as bioretention |
| Check Dams* | |
| Proper Media Incorporation Depth | Engineered Media/Compost – last steps |
| Rapid stabilization/surface protection | Proper seeding |
| Slopes (max) | Maintenance after installation |

Check Dams

Proper Embedment
(lateral/vertical)

Proper anchoring

Weep holes/notches

Proper armoring
(splash apron and
flanks)

Soil – water bars @ CD
locations

Biggest Issues:

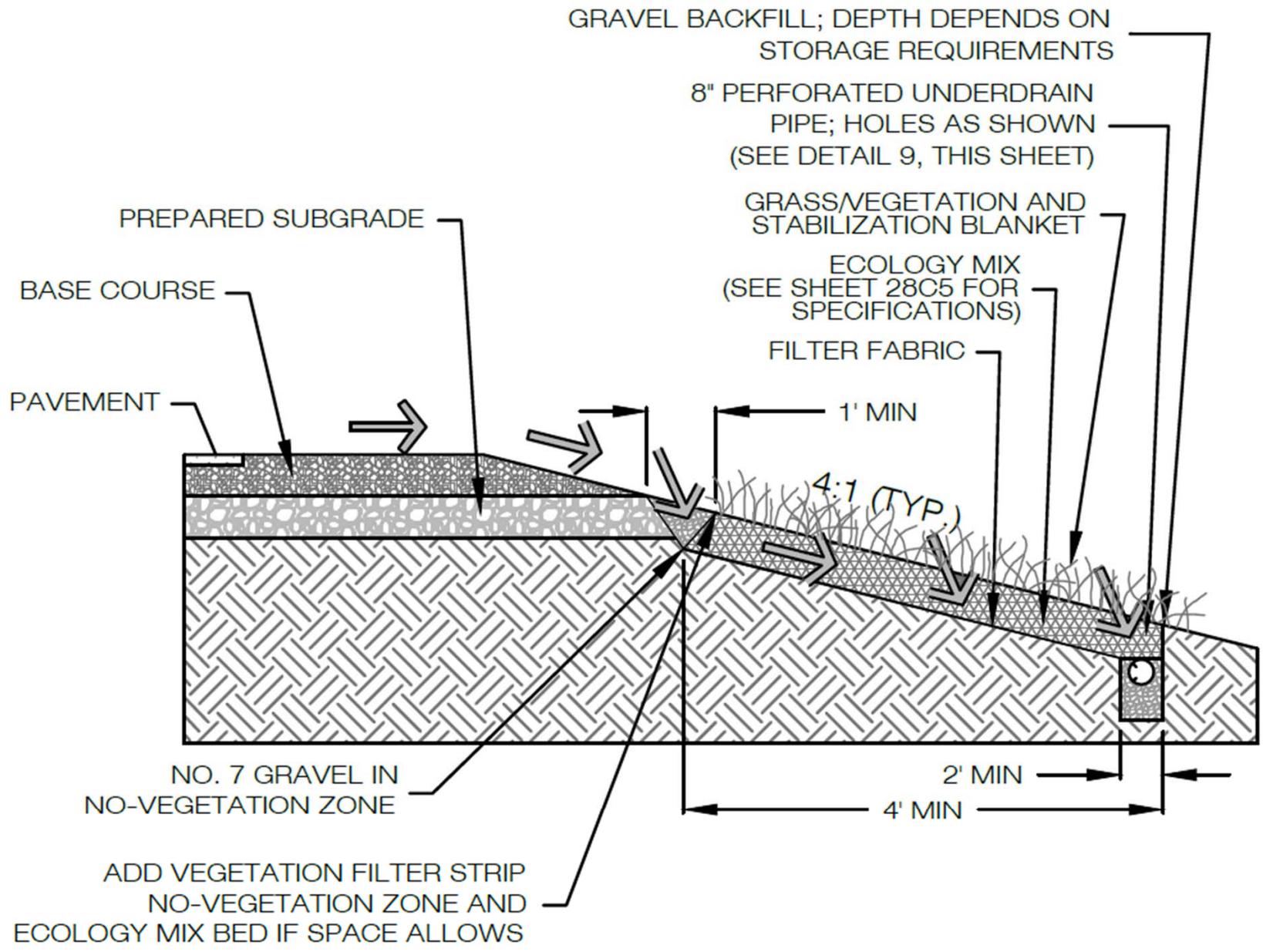
Flanking

Undermining

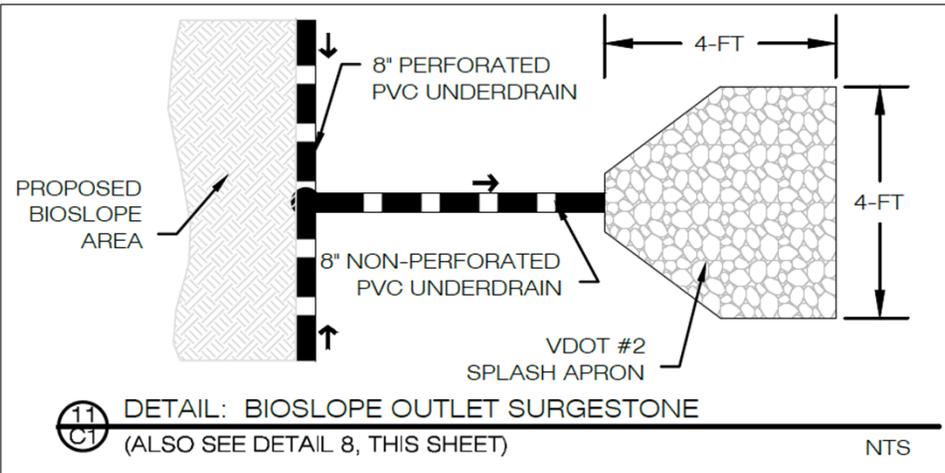
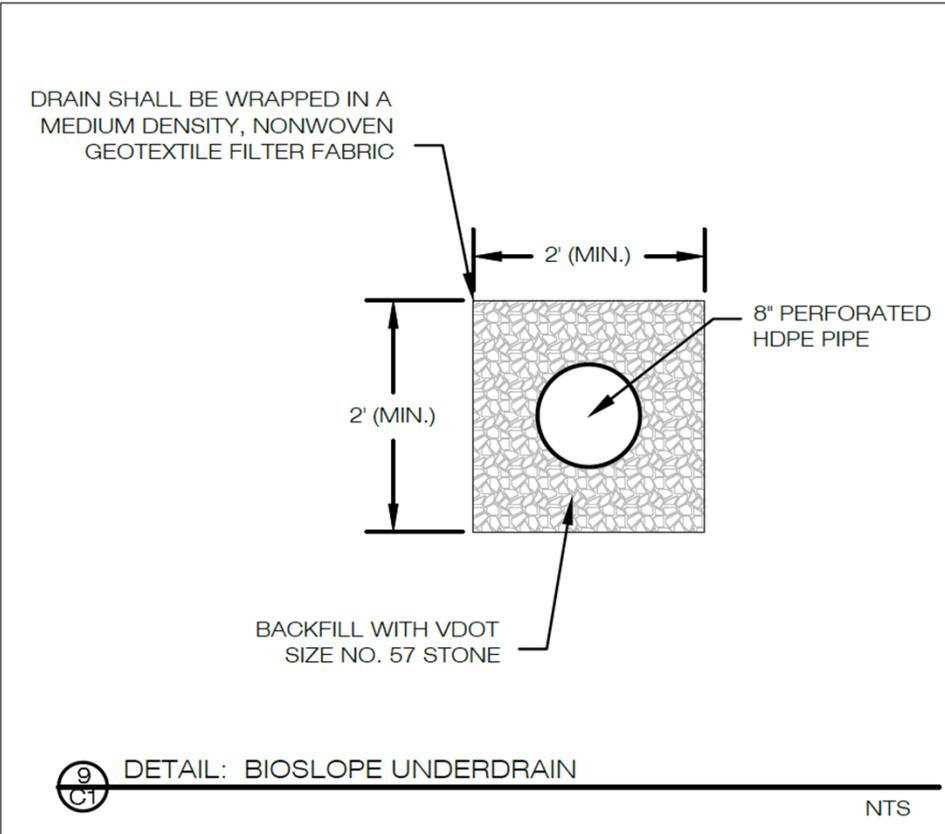
Swale Erosion due
to lack of
stabilization

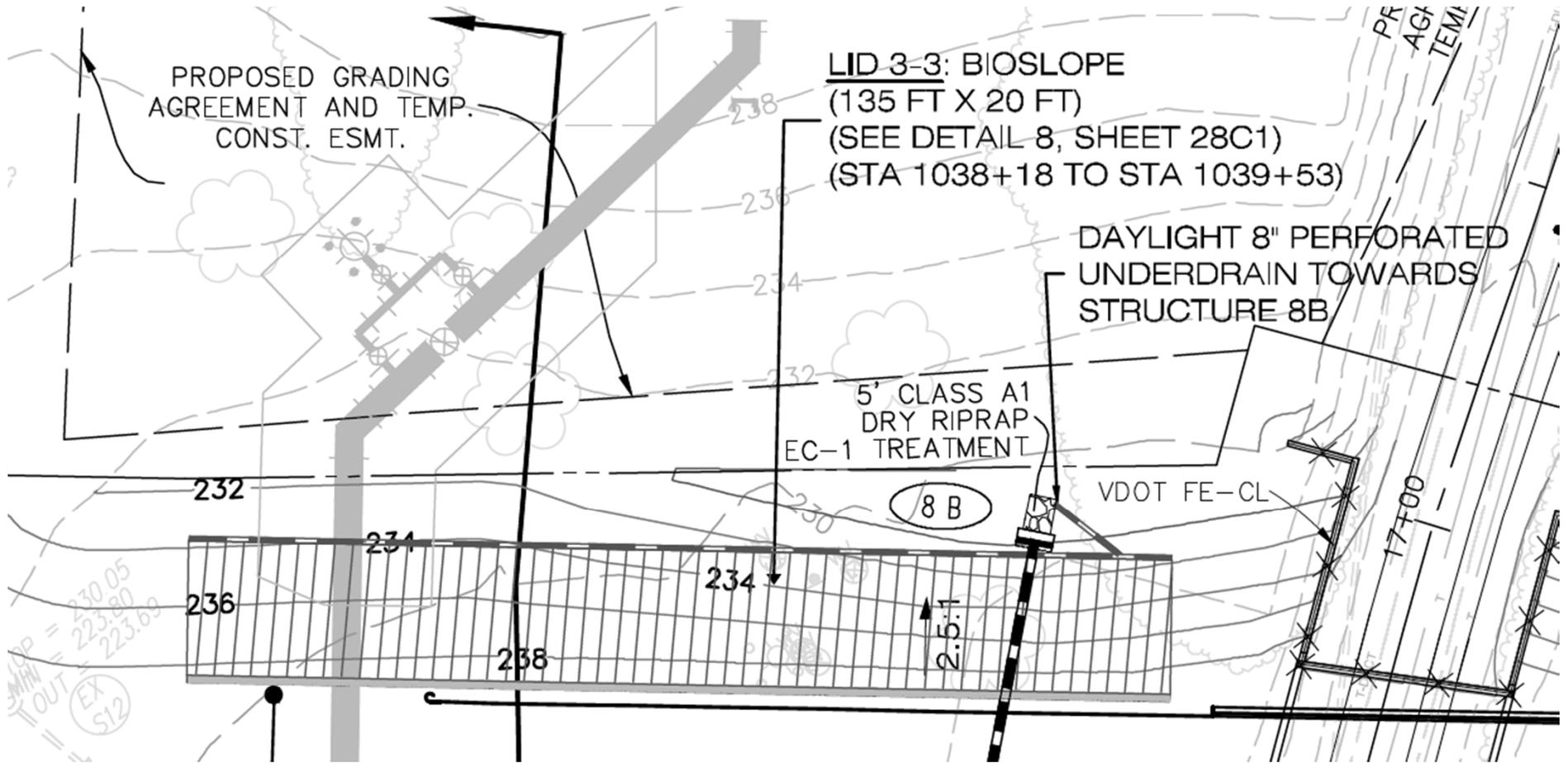
Bioslopes





8 TYPICAL DETAIL: BIOSLOPE
 C1 (ADAPTED FROM NCHRP 565 AND WSDOT HIGHWAY RUNOFF MANUAL)





Bioslopes

Different Soil Media
Mixture

Underdrains should
daylight to grade

Stabilization apron at
outlet (small apron)

Slope constraints on
all bioslopes (issues
if there is a grade
bust)

Specs recommend
obstructing flow at
top of bioslope until
it is stable –
Compost berm or
other to redirect
flow

OTHER ITEMS OF NOTE

VCTIR Research Efforts

Evolution of Specifications and Materials

Processes for RFIs?

Periodic QA Checks?

Who is completing forms and
documentation?

Schedule/Milestones?

QUESTIONS?