A G E N D A
JAMES CITY COUNTY AFD ADVISORY COMMITTEE
REGULAR MEETING
101-D Mounts Bay Road, Williamsburg, VA 23185
Building D Glass Conference Room
October 21, 2021
4:00 PM

A. CALL TO ORDER

B. ROLL CALL

C. MINUTES

1. Minutes of the January 21, 2021 Organizational Meeting

D. OLD BUSINESS

E. NEW BUSINESS

1. AFD-21-0002. 9958 Mill Pond Run, Barnes Swamp AFD Addition

F. DISCUSSION ITEMS

1. 2022 Agricultural and Forestal District Renewal Process

G. ADJOURNMENT

AGENDA ITEM NO. C.1.

ITEM SUMMARY

DATE: 10/21/2021

TO: The Agricultural and Forestal District Advisory Committee

FROM: Josh Crump, Principal Planner

SUBJECT: Minutes of the January 21, 2021 Organizational Meeting

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ATTACHMENTS:

	Description	Type
🗋	Minutes of the January 21, 2021 Organizational Meeting	Minutes

REVIEWERS:

Department	Reviewer	Action	Date
AFD Advisory Group	Crump, Josh	Approved	10/14/2021 - 9:43 AM
AFD Advisory Group	Holt, Paul	Approved	10/14/2021 - 9:53 AM
Publication Management	Daniel, Martha	Approved	10/14/2021 - 10:14 AM
AFD Advisory Group	Secretary, AFD	Approved	10/14/2021 - 10:24 AM

M I N U T E S
JAMES CITY COUNTY AFD ADVISORY COMMITTEE
ORGANIZATIONAL MEETING
101-A Mounts Bay Road, Williamsburg, VA 23185
Building A Large Conference Room
January 21, 2021
4:00 PM

A. CALL TO ORDER

1. This meeting will be held electronically pursuant to the Continuity of Government Ordinance adopted by the Board of Supervisors on April 14, 2020 and readopted on September 8, 2020. The meeting will be accessible through a Zoom audio meeting. Please go to https://zoom.us/j/91559836394 or call 312-626-6799 and enter the meeting ID 915 5983 6394. Citizen comments may be submitted via U.S. Mail to the AFD Advisory Committee Secretary, P.O. Box 8784, Williamsburg, VA 23187, via electronic mail to community.development@jamescitycountyva.gov, or by leaving a message at 757-253-6750. Comments must be submitted no later than noon on the day of the meeting. Please provide your name and address for the public record.

B. ROLL CALL

1. Electronic Meeting Resolution

   Mr. Chris Taylor called the Agricultural and Forestal District (AFD) Advisory Committee Organizational Meeting to order at 4 p.m. He called the roll and read the electronic meeting resolution.

   Mr. Sandy Wanner motioned to Adopt the electronic meeting resolution.

   The resolution was adopted by a voice vote of 8-0.

   Present:
   Chris Taylor, Chair
   Bruce Abbott, Vice Chair
   Richard Bradshaw
   Loretta Garrett
   Payten Harcum
   William Harcum
   Sue Sadler
   Sandy Wanner

   Absent:
   Thomas Hitchens

   Staff:
   Alex Baruch, Acting Principal Planner
   Beth Klapper, Community Development Assistant
   Katie Pelletier, Community Development Assistant

C. MINUTES

1. Minutes of the October 22, 2020 Regular Meeting

Mr. Bruce Abbott motioned to Approve the minutes of the Committee Meeting on October 22, 2020.

On a voice vote, the minutes were approved 8-0.

D. OLD BUSINESS

1. AFD Advisory Committee Proposed 2021/2022 Calendar

Mr. Alex Baruch reviewed the proposed 2021-2022 and tentative 2022-2023 Committee Meeting dates. He noted that AFD renewal cases were tentatively scheduled for meetings on July 21, 2022, and July 28, 2022. He asked if the Committee was ready to adopt the 2021/2022 calendar.

Mr. Abbott motioned to Approve the proposed 2021-2022 calendar, with regular Committee meetings scheduled on April 22, 2021, July 22, 2021, and October 21, 2021, and the next Organizational Committee Meeting scheduled on January 20, 2022.

The Motion was approved on a voice vote of 8-0.

E. NEW BUSINESS

1. Election of Officers

Mr. Abbott motioned to Re-elect Mr. Taylor as the Committee Chairman.

Mr. Wanner seconded the motion.

The motion was approved 8-0 after a unanimous voice vote.

Ms. Loretta Garrett motioned to Re-elect Mr. Abbott as the Committee Vice Chairman.

Mr. William Harcum seconded the motion.

The motion was approved 8-0 after a unanimous voice vote.

F. DISCUSSION ITEMS

Mr. Taylor asked if the Committee had any other questions or comments.

G. ADJOURNMENT

Mr. Wanner motioned to Adjourn the meeting.

Mr. Abbott seconded the motion.

After a voice vote of 8-0, the meeting was adjourned at 4:15 p.m.

_____ _____

Chris Taylor, Chair Josh Crump, Principal Planner

AGENDA ITEM NO. E.1.

ITEM SUMMARY

DATE: 10/21/2021

TO: The AFD Advisory Committee

FROM: Tori Haynes, Senior Planner

SUBJECT: AFD-21-0002. 9958 Mill Pond Run, Barnes Swamp AFD Addition

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ATTACHMENTS:

	Description	Type
	Staff Report	Staff Report
	1. Location Map	Backup Material
	2. Barnes Swamp AFD 2018 Renewal Ordinance and Staff Report	Backup Material
	3. State Code § 15.2-4305	Backup Material
	4. CSWCD Conservation Plan	Backup Material

REVIEWERS:

Department	Reviewer	Action	Date
AFD Advisory Group	Crump, Josh	Approved	10/14/2021 - 2:12 PM
AFD Advisory Group	Holt, Paul	Approved	10/14/2021 - 2:13 PM
Publication Management	Daniel, Martha	Approved	10/14/2021 - 2:35 PM
AFD Advisory Group	Secretary, AFD	Approved	10/14/2021 - 2:39 PM

Agricultural and Forestal District-21-0002. 9958 Mill Pond Run, Barnes Swamp AFD Addition

Staff Report for the October 21, 2021, Agricultural and Forestal District Advisory Committee Meeting

SUMMARY FACTS

Applicant:	Mr. David Hogue
Land Owner(s):	Mr. David and Ms. Karen Hogue
Proposal:	Addition of a ± 60.77-acre parcel to the Barnes Swamp Agricultural and Forestal District (AFD)
Location:	9958 Mill Pond Run
Tax Map/Parcel No.:	0540100001
Project Acreage:	± 60.77 acres
Zoning:	A-1, General Agricultural
Comprehensive Plan:	Low Density Residential
Primary Service Area: (PSA)	Inside
Staff Contact:	Tori Haynes, Senior Planner

PUBLIC HEARING DATES

AFD Committee:	October 21, 2021, 4:00 p.m.
Planning Commission:	December 1, 2021, 6:00 p.m. (Tentative)
Board of Supervisors:	January 11, 2022, 5:00 p.m. (Tentative)

FACTORS FAVORABLE

1. Staff finds that this addition to the Barnes Swamp AFD would not adversely affect surrounding development and is consistent with the core of the District.

2. Staff finds the proposal consistent with the 2035 and draft 2045 Comprehensive Plan Land Use Action 6.1.1.

3. The applicant has coordinated harvesting and resource management plans with the Virginia Department of Forestry (VDOF) and Colonial Soil and Water Conservation District (CSWCD).

4. Impacts: This proposal is not anticipated to generate any impacts that require mitigation.

FACTORS UNFAVORABLE

As this proposal is not anticipated to generate any impacts that require mitigation, staff finds no unfavorable factors.

SUMMARY STAFF RECOMMENDATION

Should the AFD Advisory Committee find that the subject property contains agriculturally and forestally significant land, staff recommends that the Committee recommend approval of the application to the Planning Commission and the Board of Supervisors.

PROJECT DESCRIPTION

- Mr. David Hogue has applied to enroll ± 60.77 acres of land located at 9958 Mill Pond Run into the Barnes Swamp AFD. The parcel is currently undeveloped. A 50-foot ingress/egress easement was granted in 2004 for access to the parcel from Mill Pond Run.

- The subject parcel is more than one mile away from the core parcels in the Barnes Swamp AFD; therefore, as specified in the Code of Virginia, the governing body must decide if this property contains agriculturally and forestally significant land to be added to the Barnes Swamp AFD (see Attachment No. 3).

- The applicant has been working with the VDOF and CSWCD for harvesting and resource management plans. Approximately five acres of harvested land will be reforested with loblolly pine under VDOF's Reforestation of Timberlands cost-share program, and the remaining harvested acreage will be converted into pasture per a conservation plan administered by CSWCD (see Attachment No. 4). VDOF noted that the soils are well-suited for timber production.

- Per the United States Department of Agriculture's *Soil Survey of James City and York Counties and the City of Williamsburg Virginia*, the parcel consists of the following soils:

Soil Type	Erosion Hazard	Equipment Limitation	Seedling Mortality	Windthrow Hazard
11C, Craven-Uchee complex, 6-10% slopes	Slight	Moderate	Slight/ Moderate	Slight
14B, Emporia fine sandy loam, 2-6% slopes	Slight	Slight	Slight	Slight
15F, Emporia complex, 25-50% slopes	Moderate	Severe	Slight	Slight
17, Johnston complex	Slight	Severe	Severe	Moderate
18B, Kempsville fine sandy loam, 2-6% slopes	Slight	Slight	Slight	Slight
19B, Kempsville-Emporia fine sandy loams, 2-6% slopes	Slight	Slight	Slight	Slight
34B, Uchee loamy fine sand, 2-6% slopes	Slight	Moderate	Moderate	Slight

DISTRICT HISTORY

- The Barnes Swamp AFD was created in 1986 for a term of four years and originally consisted of 29 parcels totaling ± 1,905 acres.

- The District was renewed in four-year intervals in 1990, 1994, 1998, 2002, 2006, 2010, 2014, and 2018, with various additions and withdrawals taking place during those periods.

- The District currently consists of ±1,894.78 acres. Should this addition be approved, the District would consist of ± 1,955.55 acres.

SURROUNDING ZONING AND DEVELOPMENT

All surrounding properties are part of the Stonehouse Master Plan, zoned PUD-R, Planned Unit Development-Residential, and designated Low Density Residential in the 2035 and draft 2045 Comprehensive Plans. Single-family residential parcels are located to the north, and are separated from the subject parcel by a minimum 50-foot vegetated buffer. There are no residential parcels directly adjacent. Parcels to the south are undeveloped and located in conservation easements.

COMPREHENSIVE PLAN

The subject parcel is designated Low Density Residential in the 2035 and draft 2045 Comprehensive Plans. Appropriate uses in Low Density Residential include single-family and multifamily units, accessory units, cluster housing, and recreation areas. While agricultural and forestal uses tend to be located in areas designated Rural Lands outside of the PSA, staff notes that these activities are consistent with the parcel's underlying zoning of A-1, General Agricultural. The proposal is also consistent with the following Goals, Strategies, and Actions:

Land Use

2035 LU Action 6.1.1: Support both the use value assessment and AFD programs to the maximum degree allowed by the Code of Virginia.

2045 LU Action 6.1.1: Support both the use value assessment and AFD programs to the maximum degree allowed by the Code of Virginia. Explore extending the terms of the County's Districts.

PUBLIC IMPACTS

This proposal is not anticipated to generate any impacts that require mitigation.

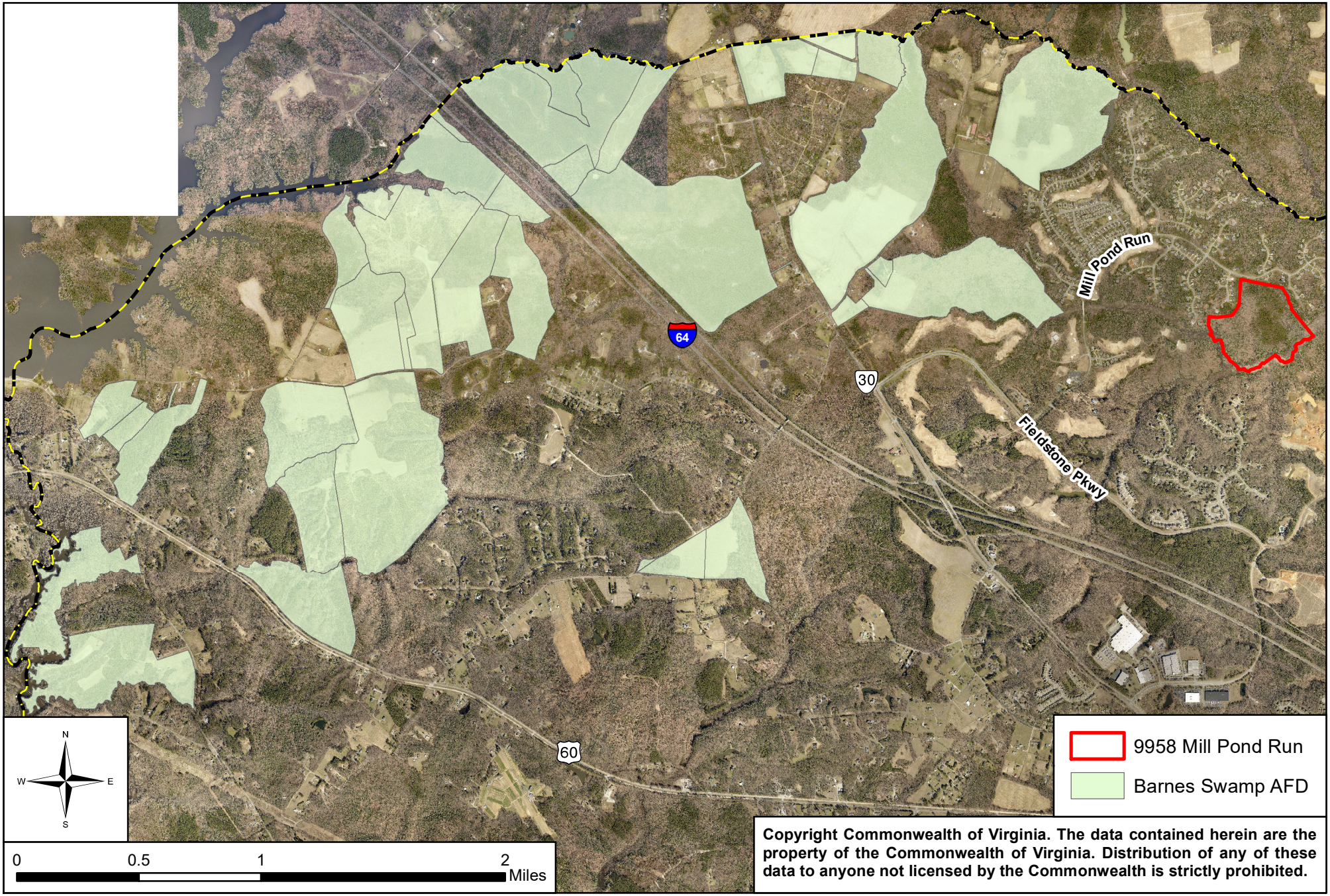
STAFF RECOMMENDATION

Should the AFD Advisory Committee find that the subject property contains agriculturally and forestally significant land, staff recommends that the Committee recommend approval of the application to the Planning Commission and the Board of Supervisors.

TH/ap
AFD21-9_9958MillPndRn

Attachments:
1. Location Map
2. Barnes Swamp AFD 2018 Renewal Ordinance and Staff Report
3. State Code § 15.2-4305 regarding AFD application criteria
4. CSWCD Conservation Plan

JCC AFD-21-0002
9958 Mill Pond Run, Barnes Swamp AFD Addition



ADOPTED

SEP 11 2018

Board of Supervisors
James City County, VA

ORDINANCE NO. 167A-14

AGRICULTURAL AND FORESTAL DISTRICT-05-86-1-2018

BARNES SWAMP 2018 RENEWAL

WHEREAS, James City County has completed a review of the Barnes Swamp Agricultural and Forestal District (the "District"); and

WHEREAS, in accordance with Section 15.2-4311 of the Code of Virginia, 1950, as amended (the "Virginia Code"), property owners have been notified, public notices have been filed, public hearings have been advertised, and public hearings have been held on the continuation of the District; and

WHEREAS, the Agricultural and Forestal District (AFD) Advisory Committee at its meeting on June 21, 2018, voted 9-0 to recommend renewal of the District; and

WHEREAS, the Planning Commission following its public hearing on August 1, 2018, concurred with the recommendation of staff and the AFD Advisory Committee and voted 5-0 to recommend renewal of the District with the conditions listed below.

NOW, THEREFORE, BE IT ORDAINED by the Board of Supervisors of James City County, Virginia, that:

1. The Barnes Swamp Agricultural and Forestal District (the "District") is hereby continued to October 31, 2022 in accordance with the provisions of the Virginia Agricultural and Forestal District Act, Virginia Code Section 15.2-4300 et. seq. (the "Act").

2. That the District shall include the following parcels, provided, however, that all land within 25 feet of road right-of-ways is excluded from the District:

Owner	Parcel No.	Acres
SD & SKI, LLC	0310100001	108.47
Jane B. Farmer & Betty B. Rady	0310100002	36.00
Katherine Leon Hockaday	0310100003	65.26
Jane Farmer & Betty Rady	0330100003	70.00
Jane Farmer & Betty Rady	0330100004	70.00
Arline H. Bowmer Estate	0330100006	96.75
Arline H. Bowmer Estate	0240100012	62.19
Martha W. McMurran & SWR-Misc, LLC	1010100001	61.61
Elizabeth O. Harwood	0320100001	43.52
Stephen E. & Rebecca Murphy, Trustee	0320100002	13.85
Frederick C. Johnson, Trustee	0320100002A	17.20
Betty L. Johnson & Lynne J. Fischer	0320100003	19.07

Betty L. Johnson & Lynne J. Fischer	0320100003A	93.98
Robert Michael Dzula	0320100004	28.07
John Avery Richardson	0410100005	42.00
John Avery Richardson	0410100006	10.00
Niceland Farm, LLC	0420100008	189.74
Cherri U. Spellmeyer	0420100014	134.00
Pamaka, LLC	0430100015	21.99
Pamaka, LLC	0430100016	52.00
Charles & Dianne Hasbrouck	0920100001	97.50
Alex Lamar Penland	0240100029	55.90
Donald A. Hazelwood	0420100020	112.44
Donald A. Hazelwood	0420100018	3.46
Donald A. Hazelwood	0440100001	6.11
John P. and Shelly D. Latoski Trustee	0310100001B	10.23
Dennis Wayne Leonituk, Jr.	0310100001A	10.00
Pamaka, LLC	0430100014A	1.34
Steven M. & Michelle T. Johnson	0340800003	52.63
Steven M. & Michelle T. Johnson	0340800005	68.43
	Total:	1,653.74

3. That pursuant to Sections 15.2-4312 and 15.2-4313 of the Act, the Board of Supervisors requires that no parcel in the District be developed to a more intensive use without prior approval of the Board of Supervisors. Specifically, the following restrictions shall apply:

   a. The subdivision of land is limited to 25 acres or more, except where the Board of Supervisors authorizes smaller lots to be created for residential use by members of the owner's immediate family, as defined in the James City County Subdivision Ordinance. Parcels of up to five acres, including necessary access roads, may be subdivided for the siting of Wireless Communications Facilities (WCFs), provided: a) The subdivision does not result in the total acreage of the District to drop below 200 acres; and b) the subdivision does not result in a remnant parcel of less than 25 acres.

   b. No land outside the Primary Service Area and within the District may be rezoned and no application for such rezoning shall be filed earlier than six months prior to the expiration of the District. Land within the District may be withdrawn from the District in accordance with the Board of Supervisors' Policy Governing the Withdrawal of Properties from Agricultural and Forestal Districts, adopted September 28, 2010.

   c. No Special Use Permit (SUP) shall be issued except for agricultural, forestal, or other activities and uses consistent with the Act, which are not in conflict with the policies of this District. The Board of Supervisors, at its discretion, may issue SUPs for WCFs on properties in the District that are in accordance with the County's policies and Ordinances regulating such facilities.

Ruth M. Larson
Chairman, Board of Supervisors

	VOTES		
	AYE	NAY	ABSTAIN
MCGLENNON	✓		
ICENHOUR	✓		
SADLER	✓		
HIPPLE	✓		
LARSON	✓		

ATTEST:

Teresa J. Fellows
Deputy Clerk to the Board

Adopted by the Board of Supervisors of James City County, Virginia, this 11th day of September, 2018.

AFD-BarnesSwpRnw-res

SUMMARY FACTS

LAND OWNERS	PARCEL ID	ACRES(±)
SD & SKI, LLC	0310100001	108.47
Jane Farmer & Betty B. Rady	*0310100002*	*64.00**
Katherine L. Hockaday	0310100003	65.26
Jane Farmer & Betty Rady	0330100003	70.00
Jane Farmer & Betty Rady	0330100004	70.00
Arline H. Bowmer Estate	0330100006	96.75
Arline H. Bowmer Estate	0240100012	62.19
Martha McMurran & SWR-Misc, LLC	1010100001	61.61
Elizabeth O. Harwood	0320100001	43.52
Stephen E. & Rebecca Murphy, Trustee	0320100002	13.85
Frederick C. Johnson, Trustee	0320100002A	17.20
Betty Johnson & Lynn Fischer	0320100003	19.07
Betty Johnson & Lynn Fischer	0320100003A	93.98
Robert M. Dzula	0320100004	28.07
John A. Richardson	0410100005	42.00
John A. Richardson	0410100006	10.00
Niceland Farm, LLC	*0420100008*	*227.98***
Cherri U. Spellmeyer	0420100014	134.00
Pamaka, LLC	0430100015	21.99
Pamaka, LLC	0430100016	52.00
Charles & Dianne Hasbrouck	0920100001	97.50****
Alex L. Penland	0240100029	55.90
Donald A. Hazelwood	0420100020	112.44
Donald A. Hazelwood	0420100018	3.46
Donald A. Hazelwood	0440100001	6.11
John P. & Shelly D. Latoski, Trustee	0310100001B	10.23
Dennis W. Leonituk, Jr.	0310100001A	10.00
Pamaka, LLC	0430100014A	1.34
Steven & Michelle Johnson	0340800003	52.63
Steven & Michelle Johnson	0340800005	68.43

TOTAL ACRES 1,719.98

**Proposing to withdraw 28 acres, with 36 acres remaining in the Agricultural and Forestal District (AFD).*

***Proposing to withdraw 38.24 acres, with 189.74 acres remaining in the AFD.*

****Acreage has been updated based on boundary surveys that have been recorded for this property.*

Zoning: A-1, General Agricultural

Comprehensive Plan: Rural Lands; Open Space and Recreation

Primary Service Area (PSA): Outside

Staff Contact: Roberta Sulouff, Senior Planner

PUBLIC HEARING DATES

Planning Commission: August 1, 2018, 6:00 p.m.
Board of Supervisors: September 11, 2018, 5:00 p.m.

STAFF RECOMMENDATION

Approval, subject to the proposed conditions.

AFD ADVISORY COMMITTEE RECOMMENDATION

At its June 21, 2018 meeting, the AFD Advisory Committee voted 9-0 to recommend the continuation of the District to the Planning Commission and Board of Supervisors.

PLANNING COMMISSION RECOMMENDATION

At its August 1, 2018 meeting, the Planning Commission voted 5-0 to recommend the continuation of the District to the Board of Supervisors.

DISTRICT HISTORY

- The Barnes Swamp AFD was created in 1986 for a term of four years and originally consisted of 29 parcels totaling ±1,905 acres.
- The District was renewed at four-year intervals again in 1990, 1994, 1998, 2002, 2006, 2010 and 2014 with various additions and withdrawals taking place during that period.
- There have been no additions to or withdrawals from the District since its most recent renewal in 2014.

DISTRICT DESCRIPTION

This District is primarily forested, though records indicate that a significant portion of the land is actively in agricultural use. All the land in this District is zoned A-1, General Agricultural, located outside of the PSA, and designated Rural Lands and Open Space and Recreation by the adopted Comprehensive Plan.

Total acreage includes all the land in the above properties with the exception of all land within 25 feet of right-of-ways. This area has been excluded to allow for possible road and/or drainage improvements.

ADDITION/WITHDRAWAL REQUESTS

- *Addition Requests:*
    - The owner of the property located at 10039 Old Stage Road (James City County Tax Map ID 0410100010) has applied to add approximately 196 acres to the District. That application will be evaluated under a separate cover and is tentatively scheduled for the Committee's consideration at the October 25, 2018, meeting.
- *Withdrawal Requests:*
    - The owners of the property located at 1245 Stewarts Road (James City County Tax Map ID No. 0310100002) have requested to withdraw 28 acres of their parcel out of the District. Thirty-six acres of the subject parcel would be left in the AFD.
    - The owners of the property located at 9812 Old Stage Road (Tax Map ID No. 0420100008) have requested to withdraw 38.24 acres of their parcel out of the District; 189.74 acres of the subject parcel would be left in the AFD.
    - With these withdrawals, the District would include a total of 1,653.56 acres, and will thus continue to meet minimum area requirements.

CHANGES TO CONDITIONS

None.

SURROUNDING ZONING AND DEVELOPMENT

The area surrounding the main body of the District is zoned A-1, General Agricultural and designated Rural Lands by the adopted Comprehensive Plan. Some parcels at the eastern end of the District are adjacent to the Stonehouse development, which is zoned Planned Unit Development and designated Low-Density Residential and Mixed Use by the adopted Comprehensive Plan. The Diascund Reservoir borders the main body of the District to the west and Mill Creek AFD is located directly south of the District.

COMPREHENSIVE PLAN

The Comprehensive Plan designates these parcels as Rural Lands and Open Space and Recreation. Land Use Action 6.1.1 of the adopted

Comprehensive Plan states the County shall "support both the use value assessment and Agricultural and Forestal (AFD) programs to the maximum degree allowed by the *Code of Virginia*."

STAFF RECOMMENDATION

Staff finds the Barnes Swamp AFD compatible with surrounding development and consistent with the recommendations of the adopted Comprehensive Plan and Zoning Ordinance. Staff recommends that the Board of Supervisors approve the renewal of this AFD for a period of four years subject to the conditions listed in the District Ordinance (Attachment No. 1).

RS/md
AFD-BarnesSwpRnw

Attachments:
1. Ordinance
2. Location Map
3. Property owner withdrawal request for 1245 Stewarts Road
4. Property owner withdrawal request and plat for 9812 Old Stage Road
5. Adopted conditions for the Barnes Swamp AFD
6. Board of Supervisors staff report for the 2014 renewal of the Barnes Swamp AFD

Code of Virginia
Title 15.2. Counties, Cities and Towns
Subtitle IV. Other Governmental Entities
Chapter 43. Agricultural and Forestal Districts Act

§ 15.2-4305. Application for creation of district in one or more localities; size and location of parcels

On or before November 1 of each year or any other annual date selected by the locality, any owner or owners of land may submit an application to the locality for the creation of a district or addition of land to an existing district within the locality. Each district shall have a core of no less than 200 acres in one parcel or in contiguous parcels. A parcel not part of the core may be included in a district (i) if the nearest boundary of the parcel is within one mile of the boundary of the core, (ii) if it is contiguous to a parcel in the district the nearest boundary of which is within one mile of the boundary of the core, or (iii) if the local governing body finds, in consultation with the advisory committee or planning commission, that the parcel not part of the core or within one mile of the boundary of the core contains agriculturally and forestally significant land. No land shall be included in any district without the signature on the application, or the written approval of all owners thereof. A district may be located in more than one locality, provided that (i) separate application is made to each locality involved, (ii) each local governing body approves the district, and (iii) the district meets the size requirements of this section. In the event that one of the local governing bodies disapproves the creation of a district within its boundaries, the creation of the district within the adjacent localities' boundaries shall not be affected, provided that the district otherwise meets the requirements set out in this chapter. In no event shall the act of creating a single district located in two localities pursuant to this subsection be construed to create two districts.

1977, c. 681, § 15.1-1511; 1979, c. 377; 1981, c. 546; 1984, c. 20; 1985, c. 13; 1987, c. 552; 1993, cc. 745, 761; 1997, c. 587; 1998, c. 833;2011, cc. 344, 355.

The chapters of the acts of assembly referenced in the historical citation at the end of this section(s) may not constitute a comprehensive list of such chapters and may exclude chapters whose provisions have expired.

Colonial Soil & Water Conservation District

Conservation Plan for Chesapeake Bay Preservation Act Compliance

James City County, Municipal Code Sec. 23-9 (b) (11).

Tax Parcel Pin # 0540100001

_____

Signature Date

Chairman of Board of Directors, Colonial SWCD

_____

Signature Date

Plan Prepared By

_____

Signature Date

Land Owner/Operator

By signing this conservation plan coversheet, you the Land Owner/Operator agree to the provisions set forth in this plan as well as the following identified measures. For the purposes of the following provisions, the Colonial Soil & Water Conservation District is referred to as the "District", and James City County is referred to as the "County".

1.) *District staff or County staff may need access to the property to assess progress of project completion, or for the purpose of verifying any ongoing managements as indicated here in; in such instances District or County staff will always seek to notify you of their intent prior to accessing the property, however by signing this document you are agreeing to offer conditional access for these purposes to the property defined in this conservation plan.*
2.) *By signing this document, the land owner/operator acknowledges that the management provisions in this plan may not ensure compliance with local, state, or federal regulations in adverse or extreme weather and/or climactic conditions (i.e. unforeseen drought, precipitation, flooding, etc.). Further management considerations may need to be undertaken to ensure soil and water resources are protected. District and County staff will assist*
3.) *By signing this document, the land owner/operator acknowledges that this plan may not ensure compliance with any future local, state, or federal laws and ordinances. It is the land owner/operator's*

- *Continued* -

responsibility to ensure that the agricultural operation outlined in this plan is in compliance with such future ordinances, though the District and the County will assist you to the fullest extent of their ability in understanding future relevant regulations.

4.) *If this conservation plan includes a Nutrient Management Plan drafted by a Dept. of Conservation and Recreation certified Virginia Nutrient Management Planner, the plan shall be followed and not deviated from, otherwise this plan shall be voided. If changes to the plan are necessary, contact the Nutrient Management Planner responsible and have an updated Nutrient Management Plan drafted, and provide a copy to the District.*

5.) *Should the operation outlined in this plan change in any meaningful way, this plan may be voided or an amendment to the plan be required, and any regulation or program satisfied by the implementation of this plan may no longer be. Such changes can include but are not limited to: the addition of livestock beyond numbers reflected by normal operation in this plan; the change in commodity crop grown, the modification of any forested or perennial grass buffer areas, the modification in any way of Chesapeake Bay Preservation Act area beyond that described in this plan, and other actions negatively impacting natural resources on or abutting this property. If you have a question about which activities may contribute to or cause a negative natural resource impact, please contact the District prior to initiating such activities.*

6.) *If this plan has not been executed or implemented within 5 years of the signature date, or meaningful steps taken towards the implementation of this plan are not readily apparent to County or District staff within that time frame, this plan shall be voided.*

I (plan recipient) have read, understand, and agree to the provisions as set forth above _____
Initial

Plan Narrative
9958 Mill Pond Run
Toano, VA 23168

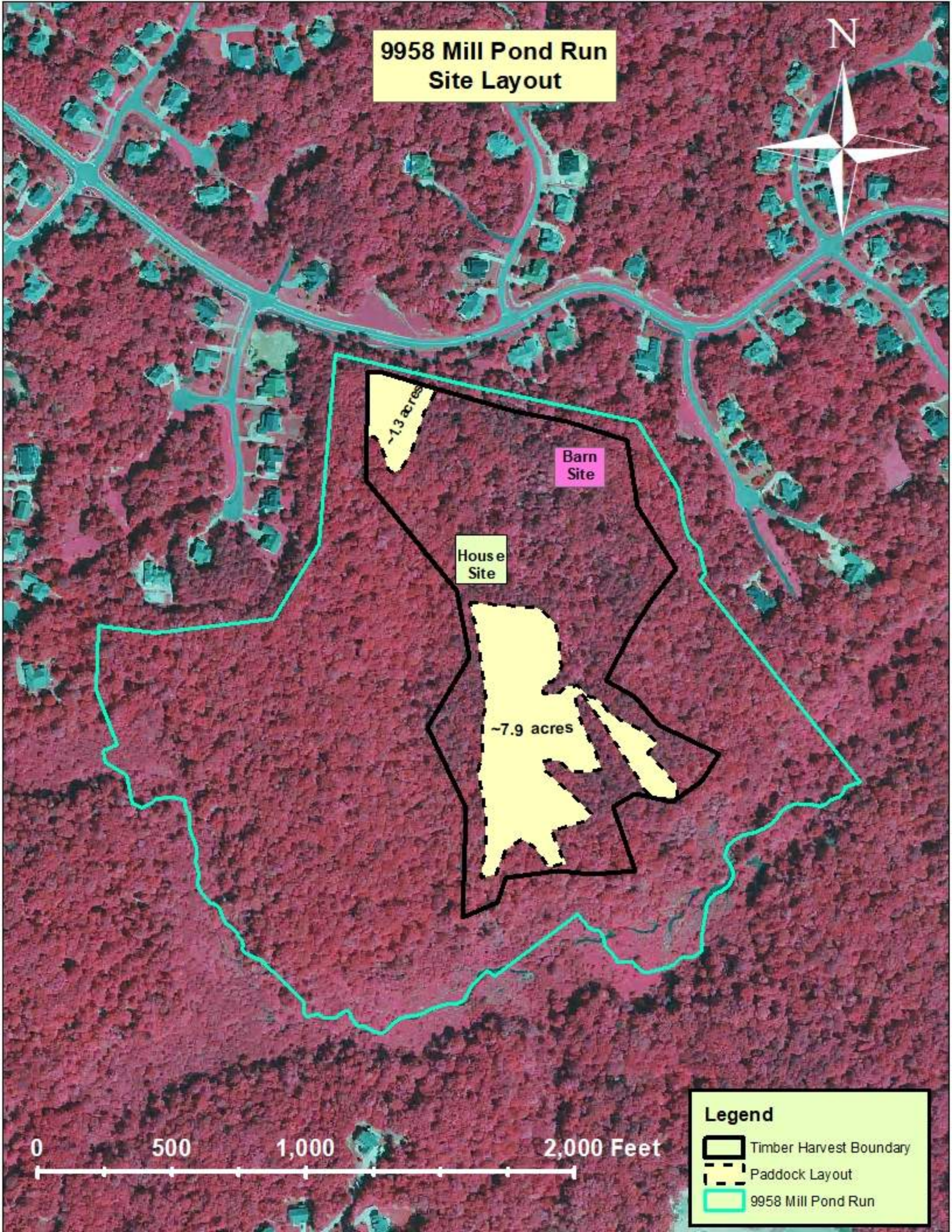
David and Karen Hogue own approximately 60 acres located off Mill Pond Run, adjacent to the Stonehouse subdivision, in James City County (photo right).

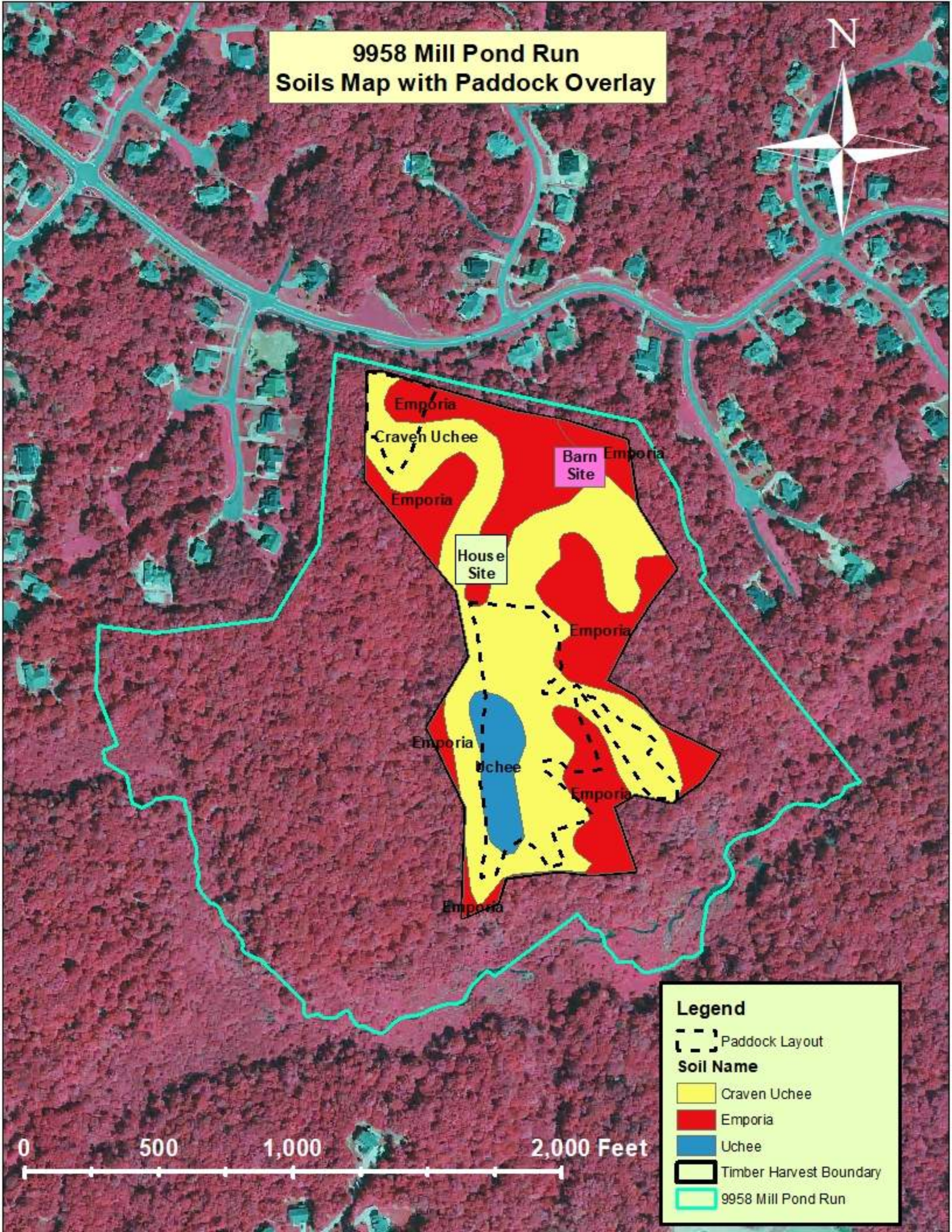
The site is zoned for general agriculture (A1) and can be further identified as James City County Parcel Number (PIN) 0540100001. The current landowners purchased the property in early 2021 with the intent to establish a small working horse farm. To facilitate the establishment of pasture, construct a barn, and install other agricultural infrastructure, approximately 23 acres of trees were harvested during the summer of 2021. The site can be characterized by its large size, relative to the residential sized lots of Stonehouse and its extreme topography, which ranges from nearly flat to very steep. Reviewing the historic aerial photography for 1937 and 1953, provided by USDA, it appears that agricultural activities have not been conducted on this parcel in the last 85 years.

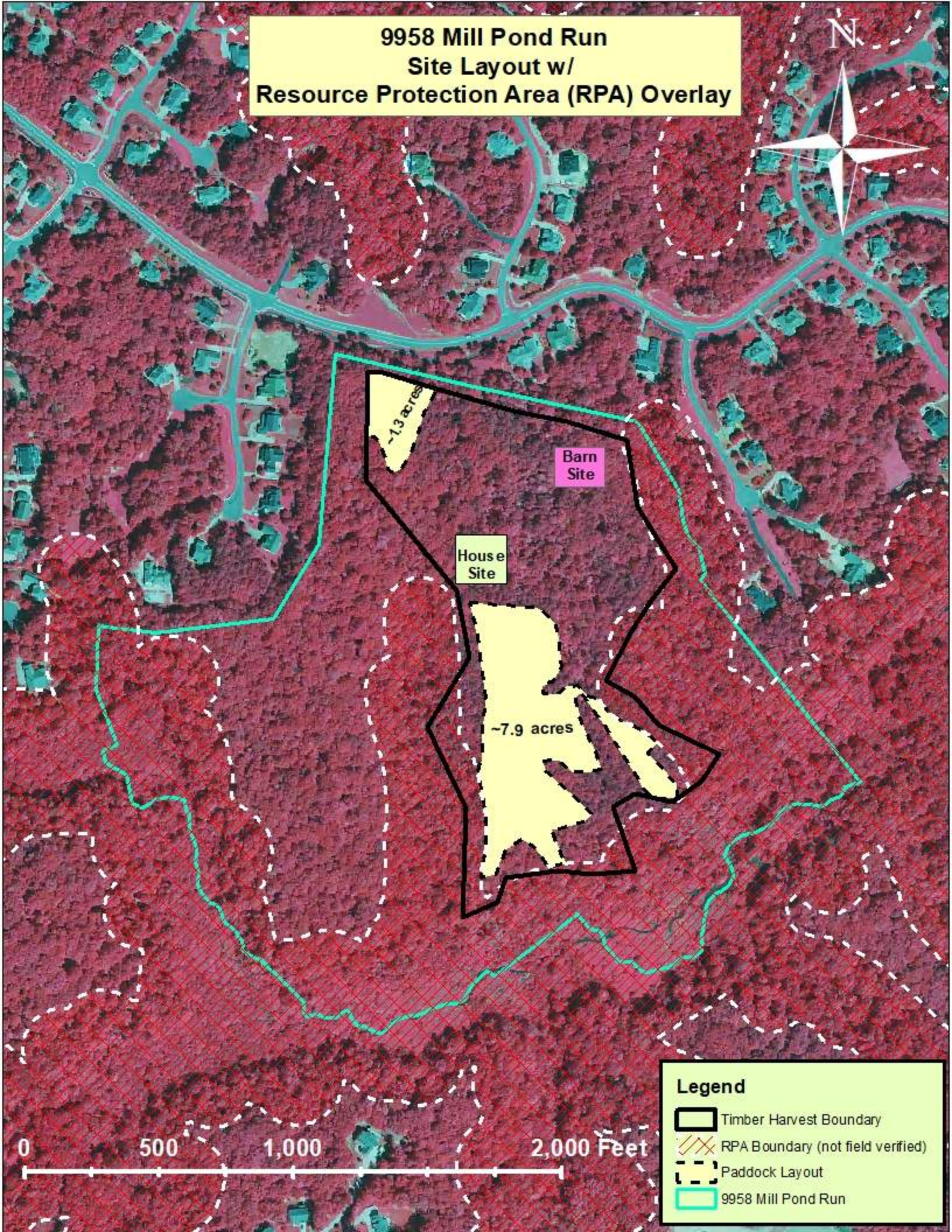
The landowner was referred to the Colonial SWCD by the Department of Forestry at the conclusion of the timber harvest, at which time district staff visited the site and collected soil samples to begin the process of developing a Soil and Water Quality Conservation Plan to comply with the County's Chesapeake Bay Preservation Ordinance. All agricultural land clearing activities in James City require a conservation plan approved by the Colonial SWCD. The following plan will offer recommendations that will help maintain stabilization throughout the process of converting portions of the parcel from a forested land use to an agricultural land use.

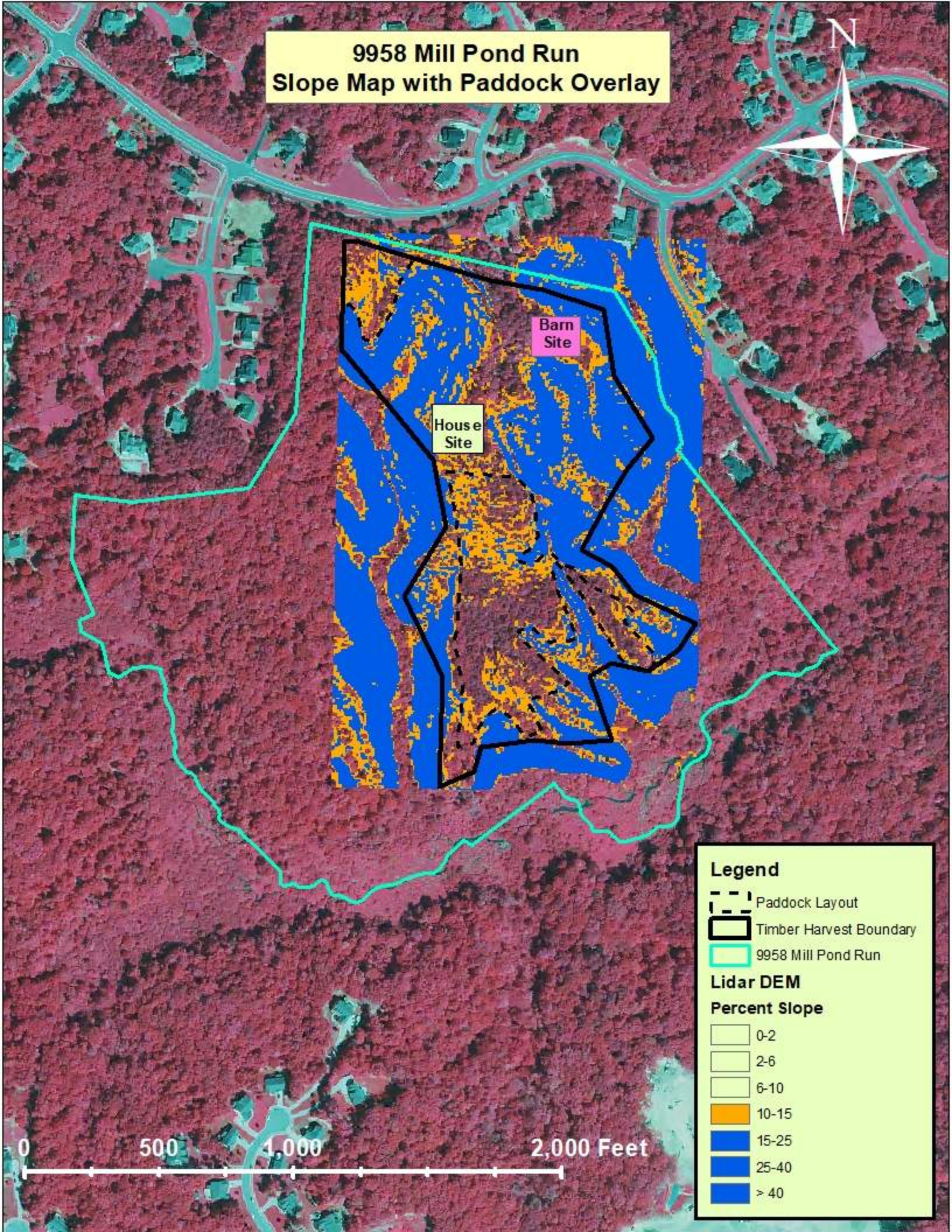
This plan has been developed to satisfy the requirements of James City County and meet the standards of the Colonial SWCD to maintain or improve water quality as it pertains to agricultural operation and management in the Commonwealth of Virginia. The conservation practices and management recommendations addressed in this plan represent treatments to protect the natural resources under the proposed agricultural production system. Material changes to the agricultural system will require updates to the plan.

The following plan has been reviewed by the District's conservation partners and approved by the Colonial SWCD Board of Directors. The County is the governing body with respect to the enforcement of this plan. In the event of an enforcement action, the Colonial SWCD will serve as a technical resource to the County to recommend appropriate management practices and suitable schedules for implementation to achieve environmental goals set forth by the County, state, and federal agencies.


9958 Mill Pond Run
Site Layout
N
~1.3 acres
Barn
Site
House
Site
~7.9 acres
0
500
1,000
2,000 Feet
Legend
Timber Harvest Boundary
Paddock Layout
9958 Mill Pond Run


9958 Mill Pond Run
Soils Map with Paddock Overlay
N
Emporia
Craven Uchee
Barn Site
Emporia
Emporia
House Site
Emporia
Emporia
Uchee
Emporia
Emporia
0
500
1,000
2,000 Feet
Legend
Paddock Layout
Soil Name
Craven Uchee
Emporia
Uchee
Timber Harvest Boundary
9958 Mill Pond Run


9958 Mill Pond Run
Site Layout w/
Resource Protection Area (RPA) Overlay
N
~1.3 acres
Barn Site
House Site
~7.9 acres
0
500
1,000
2,000 Feet
Legend
Timber Harvest Boundary
RPA Boundary (not field verified)
Paddock Layout
9958 Mill Pond Run


9958 Mill Pond Run
Slope Map with Paddock Overlay
N
Barn Site
House Site
Legend
Paddock Layout
Timber Harvest Boundary
9958 Mill Pond Run
Lidar DEM
Percent Slope
0-2
2-6
6-10
10-15
15-25
25-40
> 40
0
500
1,000
2,000 Feet

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Conservation Plan Summary

I. Intent

The intent of the following conservation plan is to document proposed agricultural management activities on the referenced parcel for the purpose of complying with the provisions of James City County's Chesapeake Bay Preservation Ordinance. Although this conservation plan has been developed to local and state government requirements for this purpose, it may not meet the requirements of the Virginia Department of Conservation and Recreation or the United States Department of Agriculture for state and federal government program eligibility or participation.

The management practices identified in this plan reflect treatments or considerations aimed to maintain stabilization of the site and protect natural resources during and after the process of converting forested land to an agricultural use. This plan includes recommendations based on the local topography, soils, and resources present on the parcel. Should the proposed agricultural management system change, or if changes to local, state, or federal regulations affect the management of the referenced parcel, an updated plan will be necessary.

II. Plan

1. Proposed Operation Description

The project proposed for 9958 Mill Pond Run, is a land conversion for agricultural purposes. The landowner intends to develop approximately 10 acres of the property for an equine facility, to include multiple grazing paddocks, fence, barn and run-in structures, and watering infrastructure to include a well, pipelines, and watering troughs. Future infrastructure to support endeavor may include a manure storage shed and a barn or shed to provide shelter for livestock and/or farm equipment.

2. Chesapeake Bay Preservation Area

All lands in James City County are designated as Chesapeake Bay Preservation Area (CBPA), per county ordinance. CBPA is differentiated as Resource Protection Area (RPA) or Resource Management Area (RMA). RPA is defined by James City County as land adjacent to water bodies with perennial flows that have an intrinsic water quality value due to the ecological and biological process they perform or are sensitive to impacts which may result in significant degradation to the quality of state waters; these later water bodies are explicitly defined as tidal wetlands, nontidal wetlands connected by surface flow and contiguous to tidal wetlands or water bodies with perennial flow, and tidal shores. RPA is designated as being a 100-ft. buffer area, measured horizontally, and located adjacent to the aforementioned features and along both sides of any water body with perennial flow. All land not considered RPA is designated as RMA. Lands of particular sensitivity within RMAs include, but are not limited to, nontidal wetlands not in RPAs, floodplains, highly erodible soils, highly permeable soils, and hydric soils.

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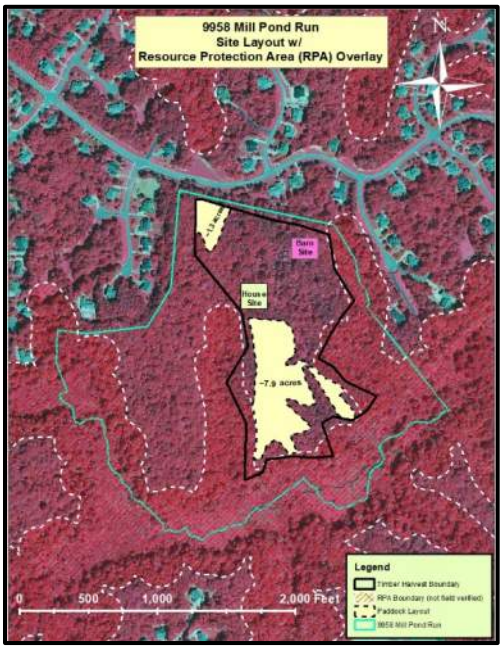
Conservation Plan Summary



The map, right, shows the County's RPA boundary in relation to the parcel boundary. The Colonial SWCD has not performed an on-site delineation of the RPA, rather has used the County's Geographic Information System (GIS) to make the claim that proposed agricultural activities will be conducted exclusively within the RMA. The RPA map shows that the timber harvest boundary (bold black line) does encroach into the 100' RPA buffer. For silvicultural activities, encroachment into the landward 50' of the RPA buffer is allowed. **No encroachment into the 100' RPA buffer is being requested by the landowner for the planned agricultural operation,** which will result in the need for that portion of the buffer to be restored or allowed to revert to its natural state.

Moving forward and as this conservation plan is implemented, should the site be determined to be out of compliance with James City County's Chesapeake Bay Preservation Ordinance, the County will have complete authority to take corrective action, as needed and authorized by the Commonwealth of Virginia. The Colonial Soil and Water Conservation District will assist the County, as appropriate, in the interest of protecting local soil and water natural resources.

3. <u>Site Conversion and Stabilization</u>

Due to the sandy and erodible nature of the soils found on site, combined with very steep topography, proper stabilization is very important. The proposed method or removing tree stumps, roots, and woody debris left over from the timber harvest will be a forest mulcher. It is highly recommended the forest mulching process grind stumps and roots as far below the soil as possible to reduce the amount of stump sprouting, incorporate mulch into the soil to aid with decomposition, and allow for adequate seed to soil contact.

The timeline for completion of this project is fluid and therefore requires alternatives for stabilization dependent upon the time of year in which the trees are cleared and site stabilization is necessary. It is recommended to be prepared to plant seed within a 30-day period after a seedbed is prepared with the forest mulcher. Long term exposure of heavily tilled/denuded soil to the elements can lead to severe erosion problems. When stabilizing slopes greater than 15%, the use of stabilization fabric is recommended along with a temporary seed mixture aimed at quick germination and establishment. Practice specifications for stabilization fabric and temporary seeding can be found at the end of this document. These practices are to be used during times of the year when establishing the primary forage species is not an option.

The table below summarizes actions to be taken based on the time of year:

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Conservation Plan Summary

Time of Year	Stabilization Species	Seeding Rate
April 15 -September 1	Millet or Sorghum-Sudan Grass	Millet – 25-40 lbs/ac Sorghum Sudan Grass – 30-40 lbs/ac
September 1 – October 15	Clover, Pea, Radish mix	Clover – 6-8 lbs/ac Pea – 10-12 lbs/ac Radish – 1-2 lbs/ac
October 15 – December 1	Cereal Rye or Annual Ryegrass	Cereal Rye – 75 lbs/ac Ryegrass – 20-30 lbs/ac
December 1 – March 1	Not Recommended	Not Recommended
March 1 – April 15	Cereal Rye or Annual Ryegrass	Cereal Rye – 75 lbs/ac Ryegrass – 20-30 lbs/ac

In general, spring planted cool season grasses such as fescue will need a grow-in period that may last 12 months before grazing is recommended. During the grow-in period, use the heavy use area to allow horses to loiter when turned out of their stalls rather than boarding the animals in the pastures. If cool season grasses cannot be planted in the window of March 1st and April 15th, consider planting a warm season (summer annual) crop to stabilize the soil and provide some supplemental grazing. Species such as Dwarf Pearl Millet or Crabgrass. Summer annuals will die with the frost in fall, and cool season species such as fescue can be direct seeded (no tillage necessary) over top of the summer annual plant residue. This fall window of seeding cool season species runs from September 1st through October 15th.

Most agricultural activities are exempt from state Erosion and Sediment Control (E&S) regulations, which require disturbed (i.e. newly cleared) lands to be stabilized with seed, straw, and or other material within 7 days after final grade is achieved. While the clearing at 9958 Mill Pond Run is not required to follow Virginia E&S laws, it is highly recommended that disturbed lands and lands denuded of vegetation be stabilized as soon as possible after a seed bed is prepared, not to exceed 30 days.

Areas that have been timbered and will not be converted to pasture, barn, house, or roadway, must be planted/seeded with stabilizing vegetation, which could be trees, wildflowers, or warm season grasses, depending on the landowners' long-term goals. Information pertaining to establishment of warm season grasses and wildflower meadows are included as an appendix to this document.

4. <u>Soils/Land Use</u>

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The soil types as mapped by USDA (Web Soil Survey) on the parcel within the timbered area include the Craven-Uchee Complex (map complex unit symbol 11C), the Emporia fine sandy loam (14B), the Emporia Complex (15F), and the Uchee loamy fine sand (34B). A custom report detailing the soil's characteristics is included at the end of this document. These soils tend to have sandy surfaces and are known to suffer the effects of erosion if not properly vegetated and managed. Slopes greater than 15% are not recommended for agricultural operations and slopes between 10% and 15% may necessitate additional management to combat the potential for erosion, which may include:

- Perimeter Controls - A perimeter control is recommended to prevent sediment enriched stormwater from leaving the site. Typical perimeter controls include staked straw bales and silt fence. An alternative method for perimeter control is to create a brush berm made from the woody debris remaining after the timbering process. The woody material is laid parallel to the slope, and intercepts surface water as the water travels downhill. Over time, as the brush berm decays, the organic material left behind will improve the soil and encourage other vegetative growth. Specifications for straw bale barriers, silt fence, and brush barriers can be found as attachments at the end of this document.
- Temporary Slope Drain – A temporary slope drain is a tube or conduit which extends from the top to the bottom of a slope designed to carry concentrated stormwater down the slope face without causing erosion. A temporary slope drain can be used in conjunction with a temporary diversion at the top of the slope and a plunge pool at the bottom of the slope. Specifications for each of these BMPs can be found at the end of this document.
- Rock Check Dams – Rock check dams are temporary stone dams built perpendicular to the flow path of a swale or ditch. The dams intercept and reduce the velocity and energy of stormwater flows. The practice specification is attached to the end of this document.
- Stabilization Blanket – mentioned previously

5. <u>Nutrient Management</u>

Nutrients, especially nitrogen and phosphorus, represent one of agriculture's greatest potential threats to pollute local waterways, while simultaneously are inexorably essential for plant growth. The basis for Virginia's nutrient management program is the balance between agricultural economics, conventional land management practices, and mandates to reduce the level of nutrients reaching local water bodies, and ultimately the greater Chesapeake Bay. Nutrient Management Plans (NMPs) are developed by planners, certified by the Commonwealth of Virginia, and are consistent with standard agronomic principles and modern conservation practices.

A Nutrient Management Plan has been developed for this parcel. Recommendations for soil amendments such as lime and fertilizer have been made based on soil analysis results from the Virginia Tech soil testing lab, following Virginia's Nutrient Management Standards and Criteria. The management of nutrient applications (i.e. timing, application rate, source of nutrients, and placement) is extremely important to the health of the pasture and assists in the protection of local waterways, therefore it is very important that lime and fertilizer applications be made in conjunction with seeding and vegetative growth. The nutrient management plan that accompanies this

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conservation plan is a free-standing document, and also a component of this plan. If the landowner intends to deviate from the nutrient management plan as written, consult the district prior to implementing any changes to discuss revisions to the nutrient management plan. The table below summarizes actions necessary to implement the nutrient management plan.

Area Name	Land Area	Lime Requirement	Fertilizer Requirement
Pasture #1	4.6 acres **or** 200,375 sq. ft.	**4 Tons/ac** • Apply 2.0 tons/acre of lime as soon as the land is prepared by the forest mulcher. • Apply 2.0 tons/ac of lime 6-12 months following the first application.	**Establishment – Year 1** **Target: 40-170-140 (N-P-K)** 325 lbs/ac of 11-52-0 fertilizer blend will provide 36-169-0 plant food. 235 lbs/ac of 0-0-60 fertilizer blend will provide 0-0-141 plant food. Together, these blends will provide 36-169-141 – close to the target **Maintenance – Years 2 & 3** **Target: 50-50-40 (N-P-K)** 350 lbs/ac of 13-13-13 fertilizer blend will provide 46-46-46 plant food – close to the target
Pasture #2	3.3 acres **or** 143,750 sq. ft.	**4 Tons/ac** • Apply 2.0 tons/acre of lime as soon as the land is prepared by the forest mulcher. • Apply 2.0 tons/ac of lime 6-12 months following the first application.	**Establishment – Year 1** **Target: 40-170-160 (N-P-K)** 325 lbs/ac of 11-52-0 fertilizer blend will provide 36-169-0 plant food. 265 lbs/ac of 0-0-60 fertilizer blend will provide 0-0-159 plant food. Together, these blends will provide 36-169-159 – close to the target **Maintenance – Years 2 & 3** **Target: 50-50-40 (N-P-K)** 350 lbs/ac of 13-13-13 fertilizer blend will provide 46-46-46 plant food – close to the target

Notes:

1. A third pasture, located at the entrance to the property is being considered. The ~1.3 acre paddock contains the same soils and has the same level of fertility as the soil samples taken over the rest of the site. If the landowner chooses to convert the area to pasture, apply the same

nutrients applied to paddocks 1 & 2. Also, apply lime to the third paddock in the same manner as paddocks 1 & 2.

2. Fertilizer recommendations above are based on a "Do-It-Yourself" application, where pre-blended, bagged fertilizer is purchased. A custom fertilizer applicator such as Southern States, Nutrien, Home Field Fertilizer, etc., may be able to blend and apply the fertilizer recommended here. If that option is available, ask for 7.9 acres of 40-170-150.
3. Lime will take some time to chemically change the soil pH. Many factors determine the rate of change, but a soil test in spring of 2022, following the first lime application is recommended to measure the rate of change in soil pH and soil fertility.
4. Fertilizer blends mentioned above are examples of a multitude of fertilizer blends available in the marketplace and do not represent an endorsement of any fertilizer company.
5. Based on the planned acreage to be converted to pasture (7.9 acres), you'll need 16 tons of lime for the first application, then another 16 tons for the 2nd application in several months.
6. Due to the exceptionally low soil pH, consider broadcasting cereal oats and/or rye this fall, as a stabilization measure. In the spring, after the lime has had a chance to chemically react and raise soil pH some, plant your perennial forage grasses. If planting cereal grains, plant 2-3 bushels per acre.

III. Additional Conservation Considerations

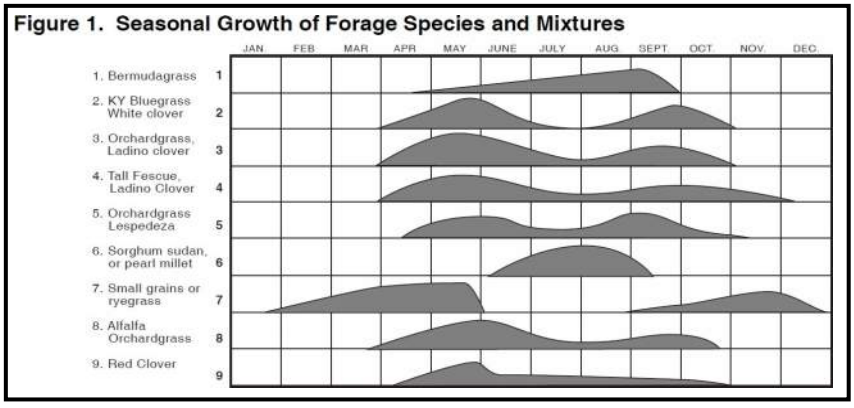
Pasture Species & Mixes

Planting pasture species targeted towards your intended livestock and for ease of maintenance is highly recommended. Therefore, use mowing/clipping to control weeds and undesirable species in areas of the pasture not grazed by the animals. If herbicides are used to selectively control weeds, be sure to follow the labeled instructions. Note:pesticide and herbicide labels, guidance, and instructions are informed by federal and state law, and are regularly updated.

It is advised that if in doubt of standards and requirements for use, the manufacturers website, orthe local Virginia Cooperative Extension office be consulted for assistance with use compliance.

Planting and maintaining multiple species can help improve soil health and function, may help alleviate pest and disease pressure, may assist in overall pasture vitality across seasonal shifts, willprovide a greater range of access to macronutrients and micronutrients for livestock, and is generally a good agricultural management consideration.

The landowner is urged to consider warm season forage such as Bermudagrass; It is drought and heat tolerant, responds well to summer nitrogen fertilization, and regenerates with fast growing stolons and rhizomes.



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Bermudagrass can be established by sodding, sprigging, or seeding. Cool season forages are a traditional choice in most pastures.
Fescue, including novel endophyte fescue, bluegrass, clover, etc. are generally planted in the coolseason of spring or fall. Specific recommendations can be found in the table below.

Forage Species	Establishment Window	"Seeding" Rate	Fertilize
Bermudagrass	Seed: March – June Sprigs: April – June Sod: April - August	Seed: 40 lb. seed/acre Sprigs: 40 bu/sprigs/ac Sod: NA	May - August
Bluegrass	March 1 – April 15 **or** September 1 – October 15	Should not be seeded alone. 4-5 lbs./ac in a mix	March 15 – April 15 **or** September 15 – November 1
Fescue	March 1 – April 15 **or** September 1 – October 15	15 – 25 lbs./ac when seeded alone **or** 6-12 lbs./ac in a mix	March 15 – April 15 **or** September 15 – November 1
Clover (white, red, orcrimson)	45 days before last killing frost of the spring **or** 30 days before the first killing frost in the fall	Should not be seeded alone. 1-2 lbs./ac in a mix	At time of planting

For additional information, refer to the Virginia Tech Agronomy Handbook at:
http://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/424/424-100/PDF_part2.pdf

During the initial site visit, the landowner mentioned using a novel endophyte fescue variety. Attached in the appendix is a publication developed by University of Georgia Extension with some valuable information about novel endophyte fescues and how to establish them. In general, novel endophyte is a better choice of forage than endophyte free fescues due to their hardiness and sustainability.

Fencing

At a minimum, the perimeter of the pasture will need to be fenced. Interior fencing to create multiple paddocks is recommended. When sizing gates, consider the width of equipment that willaccess the paddocks. This equipment may include tractors, manure spreaders, etc.

Water

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Conservation Plan Summary

Per conversation with the landowner, water to the paddocks will be supplied from a well. When possible, it is recommended that hydrants or animal waterers be placed in row with fence lines or in appropriate common areas; avoid steep slopes, low spots, and poor draining areas for waterers to reduce negative environmental impacts and improve longevity of infrastructure. The standards for laying water line follow general constructionspecifications in Virginia, and lines are recommended to be buried at a minimum depth of 2 ft. below the frost line. Other considerations recommended before install include future water use needs and location of associated hydrants, access to lines for flushing, and heavy use areas for the space directly around water troughs (recommended minimum 64 sq. ft.).

Stocking Rates

The Virginia Nutrient Management Standards and Criteria (2014) suggests that the soils on this site are capable of supporting one animal unit (1,000 lbs. of livestock, either singularly or combined) per 2-3 acres. This estimate is based on the livestock deriving 100% of their nutrition from grazing in the paddocks for 8 months out of the year. If supplemental feeding of grain and/or hay will be provided to the horses, then an increase in stocking density is possible. Over stocking of livestock, particularly horses, is a common management problem that often leads to denuded pastures, gully erosion, and poor equine health. Maintain pasture grass height at 3" or more and rotate horses out of pastures when grass height falls below 3". Use heavy use area to turn horses out when pastures have been grazed too short or when the soil is saturated or frozen.

Manure Management

The average horse produces approximately 50 lbs. of manure per day, in addition to the estimated15 lbs. of bedding material. These waste materials can build up quickly when multiple horses are boarded. In an effort to protect water resources on and adjacent to this property, we recommend composting these wastes and that any composting facility be either a self-contained unit (ex. drumcomposter) or a static pile with a concrete slab. Further, it is recommended that a heavy use area for machinery be established around and under any composting facility, and adequate protection for roof runoff of the compost structure be installed (ex. maintain or gravel perimeter at the dripline of the structure). It is also recommended that at least 2 manure composting facilities be constructed to accommodate the appropriate amount of time necessary for composting.

Key considerations for the location and construction of a manure composting structure include:

- Manure storage should be designed to limit the chance of leachate entering surface- and groundwater resources. Storage piles should be placed on a hardened surface such as a concrete pad that slope inward.
- Storage piles should not be placed in low-lying or flood-prone areas, and care should be taken to direct water from higher elevations away from the site. **Manure storage may not be located within a 100' RPA buffer area.**
- To comply with James City County ordinances, accessory structures such as a manure composting facility, should be a **minimum of 8 feet from property lines**.

- Prevailing wind direction may influence location of manure stockpiles.

While composting manure depends on several variables (Carbon:Nitrogen ratio of materials, temperature, moisture, particle size, aeration rate, etc.) some standard recommendations canguide the process.

- Compost can be managed in a relatively odorless manner, if odor is persistent consideradding more high-carbon ratio material (straw, wood chips, etc.).
- Pathogens and weed seeds are likely present in animal wastes, seek to reach and maintainthe appropriate temperature to kill off target pests. A blanket suggestion is between 131°Fand 170°F.
- Too high of a temperature within the pile can suppress the microbiota facilitating thedecomposition process. If the temperature reaches 180°F cool the pile down.
- Moisture is essential for effective composting and maintaining pile temperature. Use a moisture meter to check the pile and strive to keep the moisture between 45% and 60%.
- The pile will need to be aerated. Turn the pile every 4-7 days to achieve the fastestbreakdown timeframe.
- Compost piles may take 3 to 6 months to achieve a suitable decomposition level. If a pile isnot given the appropriate amount of time to break down, pathogens and weed seeds may still be present.

Please refer to Virginia Cooperative Extension publication 406-208 for more information onutilization of horse manure. (https://pubs.ext.vt.edu/406/406-208/406-208.html)

Heavy Use Areas

At certain times throughout the year pastures may not be suitable for animal traffic. Factors such as heavy rain, snow, herbicide applications, etc., can restrict the use of paddocks. Certain heavy use areas are highly recommended components of any livestock operation because they provide asuitable location for animals when pasture access is limited and protect soils at frequented locations. In all scenarios, it is recommended that heavy use areas are located on flat terrain.

For this operation, it is recommended that any shelters constructed for the horses have a heavy use component to reduce the impacts of animals when confined to a limited area for weather or

other reasons. An acceptable solution can be to utilize wood chips to provide an expendable, andcompostable material that will not impact animal hooves.

Additionally, for water troughs and supplemental feeding locations, heavy use areas are recommended due to the impacts associated with the frequency of use at and directly aroundthese sites.

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Heavy use areas are most effective when the footprint is excavated to a depth of 6-10 inches, a woven landscape fabric is "keyed" into to the perimeter ground, and a sturdy, porous medium added to assist with draining. Example: excavation to 10 inches, grading and leveling of excavation,installation of woven landscape fabric, 5 in. depth of sand added, 5 in. depth of gravel on top to bring the heavy use area to level with surrounding landscape.

Regardless of the material, heavy use areas should be maintained. This maintenance can includeexcavating stone when pore spaces become filled in or compacted, replacing, or removing degraded mulch, and monitoring and repairing any damage to the functioning of the drainage ofthe site due to climatic, machinery and/or livestock related impacts.

For more information regarding heavy use areas, read ***Heavy Use Areas: A Guide for Planning & Building Heavy Use Areas for Horses & Livestock*** published by the Spokane County Conservation District. (http://www.sccd.org/wp-content/uploads/2015/07/Heavy-Use-Areas.pdf)

Similar to a heavy use area, it is recommended that a 24-30" strip of gravel, crush and run rock, or some other all-weather surface be placed against the interior of the fence line along the perimeterof the down slope fence. The recommendation is based on observations that horses tend to pace or walk along fences, which creates high traffic patterns that do not support vegetative growth (i.e., grass won't grow). The rock will reduce mud and reduce the volume and velocity of stormwater surface flow moving down the slope.

Horse Pasture Management

Refer to Virginia Cooperative Extension publication 418-101 for more information on pasturemanagement (http://pubs.ext.vt.edu/418/418-101/418-101.html)

Pest Management

Using pesticides to address on farm pests can be confusing. Virginia Cooperative Extension's 2020 Pest Management Guide helps resolve some of the questions raised farm operators. The 626-pagedocument includes information on agricultural crops and livestock commonly found in Virginia, including horses. Three key principles of proper pest management include:

1. Read and follow the pesticide label for your pest problem explicitly.
2. Store pesticide in their original container, preferably locked away from access to children,pets, and food, seeds, animal feed.
3. Dispose of pesticide containers properly

Virginia Tech Agronomy Handbook at:
http://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/424/424-100/PDF_part2.pdf

Using Organic Materials

Regular additions of organic materials (i.e., leaf compost, manures, etc.) is an excellent way to improve soil quality. Organic materials contain nutrients, but the quantity of nutrients varies

greatly depending on the source. If you add organic materials to your agricultural lands, test the materials for nutrient content if an analysis isn't provided for you. The nutrients added with organic amendments should be deducted from the plant nutrient needs recommended by your soil tests.

Farm Narrative

David Hogue owns a parcel of land in James City County containing approximately 60 acres. In 2021, timer was harvested on approximately 23 of the 60 acres, and Mr. Hogue contacted the Colonial SWCD to write a conservation plan for the conversion of the cutover land to horse pasture. The land can be characterized as containing broad ridges, which transition to adjacent streams and wetlands via slopes which range from 5-40%. Soils on the site can become moderately productive with additions of lime and fertilizer, however, due to their sandy nature and topographic relief, are prone to leaching and erosion.

The conversion of the cutover land to horse pasture is proposed to be executed with a forest mulcher. Generally, forest mulchers do not penetrate far into the mineral soil. As a result, expect for tree stumps to re-sprout, which will require mechanical or chemical treatment to destroy. In addition, expect organic matter levels in the soil to increase as woody debris is mulched and left on the soil surface to decay. Through the decomposition process, microbes will consume nutrients applied as fertilizer, and may causes deficiencies, especially in nitrogen. The following plan allows for additional nitrogen to be applied in the fall of the year to produce more forage as the weather, and soil temperatures cool. The extra +/- 40 lbs. N/ac will be especially helpful in the first two years of pasture establishment. In addition to the nitrogen, phosphorus, and potassium fertilizer, lime will be a key factor in pasture establishment and grass health. Due to the extremely low soil pH, apply two tons of lime per acre when a seed bed is prepared, then apply another 2 tons per acre 6 to 12 months following the first application.

Establishing grass on this site is extremely important. For the landowner, a high-quality forage means lower feed (hay and or grain) bills. However, from an environmental standpoint, a well-established and maintained stand of grass protects the soil from rain drop impact. The roots of a well-established pasture provide structure to the sandy soil, binding it together. Maintaining the grass at no less than 3” in height will allow the grass to photosynthesize (feed itself) and slow stormwater runoff. When considered in concert, the benefits of a well-established and maintained pasture are numerous, which emphasizes how important it is to get it right the first time.

There is considerable cutover land on this tract that is not suitable for horse pasture or other agricultural activities. The Colonial SWCD does not recommend clearing slopes over 15%. The Virginia Nutrient Management Standards and Criteria (2014), the basis of this nutrient management plan, suggests that yield expectations be reduced by 25% for soils with extreme erosion potential, which can be found on this site. In addition, recommended animal stocking rates are reduced by 50% on slopes greater than 15%. Therefore, it is recommended that on areas not being converted to permanent pasture, consider reforestation, or some other permanent ground cover or use that will prevent erosion and absorb stormwater runoff.

NUTRIENT MANAGEMENT PLAN IDENTIFICATION

Operator
David Hogue
9958 Mill Pond Run
Toano, VA 23168
804-398-0424

Integrator:*None*

Farm Coordinates
Easting: 0, Northing: 0, zone: 17

Watershed Summary
watershed: YO62
county: James City

Nutrient Management Planner
Jim Wallace
205 C Bulifants Blvd.
Williamsburg, VA 23188

Certification Code: 429

Acreage Use Summary
Total Acreage in this plan: 9.2

Cropland:	0.
Hayland:	0.
Pasture:	9.2
Specialty:	0.

Livestock Summary

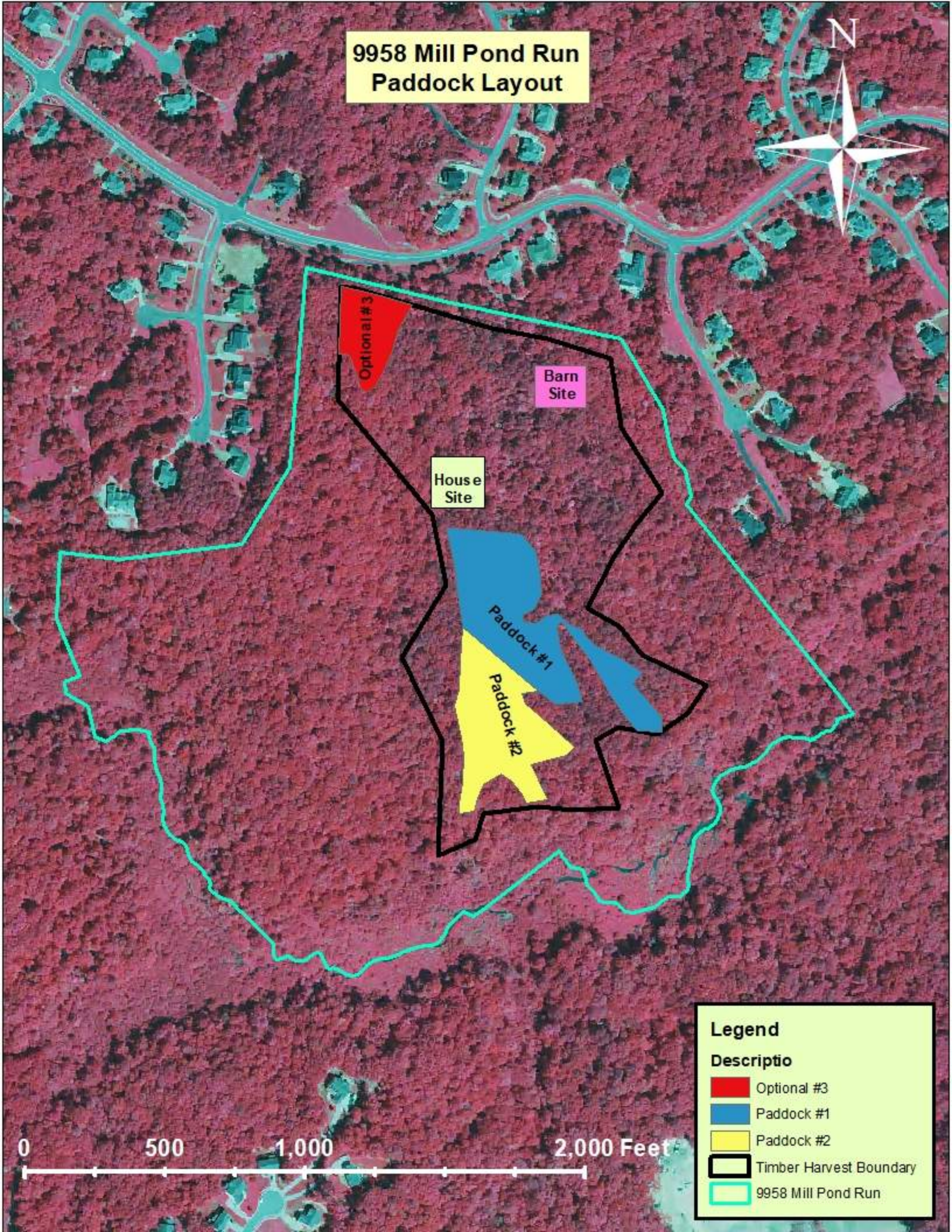
Beef Cattle	0
Dairy Cattle	0
Poultry	0
Swine	0
Other	0

Manure Production Balance

	Imported	Produced	Exported	Used	Net
kgals	0.	0.	0.	0.	0.
tons	0.	0.	0.	0.	0.

Plan written 9/28/2021
Valid until 9/28/2024

Signature: _____ 9/28/2021
Planner **date**


9958 Mill Pond Run
Paddock Layout
N
Optional #3
Barn Site
House Site
Paddock #1
Paddock #2
0
500
1,000
2,000 Feet
Legend
Descriptio
Optional #3
Paddock #1
Paddock #2
Timber Harvest Boundary
9958 Mill Pond Run

Field Productivities for Major Crops

Tract Name	Tract/ Field	Field Name	Acres	Predominant Soil Series	Corn	Small Grain	Alfalfa	Grass Hay	Environmental Warnings
Home	0/0	Optional Pas	1	Craven	IVa	III	Not Suited	III	
	0/0	Pasture #1*	5	Craven	IVb	III	Not Suited	III	High Leaching, High Slope
	0/0	Pasture #2*	3	Uchee	IVb	II	Not Suited	III	High Leaching, High Slope

* Do not apply manure or biosolids more than 30 days prior to planting. Apply commercial fertilizer nitrogen to row crops in split spring applicaions.

Yield Range

Field Productivity Group	Corn Grain Bu/Acre	Barley/Intensive Wheat Bu/Acre	Std. Wheat Bu/Acre	Alfalfa Tons/Acre	Grass/Hay Tons/Acre
I	>170	>80	>64	>6	>4.0
II	150-170	70-80	56-64	4-6	3.5-4.0
III	130-150	60-70	48-56	<4	3.0-3.5
IV	100-130	50-60	40-48	NA	<3.0
V	<100	<50	<40	NA	NA

Nutrient Management Plan Balance Sheet
(Fall, 2021-Fall, 2024)
Mill Pond Run
Planner: Jim Wallace (cert. No. 429)

Tract: Home Location: James City
(N = N based, 1P = P based, 1.5P = P based at 1.5 removal, 0P = No P allowed)

Field CFSA No. /Name	Size (ac) Total/ Used	Yr.	Crop	Needs N-P-K (lbs/ac)	Leg /Man Resid	Manure/Biosld Rate & Type (season)	IT (d)	Man/Bios N-P-K (lbs/ac)	Net = Needs - appld N-P-K (lbs/ac)	Sum P rem cred	Commercial N-P-K (lbs/ac)	Notes
0/Optional Pasture #3(N)	1/1	2021	Grass Pasture estb	40-140-140	0/0				40-140-140	N/A	40-140-140(br)	
		2022	Grass Pasture	50-30-50	0/0				50-30-50	N/A	50-30-50(br)	
											40-0-0(br)	1
		2023	... ...	50-30-50	0/0				50-30-50	N/A	50-30-50(br)	
											40-0-0(br)	1
		2024	... ...	50-30-50	0/0				50-30-50	N/A	50-30-50(br)	2
0/Pasture #1(N)	5/5	2021	Grass Pasture estb	40-170-140	0/0				40-170-140	N/A	40-170-140(br)	
		2022	Grass Pasture	50-60-60	0/0				50-60-60	N/A	50-60-60(br)	
											40-0-0(br)	1
		2023	... ...	50-60-60	0/0				50-60-60	N/A	50-60-60(br)	
											40-0-0(br)	1
		2024	... ...	50-60-60	0/0				50-60-60	N/A	50-60-60(br)	2
0/Pasture #2(N)	3/3	2021	Grass Pasture estb	40-170-160	0/0				40-170-160	N/A	40-170-160(br)	
		2022	Grass Pasture	50-60-60	0/0				50-60-60	N/A	50-60-60(br)	
											40-0-0(br)	1
		2023	... ...	50-60-60	0/0				50-60-60	N/A	50-60-60(br)	
											40-0-0(br)	1
		2024	... ...	50-60-60	0/0				50-60-60	N/A	50-60-60(br)	2

Commercial Application Methods:
br - Broadcast ba - Banded sd - Sidedress

Notes:
1 If additional production is needed later in the growing season, apply 40-60 lbs./ac N in late summer.
2 New soil tests are recommended before this nutrient application. New soil tests will gage the effectiveness of previous lime and fertilizer applications.

Virginia Cooperative Extension
Soil Test Report

Questions? Contact:
James City County Office
3127 Forge Road
P.O. Box 69
Toano, VA 23168-0069
757-564-2170

Virginia Tech Soil Testing Laboratory
145 Smyth Hall (0465)
185 Ag Quad Ln
Blacksburg, VA 24061
www.soiltest.vt.edu

SEE NOTES:
1 3
at www.soiltest.vt.edu under Report Notes

OWNER
HOGUE DAVID
9958 MILL POND RUN

TOANO, VA 23168

COPY FOR
JIM WALLACE

SAMPLE HISTORY

Sample ID	Field ID	LAST CROP		LAST LIME APPLICATION		SOIL INFORMATION				
		Name	Yield	Months Prev.	Tons/Acre	SMU-1 %	SMU-2 %	SMU-3 %	Yield Estimate	Productivity Group
PAST1				---		18B 50	11C 50			

LAB TEST RESULTS (see Note 1)

Analysis	P (lb/A)	K (lb/A)	Ca (lb/A)	Mg (lb/A)	Zn (ppm)	Mn (ppm)	Cu (ppm)	Fe (ppm)	B (ppm)	S.Salts (ppm)
Result	3	76	193	49	0.9	5.6	0.2	70.1	0.1	
Rating	L-	M-	L-	L+	SUFF	SUFF	SUFF	SUFF	SUFF	

Analysis	Soil pH	Buffer Index	Est.-CEC (meq/100g)	Acidity (%)	Base Sat. (%)	Ca Sat. (%)	Mg Sat. (%)	K Sat. (%)	Organic Matter (%)
Result	4.5	5.68	5.1	84.5	15.5	9.5	4.0	1.9	

FERTILIZER AND LIMESTONE RECOMMENDATIONS

Crop: Orchardgrass/Fescue-Clover Establishment (31)

Lime, Tons/Acre		Fertilizer, lb/A		
Amount	Type	N	P205	K20
4.75	AG	40	170	140

620. For best results, the lime should be applied six months to one year ahead of time.

121. P2O5 and K2O recommendations will supply the needed nutrients for establishment and one harvest year's growth.

823. Apply the nitrogen at the time the grass is seeded in late summer, early fall or early spring. Overseed the grass with clover the following February.

991. "Explanation of Soil Tests, Note 1" and other referenced notes are viewable at www.soiltest.vt.edu under Report Notes.

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SAMPLE HISTORY

Sample ID	Field ID	LAST CROP		LAST LIME APPLICATION		SOIL INFORMATION				
		Name	Yield	Months Prev.	Tons/Acre	SMU-1 %	SMU-2 %	SMU-3 %	Yield Estimate	Productivity Group
PAST2				---		34B 50	11C 50			

LAB TEST RESULTS (see Note 1)

Analysis	P (lb/A)	K (lb/A)	Ca (lb/A)	Mg (lb/A)	Zn (ppm)	Mn (ppm)	Cu (ppm)	Fe (ppm)	B (ppm)	S.Salts (ppm)
Result	3	54	113	30	0.6	2.6	0.1	54.5	0.1	
Rating	L-	L	L-	L	SUFF	SUFF	SUFF	SUFF	SUFF	

Analysis	Soil pH	Buffer Index	Est.-CEC (meq/100g)	Acidity (%)	Base Sat. (%)	Ca Sat. (%)	Mg Sat. (%)	K Sat. (%)	Organic Matter (%)
Result	4.4	5.79	4.1	88.4	11.6	6.9	3.0	1.7	

FERTILIZER AND LIMESTONE RECOMMENDATIONS

Crop: Orchardgrass/Fescue-Clover Establishment (31)

Lime, Tons/Acre		Fertilizer, lb/A		
Amount	Type	N	P205	K20
4	Dolomitic	40	170	160

620. For best results, the lime should be applied six months to one year ahead of time.

121. P2O5 and K2O recommendations will supply the needed nutrients for establishment and one harvest year's growth.

823. Apply the nitrogen at the time the grass is seeded in late summer, early fall or early spring. Overseed the grass with clover the following February.

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JIM WALLACE

SAMPLE HISTORY

Sample ID	Field ID	LAST CROP		LAST LIME APPLICATION		SOIL INFORMATION				
		Name	Yield	Months Prev.	Tons/Acre	SMU-1 %	SMU-2 %	SMU-3 %	Yield Estimate	Productivity Group
Option				---		15F 100				

LAB TEST RESULTS (see Note 1)

Analysis	P (lb/A)	K (lb/A)	Ca (lb/A)	Mg (lb/A)	Zn (ppm)	Mn (ppm)	Cu (ppm)	Fe (ppm)	B (ppm)	S.Salts (ppm)
Result	15	97	241	56	1.5	5.3	0.3	89.3	0.1	
Rating	M-	M-	L	L+	SUFF	SUFF	SUFF	SUFF	SUFF	

Analysis	Soil pH	Buffer Index	Est.-CEC (meq/100g)	Acidity (%)	Base Sat. (%)	Ca Sat. (%)	Mg Sat. (%)	K Sat. (%)	Organic Matter (%)
Result	4.4	5.54	6.1	84.2	15.8	9.9	3.8	2.0	

FERTILIZER AND LIMESTONE RECOMMENDATIONS

Crop: PINE ESTABLISHMENT (109)

Lime, Tons/Acre		Fertilizer, lb/A		
Amount	Type	N	P205	K20
3.75	AG	0	50	40

186. See Note 12 for further information on fertilization and liming.

991. "Explanation of Soil Tests, Note 1" and other referenced notes are viewable at www.soiltest.vt.edu under Report Notes.

Virginia Cooperative Extension
Virginia Tech • Virginia State University
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Nutrient Management for Small Farms

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Rory Maguire, Extension Specialist, School of Plant and Environmental Sciences, Virginia Tech

Introduction

The basic principles of nutrient management on small farms are similar to those of large farms. However, small farms may have a greater challenge with managing manure nutrients because of (1) the different characteristics of manure from the multiple animal species they keep, (2) the limited land area available to apply manure, and/or (3) a lack of equipment for manure management and spreading. The purpose of this publication is to outline how to quantify and determine use of manure nutrients in small farms as a crop fertilizer in order to prevent environmental damage that may be caused by nutrient losses.

What Is a Small Farm?

Small farms are diverse, ranging from retirement and residential farms with few off-farm sales to commercially oriented farms with annual sales approaching $250,000.

What Is Nutrient Management?

Nutrient management is the process used to handle the application of nutrients to crops, including their quantity, form, placement, and timing. On most farms, the nutrients predominantly come from manure and commercial fertilizer, but other sources, such as compost, can also be important. The purpose of nutrient management is to supply sufficient plant nutrients for optimum forage and crop yields, and thus prevent excess applications that can contaminate water quality. A nutrient management plan (NMP) documents the source, rate, method, and timing of nutrient applications.

Movement of Nutrients on a Farm

To manage manure effectively, it is important to consider the entire farm's nutrient balance. Figure 1 provides an overview of nutrient cycling on a farm. Usually, there is a tendency to focus on manure management alone, which may only account for a small part of the total nutrients. Nutrient dynamics include inputs, outputs, what is lost, and what is stored on the farm. It is necessary to consider the big picture in order to understand and identify the sources of nutrients potentially associated with environmental issues and how to develop solutions to deal with the problems they create.

Farm nutrient inputs include purchased animals, feed, fertilizer, legume nitrogen, and bedding. **Farm nutrient outputs** are products that are moved out of the farm through sales or given away, including animals, milk, meat, eggs, manure, and crops. Recycling of nutrients occurs on the farm when manures from livestock are used for crop fertilizer, and then the crops are harvested and fed to the livestock. The optimal goal is to have a situation whereby the farm can balance the inputs with crop and animal needs to minimize risk of environmental damage.

The major nutrients of interest are nitrogen (N) and phosphorus (P). Losses of N occur via leaching of nitrates to groundwater, volatilization of ammonia to the atmosphere, and phosphorus (P) runoff into the surface water. Phosphorus may also accumulate in the soil to levels greater than crop needs and cause excessive losses in runoff. Nutrients may leave the farm when manure is used for off-site energy generation (thermal and biological processes) and composting.

Estimating Manure Quantity and Nutrients on a Farm

In general, the quantity and nutrient content of manure depend on the species, breed, and age of the animal and the composition of feed in their diet. Table 1 presents quantity and nutrient content of freshly excreted manure from different animal species, usually referred to "as excreted."

Produced by Virginia Cooperative Extension, Virginia Tech, 2018

VT/1218/442-305(BSE-241P)

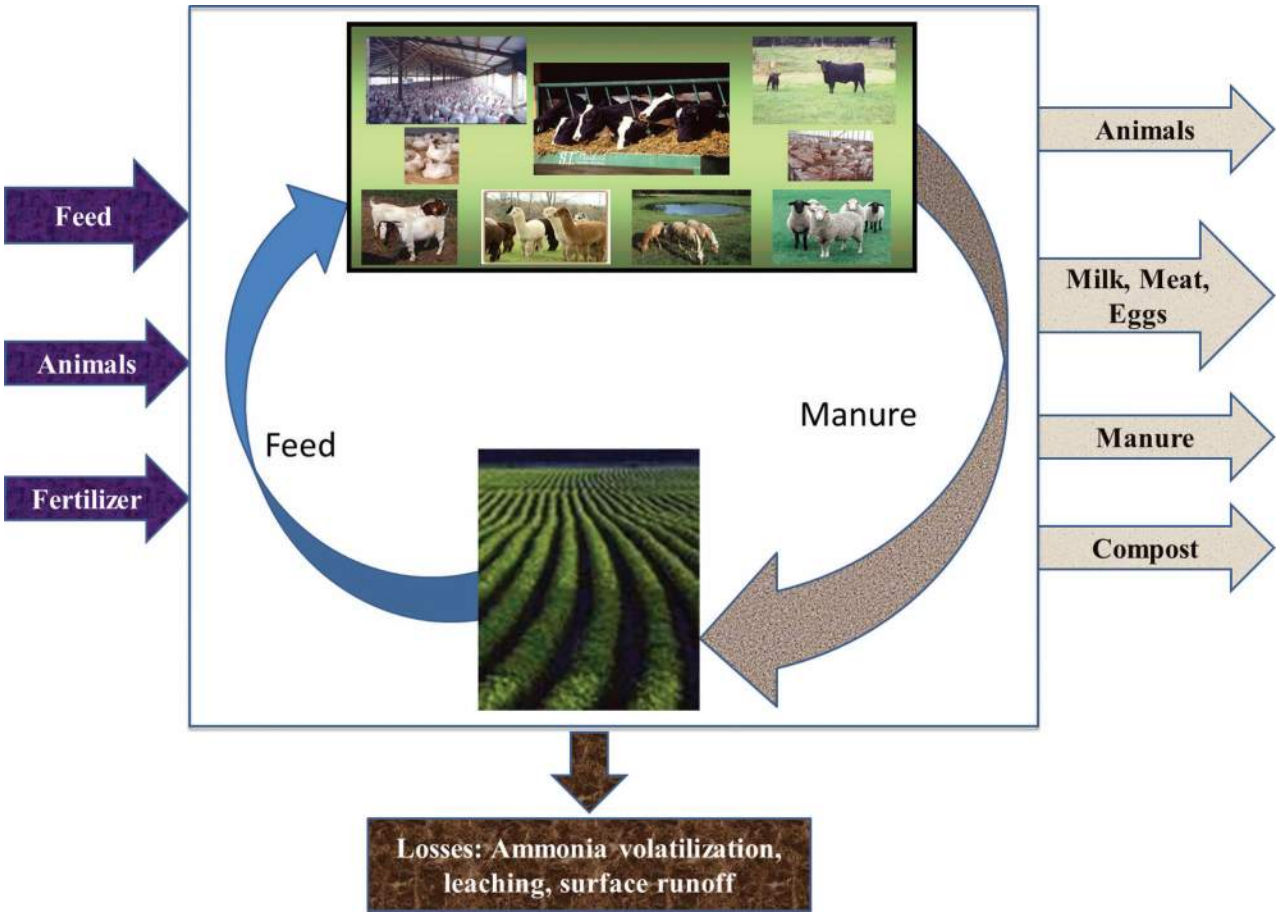

Figure 1. Nutrient cycling on a farm operation

The composition of manure applied to cropland is usually different from that of freshly excreted manure because of decomposition and losses during storage. The amount of loss depends on the climate, transformation of nutrients, storage period, and type of manure handling system used. Major losses are from N volatilization and leaching of soluble nutrients. Some studies have indicated that as much as 50 to 70 percent of N may be lost from manure (depending on how it is stored), due to ammonia volatilization and denitrification to dinitrogen gas (N_2). Phosphorus and potassium (K) losses are less likely except for manure not contained properly. Tables 2 and 3 present the nutrient content of stored manure for the common animal species in Virginia.

Manure quantities in table 1 are suitable for planning short-term storage and nutrient application where there is no manure storage on the farm. Tables 2 and 3 are useful in estimating the amount of nutrients that will be available for application to cropland after storage. The data in tables 2 and 3 also include standard deviations, which show how the nutrients in manure vary and how close individual manure samples are to the average value. These values should be used as a guide and only when manure analyses for your farm are not available.

Manure composition can vary widely, so testing is the most accurate way to determine nutrient content. Taking a representative sample from your manure is important because manure composition is not consistent. For example, manure on the surface of a pile will contain less N because of ammonia loss than that deeper in the pile. To learn how to take a representative sample, see the publication by Maguire, Hodges, and Crouse (2009).

Also, all phosphorus in manure is considered plant-available. This is not the case for N because it is so mobile and exists in many forms. The total N and ammonium-N in manure are used to calculate the plant-available component, as described in *Soil Test Note No. 5: Fertilizing with Manures*, Virginia Cooperative Extension (VCE) publication 452-705 *(https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/452/452-705/452-705_pdf.pdf)*. The example below shows how to estimate the nutrients on a farm with several animal species.

Table 1. Quantity of manure produced daily and nutrient concentrations as excreted by different animals.

Animal type	Weight (lb)	Quantity produced per day: Weight (lb)	Quantity produced per day: Volume (gal)	Moisture content (%)	Nutrients (lb/day per animal): Total N	Nutrients (lb/day per animal): Total P (P_2O_5)	Nutrients (lb/day per animal): Potassium (K_2O)
Dairy							
Lactating	Mature	150	18.00	87	0.99	0.39	0.28
Dry	Mature	83	9.72	87	0.50	0.15	0.40
Heifer	970	48	5.83	83	0.26	0.10	0.33
Calf	250	22	2.60	87	0.11	0.04	0.09
Beef							
Finishing	975	58	6.9	88	0.36	0.11	0.30
Cow (confined)	Mature	64	7.80	88	0.42	0.22	0.36
Calf (confined)	500	29	3.5	88	0.29	0.13	0.23
Horses	1,100	57	6.80	85	0.34	0.17	0.25
Poultry							
Broilers	2.5	0.2290	0.0265	74	0.0025	0.0017	0.0017
Layers	2.5	0.1900	0.0232	75	0.0035	0.0025	0.0016
Turkey							
Male (toms)	17	0.5850	0.0730	74	0.0090	0.0062	0.0051
Female (hens)	10	0.3620	0.0430	74	0.0054	0.0034	0.0029
Sheep	63	3.1800	0.4190	70	0.0319	0.0089	0.0316
Goats	64	3.4200	0.3800	64.5	0.0412	0.0092	0.0367

Source: ASABE 2005; MWPS 1993; Barker, Zublena, and Walls 2001.

Table 2. Average nutrient content (± standard deviation) of liquid manure for different animal species at the time of application in Virginia.

Animal	Samples (#)	Moisture content (%)	Nutrient (lb/1,000 gal): Total N	Nutrient (lb/1,000 gal): Ammonium-N	Nutrient (lb/1,000 gal): Total P (P_2O_5)	Nutrient (lb/1,000 gal): Potassium (K_2O)
Beef	59	93.1 (±2.3)	22.11 (±3.30)	9.51 (±1.52)	12.50 (±3.51)	19.61 (±3.42)
Dairy	1,181	94.0 (±1.3)	21.19 (±3.94)	9.18 (±0.52)	9.18 (±1.11)	21.25 (±9.79)
Swine	617	98.9 (±0.5)	9.06 (±0.93)	6.61 (±0.73)	4.20 (±1.32)	12.28 (±0.98)

Source: Virginia Department of Conservation and Recreation.

Table 3. Average nutrient content (± standard deviation) of solid manure for different animal species at the time of application in Virginia.

Animal	Samples (#)	Moisture content (%)	Nutrient concentration (lb/ton): Total N	Nutrient concentration (lb/ton): Ammonium-N (NH_4-N)	Nutrient concentration (lb/ton): Total P (P_2O_5)	Nutrient concentration (lb/ton): Potassium (K_2O)
Dairy	384	65.8 (±2.6)	19.78 (±10.94)	2.99 (±0.72)	7.93 (±1.58)	17.98 (±9.87)
Beef	142	59.6 (±4.8)	23.81 (±10.98)	2.34 (±0.43)	12.71 (±2.50)	26.08 (±11.69)
Swine	6	46.1 (±27.1)	29.45 (±13.04)	7.80 (±1.98)	24.35 (±18.34)	10.75 (±5.93)
Broiler	2,025	27.8 (±0.6)	66.58 (±3.49)	11.05 (±0.61)	48.09 (±8.50)	54.25 (±2.26)
Layer (breeders)	436	30.7 (±2.0)	48.68 (±3.98)	8.45 (±0.54)	57.85 (±8.92)	44.77 (±2.72)
Turkey	1,017	29.5 (±1.0)	66.54 (±6.44)	13.5 (±0.41)	49.74 (±7.42)	41.73 (±5.31)
Turkey (breeders)	107	24.4 (±2.6)	59.18 (±5.60)	11.91 (±1.76)	57.45 (±9.72)	38.02 (±6.12)

Source: Virginia Department of Conservation and Recreation.

Example: Estimating Quantity and Nutrients in Manure

A farm has 50 lactating cows, five dry cows, 45 heifers, 40 goats (1-year-olds), 1,000 broilers, and five horses. Estimate (1) the amount of manure generated per year; (2) the nutrient content (nitrogen, phosphorus, and potassium) in manure excreted by each of the animals; and (3) the total nitrogen, phosphorus, and potassium produced on the farm annually.

The answers to this example can be obtained by using table 1.

1. Estimate the amount of manure generated in a year.For each animal species, estimate by multiplying "volume of manure produced per day" by the number of animals on the farm and the number of days in a year.

Lactating cows:
18 gal/animal-day × 50 animals × 365 days/year = 328,500 gal

Dry cows:
9.72 gal/animal-day × 5 animals × 365 days/year = 17,739 gal

Heifers:
5.83 gal/animal-day × 45 animals × 365 days/year = 95,758 gal

Goats:
0.38 gal/animal-day × 40 animals × 365 days/year = 5,548 gal

Broilers:
0.00265 gal/bird-day ×1,000 birds × 365 days/year = 9,673 gal

Horses:
6.8 gal/animal-day × 5 animals × 365 days/year = 12,410 gal

2. Estimate the amount of nutrients in the manure that are generated in a year.

   For each animal species, estimate each nutrient — nitrogen, phosphorus, and potassium — by multiplying pounds of the nutrient in manure produced per day by the number of animals on the farm and the number of days in a year. The calculations for nitrogen values are presented below. You can estimate phosphorus and potassium using the same method and compare with the answers given in table 4.

Lactating cows:
0.99 lb N/animal-day × 50 animals × 365 days/year = 18,608 lb N

Dry cows:
0.5 lb N/animal-day × 5 animals × 365 days/year = 913 lb N

Heifers:
0.26 lb N/animal-day × 45 animals × 365 days/year = 4,271 lb N

Goats:
0.0412 lb N/animal-day × 40 animals × 365 days/year = 602 lb N

Broilers:
0.0025 lb N/bird-day ×1,000 birds × 365 days/year = 913 lb N

Horses:
0.34 lb N/animal-day × 5 animals × 365 days/year = 621 lb N

3. Estimate the total amount of manure and nutrients in the manure generated in a year.The total amount of manure and nutrients generated on the farm in a year is the sum of all the manure produced by each species, as shown in table 4.

Table 4: Total manure and nutrient production in a year.

Animal	Manure (gal)	N (lb)	P_2O_5 (lb)	K_2O (lb)
Dairy: lactating	328,500	18,608	7,118	5,293
Dairy: dry	17,739	913	274	730
Dairy: heifers	95,758	4,271	1,643	5,417
Goats	5,548	602	134	536
Broilers	9,673	913	621	621
Horses	12,410	621	310	456
Total	469,628	25,385	10,009	10,052

How To Decide Location and Nutrient Application Rates

Conduct a farm risk assessment using a farm map to determine appropriate areas for spreading. Consider slope, distance to water sources, erosion potential of the land where manure might be applied, and soil nutrient tests. Soil testing is the basis of good nutrient management, and soil samples should be taken regularly. Details regarding sampling procedures and laboratory methods are available at *www.soiltest.vt.edu*.

A soil sample should be taken every three to five years. From the soil test data, knowledge of the soil type, and the crop to be grown, nutrient and lime application rates can be determined for optimum crop growth. A three-year sampling interval is recommended for row crops and hay systems where nutrients are removed in harvested crops; a five-year sampling interval is acceptable for forage systems where grazing animals return nutrients to the soil through their manure. Soil pH must be kept within a specific range for each crop, and your soil test report will include the lime requirement (if any) along with nutrient recommendations. Lime supplies calcium, but the main benefit is to increase the pH of the predominantly acidic soils we have in Virginia.

Source of Nutrients

Once your soil test tells you the quantity of nutrients required in each field, the next step is to decide what source of nutrients to use. If you have manure on the farm, it is normally cheapest to use this before purchasing any commercial fertilizer. The problem with manure is that its ratio of nitrogen to phosphorus is low compared to crop requirements, so applying manure to meet crop nitrogen needs overapplies phosphorus (unless soil test phosphorus is low) and applying to meet crop phosphorus needs underapplies nitrogen. The solution to this is either (1) apply manure according to crop phosphorus needs or supplement with commercial nitrogen fertilizer; or (2) apply according to crop nitrogen needs once every three years, track soil test phosphorus, and use no phosphorus fertilizer or manure in the intervening two years.

Once you have decided where to use your manure, the remaining nutrient needs can be made up through commercial fertilizers. There are various fertilizers available that can be mixed to provide the correct quantities of the primary nitrogen, phosphorus, potassium, and other secondary and micronutrients. Common commercial fertilizers and how to calculate application rates are covered in *Fertilizer Types and Calculating Application Rates*, VCE publication 424-035 (*https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/424/424-035/424-035_pdf.pdf*).

Summary

Step 1: Estimate the total nutrients on your farm. Use manure analysis data for your farm if available. Otherwise, use local book values or general book values provided by professional organizations whose work involves manure.

Step 2: Test soils in the fields where manure is to be applied. This test will tell you the amount of nutrients needed for the planned crops for that field.

Step 3: Determine how much of the nutrients required by the crops in step No. 2 will come from manure. Plan use of manure based on the nutrient (phosphorus or nitrogen) that limits manure application.

Step 4: Determine how much supplemental commercial fertilizer is needed to meet crop nutrient needs for optimum production.

When and How to Apply

Lime takes time to react in the soil, so it should be applied several months in advance of planting or at the start of the growing season for perennials, if possible. Nutrients — especially nitrogen, which is very mobile in soil — should be applied as close to planting as possible or at the start of the growing season for perennials. This will maximize nutrient use by the crop and minimize unwanted losses through runoff and leaching that can be economically and environmentally damaging.

When deciding how to apply the nutrients, there are several factors to take into consideration, including manure and equipment availability and cropping system. Losses of nutrients in runoff are generally less if they can be placed under the soil surface, either through injection or incorporation. However, special equipment is needed for injection, while incorporation through tillage conflicts with forage and no-till systems and can increase soil erosion. Therefore, surface applications of manure or fertilizer are most common.

Record Keeping

Keeping good nutrient management plan records is critical for demonstration of good environmental stew-

ardship. Records should include the necessary items to help with proper development/improvement and implementation of the nutrient management plan. The records may be kept in various ways, ranging from a simple handwritten logbook to a detailed, computer-based spreadsheet. Records should document the quantity and location of nutrients on the farm.

The basic components of a record book consist of:
- Number and type of animals.
- Manure generated and inventory.
- Manure applied to land or used on the farm.
- Any manure (excess or otherwise) moved off the farm through sales or given away.
- Any other change that affects quantity of manure produced on the property that is not listed above.

Records should be maintained for a period of five years for other beneficial uses, which include making important business decisions that affect farm income; improving efficiency of production by evaluating the yields, soil tests, manure nutrients, and usage as a fertilizer; and using other commercial fertilizers. Although not a desirable situation, records provide the potential to reduce liability for producers should they be accused of environmental mismanagement. The records will help document responsibility and show the practices in place on the farm to manage nutrients.

Manure Records

Where animals are housed or confined, manure accumulation will occur, making manure collection and storage necessary. It is important to know the quantity and nutrient content of the manure to plan for its use. It is a good practice to collect and send manure samples for analysis.

Manure records should include:
- Sampling date.
- Sampling protocol.
- Name of the person who took the samples.
- Name of the analytical laboratory.
- Analytical results.

If manure is to be moved off the property, the records to keep include:
- Amount (volume or weight) of manure produced or handled.
- Date of manure transfer.
- Volume or weight of manure transferred.
- Name and address of person to whom manure is given or sold.

Storage

The two critical issues or questions one should consider about storage structures are their capacity and maintenance. Manure storage structures should have enough capacity to allow for the environmentally safe utilization of the manure and wastewater generated by an operation. “Environmentally safe utilization” means that manure and wastewater are not land-applied at times or under conditions that increase the likelihood of nutrients to enter surface water.

These conditions or periods include:
- High precipitation.
- Frozen or snow-covered ground.
- Saturated soil (with water and nutrients).
- Floods.
- Near the end of or after the growing season, when crops cannot take up applied nutrients.

Adequate capacity will provide the operator with the flexibility to make changes to the NMP, especially if manure storage for a longer time is required. Details on how to site, size, and maintain a storage structure can be found in *Selection and Location of Poultry and Livestock Manure Storage*, VCE publication 442-307*(https://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/442/442-307/442-307_pdf.pdf)*; and *Poultry and Livestock Manure Storage: Management and Safety*, VCE publication 442-308 (http://pubs.ext.vt.edu/content/dam/pubs_ext_vt_edu/442/442-308/442-308_pdf.pdf).

Specific records to keep for manure storage are:
- Animal numbers (monthly or weekly).
- Storage capacity.
- Storage volumes or levels recorded weekly.
- Any changes to the storage structure.
- Dates and quantities of any discharges from storage and corrective measures taken to manage the discharges.
- Notes on weekly or regular inspections of the storage structure’s integrity, including the liquid depth marker.
- Other information.

Land Application

Records concerning land application activities that the farmer is to maintain should be specified in the plan. Land application records are critical because they enable farmers to demonstrate that they are applying manure and wastewater in accordance with a site-specific NMP. Land application records will demonstrate that the manure and wastewater are being applied in

accordance with the requirements of the NMP.

Specific records for land application include:
- Location and description of land where manure is applied.
- Area of land where manure is applied.
- Date the manure is applied.
- Volume or weight of manure applied.
- Application rates of manure nutrients and fertilizer by field and year.
- Manure incorporation methods.
- Weather conditions at the time of application and 24 hours before and after application.
- Explanation of the basis for determining manure application rates.
- Calculations showing the total nitrogen and phosphorus to be applied to each field, including sources other than manure, litter, or process water.
- Total amount of nitrogen and phosphorus actually applied to each field, including documentation of calculations for the total amount applied.
- Methods used to apply the manure, litter, or process water.
- Dates of manure application equipment inspection.
- Expected crop yields.
- Soil test results.
- Conservation practices to reduce nutrient losses.

Other Records

- Mortality management.
- Manure and wastewater analysis.
- Soil tests.
- Crop yields.
- Equipment inspections and calibrations.
- Handling, use, and management of chemicals on the farm.

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UNIVERSITY OF GEORGIA
EXTENSION

Novel Endophyte-Infected Tall Fescue

Dennis W. Hancock, University of Georgia
John Andrae, Clemson University

Tall fescue (*Schedonorus phoenix* (Scop.) Holub) is a cool season perennial grass that fills a critical forage produc-tion gap in the Southeast and is the predominant forage crop in much of the U.S. In fact, this species is the most widely used grass in improved U.S. pastures, occupying more than 36 million acres. Its popularity is related to establishment ease, drought tolerance, excellent grazing persistence, and a long grazing season.

Some of these desirable attributes are due to the presence of a fungus (*Neotyphodium coenophialum*) that lives inside the plant (endophyte). This fungus is transmitted from one generation to the next in the seed. It is not transmitted through pollen or from plant to plant.

Unfortunately, this endophyte produces toxic alkaloids that greatly decrease animal gains and reproductive perfor-mance, which, conservatively estimated, costs the U.S. beef industry from $600 million to more than $1 billion annually. Removing the toxin-producing endophyte alleviates animal symptoms and improves animal performance but reduces the longevity, vigor, and drought tolerance of the tall fescue stand.

Recently, endophyte strains that do not produce toxic ergot alkaloids have been identified and inserted into tall fescue varieties. Replacing toxic tall fescue stands with these "novel" endophyte-infected varieties will benefit producers if new stands (1) persist as well as toxic tall fescue under grazing and (2) provide animal performance at levels comparable to endophyte-free tall fescue. This publication outlines plant persistence and animal performance characteristics of novel endophyte-infected tall fescue and provides recommended pasture renovation practices.

Development of Novel Endophyte-Infected Tall Fescue Products

Many pasture and hay acres have been planted to novel endophyte tall fescues since their release in 2000. For the first several years, only one product containing a novel endophyte was available in Georgia: MaxQ™.

MaxQ™ tall fescue was jointly developed by Dr. Joe Bouton at the University of Georgia and Dr. Gary Latch at Ag-Research Limited of New Zealand. Many naturally-occurring endophyte strains had been discovered in tall fescue in the 1980s and 90s – some of which did not produce toxic ergot alkaloids. Drs. Bouton and Latch inserted these novel endophytes into "Jesup" and "GA 5," tall fescue cultivars that were developed in Georgia (Figure 1). This resulted in two novel endophyte-containing tall fescue varieties that produced no toxic alkaloids but retained all of the positive agronomic features (excellent persistence, improved vigor, drought tolerance, etc.) of tall fescue varieties infected with the wild-type endophyte.

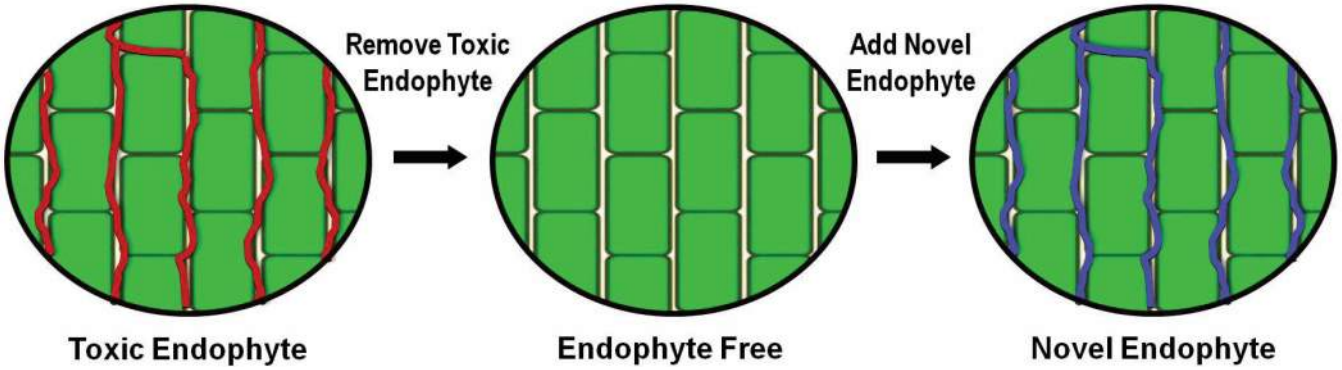

Figure 1. Hyphae of the fungal endophyte grow between the cells (green) of the tall fescue plant. When building a novel endophyte-infected tall fescue, the toxic endophyte (red lines) is removed from the tall fescue plant to create an endophyte-free plant. Then, the novel endophyte (blue lines) is introduced into the plant.

These novel endophyte tall fescue varieties were tested extensively in Georgia, both on experiment stations and producer farms. The success of these yield, persistence, and animal performance trials led to the eventual release of both "Jesup MaxQ™" and "GA 5 MaxQ™." Pennington Seed, Inc. (Madison, Ga.) obtained the rights to sell these novel endophyte varieties in North America. Although both were sold initially, Pennington Seed eventually simplified the production and marketing of the novel endophyte varieties and sold only "Jesup MaxQ™."

Additional novel endophyte tall fescues are being developed by Ag-Research, UGA, and other public and private plant breeders. These newer novel endophyte tall fescue products will be different from "Jesup." They will allow producers to select a novel endophyte tall fescue variety that better matches their climate or production goals. More information on novel endophyte tall fescue varieties that are currently recommended for use in Georgia may be found on the "Forage Species and Varieties Recommended for Use in Georgia" Web site (http://www.caes.uga.edu/commodities/fieldcrops/ forages/species.html).

Will Novel Endophyte-Infected Tall Fescue Persist?

Soon after researchers discovered the wild-type toxic endophyte in the 1980s, they noted that it could be removed from the tall fescue seed and that endophyte-free stands could be established. Gains and reproductive performance of animals grazing endophyte-free tall fescue showed much higher animal performance than toxic tall fescue. However, the stands in endophyte-free tall fescue pastures frequently failed to persist. Researchers found that the endophyte causes the tall fescue plant to be more vigorous and tolerant of heavy grazing and other stress. Without this added tolerance, endophyte-free tall fescue stands do not survive long, particularly under grazing.

Because of the potential for stand losses, many producers choose to plant more "dependable" toxic tall fescue and tolerate economic losses associated with the toxins. Novel endophyte tall fescue must persist substantially better than endophyte-free tall fescue to justify the higher costs of seed and renovating existing tall fescue stands.

Before the release of the MaxQ™ tall fescue products, tests of novel endophyte tall fescue persistence were performed near Eatonton and Calhoun, Ga. One test compared the stand persistence of novel endophyte ("Jesup MaxQ™"), endophyte-free, and toxic tall fescue planted into a bermudagrass sod near Eatonton, Ga., and subjected to severe grazing conditions (Figure 2). These plots were established on droughty soils and grazed closely (under continuous stocking) during two successive summers to accelerate stand decline and evaluate endophyte effects on plant persistence.

Because of the grazing pressure severity and the bermudagrass competition present in these pastures, the stand ratings for all of the entries, including toxic tall fescue, declined. Nevertheless, the novel endophyte tall fescue persisted as well as its toxic endophyte-infected cohort and both were more persistent than the endophyte-free plantings. The novel endophyte tall fescue maintained stands equal to toxic tall fescue over a four-year period. Similar results were also obtained in grazing trials near Calhoun, Ga.

Pure stands of novel endophyte tall fescue have also been evaluated for grazing persistence at several State Experiment Stations throughout the country, including the Southeast (except Florida). In addition to these trials, novel endophyte tall fescue has been successfully maintained in pastures throughout the South. In each case, novel endophyte tall fescue persistence has been similar to toxic tall fescues. In pure stands and under normal grazing conditions, it is reasonable to expect that novel endophyte tall fescue will survive as well as toxic tall fescue and will persist much better than endophyte-free tall fescue.

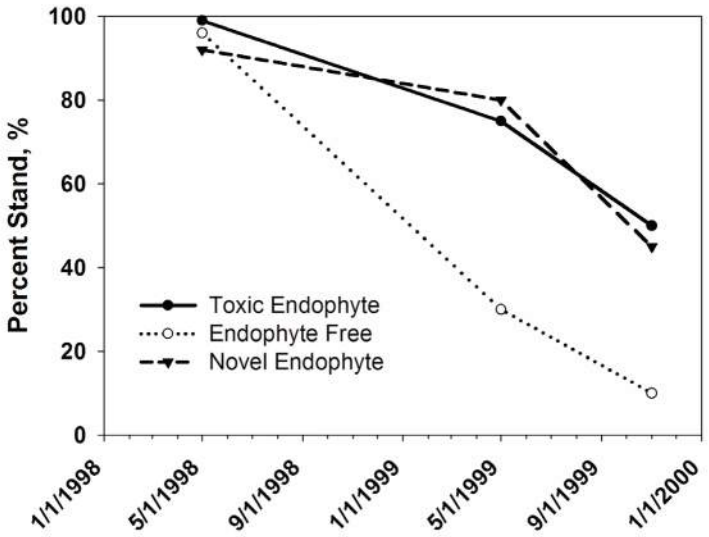

Figure 2. Stand persistence of novel endophyte-infected ("Jesup MaxQ™"), toxic endophyte-infected, and endophyte-free tall fescue in bermudagrass sod after two years of close grazing near Eatonton, Ga. (Bouton et al., 2000).

How do Animals Perform on Novel Endophyte-Infected Tall Fescue?

Cow-Calf Performance

Most cattle operations in the Southeast are cow-calf producers. To justify higher seed costs and the cost of renovating existing tall fescue stands, the novel endophyte tall fescue must substantially increase the weaning weight of calves and/or the pregnancy/calving rate of the cows. Cow-calf performance data on novel tall fescue remains limited; however, initial results appear promising.

In a study conducted in northwest Georgia, cows grazing novel endophyte infected tall fescue tended to have higher body condition scores and weights than cows that grazed toxic tall fescue. Steer and heifer calves grazing novel endophyte tall fescue also had approximately 50 and 60 pounds greater weaning weights, respectively, than their cohorts grazing toxic tall fescue (Figure 3). Unfortunately, cattle numbers were too small in this study to determine if reproductive characteristics were positively affected by the use of novel endophyte tall fescue.

A larger study was performed at the University of Arkansas where 136 pregnant cows (1078 ± 14 lbs) were split between novel endophyte and toxic tall fescue pastures. The performance of these cows and their calves has been tracked for the past two years (Table 1). From this study on cow-calf performance, it appears that novel endophyte tall fescue substantially improves both the calf weaning weight and the cow pregnancy rate. Furthermore, these data suggest that replacement heifer performance is also improved when these animals graze novel endophyte tall fescue.

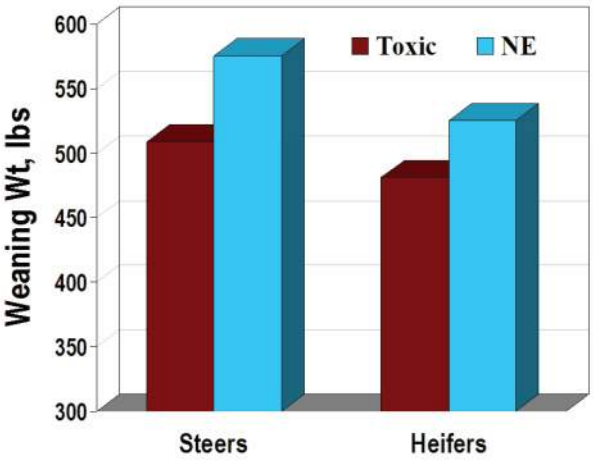

Figure 3. Calf weaning weights of cattle grazing toxic or novel endophyte (NE; "Jesup MaxQTM") tall fescue stands. Values are averages of two years' data collected near Calhoun, Ga. (Bouton et al., 2000, and Watson et al., 2001).

Table 1. Cow-calf performance on toxic or novel endophyte (NE) tall fescue stands.[†]

	Toxic	NE
Cow Performance		
Wt. at end of breeding, lbs.	1110	1236
Wt. at end of weaning, lbs.	1005	1122
BCS at end of breeding[‡]	5.4	5.7
Pregnancy Rate, %	44.7	85.1
Calf Performance		
Actual Weaning Wt., lbs.	461	529
Adj. (205 d) Weaning Wt., lbs.	436	504
ADG (birth to wean), lbs.[§]	1.7	2.1
Replacement Heifers		
Actual Weaning Wt., lbs.	459	498
Calving Rate, %	64.1	90.6

[†] Adapted from University of Arkansas Experiment Station Reports by Coffey et al. (2007 and 2008).
[‡] BCS: Body Condition Score.
[§] ADG: Average Daily Gain.

Stocker Performance

Stocker cattle performance has been examined for several years at the Central Georgia Research and Education Center near Eatonton, Ga. (Table 2). Similar studies throughout the Southeast have shown similar results, indicating that stocker gains are substantially higher for calves on novel endophyte tall fescue pastures than for those on toxic endophyte-infected tall fescue pastures. Many of these studies also indicate the stockers on novel endophyte tall fescue pastures have smoother hair coats and lower body temperatures, and spend more time grazing and less time standing in the shade or in pools of water (Figure 4).

Figure 4. Cattle grazing toxic tall fescue (foreground) spent less time grazing than cattle grazing MaxQTM (in background). Endophyte-free tall fescue had higher intakes and performance (Parish, 2001).

Table 2. The effect of endophyte status on stocker performance on tall fescue in the fall and spring.†

	ADG (lbs/hd/d)	Gain (lb/acre)	Stocking Rate (hd/acre)	Grazing Time (days)
Fall				
Toxic Endophyte-Infected Jesup	1.5	137	1.5	63
Endophyte-Free Jesup	2.3	211	1.5	63
Jesup MaxQ™	2.1	188	1.5	63
Spring				
Toxic Endophyte-Infected Jesup	0.8	119	1.6	91
Endophyte-Free Jesup	2.2	313	1.6	91
Jesup MaxQ™	1.8	251	1.6	91

† Adapted from Parish (2001).

Adding clover to both toxic endophyte-infected tall fescue pastures and novel endophyte tall fescue pastures will improve stocker gains (in addition to the benefit of replacing the toxic endophyte) (Table 3). Therefore, adding a legume to novel endophyte tall fescue is highly recommended.

Table 3. The effect of tall fescue endophyte status and the use of white clover in the pasture on stocker performance.†

	ADG (lbs/hd/d)	Gain (lb/acre)
Toxic Endophyte	1.1	126
Novel Endophyte	1.8	186
Toxic + White Clover	1.6	150
NE + White Clover	2.6	252

† Bouton, Andrae, and Hill (unpublished data).

Subsequent Feedlot Performance

Following three of these grazing studies in Georgia, the stocker cattle were finished on high-concentrate diets and their feedlot performance was tracked. No difference in animal performance, feed efficiency, or most carcass quality measurements were found in calves that had grazed novel endophyte, endophyte-free, or toxic endophyte tall fescue. However, because of improved stocker performance, the cattle that grazed endophyte-free and novel endophyte tall fescue entered the feedlot heavier and reached targeted harvest weights sooner (Figure 5). While there appeared to be no feedlot performance depression from fescue toxicosis, heavier weights going into the feedlot will either (1) increase finished weights or (2) decrease time-on-feed, both of which translate into more profitable beef production.

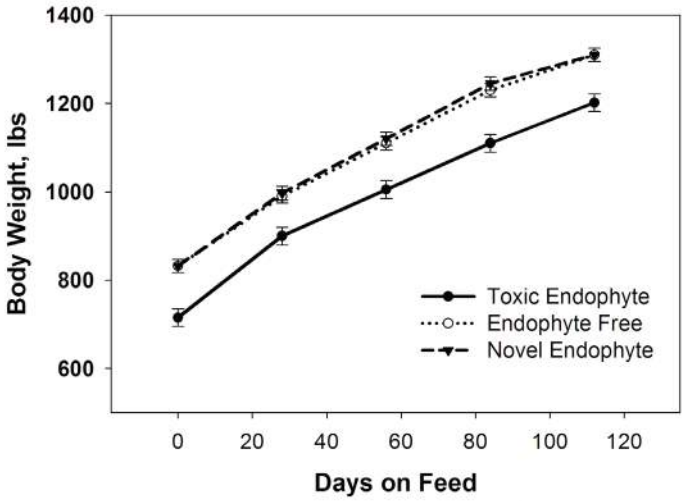

Figure 5. Subsequent feedlot performance of cattle that grazed toxic, endophyte-free, and novel tall fescue during the stocker phase. Cattle originally grazed pastures in Eatonton and Calhoun, Ga., and were finished in Stillwater, Okla. (Duckett et al., 2001).

Equine Performance

Mares in late gestation are particularly sensitive to alkaloids produced by toxic endophytes. To date, there is limited research studying the effects of novel endophyte tall fescue on mare performance in late gestation and early lactation. In a study conducted in Mississippi, five mares grazed either novel endophyte, endophyte-free, or toxic tall fescue pastures. Of the mares that grazed toxic endophyte tall fescue, 80 percent did not produce milk, 40 percent had compromised deliveries, 60 percent had retained placentas, and one mare (20%) aborted. No problems were noted for mares grazing endophyte-free or novel endophyte tall fescue. Mares grazing toxic endophyte-infected pastures also had longer gestation periods and thicker placental membranes than mares that grazed novel endophyte or endophyte-free tall fescue pastures. These findings suggest that the risk to pregnant mares grazing properly established novel endophyte tall fescue with no toxic contaminants appears to be low to nonexistent.

Renovating Infected Fescue Pastures

Completely renovating toxic endophyte-infected tall fescue pastures to establish a novel endophyte tall fescue variety is a major operation. The renovated pasture will be out of production for several months. Make plans to supply extra feed or reduce animal numbers during this period. There are four steps in this renovation program: (1) prevent seedhead production in the existing toxic endophyte-infected stand, (2) destroy the existing stand, (3) seed the new variety, and (4) manage the new planting.

Step 1: Prevent Seedhead Production – The endophyte in tall fescue is spread via seed. If seed is produced by the existing toxic endophyte tall fescue stand, then chances are high that toxic endophyte-infected plants will regenerate in the new stand. Therefore, it is critical to prevent the existing tall fescue stand from producing a seedhead during the spring prior to planting a novel endophyte tall fescue.

Mow stands when seedheads begin to develop but before they fully emerge. Two such mowings prior to viable seed production are normally required to prevent seed formation. While heavy grazing may prevent some seedhead production or merely delay seedhead emergence, mowing will almost certainly be required.

Step 2: Destroy Old Stands – There are two methods for destroying an existing stand of toxic tall fescue. The first method, generally referred to as the "spray-smother-spray" method, involves preventing seedhead formation as described above, spraying the existing stand with a moderate to heavy rate of glyphosate (commonly known by the trade names Roundup, Glyphomax, Touchdown, etc.), growing a smother crop (usually a warm season annual grass, such as pearl millet) during the summer, and then spraying surviving tall fescue plants and weeds again in the fall with a moderate to heavy rate of glyphosate before planting the new stand. Unfortunately, this method is very expensive and more problematic for most small producers than the "spray-spray-plant" method.

The "spray-spray-plant" method was developed by researchers at UGA. Their research showed that spring seedhead suppression and applying glyphosate (Roundup) in late summer and again four to six weeks later (followed by planting within one day of the second herbicide application) will successfully kill the existing fescue. The timing of this application protocol is critical, as sufficient regrowth by the survivors of the first application is needed to get a complete kill.

Destroying the stand with an herbicide using either of these two methods will be faster, cheaper, and much more effective than multiple tillage operations. Plowing alone will not sufficiently kill the existing stand and is not recommended. However, there may be some cases where preparing a tilled seedbed is desirable. In this case, the same protocol of two herbicide applications (regardless of method) is recommended prior to seedbed preparation.

Step 3: Seed the New Variety – Planting with a no-till drill should follow immediately (within one day) after the second glyphosate application. Killing fescue pastures with an herbicide and sod-seeding into the killed sod is advantageous for pastures with severe slopes. Plantings can also be made into a firm, prepared seedbed. In the Piedmont region, successful plantings can be made between mid-September and late October. Plantings in the Limestone Valley/Mountains region should occur between early September and early October. Spring seedings are generally not successful and are not recommended. Regardless of region, a planting rate of 15 to 20 pounds per acre is required for successful stand establishment.

Drought and insects frequently cause problems with fall seedings. Dry weather can reduce germination and delay seed emergence. Stands that are not well-established by December can winter-kill. Insects (grasshoppers and pygmy mole crickets) that inhabit the sod can damage new seedlings.

Step 4: Manage Novel Endophyte Tall Fescue – Like all tall fescue plantings, new plantings need special treatment. Do not cut or graze new plantings until the plants have grown at least 6 inches. Even then, only a light grazing is recommended to avoid stand damage. A light mowing can help control weeds and encourage the tall fescue to grow (i.e., tiller) and thicken-in; however, take care not to cut tall fescue below a height of 6 inches in the spring following establishment.

An early hay cutting (before May) should not be taken from new tall fescue seedings. If the novel endophyte tall fescue has been clipped to control weeds in early spring, a late hay cutting (after mid-May) can be successfully made if the planting resulted in an acceptable stand. The tall fescue stand should be managed to allow light to reach the base of the plants, which will encourage tillering; however, do not defoliate the plants too frequently or too severely.

Soon after the stand has been established (April or May following a fall seeding), novel endophyte tall fescue should be tested for the extent of novel endophyte infection. This will ensure that the novel endophyte is present in the tall fescue, that at least 80 percent of the tall fescue contains the novel endophyte, and that little or no toxic endophyte-infected tall fescue is present. More information on testing the endophyte status of tall fescue stands can be found at: http://www.caes.uga.edu/commodities/ fieldcrops/forages/questions/testingtallfescue.html.

Although novel endophyte tall fescue generally is as persistent as toxic endophyte-infected tall fescue, some management differences are worth noting. Like all tall fescues, at least 2 ½ to 3 inches of growth should be maintained on novel endophyte tall fescue stands at all times. Unlike toxic tall fescue, livestock may not continue to graze novel endophyte varieties during tall fescue's summer dormancy or in periods of drought (Figure 4). Severe overgrazing can cause stand loss that may not have occurred with toxic endophyte-infected tall fescue. Therefore, it is critical to reduce the stocking rate or rotate the animals to warm season pastures to avoid overgrazing novel endophyte tall fescue, especially when pastures are dormant or under moisture stress.

Summary

Tall fescue varieties containing a novel endophyte (e.g., Jesup MaxQ™) produce animal gains similar to endophyte-free tall fescue. The persistence of novel endophyte-infected tall fescues approaches or equals toxic endophyte-infected tall fescue and makes the novel endophyte tall fescue products an attractive alternative to either toxic or endophyte-free tall fescue in the pasture. A novel endophyte tall fescue is recommended when establishing or renovating an existing pasture in an area where tall fescue is desired. Information about recommended varieties of novel endophyte tall fescue may be found on the "Forage Species and Varieties Recommended for Use in Georgia" Web site (http://www.caes.uga.edu/commodities/ fieldcrops/forages/species.html).

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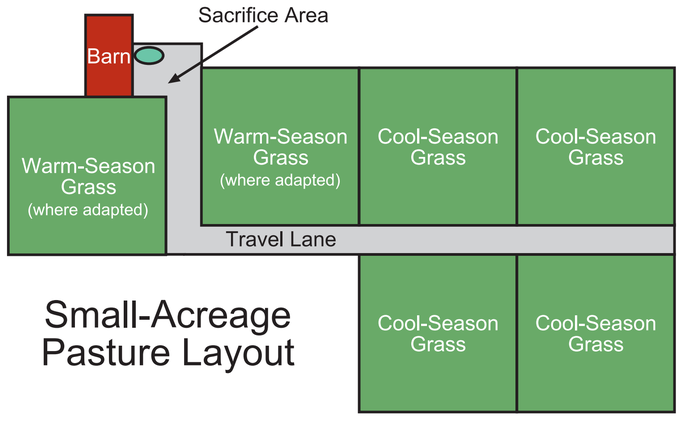
Maintaining Healthy Horse Pastures

C.D. Teutsch, Virginia Tech, and S.R. Smith, University of Kentucky

Well-maintained pastures can serve as an economical and high-quality feed source. Here a mature pleasure horse grazes contently in a field of annual ryegrass.

Horses can graze very closely. In this photo a horse grazes a bermudagrass sod too close.

Close and frequent grazing weakened this sod, resulting in a pasture that is less productive and more susceptible to erosion and weed encroachment.



This is an example of a small-acreage pasture layout for pleasure horses. The inclusion of a warm-season grass provides grazing during the summer.

Pasture Management

Once pastures have been established (18-24 months after planting), sound pasture management is critical for maintaining a healthy and vigorous sod that benefits the horse, owner, and environment.

SOIL TEST PASTURES. Pastures should be soil tested every 2-3 years in order to provide a baseline for tracking changes in pH and fertility.

MAINTAIN ADEQUATE SOIL PH. Soil pH can dramatically affect nutrient availability and plant growth. Maintain pH between 6.2 and 6.5 for grass-legume pastures by applying lime according to the soil test.

MAINTAIN ADEQUATE PHOSPHORUS AND POTASSIUM. Phosphorus and potassium should be maintained in the high range as determined by soil testing.

DISTRIBUTE DUNG PILES. Drag pastures to distribute dung piles and encourage uniform grazing.

PROVIDE 2-3 ACRES PER HORSE. If land area is limited, grazing must be controlled to maintain healthy pastures.

SUBDIVIDE PASTURES. Establish four or more pastures and graze them rotationally.

REST PASTURES BETWEEN GRAZING EVENTS. Resting pastures allows plants to replenish food reserves. Allow pastures to regrow to a height of 8-10". In the spring when cool-season grasses are growing rapidly, rest periods will be shorter. In midsummer when plant growth is slower, rest periods will be longer.

LEAVE PLENTY OF LEAF AREA. Do not graze closer than 2-4". Leaving plenty of leaf area results in faster regrowth and helps maintain a vigorous sod. Horses tend to graze some areas closer than others, so rotate horses to a fresh pasture when heavily grazed areas are at 2-4". Clip ungrazed areas of the pasture.

DO NOT GRAZE PASTURES WHEN PLANTS ARE NOT GROWING. Feed hay in a sacrifice area to avoid overgrazing pastures during the winter and summer.

REMOVE HORSES FROM PASTURES DURING WET WEATHER. Hoof action can seriously damage established sods during wet periods of the year. Place horses in the sacrifice area and feed hay when the soil is soft.

Pasture Layout and Design

Proper pasture design allows horse owners to control grazing. In some cases it is advisable to establish a permanent perimeter fence and cross-fence with temporary fencing until a suitable layout is found.

INDIVIDUAL PASTURES SHOULD BE SQUARE. Long and narrow or odd shaped pastures are not uniformly grazed.

PASTURES SHOULD BE UNIFORM. Pastures should contain similar forage species, soil types, slopes, and aspects.

HORSES SHOULD HAVE ACCESS TO FRESH WATER AND SHADE. Ideally, each pasture should contain water and shade. In some cases lanes can allow access to the barn from all pastures (see small-acreage example).

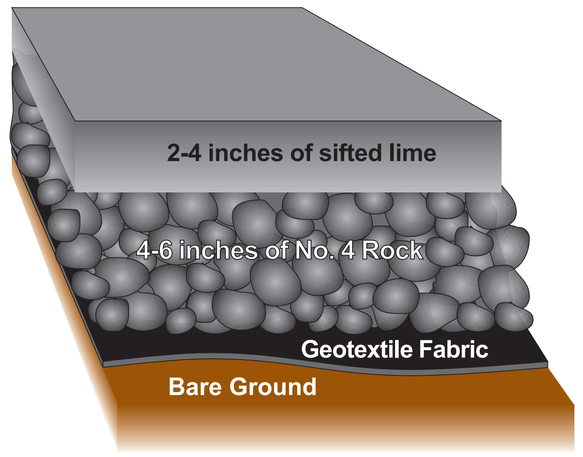
LIMIT ACCESS TO TREES. Trees should be fenced out to prevent girdling.

ESTABLISH A SACRIFICE AREA. Allow 600 to 1,000 sq ft per horse of well-drained area located near the barn. In most cases a rock pad will be required to keep area from becoming muddy (see diagram of rock pad).

USE ELECTRIFIED POLYTAPE TO CONTROL GRAZING. For this type of fencing to be effective, it must be electrified at all times.

Healthy pasture sods supply a safe exercise surface for growing foals.

Sacrifice areas often become muddy and require the construction of a rock pad.



Rock pads are constructed by placing geotextile fabric over the soil, covering it with 4-6" of No. 4 rock, and capping the rock with 2-4" of sifted lime.

Trees must be fenced out to avoid girdling by horses. In this photo an unfenced tree has been fatally injured.

For more information on maintaining healthy horse pastures, contact your local Virginia Cooperative Extension Office or visit the Virginia Cooperative Extension website at http://www.ext.vt.edu/resources/.

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Reviewed by Celeste Crisman, Extension specialist, Animal and Poultry Sciences

Virginia Cooperative Extension

PUBLICATION 418-101

Virginia's Horse Pastures: Grazing Management

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Sound grazing management can decrease feeding expenses and stable cleaning and other chores, leaving more time for the recreational enjoyment of horses. In addition, pastures also help to maintain healthy horses by providing exercise and fresh air. Although properly managed pastures can be beneficial to both the horse and owner; improperly managed pastures can be a serious environmental concern. Poor grazing management results in the loss of groundcover that can lead to soil erosion, the degradation of water quality in neighboring streams and ponds, and increased weed pressure in pastures.

Proper grazing management includes allowing adequate time for the plants to establish themselves, providing adequate land area per horse, utilizing rotation and rest periods, confining horses to a "sacrifice area" or exercise lot during periods of drought or wet soil conditions, managing manure, maintaining soil fertility, and clipping the pasture to even out under-grazed areas and control weed populations.

Let the pasture become established. Do not allow new seedlings to be grazed until the plants have become well established. The root systems should be well developed to prevent the seedlings from being pulled out of the soil by grazing animals and to reduce damage by the hooves of running horses. This rule applies not only to newly seeded pastures but also perennial pastures that have been renovated. New forage stands require 18 to 24 months to become fully established. Overgrazing during this period can severely damage developing sods. On the other hand, light and infrequent grazing can be beneficial for sod formation. During the establishment period do not graze sods closer than four to six inches and allow at least 30 days rest for actively growing pastures and longer for slow growing pastures during the summer months.

Provide adequate land area. Proper pasture management begins with providing adequate area for each horse. Overstocking pasture areas will lead to the rapid loss of desirable forage species due to overgrazing and trampling. It also will encourage the growth of unpalatable and in some cases poisonous weeds. In Virginia, two to three acres of well-managed pasture should provide adequate grazing and exercise for a mature horse. However, with careful, sustainable pasture management a horse may be adequately kept on less acreage. Regardless of acreage, both the large equine business and the small hobbyist will benefit from sustainable grazing management, which is critical to a healthy sod that benefits the horse, the owner, and the environment.

Rotate and rest pastures. Even the best pasture needs rest after grazing to allow plants time to regrow and replenish food reserves. The length of the rest period will depend on the time of the year and weather conditions. It should ultimately be based on the height of the regrowing plant (Table 1). Optimally, pasture acreage should be divided into at least four to six pastures. Continuous grazing weakens and thins stands and allows weeds and poisonous plants to invade pastures. Horses should be rotated from pasture to pasture based on the height of the forage. Never allow pastures or portions of pastures to become overgrazed. *Since horses are spot grazers, rotate to a new pasture when the grazed areas reach the minimum height rather than waiting for the entire pasture area to be grazed to the minimum height.* Target heights for starting and stopping grazing of commonly used forage species are shown in Table 1. Some forage species are more tolerant of grazing than others. For more information on forage species, see *Virginia's Horse Pastures: Forage Species for Horse Pastures*, Virginia Cooperative Extension publication 418-102.

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Table 1. Starting and stopping grazing heights for forage species commonly used in horse pastures.

Forage Species	Start Grazing (inches)	Stop Grazing (inches)	Usual Rest Period[1] (weeks)
Kentucky Bluegrass + Clover	8-10	2-4	2-3
Orchardgrass + Clover	8-12	4-6	2-4
Tall Fescue + Clover	6-8	2-4	2-4
Bermudagrass	4-8	1-2	1-2

[1] Usual rest period is based on optimal growing conditions. Temperature and rainfall can dramatically impact regrowth and either shorten or lengthen the rest period significantly.

Rotating livestock in pastures. There are advantages to grazing different types of livestock in horse pastures, primarily because it allows more efficient use of the pasture. Although all livestock are selective grazers, compared to horses, cattle and sheep are less selective. Rotating different livestock through the pastures keeps them grazed more uniformly and helps maintain the high-quality leafy stage of growth. Cows and sheep will also graze around manure piles left by horses. Cattle or sheep and horses may be stocked together in the same field or alternately, cattle or sheep may follow horses in the pasture rotation system.

Utilizing a "sacrifice" or "exercise area." In cases where land is limited to less than two acres per horse, it is nearly impossible to maintain pasture sod with continuous grazing. Maintaining an exercise area, that is, an exercise lot where no plants will grow is a practical solution. Permit grazing only when the pasture has reached the target height. Proper fertilization and timely irrigation of the pasture area can significantly increase forage growth and reduce the time period between grazing events. The exercise area should be used during periods of wet soil conditions and drought—and during winter/nongrowing season. Hoof action can seriously damage even well-established pasture sods when soil conditions are wet. Do not graze pastures during periods of drought stress and slowed growth. Overgrazing during these periods will significantly weaken and eventually kill even well -established stands. Footing in exercise areas may become unsafe due to mud, so a base comprised of a geotextile (available at many agricultural or landscape supply stores) covered with six to eight inches of one- to two-inch rock capped with two to three inches ground stone dust or sand should be constructed to improve the footing and prevent soil loss. Removing and composting manure and other organic materials such as hay and bedding every three days will also improve footing, and reduce parasite and fly exposure.

Provide hay as alternate forage. During times of the year when adequate pasture is not available (e.g. winter or drought conditions), provide hay as a forage alternative to pasture. Hay fed at a rate of 1 to 2 percent of body weight will provide adequate roughage to maintain digestive tract health. Horses will graze pasture during periods of nongrowth if they have no alternative. However, limited forage availability and poor quality of nongrowing pasture do not provide adequate nutrition for horses. Also, the grazing will weaken and kill desirable pasture plants. Since horses will tend to graze even if hay is provided, hay should be fed in the sacrifice area. Hay feeders should be utilized rather than feeding hay on the ground to avoid the ingestion of soil, sand, or stone dust that can lead to colic, and impaction.

Mowing maintenance. The tendency of horses to spot graze pastures leaves some areas ungrazed. These areas need to be clipped to approximately four inches to remove mature growth and seed heads, promote new growth, increase forage quality, and encourage grazing. Mowing will also slow weed propagation by removing seed heads. Many grasses (ryegrass, fescue, bluegrass, small grains, etc.) may be susceptible to infection with an ergot mold, which may cause equine ergotism. Normally the ergot is only a problem when the forage is allowed to produce a seed head. Therefore, pastures should be clipped to avoid seed head formation.

Grazing Management at a Glance

- Allow pastures to become established before grazing.
- Do not graze pastures closer than two to four inches.
- Allow pastures to rest between grazing events.
- Graze pastures only after regrowth has reached a height of six to 12 inches.
- Do not graze pastures that are not actively growing.
- Feed hay when pasture growth is slowed or stopped.
- Do not graze pastures when soil conditions are wet.
- Mow pastures to remove mature forage and encourage grazing.
- Harrow pastures to spread manure.
- Create and utilize an "exercise area" to feed hay when pastures are not ready to be grazed.

Removing or harrowing manure. Piles of manure droppings contribute to under-grazed areas of the pasture, because horses will avoid these areas and the nutrients contained in the manure will promote rapid plant growth. Manure piles in the pasture should be scattered periodically, by dragging a chain harrow, spiketooth harrow, or other similar implement across the pasture. Harrowing the manure will promote uniform grazing. Additionally, breaking up and spreading the manure piles may also help to reduce parasite populations. A good time to harrow the manure piles is shortly after the horses have been rotated to a fresh pasture and the resting pasture has been mowed.

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Virginia Cooperative Extension

PUBLICATION 406-208

Horse Manure Management

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Introduction

Manure management is a vital part of modern day horse ownership. Many horses spend a significant portion of their day in stalls, accumulating large amounts of manure and stall waste. Horse owners generally have a limited amount of time to spend caring for their equine charges; thus, efficient manure removal and disposal is crucial. Additionally, horse facilities are often managed on relatively small acreage, limiting manure storage and application options.

The intent of this publication is to educate horse owners on the effective management of horse manure. Horse owners will first gain a thorough understanding of the quantity and characteristics of manure produced by horses. Finally, on-site options for handling, storing and treating manure will be discussed, keeping sound facility management and environmental stewardship in mind.

Managing horse manure can be a complex topic, and the principles presented here should be tailored to your specific situation. Please contact your local Extension agent or Natural Resources Conservation Service Field Office for technical support.

Horse Manure Production and Characteristics

Horses produce large amounts of manure. In fact, if the manure produced from one horse were allowed to pile up in a 12-foot-by-12-foot box stall for one year, it would accumulate to a height of six feet! On any given day, the average 1,000-pound horse will produce approximately 50 pounds of manure. This amounts to about eight and a half tons per year!

Manure is not the only material being removed when stalls are cleaned. Wet and soiled bedding material must also be removed, and can equal almost twice the volume of the manure itself. The amount of bedding material removed will vary by type (shavings, sawdust, straw), but on average totals between eight and 15 pounds. Total stall waste produced averages between 60 and 70 pounds per day, which amounts to approximately 12 tons of stall waste per year!

When managed properly, horse manure can be a valuable resource. Manure is a source of nutrients for pasture production and can be utilized as part of a pasture management strategy to improve soil quality. The fertilizer value of the eight and a half tons of manure produced annually from a 1000-pound horse can amount to 102 pounds of nitrogen (N), 43 pounds of phosphorous (P_2O_5), and 77 pounds of potash (K_2O). Nutrient values for manure vary widely. The type and quantity of bedding material included also affects the overall fertilizer value. If a more accurate measure of nutrient content is needed, contact your local Cooperative Extension office for a list of laboratories that perform manure analysis.

Environmental and Health Impacts

Many horse owners do not have enough land or vegetative cover to properly apply large amounts of manure and nutrients. If not managed properly, manure can deposit excess nutrients into the environment via surface runoff or as leachate (water contaminated with manure) from improper manure storage and land application. This can negatively impact water quality and subject landowners to investigation, and in some cases, legal action under the Virginia Agricultural Stewardship Act. For these reasons, horse operations are encouraged to use best management practices and develop a nutrient man-

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agement plan. Nutrient management plans describe the farm's manure production, soil fertility, and recommended manure application and removal rates. For more information on designing a plan specific to your farms needs or identifying other conservation resources contact your local Cooperative Extension office.

Internal parasites, insects, rodents, and odors can be manure related health concerns on horse farms. These issues can be minimized through carefully planned manure storage and handling. Internal parasites may be found in horse manure and can compromise the health and welfare of the horses stabled or grazing the land. Composting manure and properly timed land application can limit the risk of parasite exposure. Insects, especially flies, become a nuisance on farms where stockpiled manure serves as the fly larvae habitat. Flies breed when spring temperatures rise above 65°F. Flies deposit their eggs in the top few inches of moist manure and these eggs can hatch in as little as seven days under optimal temperature and moisture conditions. Therefore, fewer flies will develop if you remove manure from the site or make it undesirable for fly breeding (through processes such as composting) within a maximum seven-day cycle. Naturally occurring fly predators can also be used to limit the fly population at the manure pile, but are no replacement for sound management practices. Rodents can be a problem when manure is stockpiled for extended periods of time; providing a warm, safe environment. Additionally, nuisance odor from manure piles can result in strained relationships with neighbors. Composting or timely removal of manure piles will help keep odors to a minimum. Finally, keep in mind that large piles of manure are not aesthetically pleasing to your neighbors or those visiting your farm. Keeping the manure storage site screened with vegetation, fencing, or by location will help to enhance the beauty of your farm.

Horse Manure Storage and Utilization

The average horse produces between 60 and 70 pounds of stall waste per day. Multiply this by several horses, and it is easy to see the importance of having methods in place to manage the manure produced on a daily basis. Letting manure pile up in stalls and paddock areas leads to a host of problems. It is not only unhealthy for your horse, inviting for pests and odors, and aesthetically unpleasing, but the sheer amount of manure produced will overwhelm you! Many handling and storage options exist, but it's up to you to choose the method that best suits your horse operation.

Horse operations with available land may choose to apply stall waste to pastures as fertilizer. This should be done based on soil-test results and nutrient needs. A soil analysis is needed to determine the fertility needs of a pasture. Soil analysis is provided through the Virginia Tech Soil Testing Laboratory for agricultural operations (which includes horse farms) free of charge. Contact your local Cooperative Extension office for instructions on how to take a soil sample. There are also private laboratories that offer soil-testing services.

In many situations, manure can be picked directly from the stall, deposited into a manure spreader, applied to the pasture, and harrowed into the soil. Barns not constructed with a management scheme allowing for stall access by a manure spreader, require manure to be carted from the stall to the manure spreader some distance away. In this case, ramps or dropped spreader parking can be helpful to avoid lifting the heavy, cumbersome stall waste. Keep in mind that when spreading manure from stalls bedded with sawdust or shavings, the applied stall waste can stunt plant growth. Wood products contain carbon that soil microbes use for energy, but not enough nitrogen to build proteins. The microbes draw nitrogen from the soil to make up for this deficit to such a degree that they can actually limit plant growth. To manage this nitrogen deficiency, nitrogen fertilizer can be applied. Or, to avoid the problem completely, manure can be composted before it is applied to the land.

When direct pasture application is not an option, manure storage facilities become a necessity. The storage facility should be convenient to the barn. A general rule of thumb is to plan for 180 days of long-term manure storage. This allows operations the flexibility to store manure when conditions are not ideal for manure application (frozen or wet fields). This storage area should be accessible to the equipment that will ultimately remove the accumulated stall waste. Manure storage facilities should also be downwind and screened from nearby homes to avoid potential complaints about odors and aesthetics. The size, type, and location of manure storage facilities will vary by horse operation based on the amount of manure produced, length of time the manure will be stored, and available land area. Always be sure to contact your local authorities regarding zoning regulations and additional restrictions.

Minimum separation distances commonly recommended for composting and manure-handling activities. Source: On-Farm Composting Handbook, NRAES-54

Sensitive area	Minimum separation distance (feet)
Property line	50-100
Residence or place of business	200-500
Private well or other potable water source	100-200
Wetlands or surface water (streams, ponds, lakes)	100-200
Subsurface drainage pipe or drainage ditch discharging to a natural water course	25
Water table (seasonal high)	2-5
Bedrock	2-5

Manure Storage Construction

Manure storage should be designed to limit the chance of leachate entering surface- and groundwater resources. Ideally, storage piles should be placed on gravel, hardened clay, or concrete pads that slope inward. The construction of manure storage sites will vary based on individual situations and soil types. For instance, concrete pads may be necessary in areas with sandy soils where contaminants are more likely to reach groundwater. Storage piles should not be placed in low-lying or flood-prone areas, and care should be taken to direct water from higher elevations away from the site. The Natural Resources Conservation Service or local Soil and Water Conservation District offices can provide individualized manure storage design specifications.

Composting

Composting horse manure is relatively simple, but does involve more than simply piling the waste. While many farms stockpile their manure, few truly compost. Composting is essentially managed decomposition. Managing the process can virtually eliminate odor, flies, weed seeds, and internal parasites found in horse manure and create a valuable soil amendment for resale or for pasture application. To manage a compost pile, the following factors must be taken into consideration: carbon to nitrogen ratio, oxygen, moisture, and temperature.

The microorganisms found in compost are most active when their diet contains about 30 times more carbon than nitrogen (or a C:N ratio of 30:1). Horse manure's C:N ratio is typically 40:1 due to the large amounts of bedding mixed with it, but generally doesn't require additional nitrogen provided it has enough moisture and oxygen.

Composting is an aerobic (requires oxygen) process. If a compost pile doesn't get enough oxygen, these anaerobic conditions can result in unpleasant odors (such as those normally associated with stockpiling manure) and slowed decomposition. There are several ways to provide oxygen to a compost pile. The most common way is to turn the pile. For large piles or windrows, turning is generally done using the bucket of a tractor or front-end loader. For smaller piles, a pitchfork will certainly get the job done, but these operations may want to consider using an aerated static pile design which doesn't require turning.

Benefits of Composting

- Creates valuable soil amendment
- Stabilizes nitrogen into a slow-release form
- Avoids the problem of nitrogen immobilization
- Reduces manure volume by 50 percent
- Destroys weed seeds, fly larvae, and internal parasites
- Eliminates or reduces the cost of off-site disposal

Typical horse-stall waste tends to be dry and will need added moisture to create the ideal conditions for compost microbes. The moisture content should be about 50 percent, or roughly the consistency of a wrung-out sponge. If rainfall does not provide enough additional moisture, the pile may need to be watered periodically. On the other hand, too much water can also be detrimental, displacing oxygen inside the pile and causing anaerobic conditions. If environmental conditions (rain or snow) are providing too much water, the pile may need to be covered. Some compost-storage designs call for permanent roofs, but properly anchored plastic tarps can be just as effective.

Compost Trouble-Shooting*

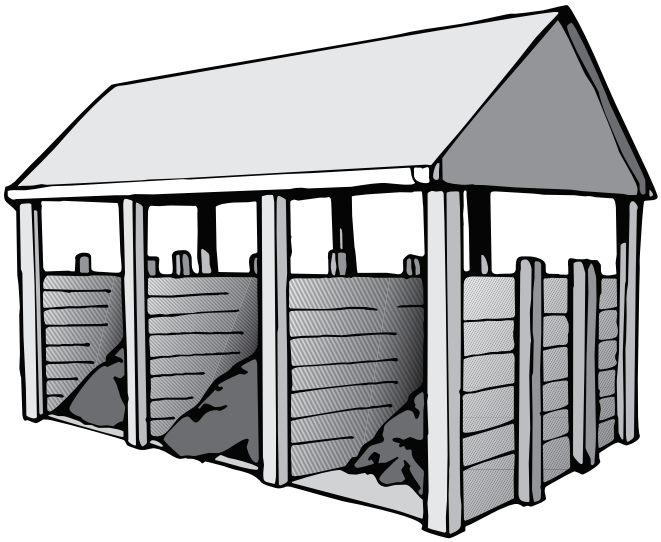
Problem	Possible Cause	Remedy
Fresh manure, but pile won't heat up	The pile is: 1. Too dry 2. Too wet; and/or 3. Outside temp is too cold	1. Add water evenly to pile 2. Aerate and cover 3. Wait for warmer temps and turn as needed
Pile was hot, but now temps are falling	1. Pile is settling 2. Moisture is less than 50%	1. Turn pile; and/or 2. Add water evenly to pile
Pile is more than 160ºF and has gray ash-like mold	Pile is too dry	Add water evenly to pile
Pile has gone through two or more heat cycles, but still has some material that has not decomposed	Wood shavings decompose slowly.	Ensure that pile has proper moisture content; add water if needed.
Pile emits bad odor	Pile is too wet and has become anaerobic inside	Turn to aerate and increase water evaporation, apply cover to limit additional rainwater.

* Table does not include all scenarios; see Conclusions for more in-depth publications on the subject.

One of the best ways to monitor your compost pile is by using a thermometer. Compost thermometers should have a probe at least 36 inches long and are available through many garden supply stores. The goal is to have sustained temperatures of 130º to 150ºF in the pile interior. This will optimize decomposition and also kill pathogens and weed seeds.

Compost-pile design and storage facilities will depend on the size of the operation and the equipment available. For a farm with two to six horses, small static piles, which use perforated PVC pipes to draw in air and don't require turning, may be ideal. While not necessary, the use of multiple bins can allow separation of distinct "batches." In this situation, horse manure should be piled approximately five to eight feet high with a base that is two times the width and length of the height. For example, a 10-foot-by-10-foot bin could accommodate a pile that is five feet high. PVC pipes should be placed after the pile is about one foot high and so that the ends remain visible as more manure is added.

Aerated static pile with perforated PVC pipes.



Example of bins suitable for small farms – doors and roof are optional.

For larger farms with access to bucket loaders, manure spreaders, and/or specialized composting equipment, larger piles or windrows may be the most efficient design options. These piles may be slightly larger in height and width and considerably longer, but will require periodic turning.

Compost will decompose more efficiently if the mix is uniform. Starting with a uniform mix is even more important in the case of static piles, since they will not be turned during the decomposition process. Some farms utilize a temporary storage and mixing area to aid in this process.

Example of mixing/storage area with buck wall.

Conclusion

With careful planning, proper manure management not only protects the environment and increases the efficiency and aesthetics of your farm, but might also save you money while enhancing your pastures. The following resources provide more information on composting and additional facility design specifications:

Field Guide to On-Farm Composting and the On-Farm Composting Handbook, available from the Natural Resource, Agriculture, and Engineering Service (NRAES) at *www.NRAES.org*.

Horse Facilities Handbook, available from the MidWest Plan Service at *www.mwpshq.org*.

The Virginia Tech Agronomy Handbook contains information on soil production, soil sampling, nutrient management, utilization of organic waste and more; available at *www.ext.vt.edu/pubs/agronomy/index.html*.

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Publication 442-307

Selection and Location of Poultry and Livestock Manure Storage Structures on Farms

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Introduction

If you raise dairy cows, broilers, layers, turkeys, horses, beef cattle, sheep, goats, alpacas, or swine for income or a hobby, you will have to deal with the manure they produce. The amount of manure produced by the birds or animals you keep depends on their type, age, size, and diet. Tables 1 and 2 present the manure characteristics of various animal types, compiled by the American Society of Agricultural and Biological Engineers, that can be used to assist in planning and designing manure handling and utilization systems if values for local farms are not available.

Manure storage is part of the manure management system of a facility or property where animals and/or poultry are raised. Manure should be considered a resource – not a waste to be discarded. Manure contains valuable organic matter and nutrients that can be used as a fertilizer and/or to produce energy. Manure will accumulate quickly and must be properly managed to minimize the potential for causing nuisance from odors and contamination of surface water and groundwater if entrained in runoff during rainfall events. Manure storage allows a strategic approach to manure application by providing livestock and poultry owners the flexibility for scheduling application or use

Table 1. Estimated typical manure characteristics as excreted by meat-producing livestock and poultry

Animal type and production grouping	Total manure[1]		Moisture[2]	Total solids	Volatile solids	Nitrogen (N)	Phosphorus (P)	Potassium (K)	Assumed finishing time (days)
	lb/f-a	cu. ft	% wet basis	Pounds per finished animal (lb/f-a)					
Beef									
Finishing cattle	9,800	160	92	780	640	55	7.3	38	153
Swine									
Nursery pig (27.5 lb)	87	1.4	90	10	8.7	0.91	0.15	0.35	36
Grow-finish (154 lb)	1,200	20	90	120	99	10	1.7	4.4	120
Poultry									
Broiler	11	0.17	74	2.8	2.1	0.12	0.035	0.068	48
Male turkey (toms)	78	1.3	74	20	16	1.2	0.36	0.57	133
Female turkey (hens)	38	0.61	74	9.8	7.8	0.57	0.16	0.25	105
Duck	14	0.23	74	3.7	2.2	0.14	0.048	0.068	39

Source: ASABE Standard D384.2

1. Total manure is calculated from total solids and manure moisture content.
2. As excreted, manure moisture content ranges from 75-90%. At these moisture levels, manure has a density equal to that of water; a specific gravity of 1.0 was assumed in the calculation of manure volume.
3. f-a = finished animal

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Table 2. Estimated typical manure characteristics as excreted by all other livestock and poultry

Animal type and production grouping	Total manure[1]		Moisture[2]	Total solids	Volatile solids	Nitrogen (N)	Phosphorus (P)	Potassium (K)
	lb/d-a	cu. ft. d-a	% wet basis	Pounds per day per animal (lb/d-a)				
Beef								
Confined cow [3, 4]	–	–	88	15	13	0.42	0.097	0.30
Confined growing calf	50	0.81	88	6.0	5.0	0.29	0.055	0.19
Dairy								
Lactating cow	150	2.4	87	20	17	0.99	0.17	0.23
Dry cow	83	1.3	87	11	9.2	0.50	0.066	0.33
Heifer (970 lb)	48	0.78	83	8.2	7.1	0.26	–	–
Horse (1,100 lb)[5]								
Sedentary	56	0.90	85	8.4	6.6	0.20	0.029	0.060
Intensive exercise	57	0.92	85	8.6	6.8	0.34	0.073	0.21
Poultry								
Layer	0.19	0.0031	75	0.049	0.036	0.0035	0.0011	0.0013
Swine								
Gestating sow (440 lb)	11	0.18	90	1.1	0.99	0.071	0.020	0.048
Lactating sow[6] (423 lb)	25	0.41	90	2.5	2.3	0.19	0.055	0.12
Boar (440 lb)	8.4	0.13	90	0.84	0.75	0.061	0.021	0.039

Source: ASABE Standard D384.2

1. Total manure is calculated from total solids and manure moisture content.
2. As excreted, manure moisture content ranges from 75-90%. At these moisture levels as excreted, manure has a density equal to that of water. A specific gravity of 1.0 was assumed in the calculation of manure volume.
3. Solids estimates do not include solids in urine.
4. Beef-cow values are representative of animals during nonlactating periods and the first six months of gestation.
5. These values apply to horses 18 months of age or older that are not pregnant or lactating. The representative number applies to 1,100-lb horses, and the range represents horses from 880 lb to 1,320 lb. "Sedentary" applies to horses not receiving any imposed exercise.
6. Nitrogen and phosphorus values include contribution of nursing pigs.

that takes advantage of the resources in the manure. This publication provides guidelines and information to consider for selecting and locating manure storage facilities.

Reasons to Store Manure

Manure is stored so that it can be used effectively as a fertilizer to produce crops, decrease handling costs, and minimize the potential to pollute the environment. Storage allows effective use of manure nutrients when applied at a time when nutrients can be available to crops (before planting and on actively growing pastures) and soil conditions are right. When manure is applied at agronomic rates, you receive the maximum benefits of manure as a fertilizer and reduce the risks of groundwater and surface water contamination from nutrients and pathogens that may be contained in the manure.

Manure properties may change over time due to natural degradation processes or loss of volatile compound constituents of the manure. Manure storage keeps manure in one location, making it convenient to sample for content analysis to determine its fertilizer value (e.g., nitrogen, phosphorus, and potassium). When sampling manure, be sure to obtain a representative sample. This information – combined with knowledge of the crop production needs (amount of manure applied per acre) and corresponding losses of nutrients because of application and storage – determines whether additional commercial fertilizer is needed to meet realistic crop production goals.

Adequate manure storage reduces the need for land application when weather and soil conditions are not favorable, i.e., during winter months when soil is saturated or frozen. This improves efficiency, saves wear and tear on equipment, conserves nutrients contained in the manure, and minimizes manure nutrient leaching and runoff. Storage may allow additional farm acreage to be used for manure spreading because applications can be made when the risks of leaching or runoff are minimized.

Types of Manure Storages

Manure storage type depends on how the manure is handled. Manure can be handled as liquid, slurry, semisolid, or solid. The total solids (dry matter) and preferred method for manure application/utilization (figure 1) influence the choice of storage system.

Liquid Manure Storage

Used for manure with up to 10 percent solids content. Usually, water is added to make manure flow. Manure storage structures include belowground tanks or pits (either separate or under the animal housing), earthen storage ponds, and aboveground, fabricated concrete or steel tanks. Liquid manure is best handled with manure pumps, but gravity can also be used to transport liquid manure.

Dilution water may need to be added or solids may need to be separated from the liquid to produce liquid manure that can be handled with pumps (separated solids will have to be handled separately). Manure with a solids content of less than 4 percent is best for pumping. Manure with solids content between 4 percent and 10 percent is sometimes called slurry. If you choose to use pumps to move liquid manure, check manure pump manufacturer recommendations for pump operation and for its appropriateness for the type of manure you want to pump. Liquid manure storages are suitable for operations where manure is flushed or scraped with the addition of some liquid, such as on dairy and swine farms.

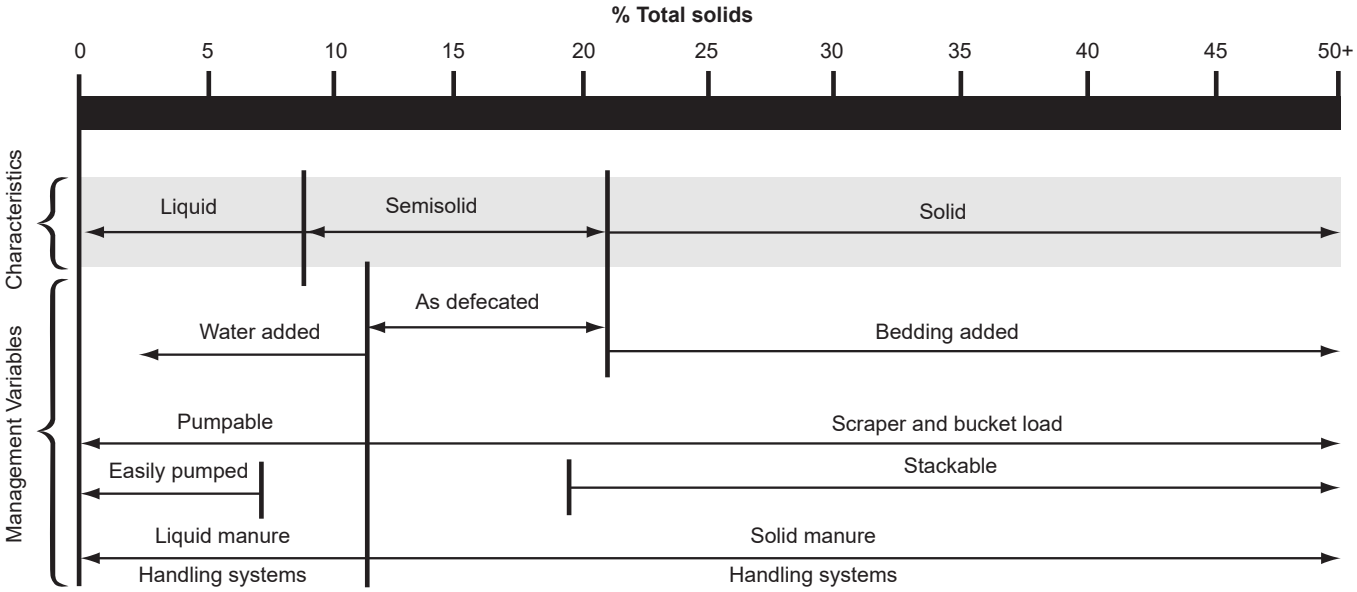
Semisolid Manure Storage

Used for manure with 10 percent to 20 percent solids content. Semisolid manure may "stack" if some bedding is added, although semisolid manure will not stack as well as solid manure. Semisolid manure storage facilities include aboveground structures – with or without roofs – aboveground silos or rectangular tanks, earthen or concrete banks with concrete floors, and roofed vertical-wall structures. Uncovered semisolid and solid manure storages will need containment for any accidental leaks or runoff due to excessive rainfall events. This storage type is common in dairy cattle, swine, horse, and poultry operations.

Solid Manure Storage

Used for manure with 20 percent to 25 percent or more solids content. Solid manure can be stacked and is best handled with a scraper and front-end loader. Solid manure is common where bedding is added to absorb

Figure 1. Manure total solids characterization and handling requirements.



liquid or drain off liquid and allow it to air dry. Solid manure is common in dairy cattle, beef cattle, horse, sheep, and goat operations. Solid manure can be stored in roofed stacking structures, concrete or earthen-baked structures with concrete floors, picket dams (retain manure solids on one side but the liquid flows through the dam into storage or treatment), and bedded packs.

Typical Manure Storage for Different Animal Species

Dairy Cattle

Manure can be stored as liquid in a manure storage pit, tank, or earthen pond. Semisolid or solid manure can be stored in a stacked facility; solid manure can also be stored in a bedded pack. Milking-house wastewater and contaminated runoff must be stored as a liquid. Bedding plays an important role in determining the manure storage for dairy cattle. If sand is used as bedding, the manure storage will most likely be liquid.

Beef Cattle

Manure can be stored as solid in a bedded pack in a confinement area where bedding is added in sufficient quantities. Manure can also be stored as liquid or slurry, depending on its consistency. Solid manure can also be stored in dry stack structures.

Poultry

Litter from broiler and turkey operations is stored on the floor of the housing facility; when removed, it can be transported directly to the field for land application. If field conditions are not favorable, litter must be removed and stored outside the house in temporary or permanent structures as described in *Storing and Handling Poultry Litter*, Virginia Cooperative Extension (VCE) publication 442-054. Manure from layers can be stored in a roofed facility. If it is wet, consider using a structural tank or earthen storage pond.

Swine

Swine manure is usually stored as a liquid or slurry. Manure storage can be in outdoor tanks, earthen pits or part of anaerobic lagoons used for manure treatment.

Sheep, Goats, and Alpacas

Manure from these animals can be managed as solids. Where animals are grown on the pasture, proper stocking, pasture rotation, and grazing management will assist in nutrient dispersion. For animals in confinement, manure is periodically removed by scraping for immediate land application or storage in stacks.

Horses

Horse stalls receive liberal beddings and so most manure is handled as solids. If possible, manure should be used from stalls daily if possible and land applied. Manure can be stored as solids in stack structures and/or composted.

Planning a Manure Storage System

Plan a manure storage and management system carefully in order to ensure production efficiency, allow for future expansion, protect the environment, and meet regulatory guidelines. Some guidelines to use in planning and selecting a manure storage facility are discussed below.

Size/Capacity of Storage

The required capacity of a manure storage unit depends on the volume of the manure, volume of bedding and other waste streams, extra storage depth required for freeboard and precipitation, and length of time the manure will be stored. The Virginia Natural Resources and Conservation Service (NRCS) provides guidelines on how to properly size storage structures. The document is available at: *https://www.nrcs.usda.gov/wps/portal/nrcs/detail/va/home/?cid=nrcs144p2_027217*. A brief description of what to consider when sizing the storage unit is listed below.

Manure, Wastewater, Wasted Feed, Bedding and Other Recoverable Material

Manure volume depends on animal age, species, diet, and other factors. The size of the animal affects the amount of manure produced. In general, the larger the animal, the more manure it produces. Manure production characteristics of different animals are provided in tables 1 and 2. Other sources of waste include spilled feed, overflowed drinking water, cleansers, medicines, hair, etc., that may be included in the manure and must be taken into consideration when designing storage facilities. Reduce other sources of waste when possible because they increase production costs (e.g., additional feed to account for spill, loss of clean water) and may be hard on equipment.

Increase the storage size according to the quantity of other sources of waste to be stored. When possible, actual quantities of bedding and drinking water losses should be used in the design calculations. Include the volume of milking-center wastewater for dairy farms and water for cleaning buildings between cycles for hogs. This amount varies from farm to farm, and the actual volume used on the farm should be measured and used in the design of the storage tank.

Precipitation and Runoff

Extra storage depth must be provided to allow for precipitation and mandatory freeboard. This is usually based on normal precipitation less the evaporation on the surface area of the storage facility, and the 25-year, 24-hour rainfall on the surface of the facility. The 25-year, 24-hour rainfall information can be obtained from Virginia NRCS offices or at the following website: *www.va.nrcs.usda.gov/technical/hydrology.html*. Include the volume of normal runoff and the 25-year, 24-hour runoff from the facility's drainage area during the storage period. Minimize the discharge of nonpolluted runoff into the storage structure.

Once the capacity of the required storage is known, the dimensions of the storage structure can be calculated.

Where to Locate a Manure Storage Facility

Consider all farmstead operations, locations of buildings and potable water wells, surface waters, future building expansions, prevailing winds, trees, and neighbors. Locate, size, and construct storage facilities for convenient filling and emptying and provide an all-weather access road.

Minimum separation distances from points of interest listed in table 3 should be observed. All efforts should be made to meet current Virginia recommendations and regulations.

Some other points to note include:

- Locate the manure storage structure as close to the source as possible and outside of flood plains. If site restrictions exist and require location within a flood plain, protect the storage structure from inundation or damage from a 100-year flood event or what is stipulated in the regulations, laws, and rules.

- Observing these separation distances when locating a new facility is a good way to help protect your drinking water. Locate manure storage facilities downslope from the well to protect your water supply. While observing the minimum distance for well separation may help to protect your own well, poorly designed or poorly maintained animal manure storage facilities could still contaminate the groundwater that supplies other local drinking-water wells. Protecting the groundwater resource as a whole can help protect your neighbors' wells, and the quality of drinking water supplies for future generations. If land constraints do not allow for this, it is very important that the manure and livestock lots be covered or contained, reducing or eliminating runoff from these areas.

- Locate facilities to minimize the potential impacts from breach of embankments, accidental release, and liner failure.

- Provide enough separation distance to minimize the impact of odor from the storage facility.

Locate manure storage areas for practical loading and unloading. When using equipment such as a front-end loader, manure storage areas with a corner push-up wall can be useful. Earthen, wooden, or precast concrete-block walls can also help with containment and with diverting clean storm water from entering the manure storage area.

Table 3. Natural Resources Conservation Service: Virginia guidelines for minimum distance requirements for waste storage facilities

Public or private facilities	Minimum distance from waste storage facility
Any public-use area (e.g., church, picnic area, playground, park, cemetery)	700 ft (215 m)
Drainage ditch	100 ft (30 m)
Milking parlor	100 ft (30 m)
Natural water course	200 ft (60 m)
Private potable well	100 ft (30 m)
Public potable well	300 ft (90 m)
Residence or place of habitation (other than owner or tenant)	700 ft (215 m)
Area specified by state or local ordinance	Greater of state or local distance or distance shown above

Figure 2. Types of manure storages (clockwise from top left): aboveground steel tank for liquid or semiliquid manure, aboveground concrete tank for liquid or semiliquid manure, earthen pond for liquid or semisolid manure, and stack shed for solid manure.

Site Guidelines

- Do not locate unlined storages over limestone, gravel, or fractured bedrock. If any of these conditions are present, check with your local Extension, NCRS, or SWCD to find out if there are any local and state environmental regulations, and consult a registered professional engineer.
- Do not locate unlined storages at/or below the water table. Virginia requires 2 feet or more separation distance between the storage bottom and high-water table, but check with local environmental regulatory agencies before building.
- Do not locate unlined storages in sandy or gravel-like soils, because these soils allow seepage to percolate through to the groundwater more easily. The NRCS can often help analyze the suitability of various sites for manure storage facility sites.
- Check for buried utilities and drainage tiles before building. These must be rerouted before construction or another site must be selected.

Storage Period

The storage period is the maximum length of time anticipated between emptying events. The minimum storage period is 120 days or what the storage needs to utilize the manure according to the nutrient management plan. Six months is the optimal storage period based on timing required for environmentally safe waste utilization considering climate, crops, soil, equipment, and local, state, and federal regulations.

Personal Preference

Select a manure storage system that matches your management strengths and abilities. For example, if you have an off-farm job, you may want to avoid systems with a lot of daily labor. For manure storage management and safety, see *Poultry and Livestock Manure Storage: Management and Safety*, VCE publication 442-308.

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Other Helpful VCE Publications

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Publication 442-309

Manure Management and Environmental Stewardship

By Jactone Arogo Ogejo, Extension Specialist, Biological Systems Engineering, Virginia Tech

Introduction

Manure is one resource that – if not managed properly – will affect the quality of the environment. Thus, livestock and poultry producers, regardless of size, need to manage manure for better economic returns and environmental protection. Quite often, we read or hear from news media about conflicts arising from the nuisance of odors from livestock and poultry operations, fish kills in water bodies, or the pollution potential of surface or groundwater that results from poor manure management. These concerns have created strained relationships between animal agriculture and the general public. To avoid or repair these relationships, it is important that we manage manure and other agricultural wastes associated with animal production in a responsible manner.

Environmental Stewardship

According to the U.S. Environmental Protection Agency, environmental stewardship is the responsibility for environmental quality shared by all those whose actions affect the environment.

Good manure management starts with recognizing and understanding the value of manure as a resource that contains nutrients for crop production as well as the potential negative impacts manure can have on air, water, and soil. This publication outlines the general guidelines about managing livestock and poultry manure and provides a list of resources with detailed information on specific topics of good practices for manure management and use.

Benefits of Manure

Manure is commonly used as a fertilizer and as an amendment to improve the quality of the soil. When manure is applied and managed properly according to the agronomic needs of crops, manure will improve crop productivity and reduce the demand for commercial fertilizer (see *Phosphorus, Agriculture & the Environment*, Virginia Cooperative Extension [VCE] publication 424-029; and *Impact of Changing From Nitrogen- to Phosphorus-Based Manure Nutrient Management Plans*, VCE publication 442-310). Managing manure to provide balanced nutrients that can be used as fertilizer may require that some nutrients be removed, conserved, or concentrated. For example, if the nitrogen (N) to phosphorus (P) ratio in the manure is one-to-one (1:1) and the agronomic requirement for these nutrients by a crop is four-to-one (4:1), meeting the agronomic needs of the crop using manure may require that some phosphorus be removed. Also, knowing that nitrogen can be lost from manure through volatilization of ammonia, it may be necessary to use management practices that will conserve nitrogen in the manure. If manure must be transported for long distances, it may be important to concentrate the nutrients to reduce the volume of water that has to be transported with manure in order to reduce transportation costs.

Nutrients can be recovered, conserved, or concentrated in manure through one or a combination of physical, chemical, or biological methods (see *Selecting a Treatment Technology for Manure Management*, VCE publication 442-306). Crops usually need more nitrogen than phosphorus; therefore, it would be beneficial to concentrate the nitrogen and remove the excess phosphorus from the manure to get the full benefits of manure using nutrient-recovery technologies that involve chemical, biological – or a combination of both – methods and a manure-separation system.

If handled properly, manure can be used to produce biogas that can be used as an alternative energy source (see

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Biomethane Technology, VCE publication 442-881). The biogas can then be used to produce electricity, hot water, steam, and/or transportation fuels. The quantity and quality of gas produced will depend on the digester design, operating temperature, and the type and quality of manure fed to the digester. Animal manure can also be subjected to the process of pyrolysis to produce char, oils, and gas. The oils and chars can be used for fuel or further processed to produce value-added products, such as plastics. Other considerations are to burn dried or solid manure in combustors or gasifiers to produce heat.

Animal manure can also be used for yeast and algae production, which can then be used to produce animal and fish feed and biofuel (see *Microalgae as a Feedstock for Biofuel Production*, VCE publication 442-886). Manures can also be used in the production of mushrooms or composted to produce a weed- and pathogen-free, high-quality soil amendment.

Manure Management and Water Quality

Water quality is everyone's concern and it is important to remember that poor nutrient management can lead to water quality problems. The EPA reports that manure from animal agriculture is one of the major sources of contamination of our water supply. Manure contains nitrogen, phosphorus, organic matter, and pathogens that are considered four primary contaminants that affect water quality. These pollutants may enter water resources by runoff, leaching, and deposition from the atmosphere. Nutrients from the atmosphere may be deposited on land through precipitation (rain and snow fall) or dry deposition. These contaminants may increase the cost of treating the water for domestic and industrial uses.

How Manure Constituents Affect Water Quality

Nitrogen

Nitrogen is one of the basic components of proteins, which is a part of all living things. Nitrogen is usually provided to animals via feed. Animals use only part of the nitrogen in their feed to produce meat, milk, or eggs and for body growth and maintenance. The remaining protein is excreted.

Nitrogen in manure exists in two forms that can be described as inorganic or organic. The inorganic forms include ammonia, nitrate, and nitrite. The organic forms include urea, undigested proteins in manure and feed, and other animal waste products such as hair and feathers. The inorganic forms readily cause pollution when compared to the organic forms. However, when the organic forms of nitrogen decompose, ammonia is produced. Ammonia can be transformed into nitrates and nitrites when oxygen is provided to the manure. Ammonia can easily be lost to the atmosphere from the manure by volatilization. Different forms of nitrogen present different risks to water quality. Ammonia concentration exceeding 2 parts per million (ppm) can lead to fish kills. Nitrates above 10 ppm in drinking water may cause blue baby syndrome when consumed by infants. Excess nitrogen can cause eutrophication of surface-water resources.

Phosphorus

Phosphorus is an essential nutrient to plant growth and development. Animals require it for bone development and optimum production. Animal manure that is land-applied to supply nutrients for crop growth typically does not match the nitrogen-to-phosphorus (N:P) ratio required by crops. Consequently, if manure is applied to satisfy the nitrogen requirements of a crop, phosphorus is over-applied and the soil phosphorus levels can increase (see *Soil Test Note No. 5: Fertilizing with Manures*, VCE publication 452-705; and *Phosphorus, Agriculture & the Environment*, VCE publication 424-029). When soils become saturated with phosphorus, the potential for losing it in runoff water increases. Phosphorus typically moves with water runoff and soil erosion. It can be attached to minerals containing iron, aluminum, and calcium or to organic matter such as crop residue, bacteria in the soil or manure, or decaying organic matter.

Pathogens

Pathogens include microorganisms such as viruses, bacteria, and protozoa that cause infection or disease. Disease-causing microorganisms may be present in manure. Therefore, it is important to maintain adequate separation between the potential source of pollutants and water sources. Pathogens are most likely transported to water with surface runoff and erosion or by direct animal access to surface water. Streams and lakes used for drinking water and recreational purposes provide the greatest opportunities for transmitting these pathogens. Human beings may be infected if they consume crops irrigated with untreated manure that contains pathogens.

Organic Matter

Organic matter in manure can be a valuable environmental resource if managed properly; however, if manure reaches a water body or moves off-site by water runoff, organic matter can become a harmful pollutant. Organic matter can come from manure, silage leachate, and milking center wastewater. Organic matter degrades rapidly in water and may result in oxygen depletion in bodies of water. Organic matter is transported into water by surface runoff. Rarely does organic matter leach through the soil.

Manure Management and Air Quality

Manure handling, storage, and utilization in livestock and poultry production results in a wide range of air emissions, which may create air quality concerns. The airborne emissions from livestock and animal production systems include hazardous gases, (e.g., ammonia [NH_3] and hydrogen sulfide [H_2S]), odor, dust, and greenhouse gases (e.g., methane [CH_4], nitrous oxide [N_2O] and carbon dioxide [CO_2]). Dust is generated from regular farm traffic, land preparation, and other crop production activities, as well as from livestock and poultry barns with ventilation exhaust air. The concerns from these emissions include odor, atmospheric visibility, and respiratory health issues (see *Ammonia Emissions and Animal Agriculture*, VCE publication 442-110).

Relationships and Manure Management

Complex technologies or treatment systems are not the solution to good manure management. Sometimes the often forgotten or ignored relationship with your neighbor can resolve many issues arising from animal agriculture, especially with respect to odor.

Impacts of Air Emissions

Odorous compounds are commonly considered to be unpleasant or nuisance experiences by neighbors. Neighbors sometimes relate or determine odor nuisance by a number of factors, including frequency and duration of occurrence; intensity of the odor experience; social factors, such as past experience with agriculture and relationship with the producer; and appearance of the production facility. Some neighbors may have strong emotional reactions and possible health-related issues to livestock- and poultry animal-related odor. Their concerns should be taken seriously. Ammonia released into the atmosphere is a loss of fertilizer value of the manure nitrogen. It may also result in formation of particulate matter that contributes to haze in the atmosphere. If the particulate matter is deposited back on land or on surface water, it may lead to area nitrogen enrichment and cause pollution. Livestock production is a source of greenhouse gases, and greenhouse gases contribute to global warming.

Principles of Environmental Stewardship

According to the EPA, "Environmental stewardship is the responsibility for environmental quality shared by all those whose actions affect the environment." Some good manure management and environmental stewardship principles that may be of benefit to livestock and poultry producers are summarized below.

Awareness of Environmental Risks

Familiarize yourself with your operation's potential environmental impacts by conducting an evaluation to determine the highest-risk situations or practices on your farm. Develop plans and invest resource to address the high-risk situations, e.g., handling manure emergency spills and manure storage failures. Your local Extension office, the soil and water conservation district office, and the National Resources Conservation Service may provide you with information on how to perform this task.

Farm Nutrient Balance and Nutrient Management Plan

Animal producers should set a goal to balance nutrients on their farm and also manage soils in ways to minimize nutrient losses. Nutrient balance should consider what is coming into the farm as purchased feed and fertilizer and the nutrients leaving as managed products, such as crops, animals, or animal products. An example of nutrient flow in a farm is provided in figure 1.

If the nutrients coming into the farm are more than what leaves, this will result in an accumulation of those nutrients on the farm. To correct the nutrient concentration, consider a whole-farm approach rather than focusing on a small part of the production, such as nutrients in manure and their losses to the environment. Understand the big picture by identifying the underlying cause of nutrient concentration and develop effective solutions to address the critical areas for better

utilization and management of nutrients on your farm. Some strategies to reduce and manage manure nutrients are presented in *Strategies to Reduce Amounts of Nitrogen and Phosphorus in Dairy Rations*, VCE publication 404-130; and *Selecting a Technology to Manage Manure Nutrients*,VCE publication 442-326.

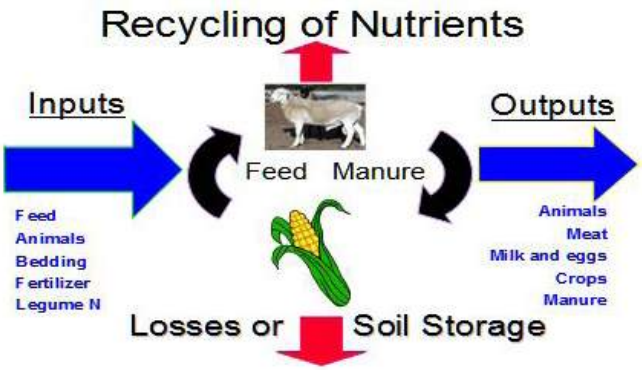

Figure 1. General nutrient balance on a farm.

Recycle nutrients between livestock and crop components within the boundaries of the farm. Manure nutrients are recycled as fertilizer for crop production. Crops are then cycled as feed to livestock or poultry. Nutrients leave the farm as products, i.e., animals or crops products such as milk and eggs and manure sold or given away for use outside the farm. These nutrients are sometimes referred to as "managed outputs." Some nutrients will leave the farm as environmental losses, e.g., nitrogen lost to the atmosphere as ammonia, nitrates to groundwater, and nitrogen and phosphorus in surface-water runoff.

Use manure according to a nutrient management plan. The nutrient management plan should maintain a balance between nutrient application and crop use and the needs of that nutrient. Test manure to know its nutrient content. Test soils to establish existing soil fertility levels to know what is needed for the different crops you grow (see *Soil Test Note No. 1: Explanation of Soil Tests,* VCE publication 452-701; *Soil Test Note No. 2: Field Crops,* VCE publication 452-702; *Soil Test Note No. 3: Forage Crops,* VCE publication 452-703; and *Soil Test Note No. 4: Trace Elements,* VCE publication 452-704).

Apply manure at uniform rates based on crop nutrient needs while avoiding soil contamination, crop damage, and runoff (see *Soil Test Note No. 5: Fertilizing with Manure*, VCE publication 452-705). Adjust the rate of supplemental fertilizer to compensate for the nutrients applied in the manure. Keep records of all your activities.

Use of manure and fertilizer as nutrient sources for crop production must be managed properly to ensure that they do not contaminate groundwater or surface water. Check soil moisture before applying manure and adjust application rates to avoid runoff. Limit the volume of water applied to an amount that brings the soil to field-moisture capacity. Do not apply manure to saturated soils. Incorporate raw or untreated manure to reduce odors and nitrogen losses. Calibrate application equipment to obtain the desired application rate (see *Land Application of Broiler and Turkey Litter for Farming Operations Without a DEQ Permit,* VCE publication 442-052; *Manure Spreader Calibration for Rear-Discharge Equipment: Handling Solid and Semisolid Manures and Poultry Litter,* VCE publication 442-004).

Be a Good Neighbor

Animal production creates several potential nuisances, including odors, flies, noise, and dust. You need to be fully aware of these nuisances and your neighbors' possible concerns. The demographics of rural areas (where farming has traditionally occurred) are changing and what used to be exclusively rural areas are becoming urbanized. Public awareness of environmental issues is changing. As a result, farm-neighbor conflicts are increasing around the country. Nonfarm communities complain that farming activities near their homes affect their quality of life. Increasingly, farmers are being forced to consider social as well as air-quality concerns in developing manure management plans. Following are some reminders of good practice as part of your manure management strategy:

Know Your Neighbors

We have numerous and diverse neighbors. Some are long-term residents who farmed in the area and are now retired. Some are the result of urban sprawl. Some live in communities within the city limits but next to agricultural land. Schools, churches, hospitals, and golf courses are also some of your neighbors. It is interesting to note that some nonfarm community members are buying former farms and moving into the country, seeking "fresh" air. The bottom line is that urbaniza-

tion of rural areas and consolidation of livestock farms often lead to tense relationships between farmers and nonfarming neighbors. It is important to recognize this fact and to proactively pursue ways to deal with it. How you handle business on your farm may impact how you resolve conflicts related to your farm.

Recognize Your Challenges

Large numbers of animals concentrated near nonagricultural residents will produce odor and visual issues related to confined-animal feeding operations. With the changing demographics, rural roads may start experiencing aggressive drivers who do not appreciate or recognize the slower farm traffic. With the hectic pace of life there may be little, if any, communication between the farmer and neighbors. This can create situations for misunderstanding and a greater likelihood that conflicts will occur. Sometimes common ground and mutual agreement is not realized until later. Do not let issues concerning your manure management get out of control. Be proactive in talking to your neighbors. Implement responsible farm management practices while conducting activities that promote the benefits of the farm to neighbors and the community.

Tell Your Story

There are a variety of outreach efforts you may want to consider to enhance the perception of the farm among neighbors and the larger community. Accept visitors to your farm as your schedule will allow and within the bounds of biosecurity. Tell visitors what you do and why you do it. Visitors should include all ages and groups. If possible, provide neighbors with sample farm products, assist with or volunteer to mow brush in the summer, plow snow in the winter, and consider allowing access to areas of the farm for recreational activities. Let your neighbors know about your farming operations and activities. This should include the manure application schedule. If neighbors have special events occurring at their homes on certain dates that may be impacted by a farming operation, such as land application of manure, work with them to reschedule that operation. Note: Outreach to community, open houses, and neighborly assistance can help cultivate open communication and understanding between the farming and nonfarming communities.

Engage Local Leadership

Before embarking on new projects or expanding existing enterprises on the farm, arrange to meet with the local authority boards to show them your plans and solicit questions and comments. After finishing the project, hold a neighborhood barbecue and tour to meet the neighbors; show them what you do and why. It is more difficult to carry a disagreement with someone you know and are friendly with or who has made a first move to get to know you.

Neighbor Relations

When planning farm operations that will impact people in the area (e.g., spraying liquid manure next to a school, church, or golf course), communicate and explain the operation ahead of time. Plan the operation at a time that causes the least disruptions to the other parties. Remember, people are much more accommodating if issues are addressed ahead of time, even if it is something they do not particularly like. In most cases, people will give you more latitude with something they do not like if you make a good faith effort to deal with their concerns about your farming operation.

Cleanliness

Many times people tend to smell with their eyes more than their noses. It is therefore extremely important to have a neat facility, clean animals, well-tended crops and buildings, and machinery in good repair. Yards

Figure 2. Examples of neatly kept farm surroundings.

Figure 3. Example of undesirable situations around the farm.

around barns and along the road and ditches should be mowed. It is not always possible to prevent all farm odors, but if people are presented with the picture of a clean, orderly, well-managed farm, they will tolerate more actual odor than from a farm that looks untidy (figures 2 and 3).

Safety and Manure Handling

Liquid manure can produce gases that can be toxic. Production of manure gases is enhanced in hot weather, so practice caution when handling manure in the summer. Remember that outdoor manure storages can be deathtraps (see *Manure Storage: Selection and Location of Poultry and Livestock Manure Storage,* VCE publication 442-307; and *Poultry and Livestock Manure Storage: Management and Safety*, VCE publication 442-308).

Acknowledgements

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STD & SPEC 3.15

TEMPORARY SLOPE DRAIN

Definition

A flexible tubing or conduit extending from the top to the bottom of a cut or fill slope.

Purpose

To temporarily conduct concentrated stormwater runoff safely down the face of a cut or fill slope without causing erosion on or below the slope.

Conditions Where Practice Applies

On cut or fill slopes where there is a potential for upslope flows to move over the face of the slope causing erosion and preventing adequate stabilization.

Planning Considerations

There is often a significant lag between the time a cut or fill slope is completed and the time a permanent drainage system can be installed. During this period, the slope is usually not stabilized and is particularly vulnerable to erosion. This situation also occurs on slope construction which is temporarily delayed before final grade is reached. Temporary slope drains can provide valuable protection of exposed slopes until permanent drainage structures can be installed or vegetation can be established.

Temporary slope drains can be used in conjunction with diversion dikes to convey runoff from the entire drainage area above a slope to the base of the slope without erosion. It is very important that these temporary structures be installed properly, since their failure will often result in severe gully erosion on the site and sedimentation below the slope. The entrance section must be securely entrenched, all connections must be watertight, and the conduit must be staked securely.

Design Criteria

Drainage Area

The maximum allowable drainage area per slope drain is 5 acres.

Flexible Conduit

The slope drain shall consist of heavy-duty, flexible material designed for this purpose. The diameter of the slope drain shall be equal over its entire length. Reinforced hold-down grommets shall be spaced at 10-foot (or less) intervals. Slope drains shall be sized as listed in Table 3.15-A.

Entrance Sections

The entrance to the slope drain shall consist of a standard VDOT flared end-section for metal pipe culverts (see Plates 3.15-2 and 3.15-3) with appropriate inlet protection as set forth in CULVERT INLET PROTECTION, Std. & Spec. 3.08. If ponding will cause a problem at the entrance and make such protection impractical, appropriate sediment-removing measures shall be taken at the outlet of the pipe. Extension collars shall consist of 12-inch long corrugated metal pipe. Watertight fittings shall be provided (see Plate 3.15-1).

Note: End-sections made of heavy-duty, flexible material may be utilized if determined by the Plan-Approving Authority to provide a stable inlet or outlet section.

TABLE 3.15-A

SIZE OF SLOPE DRAIN

Maximum Drainage Area (acres)	Pipe Diameter (inches)
0.5	12
1.5	18
2.5	21
3.5	24
5.0	30

Source: Va. DSWC

Dike Design

An earthen dike shall be used to direct stormwater runoff into the temporary slope drain and shall be constructed as set forth in DIVERSION, Std. & Spec. 3.12. See Plate 3.15-1 for placement of dike in relation to the slope drain.

The height of the dike at the centerline of the inlet shall be equal to the diameter of the pipe plus 6 inches. Where the dike height is greater than 18 inches at the inlet, it shall be sloped at the rate of 3:1 or flatter to connect with the remainder of the dike (see Plate 3.15-1).

Outlet Protection

The outlet of the slope drain must be protected from erosion as set forth in OUTLET PROTECTION, Std. & Spec. 3.18.

Construction Specifications

1. The measure shall be placed on undisturbed soil or well-compacted fill.

2. The entrance section shall slope toward the slope drain at the minimum rate of 1/2-inch per foot.

3. The soil around and under the entrance section shall be hand-tamped in 8-inch lifts to the top of the dike to prevent piping failure around the inlet.

4. The slope drain shall be securely staked to the slope at the grommets provided.

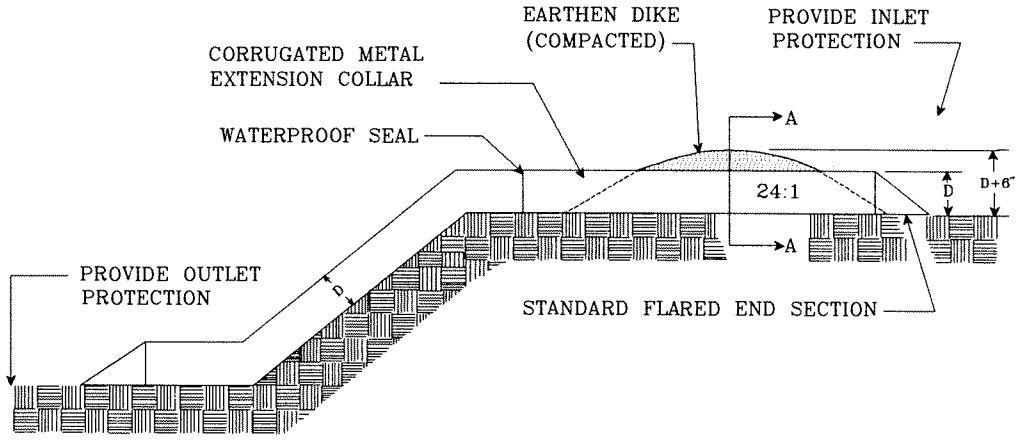
5. The slope drain sections shall be securely fastened together and have watertight fittings.

6. Install CULVERT INLET PROTECTION and OUTLET PROTECTION as per Std. & Spec.'s 3.08 and 3.18, respectively.

Maintenance

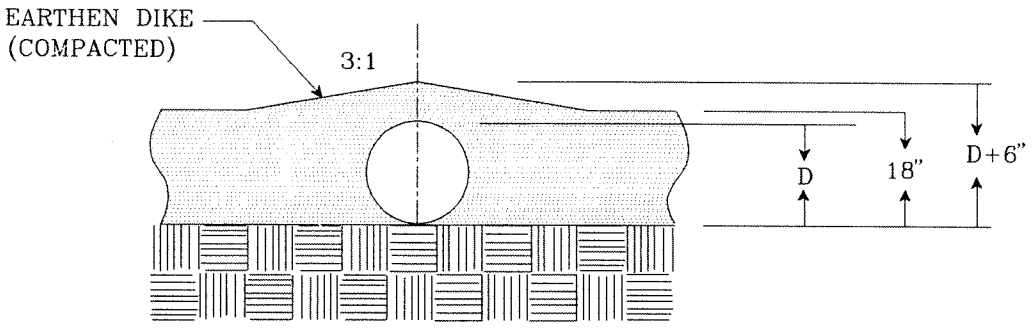
The slope drain structure shall be inspected weekly and after every storm, and repairs made if necessary. The contractor should avoid the placement of any material on and prevent construction traffic across the slope drain.

TEMPORARY SLOPE DRAIN



SECTION VIEW

NOTE: SEDIMENT MAY BE CONTROLLED AT OUTLET IF UPLAND PONDING WILL CREATE PROBLEMS

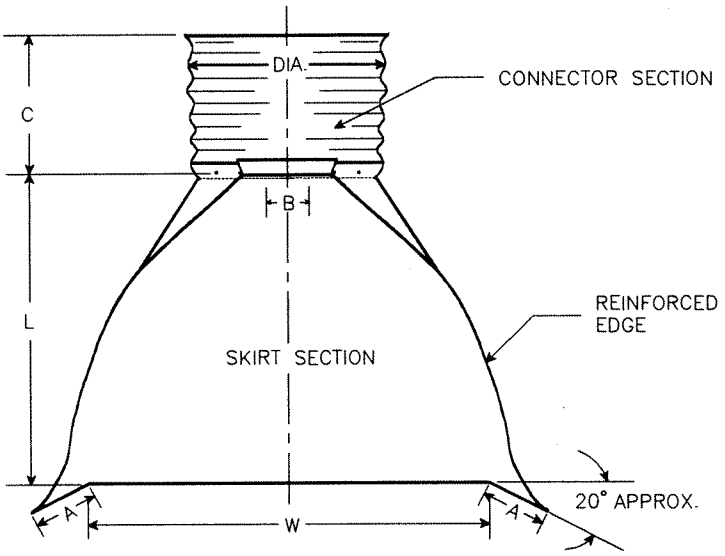


SECTION A – A

Source: Va. DSWC

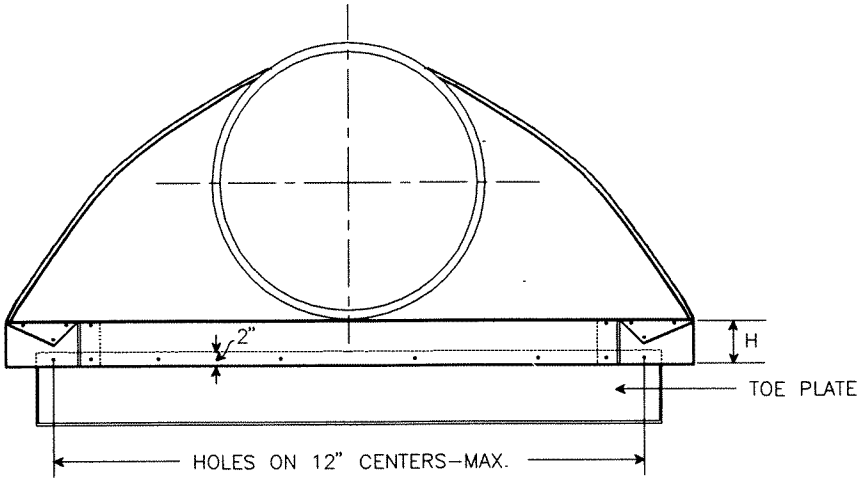
Plate 3.15-1

FLARED END–SECTION



PLAN

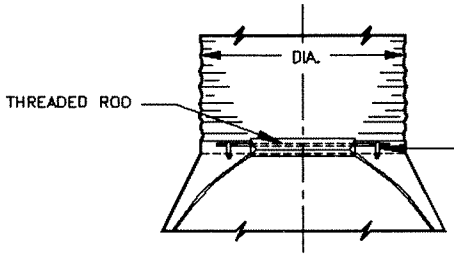
WHERE FLARED END–SECTIONS ARE TO BE USED WITH BITUMINOUS COATED AND PAVED METAL PIPE, THEY ARE TO BE GALVANIZED ONLY.



ELEVATION

Source: VDOT Road and Bridge Standards Plate 3.15-2

FLARED END–SECTION
(CONTINUED)



ALTERNATE CONNECTION

TOE PLATE, WHERE NEEDED, TO BE PUNCHED TO MATCH IN SKIRT LIP. 3/8" GALV. BOLTS TO BE FURNISHED. LENGTH OF TOE PLATE IS W + 10" FOR 12" TO 30" DIA. PIPE AND W + 22" FOR 36" TO 60" DIA. PIPE.

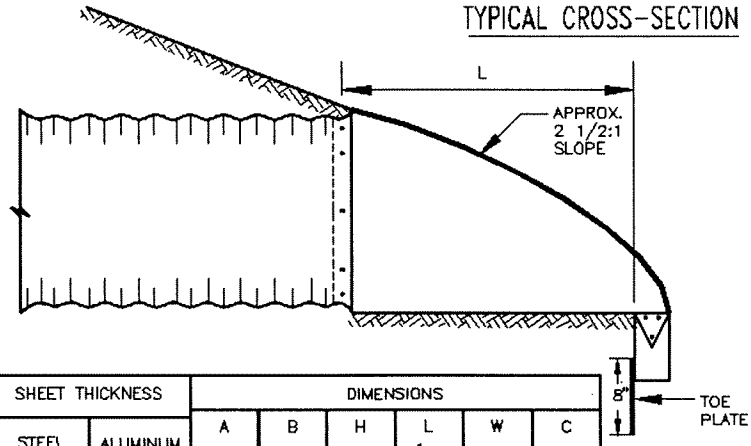
SKIRT SECTION FOR 12" TO 30" DIA. PIPE TO BE MADE IN ONE PIECE.

SKIRT SECTION FOR 36" TO 54" DIA. PIPE MAY BE MADE FROM TWO SHEETS JOINED BY RIVETING OR BOLTING ON CENTER LINE. 60" MAY BE CONSTRUCTED IN 3 PIECES.

CONNECTOR SECTION, CORNER PLATE AND TOE PLATE TO BE SAME SHEET THICKNESS AS SKIRT.

END–SECTIONS AND FITTINGS ARE TO BE GALVANIZED STEEL OR ALUMINUM ALLOY FOR USE WITH LIKE PIPE.

TYPICAL CROSS–SECTION



PIPE DIA.	SHEET THICKNESS		DIMENSIONS					
	STEEL	ALUMINUM	A 1"TOL.	B MAX.	H 1"TOL.	L $1\frac{1}{2}$"TOL.	W 2"TOL.	C
12"	.064"	.060"	6"	6"	6"	21"	24"	24"
15"	.064"	.060"	7"	8"	6"	26"	30"	24"
18"	.064"	.060"	8"	10"	6"	31"	36"	24"
21"	.064"	.060"	10"	12"	6"	36"	42"	24"
24"	.064"	.060"	10"	13"	6"	41"	48"	24"
27"/30"	.064"	.075"	12"	16"	8"	51"	60"	24"
36"	.064"	.075"	14"	19"	9"	60"	72"	36"
42"	.064"	.105"	16"	22"	11"	69"	84"	36"
48"	.064"	.105"	18"	27"	12"	78"	90"	24"
54"	.064"/.079"	.105"	18"	30"	12"	84"	102"	36"
60"	.064"/.109"	.105"/.135"	18"	33"	12"	87"	114"	36"

Source: VDOT Road and Bridge Standards Plate 3.15-3

STD & SPEC 3.06

BRUSH BARRIER

BB

Definition

A temporary sediment barrier constructed at the perimeter of a disturbed area from the residue materials available from clearing and grubbing the site.

Purpose

To intercept and retain sediment from disturbed areas of limited extent, preventing sediment from leaving the site.

Conditions Where Practice Applies

1. Below disturbed areas subject to sheet and rill erosion, where enough residue material is available for construction of such a barrier.

2. Where the size of the drainage area is no greater than one-fourth of an acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet; and the maximum slope gradient behind the barrier is 50 percent (2:1).

Planning Considerations

Organic litter and spoil material from site clearing operations is usually burned or hauled away to be dumped elsewhere. Much of this material can be used effectively on the construction site itself. During clearing and grubbing operations, equipment can push or dump the mixture of limbs, small vegetation and root mat along with minor amounts of rock into windrows along the toe of a slope where erosion and accelerated runoff are expected. Because brush barriers are fairly stable and composed of natural materials, maintenance requirements are small. Field experience has shown, however, that many brush barrier installations are not effective when there are large voids created by the use of material which is too large (such as tree stumps) to provide a compact, dense barrier. Therefore, it is necessary to use residual material under 6 inches in diameter which will create a more uniform barrier or utilize a filter fabric overlay to promote enhanced filtration of sediment-laden runoff.

Design Criteria

A formal design is not required.

Construction Specifications

Without Filter Cloth

1. The height of a brush barrier shall be a minimum of 3 feet.

2. The width of a brush barrier shall be a minimum of 5 feet at its base (the sizes of brush barriers may vary considerably based upon the amount of material available and the judgement of the design engineer).

3. The barrier shall be constructed by piling brush, stone, root mat and other material from the clearing process into a mounded row on the contour. Material larger than 6 inches in diameter should not be used to create the mound as the non-homogeneity of the mixture can lead to voids where sediment-laden flows can easily pass.

If a Filter is Used (see Plate 3.06-1)

1. Filter fabric must meet the minimum physical requirements noted in Table 3.05-B.

2. The filter fabric shall be cut into lengths sufficient to lay across the barrier from its up-slope base to just beyond its peak. Where joints are necessary, the fabric shall be spliced together with a minimum 6-inch overlap and securely sealed.

3. A trench shall be excavated 6-inches wide and 4-inches deep along the length of the barrier and immediately uphill from the barrier.

4. The lengths of filter fabric shall be draped across the width of the barrier with the uphill edge placed in the trench and the edges of adjacent pieces overlapping each other.

5. The filter fabric shall be secured in the trench with stakes set approximately 36 inches on center.

6. The trench shall be backfilled and the soil compacted over the filter fabric.

7. Set stakes into the ground along the downhill edge of the brush barrier, and anchor the fabric by tying twine from the fabric to the stakes.

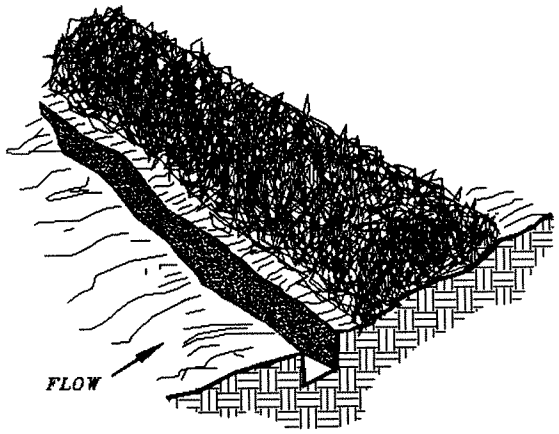
Maintenance

1. Brush barriers shall be inspected after each rainfall and necessary repairs shall be made promptly.

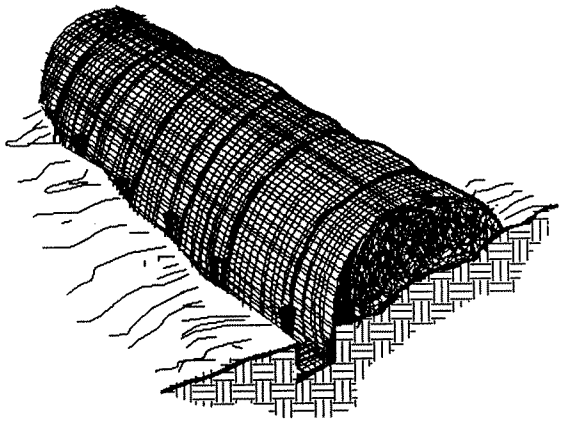
2. Sediment deposits must be removed when they reach approximately one-half the height of the barrier.

CONSTRUCTION OF A BRUSH BARRIER COVERED BY FILTER FABRIC

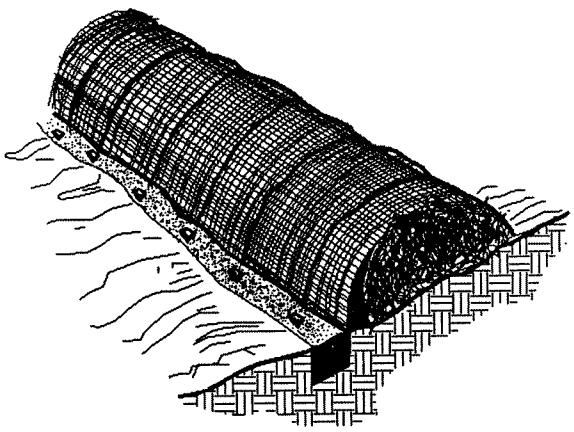
(TREE/RESIDUAL MATERIAL WITH DIAMETER > 6")



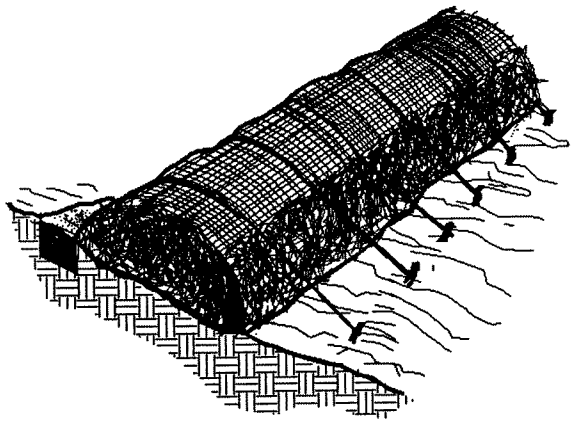
1. EXCAVATE A 4"X 4" TRENCH ALONG THE UPHILL EDGE OF THE BRUSH BARRIER.



2. DRAPE FILTER FABRIC OVER THE BRUSH BARRIER AND INTO THE TRENCH. FABRIC SHOULD BE SECURED IN THE TRENCH WITH STAKES SET APPROXIMATELY 36" O.C.



3. BACKFILL AND COMPACT THE EXCAVATED SOIL.



4. SET STAKES ALONG THE DOWN-HILL EDGE OF THE BRUSH BARRIER, AND ANCHOR BY TYING TWINE FROM THE FABRIC TO THE STAKES.

Source: Va. DSWC

Plate 3.06-1

STD & SPEC 3.05

SILT FENCE

SF

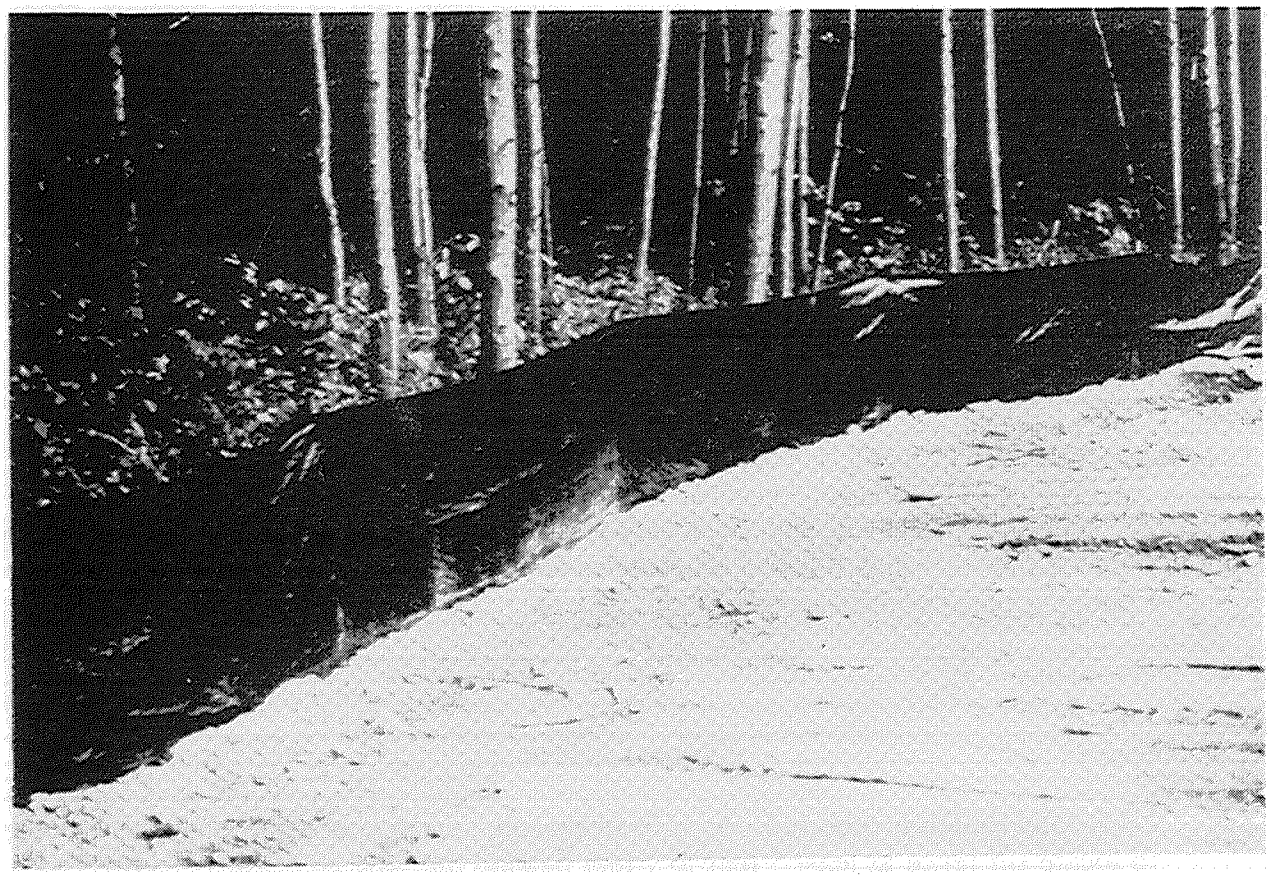
Definition

A temporary sediment barrier consisting of a synthetic filter fabric stretched across and attached to supporting posts and entrenched.

Purposes

1. To intercept and detain small amounts of sediment from disturbed areas during construction operations in order to prevent sediment from leaving the site.

2. To decrease the velocity of sheet flows and low-to-moderate level channel flows.



Conditions Where Practice Applies

1. Below disturbed areas where erosion would occur in the form of sheet and rill erosion.

2. Where the size of the drainage area is no more than one quarter acre per 100 feet of silt fence length; the maximum slope length behind the barrier is 100 feet; and the maximum gradient behind the barrier is 50 percent (2:1).

3. In minor swales or ditch lines where the maximum contributing drainage area is no greater than 1 acre and flow is no greater than 1 cfs.

4. Silt fence will not be used in areas where rock or some other hard surface prevents the full and uniform depth anchoring of the barrier.

Planning Considerations

Laboratory work at the Virginia Highway and Transportation Research Council (VHTRC) has shown that silt fences can trap a much higher percentage of suspended sediments than straw bales, though silt fence passes the sediment-laden water slower. Silt fences are preferable to straw barriers in many cases because of their durability and potential cost savings. While the failure rate of silt fences is lower than that of straw barriers, many instances have been observed where silt fences are improperly installed, inviting failure and sediment loss. The installation methods outlined here can improve performance and reduce failures.

As noted, flow rate through silt fence is significantly lower than the flow rate for straw bale barriers. This creates more ponding and hence more time for sediment to fall out. Table 3.05-A demonstrates these relationships.

Both woven and non-woven synthetic fabrics are commercially available. The woven fabrics generally display higher strength than the non-woven fabrics and, in most cases, do not require any additional reinforcement. When tested under acid and alkaline water conditions, most of the woven fabrics increase in strength, while the reactions of non-woven fabrics to these conditions are variable. The same is true of testing under extensive ultraviolet radiation. Permeability rates vary regardless of fabric type. While all of the fabrics demonstrate very high filtering efficiencies for sandy sediments, there is considerable variation among both woven and non-woven fabrics when filtering the finer silt and clay particles.

Design Criteria

1. No formal design is required. As with straw bale barriers, an effort should be made to locate silt fence at least 5 feet to 7 feet beyond the base of disturbed slopes with grades greater than 7%.

TABLE 3.05-A

TYPICAL FLOW RATES AND FILTERING EFFICIENCIES OF PERIMETER CONTROL

Material	Flow Rate (gal./sq.ft./min)	Filter Efficiency(%)
Straw	5.6	67
Synthetic Fabric	0.3	97

Source: VHTRC

2. The use of silt fences, because they have such a low permeability, is limited to situations in which only sheet or overland flows are expected and where concentrated flows originate from drainage areas of 1 acre or less.

3. Field experience has demonstrated that, in many instances, silt fence is installed too short (less than 16 inches above ground elevation). The short fence is subject to breaching during even small storm events and will require maintenance "clean outs" more often. Properly supported silt fence which stands 24 to 34 inches above the existing grade tends to promote more effective sediment control.

Construction Specifications

Materials

1. Synthetic filter fabric shall be a pervious sheet of propylene, nylon, polyester or ethylene yarn and shall be certified by the manufacturer or supplier as conforming to the requirements noted in Table 3.05-B.

2. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0° F to 120° F.

3. If wooden stakes are utilized for silt fence construction, they must have a diameter of 2 inches when oak is used and 4 inches when pine is used. Wooden stakes must have a minimum length of 5 feet.

TABLE 3.05-B

PHYSICAL PROPERTIES OF FILTER FABRIC IN SILT FENCE

Physical Property	Test	Requirements
Filtering Efficiency	ASTM 5141	75% (minimum)
Tensile Strength at 20% (max.) Elongation*	VTM-52	Extra Strength - 50 lbs./linear inch (minimum) Standard Strength - 30 lbs./linear inch (minimum)
Flow Rate	ASTM 5141	0.2 gal./sq.ft./ minute (minimum)
Ultraviolet Radiation Stability %	ASTM-G-26	90% (minimum)

* Requirements reduced by 50% after six months of installation.

Source: VHTRC

4. If steel posts (standard "U" or "T" section) are utilized for silt fence construction, they must have a minimum weight of 1.33 pounds per linear foot and shall have a minimum length of 5 feet.

5. Wire fence reinforcement for silt fences using standard-strength filter cloth shall be a minimum of 14 gauge and shall have a maximum mesh spacing of 6 inches.

Installation

1. The height of a silt fence shall be a minimum of 16 inches above the original ground surface and shall not exceed 34 inches above ground elevation.

2. The filter fabric shall be purchased in a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter cloth shall be spliced together only at a support post, with a minimum 6-inch overlap, and securely sealed.

3. A trench shall be excavated approximately 4-inches wide and 4-inches deep on the upslope side of the proposed location of the measure.

4. When wire support is used, standard-strength filter cloth may be used. Posts for this type of installation shall be placed a maximum of 10-feet apart (see Plate 3.05-1). The wire mesh fence must be fastened securely to the upslope side of the posts using heavy duty wire staples at least one inch long, tie wires or hog rings. The wire shall extend into the trench a minimum of two inches and shall not extend more than 34 inches above the original ground surface. The standard-strength fabric shall be stapled or wired to the wire fence, and 8 inches of the fabric shall be extended into the trench. The fabric shall not be stapled to existing trees.

5. When wire support is not used, extra-strength filter cloth shall be used. Posts for this type of fabric shall be placed a maximum of 6-feet apart (see Plate 3.05-2). The filter fabric shall be fastened securely to the upslope side of the posts using one inch long (minimum) heavy-duty wire staples or tie wires and eight inches of the fabric shall be extended into the trench. The fabric shall not be stapled to existing trees. This method of installation has been found to be more commonplace than #4.

6. If a silt fence is to be constructed across a ditch line or swale, the measure must be of sufficient length to eliminate endflow, and the plan configuration shall resemble an arc or horseshoe with the ends oriented upslope (see Plate 3.05-2). Extra-strength filter fabric shall be used for this application with a maximum 3-foot spacing of posts.

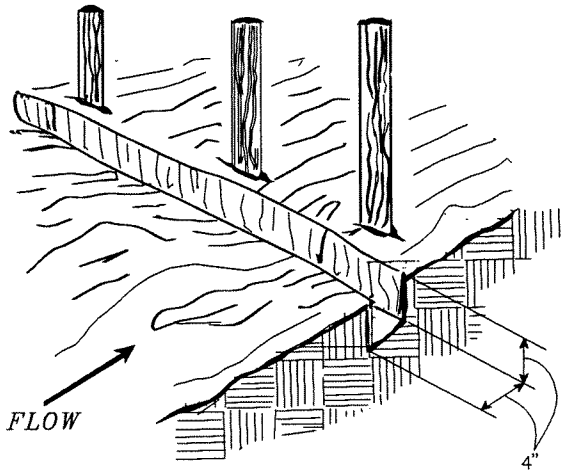
   All other installation requirements noted in #5 apply.

7. The 4-inch by 4-inch trench shall be backfilled and the soil compacted over the filter fabric.

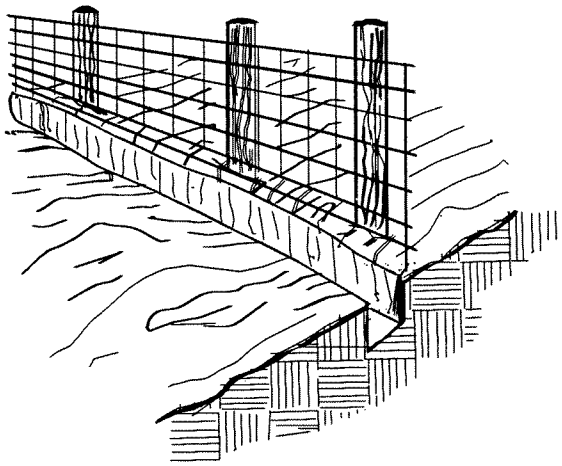
8. Silt fences shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.

CONSTRUCTION OF A SILT FENCE (WITH WIRE SUPPORT)

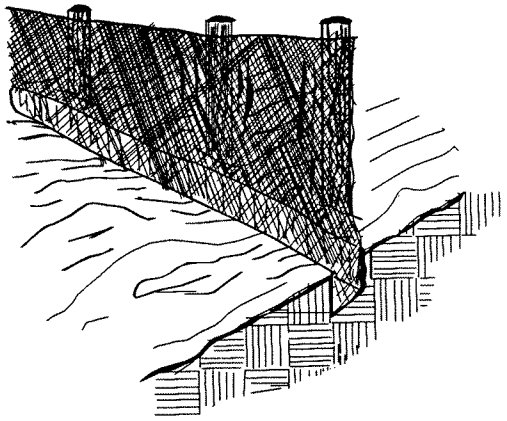
1. SET POSTS AND EXCAVATE A 4"X4" TRENCH UPSLOPE ALONG THE LINE OF POSTS.



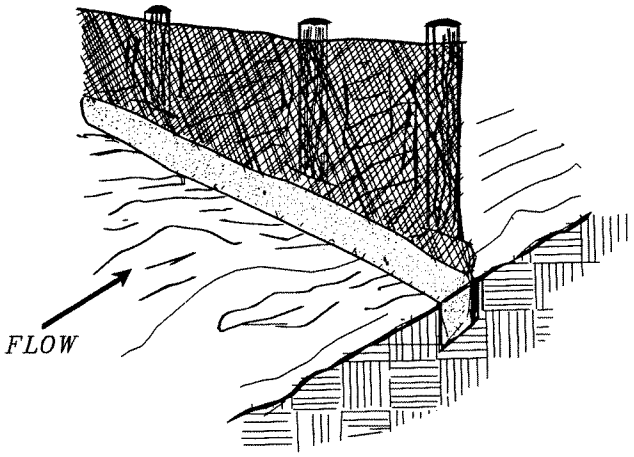
2. STAPLE WIRE FENCING TO THE POSTS.



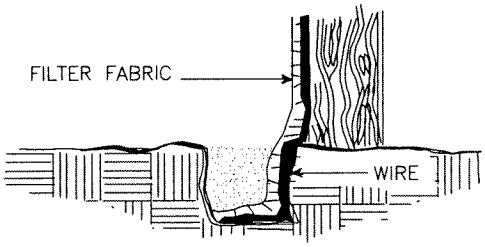
3. ATTACH THE FILTER FABRIC TO THE WIRE FENCE AND EXTEND IT INTO THE TRENCH.



4. BACKFILL AND COMPACT THE EXCAVATED SOIL.



EXTENSION OF FABRIC AND WIRE INTO THE TRENCH.

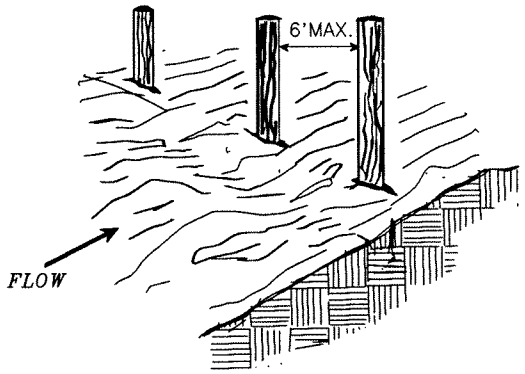


Source: Adapted from Installation of Straw and Fabric Filter Barriers for Sediment Control, Sherwood and Wyant

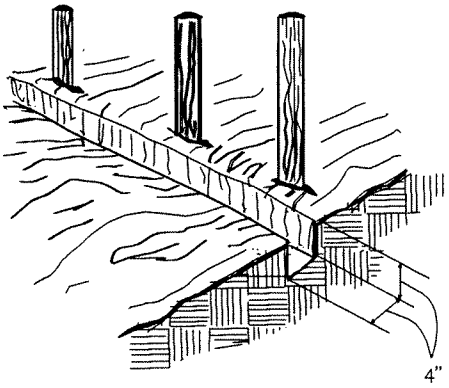
Plate 3.05-1

CONSTRUCTION OF A SILT FENCE (WITHOUT WIRE SUPPORT)

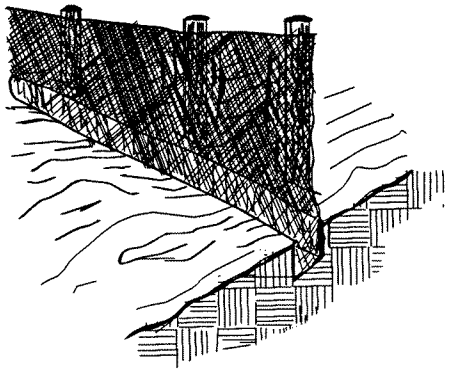
1. SET THE STAKES.



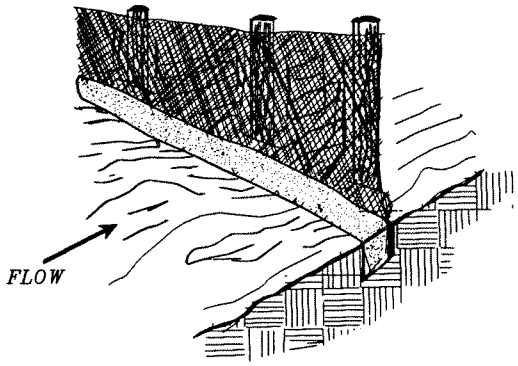
2. EXCAVATE A 4"X 4" TRENCH UPSLOPE ALONG THE LINE OF STAKES.



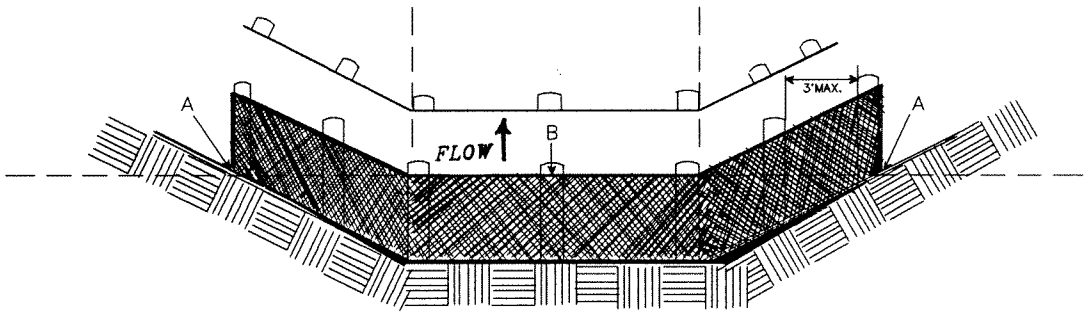
3. STAPLE FILTER MATERIAL TO STAKES AND EXTEND IT INTO THE TRENCH.



4. BACKFILL AND COMPACT THE EXCAVATED SOIL.



SHEET FLOW INSTALLATION
(PERSPECTIVE VIEW)



POINTS A SHOULD BE HIGHER THAN POINT B.

DRAINAGEWAY INSTALLATION
(FRONT ELEVATION)

Source: Adapted from Installation of Straw and Fabric Filter Barriers for Sediment Control, Sherwood and Wyant

Plate 3.05-2

Maintenance

1. Silt fences shall be inspected immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs shall be made immediately.

2. Close attention shall be paid to the repair of damaged silt fence resulting from end runs and undercutting.

3. Should the fabric on a silt fence decompose or become ineffective prior to the end of the expected usable life and the barrier still be necessary, the fabric shall be replaced promptly.

4. Sediment deposits should be removed after each storm event. They must be removed when deposits reach approximately one-half the height of the barrier.

5. Any sediment deposits remaining in place after the silt fence is no longer required shall be dressed to conform with the existing grade, prepared and seeded.

STD & SPEC 3.04

STRAW BALE BARRIER

STB

Definition

A temporary sediment barrier consisting of a row of entrenched and anchored straw bales.

Purposes

1. To intercept and detain small amounts of sediment from disturbed areas of limited extent in order to prevent sediment from leaving the construction site.

2. To decrease the velocity of sheet flows.

Conditions Where Practice Applies

1. Below disturbed areas subject to sheet and rill erosion.

2. Where the size of the drainage area is no greater than one-fourth of an acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet; and the maximum slope gradient behind the barrier is 50 percent (2:1).

3. Where effectiveness is required for less than 3 months.

4. Under no circumstances should straw bale barriers be constructed in live streams or in swales where there is the possibility of a washout.

5. The measure should not be used where water may concentrate in defined ditches and minor swales.

6. Straw bale barriers shall not be used on areas where rock or another hard surface prevents the full and uniform anchoring of the barrier.

Planning Considerations

Based on observations made in Virginia, Pennsylvania, Maryland and other parts of the nation, straw bale barriers have not been as effective as many users had hoped they would be - especially when used to slow down and filter concentrated flows. They should be used judiciously and with caution as erosion control measures. There are three major reasons for such ineffectiveness.

First, improper utilization of straw bale barriers has been a major problem. Straw bale barriers have been used in streams and drainageways where high water depth and velocities have destroyed or damaged the control. Secondly, improper placement and installation of the barriers, such as staking the bales directly to the ground with no soil seal or entrenchment, has allowed undercutting and end flow. This has resulted in additions of, rather than removal of, sediment from runoff waters. Finally, inadequate maintenance lowers the effectiveness of these barriers. Trapping efficiencies of carefully installed straw bale barriers on one project in Virginia dropped from 57% to 16% in one month due to lack of maintenance.

There are serious questions about the continued use of straw bale barriers as they are presently installed and maintained. Averaging from $3 to $6 per linear foot, the thousands of straw bale barriers used annually in Virginia represent such a considerable expense that optimum installation procedures should be emphasized.

Design Criteria

A formal design is not required. However, an effort should be made to locate the straw bale barrier, as well as other perimeter controls, at least 5 to 7 feet from the base of disturbed slopes with grades greater than 7%. This will help prevent the measure from being rendered useless following the initial movement of soil.

Construction Specifications

Sheet Flow Application

1. Bales shall be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another.

2. All bales shall be either wire-bound or string-tied. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales in order to prevent deterioration of the bindings (see Plate 3.04-1).

3. The barrier shall be entrenched and backfilled. A trench shall be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked and chinked (gaps filled by wedging), the excavated soil shall be backfilled against the barrier. Backfill soil shall conform to the ground level on the downhill side and shall be built up to 4 inches against the uphill side of the barrier (see Plate 3.04-1).

4. Each bale shall be securely anchored by at least two stakes (minimum dimensions 2 inches x 2 inches x 36 inches) or standard "T" or "U" steel posts (minimum weight of 1.33 pounds per linear foot) driven through the bale. The first stake or steel post in each bale shall be driven toward the previously laid bale to force the bales together. Stakes or steel pickets shall be driven a minimum 18 inches deep into the ground to securely anchor the bales.

5. The gaps between bales shall be chinked (filled by wedging) with straw to prevent water from escaping between the bales. Loose straw scattered over the area immediately uphill from a straw bale barrier tends to increase barrier efficiency.

6. Inspection shall be frequent and repair or replacement shall be made promptly as needed.

7. Straw bale barriers shall be removed when they have served their usefulness, but not before the upslope areas have been permanently stabilized.

Maintenance

1. Straw bale barriers shall be inspected immediately after each rainfall and at least daily during prolonged rainfall.

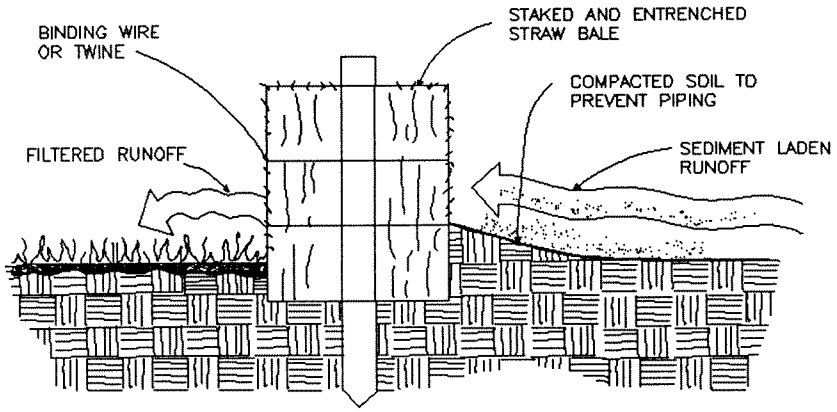
2. Close attention shall be paid to the repair of damaged bales, end runs and undercutting beneath bales.

3. Necessary repairs to barriers or replacement of bales shall be accomplished promptly.

4. Sediment deposits should be removed after each rainfall. They must be removed when the level of deposition reaches approximately one-half the height of the barrier.

5. Any sediment deposits remaining in place after the straw bale barrier is no longer required shall be dressed to conform to the existing grade, prepared and seeded.

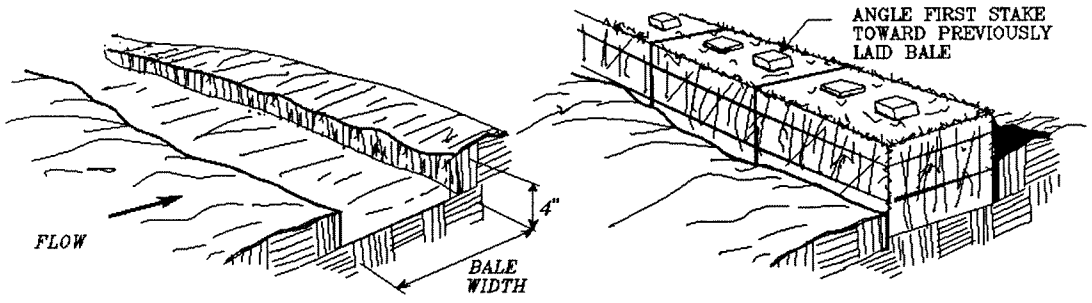
STRAW BALE BARRIER

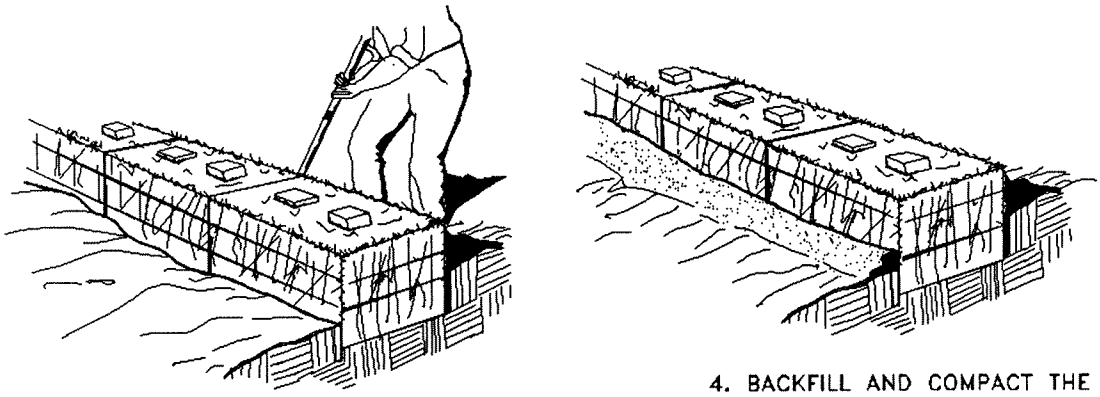


PROPERLY INSTALLED STRAW BALE
(CROSS SECTION)

1. EXCAVATE THE TRENCH.

2. PLACE AND STAKE STRAW BALES.





3. WEDGE LOOSE STRAW BETWEEN BALES.

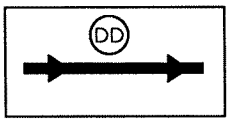
4. BACKFILL AND COMPACT THE EXCAVATED SOIL.

CONSTRUCTION OF STRAW BALE BARRIER

Source: Va. DSWC

Plate 3.04-1

STD & SPEC 3.09



TEMPORARY DIVERSION DIKE

Definition

A temporary ridge of compacted soil constructed at the top or base of a sloping disturbed area.

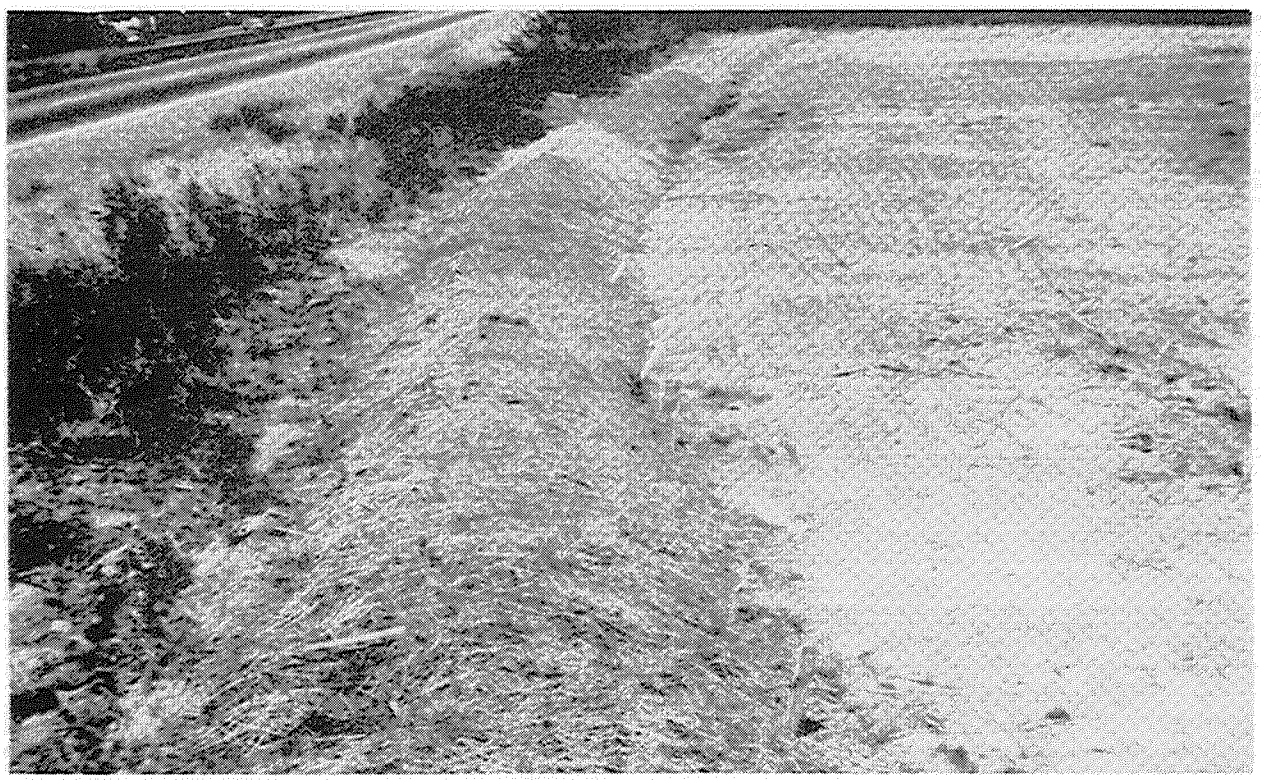
Purposes

1. To divert storm runoff from upslope drainage areas away from unprotected disturbed areas and slopes to a stabilized outlet.

2. To divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or sediment basin.

Conditions Where Practice Applies

Wherever stormwater runoff must be temporarily diverted to protect disturbed areas and slopes or retain sediment on site during construction. These structures generally have a life expectancy of 18 months or less, which can be prolonged with proper maintenance.



Planning Considerations

A temporary diversion dike is intended to divert overland sheet flow to a stabilized outlet or a sediment-trapping facility during establishment of permanent stabilization on sloping disturbed areas. When used a the top of a slope, the structure protects exposed slopes by keeping upland runoff away. When used at the base of a slope, the structure protects adjacent and downstream areas by diverting sediment-laden runoff to a sediment trapping facility.

As per M.S. #5, it is very important that a temporary diversion dike be stabilized immediately following installation with temporary or permanent vegetation to prevent erosion of the dike itself. The gradient of the channel behind the dike is also an important consideration. The dike must have a positive grade to assure drainage, but if the gradient is too great, precautions must be taken to prevent erosion due to high-velocity channel flow behind the dike. The cross-section of the channel which runs behind the dike should be of a parabolic or trapezoidal shape to help inhibit a high velocity of flow which could arise in a vee ditch.

This practice is considered an economical one because it uses material available on the site and can usually be constructed with equipment needed for site grading. The useful life of the practice can be extended by stabilizing the dike with vegetation. Diversion dikes are preferable to silt fence because they are more durable, less expensive, and require much less maintenance when constructed properly. Along with a TEMPORARY SEDIMENT TRAP (Std. & Spec. 3.13), they become a logical choice for a control measure once the control limits of the silt fence or straw bale barrier have been exceeded.

Temporary diversion dikes are often used as a perimeter control in association with a sediment trap or a sediment basin, or a series of sediment-trapping facilities, on moderate to large construction sites. If installed properly and in the first phase of grading, maintenance costs are very low. Often, cleaning of sediment-trapping facilities is the only associated maintenance requirement.

As specified herein, this practice is intended to be temporary. However, with more stringent design criteria, it can be made permanent in accordance with DIVERSIONS (Std. & Spec. 3.12).

Design Criteria

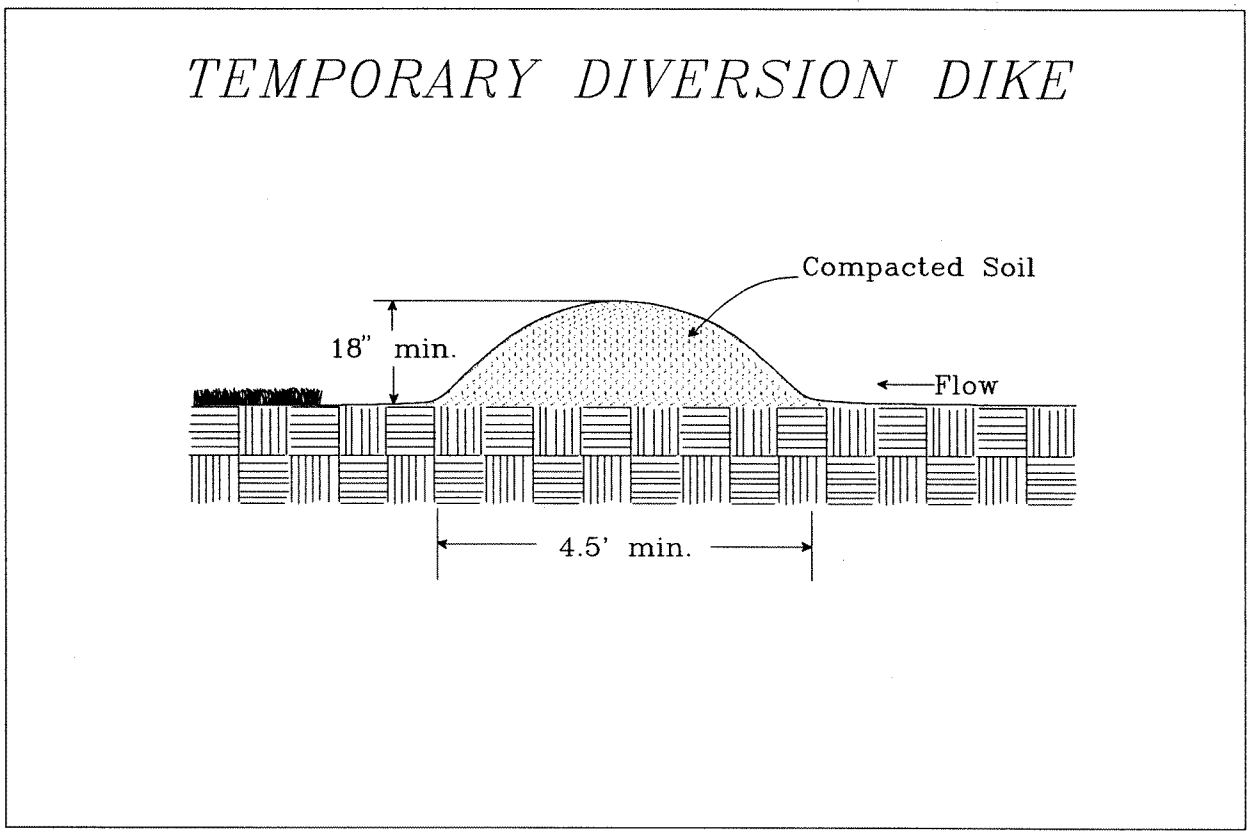
No formal design is required. The following criteria shall be met:

Drainage Area

The maximum allowable drainage area is 5 acres.

Height

The minimum allowable height measured from the upslope side of the dike is 18 inches (see Plate 3.09-1).



Source: Va. DSWC Plate 3.09-1

Side Slopes

1½:1 or flatter, along with a minimum base width of 4.5 feet (see Plate 3.09-1).

Grade

The channel behind the dike shall have a positive grade to a stabilized outlet. If the channel slope is less than or equal to 2%, no stabilization is required. If the slope is greater than 2%, the channel shall be stabilized in accordance with Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNEL.

Outlet

1. The diverted runoff, if free of sediment, must be released through a stabilized outlet or channel.

2. Sediment-laden runoff must be diverted and released through a sediment-trapping facility such as a TEMPORARY SEDIMENT TRAP (Std. & Spec. 3.13) or TEMPORARY SEDIMENT BASIN (Std. & Spec. 3.14).

Construction Specifications

1. Temporary diversion dikes must be installed as a first step in the land-disturbing activity and must be functional prior to upslope land disturbance.

2. The dike should be adequately compacted to prevent failure.

3. Temporary or permanent seeding and mulch shall be applied to the dike immediately following its construction.

4. The dike should be located to minimize damages by construction operations and traffic.

Maintenance

The measure shall be inspected after every storm and repairs made to the dike, flow channel, outlet or sediment trapping facility, as necessary. Once every two weeks, whether a storm event has occurred or not, the measure shall be inspected and repairs made if needed. Damages caused by construction traffic or other activity must be repaired before the end of each working day.

STD & SPEC 3.31

TEMPORARY SEEDING

TS

Definition

The establishment of a temporary vegetative cover on disturbed areas by seeding with appropriate rapidly growing annual plants.

Purposes

1. To reduce erosion and sedimentation by stabilizing disturbed areas that will not be brought to final grade for a period of more than ~~30~~ 14 days. RWE; DEQ-OTS 3-12-14

2. To reduce damage from sediment and runoff to downstream or off-site areas, and to provide protection to bare soils exposed during construction until permanent vegetation or other erosion control measures can be established.

Conditions Where Practice Applies

Where exposed soil surfaces ~~are not to be fine graded for periods longer than 30~~ will not be at final grade for more than 14 days. Such areas include denuded areas, soil stockpiles, dikes, dams, sides of sediment basins, temporary roadbanks, etc. (see MS #1 and MS #2). A permanent vegetative cover shall be applied to areas that will be left dormant for a period of more than 1 year.

Planning Considerations

Sheet erosion, caused by the impact of rain on bare soil, is the source of most fine particles in sediment. To reduce this sediment load in runoff, the soil surface itself should be protected. The most efficient and economical means of controlling sheet and rill erosion is to establish vegetative cover. Annual plants which sprout rapidly and survive for only one growing season are suitable for establishing temporary vegetative cover. Temporary seeding is encouraged whenever possible to aid in "controlling" construction sites.

Temporary seeding also prevents costly maintenance operations on other erosion control systems. For example, sediment basin clean-outs will be reduced if the drainage area of the basin is seeded where grading and construction are not taking place. Perimeter dikes will be more effective if not choked with sediment.

Temporary seeding is essential to preserve the integrity of earthen structures used to control sediment, such as dikes, diversions, and the banks and dams of sediment basins.

Proper seedbed preparation and the use of quality seed are important in this practice just as in permanent seeding. Failure to carefully follow sound agronomic recommendations will often result in an inadequate stand of vegetation that provides little or no erosion control.

Specifications

Prior to seeding, install necessary erosion control practices such as dikes, waterways, and basins.

Plant Selection

Select plants appropriate to the season and site conditions from Tables 3.31-B and 3.31-C. Note that Table 3.31-B presents plants which can be used without extensive evaluation of site conditions; Table 3.31-C presents more in-depth information on the plant materials.

Seedbed Preparation

To control erosion on bare soil surfaces, plants must be able to germinate and grow. Seedbed preparation is essential.

1. Liming: An evaluation should be conducted to determine if lime is necessary for temporary seeding. In most soils, it takes up to 6 months for a pH adjustment to occur following the application of lime. Therefore, it may be difficult to justify the cost of liming a temporary site, especially when the soil will later be moved and regraded. The following table may be used to determine the actual need along with suggested application rates.

TABLE 3.31-A

LIMING REQUIREMENTS FOR TEMPORARY SITES

pH Test	Recommended Application of Agricultural Limestone
below 4.2	3 tons per acre
4.2 to 5.2	2 tons per acre
5.2 to 6	1 ton per acre

Source: Va. DSWC

2. Fertilizer: Shall be applied as 600 lbs./acre of 10-20-10 (14 lbs./1,000 sq. ft.) or equivalent nutrients. Lime and fertilizer shall be incorporated into the top 2 to 4 inches of the soil if possible.

3. Surface Roughening: If the area has been recently loosened or disturbed, no further roughening is required. When the area is compacted, crusted, or hardened, the soil surface shall be loosened by discing, raking, harrowing, or other acceptable means (see SURFACE ROUGHENING, Std. & Spec. 3.29).

4. Tracking: Tracking with bulldozer cleats is most effective on sandy soils. This practice often causes undue compaction of the soil surface, especially in clayey soils, and does not aid plant growth as effectively as other methods of surface roughening.

Seeding

Seed shall be evenly applied with a broadcast seeder, drill, cultipacker seeder or hydroseeder. Small grains shall be planted no more than 1½ inches deep. Small seeds, such as Kentucky Bluegrass, should be planted no more than 1/4 inch deep. Other Grasses and Legumes should be planted from 1/4 inch to 1/2 inch deep.

Mulching

1. Seedings made in fall for winter cover and during hot and dry summer months shall be mulched according to MULCHING, Std. & Spec. 3.35, except that hydromulches (fiber mulch) will not be considered adequate. Straw mulch should be used during these periods.

2. Temporary seedings made under favorable soil and site conditions during optimum spring and fall seeding dates may not require mulch.

Re-seeding

Areas which fail to establish vegetative cover adequate to prevent rill erosion will be re-seeded as soon as such areas are identified.

TABLE 3.31-B

ACCEPTABLE TEMPORARY SEEDING PLANT MATERIALS

"QUICK REFERENCE FOR ALL REGIONS"

Planting Dates	Species	Rate (lbs./acre)
Sept. 1 - Feb. 15	50/50 Mix of Annual Ryegrass (Lolium multi-florum) & Cereal (Winter) Rye (Secale cereale)	50 - 100
Feb. 16 - Apr. 30	Annual Ryegrass (Lolium multi-florum)	60 - 100
May 1 - Aug 31	German Millet (Setaria italica)	50

Source: Va. DSWC

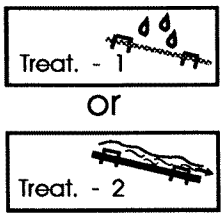
TABLE 3.31-C

TEMPORARY SEEDING PLANT MATERIALS, SEEDING RATES, AND DATES

SPECIES	SEEDING RATE		NORTH[a]			SOUTH[b]			PLANT CHARACTERISTICS
	Acre	1000 ft^2	3/1 to 4/30	5/1 to 8/15	8/15 to 11/1	2/15 to 4/30	5/1 to 9/1	9/1 to 11/15	
OATS (Avena sativa)	3 bu. (up to 100 lbs., not less than 50 lbs.)	2 lbs.	X	-	-	X	-	-	Use spring varieties (e.g., Noble).
RYE[d] (Secale cereale)	2 bu. (up to 110 lbs., not less than 50 lbs.)	2.5 lbs.	X	-	X	X	-	X	Use for late fall seedings, winter cover. Tolerates cold and low moisture.
GERMAN MILLET (Setaria italica)	50 lbs.	approx. 1 lb.	-	X	-	-	X	-	Warm-season annual. Dies at first frost. May be added to summer mixes.
ANNUAL RYEGRASS[c] (Lolium multi-florum)	60 lbs.	1½ lbs.	X	-	X	X	-	X	May be added in mixes. Will mow out of most stands.
WEEPING LOVEGRASS (Eragrostis curvula)	15 lbs.	5½ ozs.	-	X	-	-	X	-	Warm-season perennial. May bunch. Tolerates hot, dry slopes and acid, infertile soils. May be added to mixes.
KOREAN LESPEDEZA[c] (Lespedeza stipulacea)	25 lbs.	approx. 1½ lbs.	X	X	-	X	X	-	Warm season annual legume. Tolerates acid soils. May be added to mixes.

[a] Northern Piedmont and Mountain region. See Plates 3.22-1 and 3.22-2.
[b] Southern Piedmont and Coastal Plain.
[c] May be used as a cover crop with spring seeding.
[d] May be used as a cover crop with fall seeding.
X May be planted between these dates.
- May not be planted between these dates.

STD & SPEC 3.36



SOIL STABILIZATION BLANKETS & MATTING

B/M

Definition

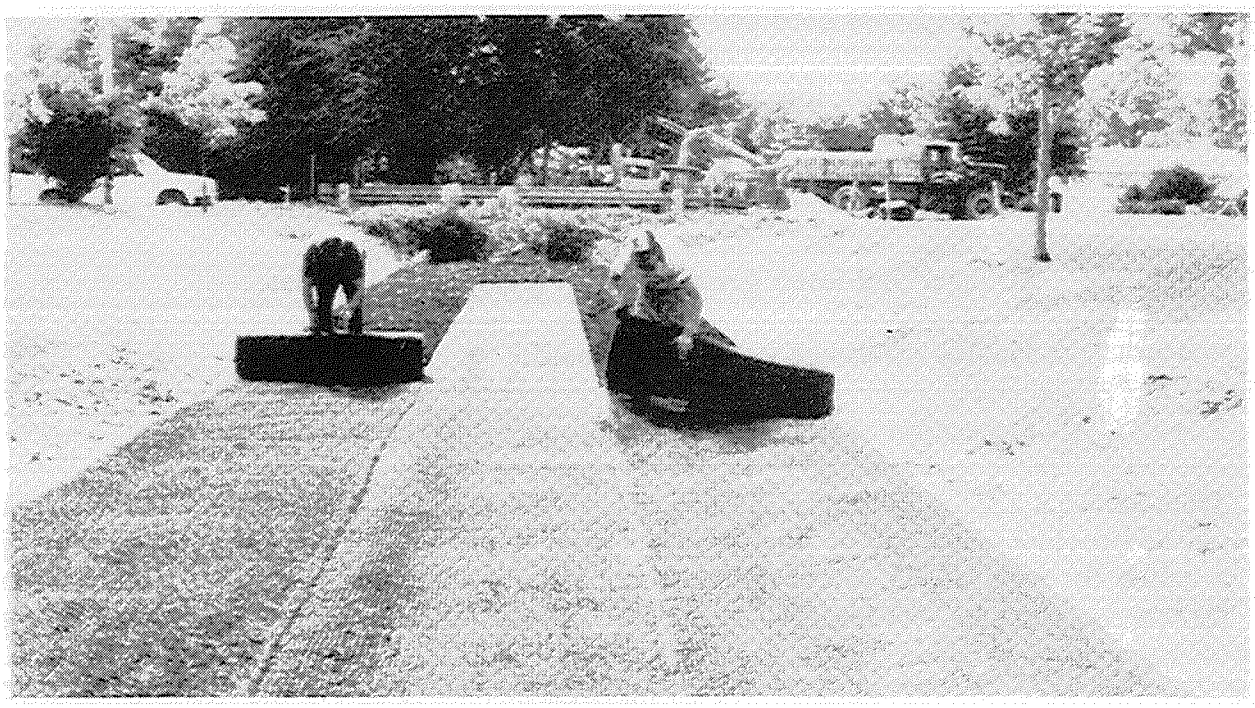
The installation of a protective covering (blanket) or a soil stabilization mat on a prepared planting area of a steep slope, channel or shoreline.

Purpose

To aid in controlling erosion on critical areas by providing a microclimate which protects young vegetation and promotes its establishment. In addition, some types of soil stabilization mats are also used to raise the maximum permissible velocity of turf grass stands in channelized areas by "reinforcing the turf" to resist the forces of erosion during storm events.

Conditions Where Practice Applies

On short, steep slopes where erosion hazard is high and planting is likely to be too slow in providing adequate protective cover; in vegetated channels where the velocity of design flow exceeds "allowable" velocity; on streambanks or tidal shorelines where moving water is likely to wash out new plantings; or in areas where the forces of wind prevent standard mulching practices from remaining in place until vegetation becomes established.



Planning Considerations

Soil stabilization blankets and mats can be applied to problem areas to supplement nature's erosion control system (vegetation) in its initial establishment and in providing a safe and "natural" conveyance for high velocity stormwater runoff. They are being used today in many applications were previously a structural lining would have been required. Care must be taken to choose the type of blanket or matting which is most appropriate for the specific needs of a project. Two general types of blankets and mats are discussed within this specification. However, with the abundance of soil stabilization products available today, it is impossible to cover all the advantages, disadvantages and specifications of all manufactured blankets and mats. Therefore, as with many erosion control-type products, there is no substitute for a thorough understanding of the manufacturer's instructions and recommendations and a site visit by a designer or plan reviewer to verify a product's appropriateness.

Treatment-1 is a degradable soil stabilization blanket which includes "combination" blankets consisting of a plastic netting which covers and is intertwined with a natural organic or man-made mulch; or, a jute mesh which is typically homogeneous in design and can act alone as a soil stabilization blanket.

It should be used to help establish vegetation on previously disturbed slopes - normally problem slopes of 3:1 or greater. Since the materials which compose the soil stabilization blankets will deteriorate over time, they should be used in permanent conveyance channels with the realization that the system's resistance to erosion is based on the type of vegetation planted and the existing soil characteristics. During the establishment of vegetation, **Treatment-1** should not be subjected to shallow or deep concentrated flows moving at greater than 4 feet/second.

Treatment-1 provides the following benefits in the achievement of vegetative stabilization when properly applied over seed and required amendments:

1. Protection of the seed and soil from raindrop impact and subsequent displacement.

2. Thermal consistency and moisture retention for seedbed area.

3. Stronger and faster germination of grasses and legumes.

4. Planing off excess stormwater runoff.

5. Prevention of sloughing of topsoil added to steeper slopes.

Treatment-2 is a soil stabilization matting which consists of a non-degradable, 3-dimensional plastic structure which can be filled with soil prior to planting. This configuration provides a matrix for root growth where the matting becomes entangled and penetrated by roots, forming continuous anchorage for surface growth and promoting enhanced energy

dissipation. **Treatment-2** can be used on problem slopes (normally 3:1 or greater), and in stormwater conveyance channels.

In addition to those benefits noted for **Treatment-1**, **Treatment-2** provides the following benefits in the achievement of vegetative stabilization and in the replacement of more traditional channel linings such as concrete and riprap:

1. Causes soil to drop out of stormwater and fill matrix with fine soils which become the growth medium for the development of roots.

2. When embedded in the soil within stormwater channels, it acts with the vegetative root system to form an erosion resistant cover which resists hydraulic lift and shear forces.

Since **Treatment-2** is non-degradable, it can be used in permanent conveyance channels and can withstand higher velocities of flow than the vegetation and soil would normally allow. However, a 10 feet/second velocity of flow should be the maximum allowed in a conveyance system which utilizes **Treatment-2.**

VDOT Nomenclature and Product Information

The Virginia Department of Transportation has its own nomenclature for many of the standards and specifications found in this handbook; this is true in the case of soil stabilization blankets and matting. The following relationship exists between the two methods of naming the practice:

Va. E&S-C Handbook		VDOT Specifications
Treatment-1	(is equivalent to)	EC-2
Treatment-2	(is equivalent to)	EC-3

It is recommended that most current VDOT "Approved Products List" for these products be consulted prior to installation of a particular blanket or mat. Importantly, the list names those products approved for a certain range of flow velocities when **Treatment-2** (VDOT's EC-3) installation is contemplated.

TREATMENT-1: SOIL STABILIZATION BLANKET

(Allowable Velocity Range During Vegetation Establishment: 0 - 4 f.p.s.)

Materials

1. Combination Blankets - They shall consist of a photo-degradable plastic netting which covers and is entwined in a natural organic or man-made mulching material.

The mulching material shall consist of wood fibers, wood excelsior, straw, coconut fiber, or man-made fibers, or a combination of the same. The blanket shall be of consistent thickness with the mulching material/fibers evenly distributed over its entire length. The mulching material/fibers must interlock or entwine to form a dense layer which not only resists raindrop impact, but will allow vegetation to penetrate the blanket.

The blanket shall be nontoxic to vegetation and to the germination of seed and shall not be injurious to the unprotected skin of humans. At a minimum, the plastic netting must cover the top side of the blanket and possess a high web strength. The netting shall be entwined with the mulching material/fiber to maximize strength and provide for ease of handling.

2. Jute Mesh - It shall be of a uniform, open, plain weave, of undyed and unbleached single jute yarn. The yarn shall be of loosely twisted construction and shall not vary in thickness by more than one half of its normal diameter. Jute mesh shall be new and shall conform to the following:

   a. Length of jute mesh shall be marked on each roll.

   b. There shall be 0.60-inch openings (± 25%) between strands, lengthwise.

   c. There shall be 0.90-inch openings (± 25%) between strands, lengthwise.

   d. Weight shall average 0.90 lbs./square yard with a tolerance of 5%.

   As previously noted, jute mesh provides such good coverage (large surface area of strands) and contains such small openings that it can be used alone as a blanket.

3. Other **Treatment-1** Products - These shall conform to manufacturer's specifications and be approved by the Plan-Approving Authority prior to being specified for a particular application. These products should be installed in accordance with manufacturer's recommendations, provided those recommendations are at least as stringent as this specification. Again, it is recommended that VDOT's "Approved Products List" be consulted. In no case shall these products cover less than 30% of the soil surface.

4. Staples - Staples for anchoring Treatment-1 shall be No. 11-gauge wire or heavier. Their length shall be a minimum of 6 inches. A larger staple with a length of up to 12 inches should be used on loose, sandy, or unstable soils.

Installation Requirements

Site Preparation - After site has been shaped and graded to approved design, prepare a friable seedbed relatively free from clods and rocks more than 1½ inches in diameter and any foreign material that will prevent uniform contact of the protective covering with the soil surface.

Planting - Lime, fertilize, and seed in accordance with seeding or other type of planting plan. When using jute mesh on a seeded area, apply approximately one-half the seed after laying the mat. The protective covering can be laid over sprigged areas where small grass plants have been inserted into the soil. Where ground covers are to be planted, lay the protective covering first and then plant through the material as per planting design.

When open-weave nets are used, lime, fertilizer, seed and mulch should be applied before laying the net. When a combination blanket (such as an "excelsior" blanket) is used, seed and soil amendments must also be applied before the blanket is laid.

Orientation - See Plate 3.36-1 for orientation of **Treatment-1** for different topographic conditions.

Laying and Stapling (see Plate 3.36-2) - If instructions have been followed, all needed check slots will have been installed, and the protective covering will be laid on a friable seedbed free from clods, rocks, roots, etc. that might impede good contact.

1. Start laying the protective covering from the top of the channel or top of slope and unroll down-grade.

2. Allow to lay loosely on soil - do not stretch.

3. Upslope ends of the protective covering should be buried in a anchor slot no less than 6-inches deep. Tamp earth firmly over the material. Staple the material at a minimum of every 12 inches across the top end.

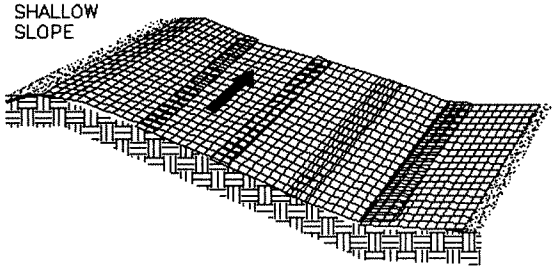
4. Edges of the material shall be stapled every 3 feet. Where multiple widths are laid side by side, the adjacent edges shall be overlapped a minimum of 2 inches and stapled together.

5. Staples shall be placed down the center, staggered with the edges at 3 foot intervals.

Check slots - On highly erodible soils and on slopes steeper than 4:1, erosion check slots should be made every 50 feet (see Plate 3.36-2). Insert a fold of the material (separate piece) into a 6-inch trench and tamp firmly. Staple fold to "main" blanket at minimum 12-inch intervals across the upstream and downstream portion of the blanket.

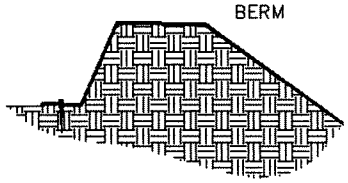
TYPICAL ORIENTATION OF TREATMENT – 1 (SOIL STABILIZATION BLANKET)

SHALLOW SLOPE

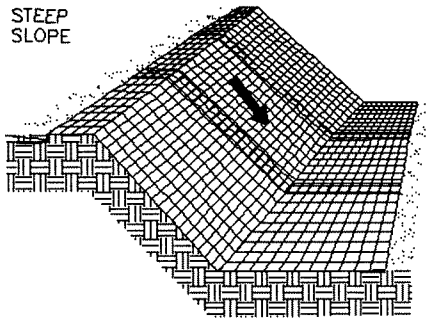


ON SHALLOW SLOPES, STRIPS OF NETTING PROTECTIVE COVERINGS MAY BE APPLIED ACROSS THE SLOPE.

WHERE THERE IS A BERM AT THE TOP OF THE SLOPE, BRING THE MATERIAL OVER THE BERM AND ANCHOR IT BEHIND THE BERM.

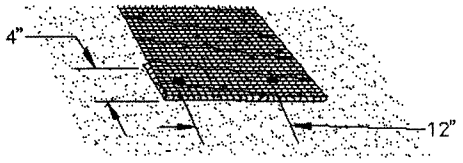


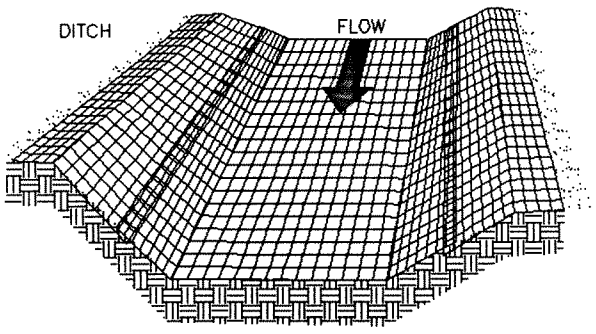
STEEP SLOPE



ON STEEP SLOPES, APPLY PROTECTIVE COVERING PARALLEL TO THE DIRECTION OF FLOW AND ANCHOR SECURELY.

BRING MATERIAL DOWN TO A LEVEL AREA BEFORE TERMINATING THE INSTALLATION. TURN THE END UNDER 4" AND STAPLE AT 12" INTERVALS.

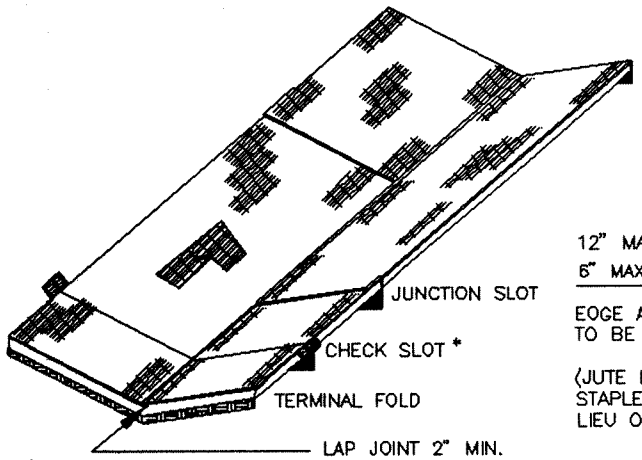




IN DITCHES, APPLY PROTECTIVE COVERING PARALLEL TO THE DIRECTION OF FLOW. USE CHECK SLOTS AS REQUIRED. AVOID JOINING MATERIAL IN THE CENTER OF THE DITCH IF AT ALL POSSIBLE.

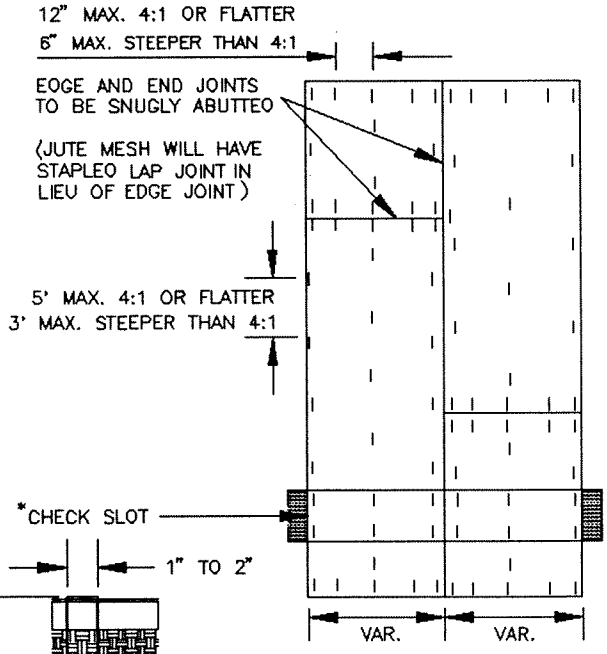
Source: Adapted from Ludlow Products Brochure Plate 3.36-1

TYPICAL TREATMENT – 1
(SOIL STABILIZATION BLANKET)
INSTALLATION CRITERIA

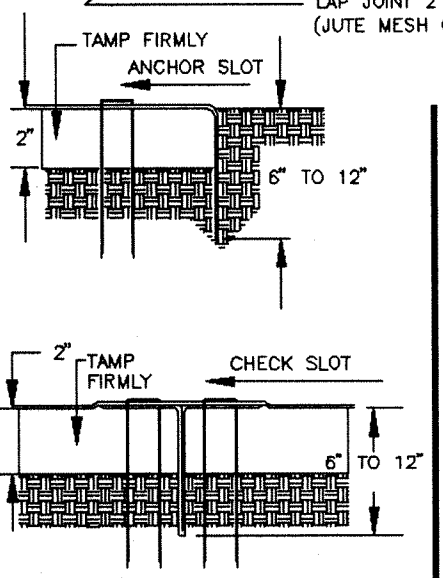


NOTES

APPROXIMATELY 200 STAPLES REQUIRED PER 100 SQ. YDS. OF MATERIAL ROLL. ANCHOR SLOTS, JUNCTION SLOTS & CHECK SLOTS TO BE BURIED 6" TO 12".

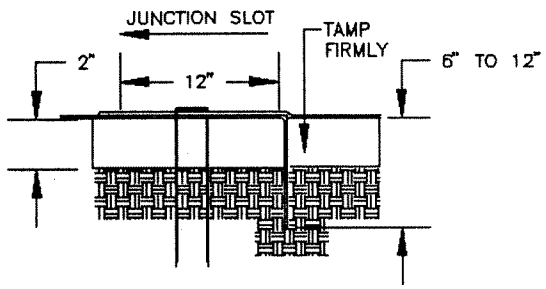


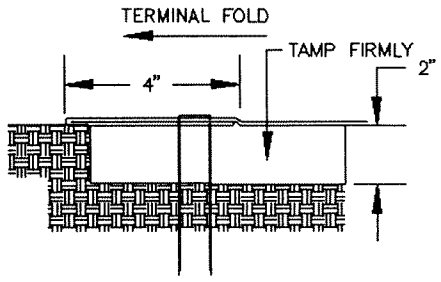
PLAN VIEW
STAPLING DIAGRAM



STAPLE FORMED FROM NO.11 STEEL WIRE.
8" STAPLE MIN. LENGTH FOR SANDY SOIL.
6" STAPLE MIN. LENGTH FOR OTHER SOIL.

*CHECK SLOTS AT MIN. 50' C–C INTERVALS; NOT REQ.'D WITH ALL "COMBINATION" BLANKETS





Source: VDOT Road and Bridge Standards

Plate 3.36-2

Note: Many combination blankets are designed and manufactured to resist movement and uplift to a point which check slots may not be required. Plan designers and review authorities are urged to study manufacturers' recommendations and site conditions.

Joining Protective Coverings - Insert a new roll of material into an anchor slot, as with upslope ends. Overlap the end of the previous roll a minimum of 12 inches, and staple across the end of the roll just below the anchor slot and across the material every 12 inches.

Terminal End - At the point at which the material is discontinued, or at which time the protective covering meets a structure of some type, fold 4 inches of the material underneath and staple every 12 inches (minimum).

At bottom of slopes - Lead net out onto a level area before anchoring. Turn ends under 4 inches, and staple across end every 12 inches.

Final Check - These installation techniques must be adhered to:

1. Protective blanket is in uniform contact with the soil.
2. All lap joints are secure.
3. All staples are driven flush with the ground.
4. All disturbed areas have been seeded.

TREATMENT-2: SOIL STABILIZATION MATTING

(Allowable velocity range after vegetative establishment: 0 - 10 f.p.s.)

Materials

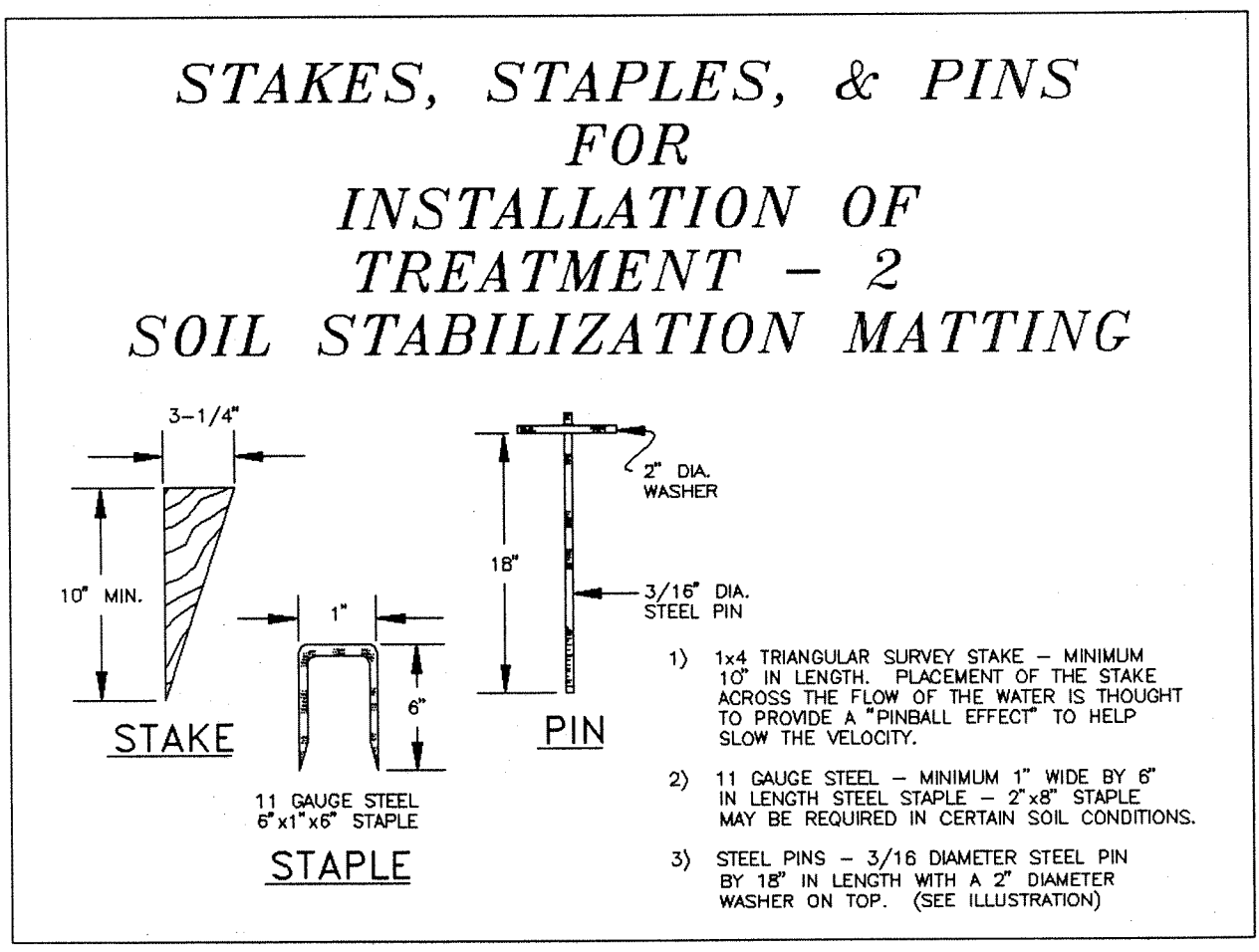
Matting - The majority of these products provide a three dimensional geomatrix of nylon, polyethylene, or randomly oriented monofilaments, forming a mat. These products contain ultra violet (UV) inhibiting stabilizers, added to the compounds to ensure endurance and provide "permanent root reinforcement."

The three dimensional feature creates an open space which is allowed to fill with soil. The roots of the grass plant become established within the mat itself, forming a synergistic root and mat system. As the grass becomes established, the two actually "reinforce" each other, preventing movement or damage to the soil. Allowable velocities are increased considerably over natural turf stands.

Selection of the appropriate matting materials along with proper installation become critical factors in the success of this practice. VDOT's "Approved Products List" can be a real asset in the selection process. Consultation with the supplier or the manufacturer and thorough

evaluation of performance data to ensure proper selection of a soil stabilization matting are also essential. Although many manufacturers claim their products may inhibit erosion associated with channel velocities of up to 20 ft./sec., it is recommended that any velocities that exceed 10 ft./sec. be properly protected with some form of structural lining (see Std. & Spec. 3.17, STORMWATER CONVEYANCE CHANNEL).

Staples - Staples or anchoring methods and recommendations vary by manufacturers. The expectation of high velocities should dictate the use of more substantial anchoring. Some of the typically recommended stakes, staples and pins are depicted in Plate 3.36-3



Source: Product literature from Greenstreak, Inc. Plate 3.36-3

Installation Requirements

Site Preparation - After site has been shaped and graded to approved design, prepare a friable seedbed relatively free from clods and rocks more than 1 inch in diameter, and any foreign material that will prevent contact of the soil stabilization mat with the soil surface. If necessary, redirect any runoff away from the ditch or slope during installation.

Planting - Lime, fertilize and seed in accordance with MS #1 and the approved plan, paying special attention to the plant selection that may have been chosen for the matted area. If the area has been seeded prior to installing the mat, make sure and reseed all areas disturbed during installation.

Mulching - Mulch (normally straw) should be applied following installation of **Treatment-2** at rates noted in Std. & Spec. 3.35, MULCHING.

Laying and Securing - See Plates 3.36-4, 3.36-5 and 3.36-6. Similar to installing **Treatment-1**, but Plan Approving Authority's requirements or manufacturer's recommendations must be followed as detailed. The key to achieving desired performance is dependent upon proper installation.

Check Slots - See Plate 3.36-4. Matting manufacturers vary significantly in their check slot requirements. Similar to the installation of **Treatment-1**, a check slot may be required when laying **Treatment-2** to "correct" the flow of water if it has the potential to undermine the matting. Most authorities (including VDOT) require that the sides of the matting also be entrenched, creating a slope shelf for the material to rest on, preventing water from entering under the mat on the sides.

Securing the Material and Joining Mats - Again, product specifications vary - upstream and downstream terminal slots, new roll overlaps and multiple width installations differ by various products and manufacturers.

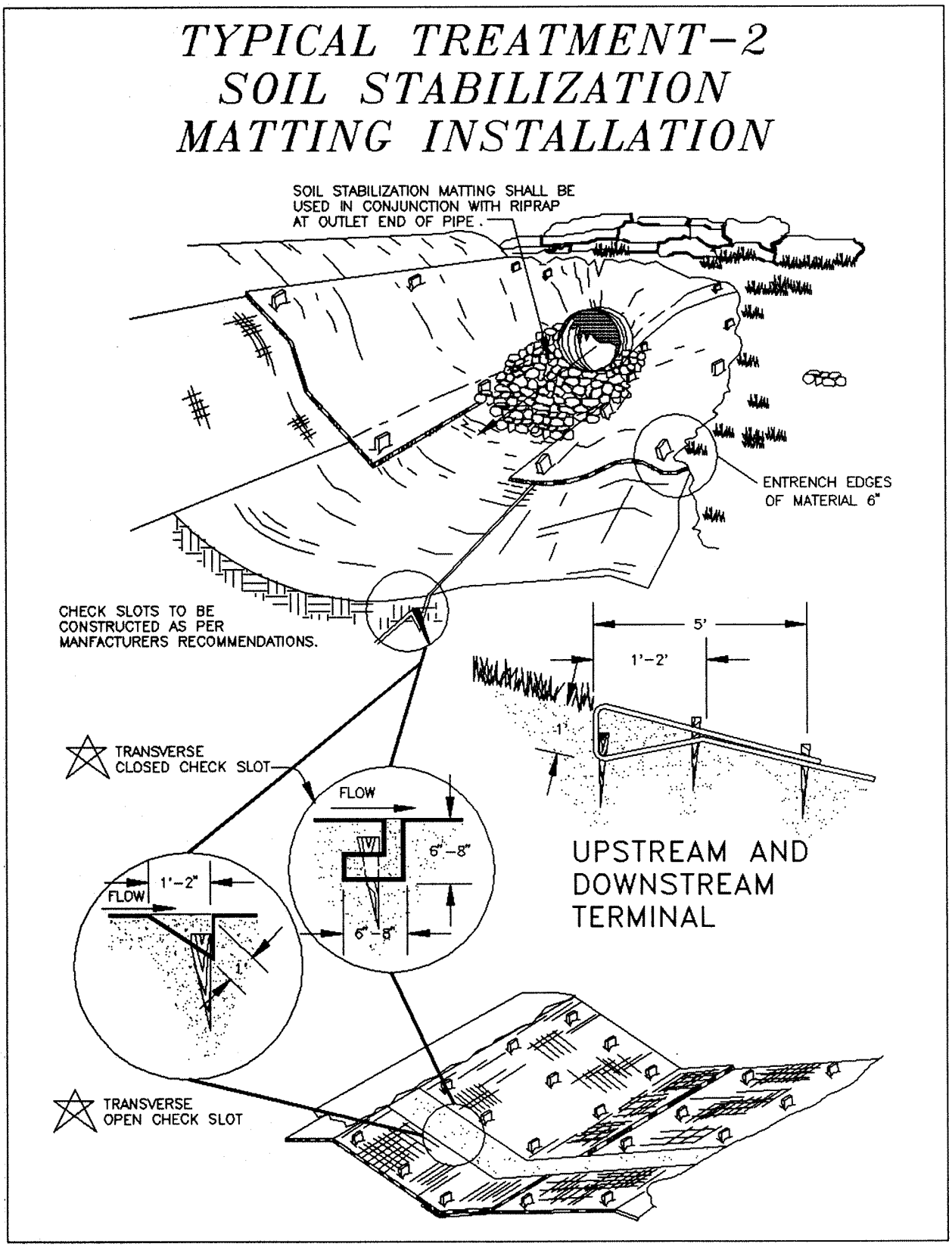
Final Check - These installation techniques must be adhered to:

1. Soil stabilization mat is in uniform contact with the soil.
2. All required slots and lapped joints are in place.
3. The material is properly anchored.
4. All disturbed areas are seeded.

Maintenance

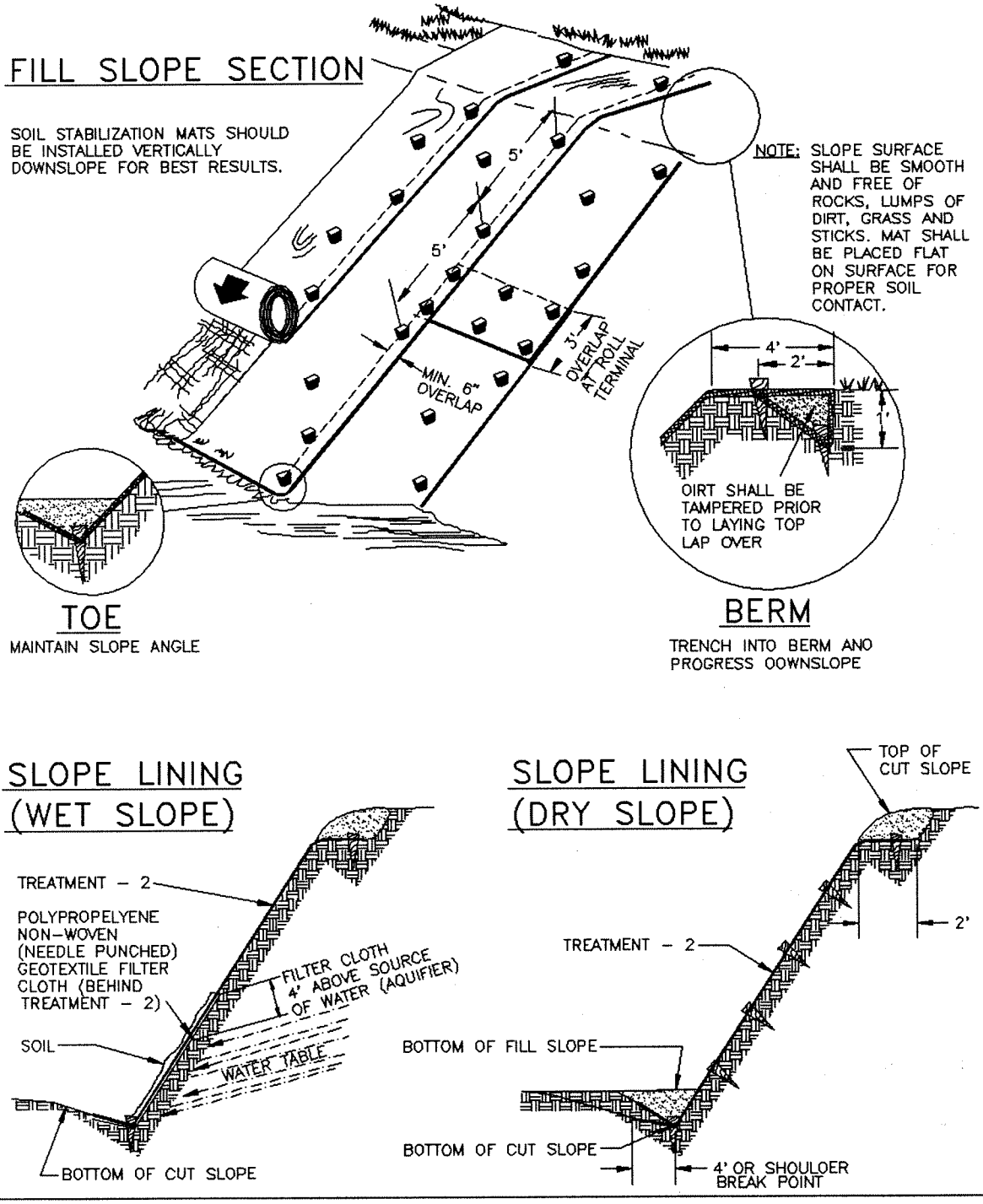
All soil stabilization blankets and matting should be inspected periodically following installation, particularly after rainstorms to check for erosion and undermining. Any dislocation or failure should be repaired immediately. If washouts or breakage occurs, re-install the material after repairing damage to the slope or ditch. Continue to monitor these areas until which time they become permanently stabilized; at that time an annual inspection should be adequate.

TYPICAL TREATMENT–2 SOIL STABILIZATION MATTING INSTALLATION



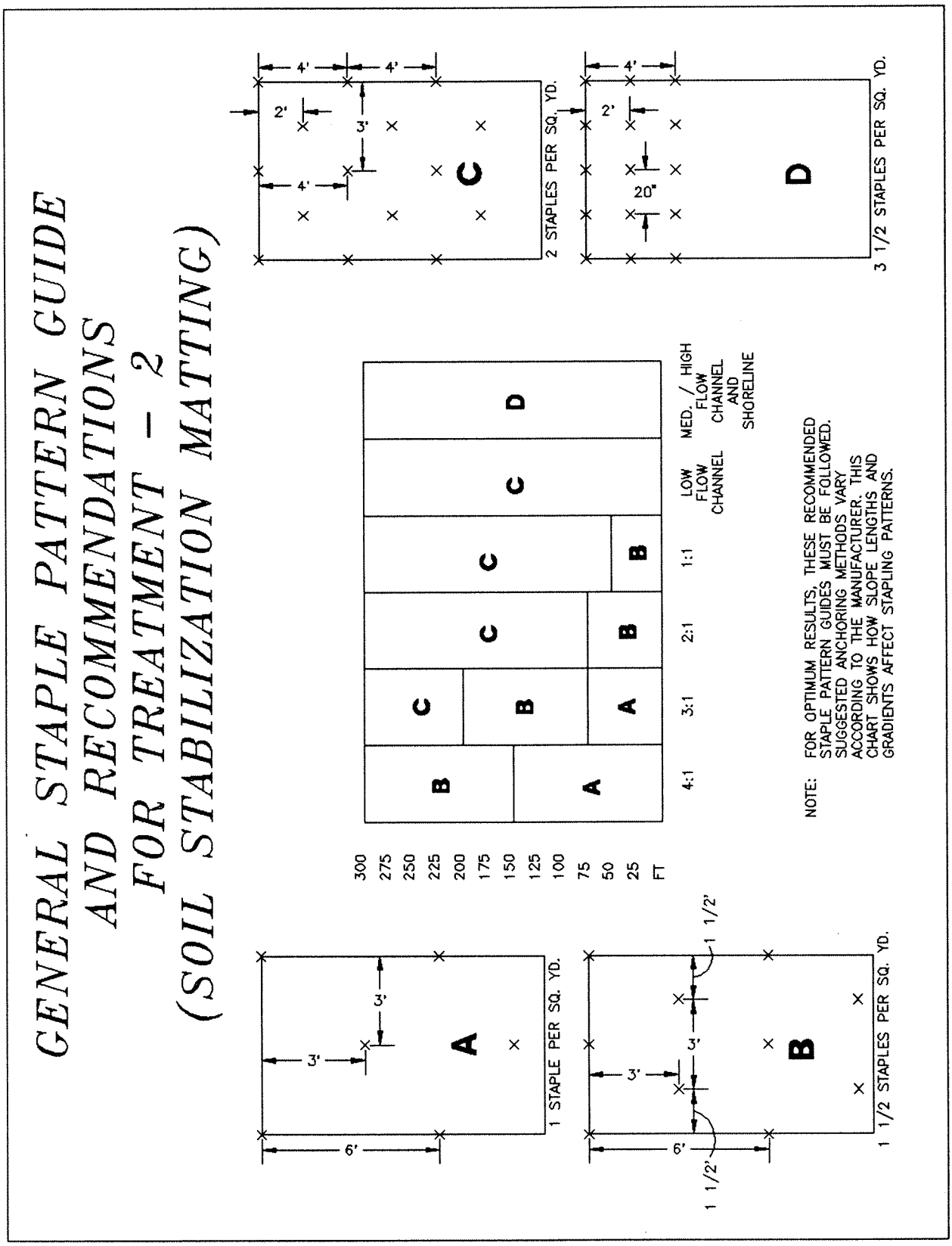
Source: VDOT Road and Bridge Standards Plate 3.36-4

TYPICAL TREATMENT – 2
SOIL STABILIZATION MATTING
SLOPE INSTALLATION



Source: VDOT Road and Bridge Standards

Plate 3.36-5



Source: Product literature from North American Green

Plate 3.36-6

12-2004

PB1746 A Landowner's Guide to Native Warm-Season Grasses in the Mid-South

The University of Tennessee Agricultural Extension Service

UT Extension
PB 1746

A Landowner's Guide to Native Warm-Season Grasses in the Mid-South

THE UNIVERSITY of TENNESSEE

Contents

A Landowner's Guide to Native Warm-Season Grasses in the Mid-South

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Native warm-season grasses (nwsg) are grasses historically native to an area that grow during the warm months of the year and are dormant during autumn and winter. They differ from cool-season grasses, which make their active growth during spring and fall. There are many warm-season grasses native to the Mid-South region; however, seven species are most commonly promoted as cover for wildlife and/or forage for livestock. These are big bluestem, little bluestem, broomsedge bluestem, indiangrass, switchgrass, sideoats grama and eastern gamagrass. Not all of these, however, have the same quality for wildlife habitat or livestock forage. For example, broomsedge offers excellent nesting habitat for bobwhites, but poor forage for livestock.

IDENTIFICATION AND DESCRIPTION

Big bluestem may reach 8–9 feet, depending on cultivar and site conditions. One of the best features used to identify this grass before flowering is the presence of fine silky hairs dispersed near the base of the upper leaf surface. The seedhead has three racemes that resemble a turkey's foot. Seed are relatively dark and hairy. Big bluestem grows on a wide variety of soils and is extremely drought-tolerant, with root systems that may grow 12 feet deep. Big bluestem provides excellent wildlife habitat and quality forage for livestock. 'Rountree,' 'Kaw' and 'Oz-70' are cultivars suited for the Mid-South.


Big bluestem


Little bluestem

Little bluestem grows 2–4 feet in height. The stem is flattened at the base and often red or purplish during early growth. Mature plants are reddish-brown. Little bluestem seed also appear hairy. Little bluestem grows on a wide variety of soils and is one of the most attractive grasses in summer and fall. Little bluestem provides quality wildlife habitat and has great potential for landscaping and erosion control on poor, droughty soils. The 'Aldous' cultivar is best suited for the Mid-South.

Broomsedge bluestem grows 2–4 feet in height and is commonly seen throughout the Mid-South. The stem is flattened at the base and smooth. Mature plants are tannish-brown and somewhat resemble little bluestem; however, broomsedge is lighter in color than little bluestem, which usually has a reddish hue. When dormant, broomsedge appears quite orange, while little bluestem is distinctly more reddish-brown. Broomsedge grows on a wide variety of soils and is renowned for growing in fields low in fertility. Broomsedge provides quality nesting habitat for many birds, but its forage quality is low.

Broomsedge bluestem

Indiangrass is typically 4–7 feet in height. Leaves are flat and narrow at the base, growing 10–24 inches long. The seedhead is golden bronze-to-yellow, 6–12 inches long, and usually formed in late August. The seed are tan and very fluffy. Indiangrass produces a deep root system and is quite drought-tolerant. Indiangrass provides quality wildlife habitat and quality forage for livestock. ‘Newberry,’ ‘Osage’ and ‘Rumsey’ are cultivars best-suited for the Mid-South.

Indiangrass

Switchgrass typically reaches 3–6 feet in height. Switchgrass is an early-maturing warm-season grass, flowering in early to mid-June. Switchgrass is adapted to a wide variety of soils and site conditions. With an extensive root system, switchgrass is extremely drought-tolerant, but also does well on relatively wet sites with at least one cultivar (‘Kanlow’) tolerant of extended flooding. Seed from switchgrass are small, smooth and hard, somewhat resembling millet in size and color. There are many cultivars of switchgrass. In the Mid-South, ‘Kanlow’ (uplands and lowlands) and ‘Cave-in-Rock’ (uplands) are well-suited for wildlife cover and livestock forage. ‘Durham’ and ‘Blackwell’ are well-suited for wildlife habitat.

Switchgrass

Sideoats grama grows to a height of 1–3 feet. Seedstalks begin to appear in June and July. The oat-like seeds hang down uniformly along one side of the slender rachis, thus the name “sideoats.” Leaf blades are fine and have single hairs evenly spaced along the edges of the blade. Sideoats grama grows well on well-drained uplands and shallow ridges, but is not well-adapted to lowlands. ‘El Reno’ and ‘Trailway’ are cultivars best-suited for the Mid-South.

Sideoats grama

Eastern gamagrass may reach 6–8 feet in height, producing conspicuous stools up to 4 feet in diameter. Over time, stool size increases with age and the center will lack stems and leaves. Eastern gamagrass will grow to 5–9 feet tall. The seedhead is comprised of two or three terminal spikes 6–10 inches long. Seed somewhat resemble corn kernels. It is highly recommended to use cold-stratified seed when planting to maximize germination. Eastern gamagrass is extremely deep-rooted and drought-tolerant. It grows best on relatively moist, well-drained fertile soils, but does not tolerate standing water for long periods. 'Highlander,' 'Pete' and 'Iuka' are cultivars well-suited for the Mid-South.

Eastern gamagrass

Other nwsg found in the Mid-South include splitbeard bluestem, Elliot's bluestem, bushy bluestem, purpletop, giant cane, beaked panicum, Scribner's panicum, Florida paspalum, silver plumegrass, knotroot bristlegrass and lovegrass. Their value to wildlife varies, but their value as forage is minimal.

USING NATIVE WARM-SEASON GRASSES FOR WILDLIFE HABITAT

Native grasslands are the most endangered ecosystem in the Mid-South. Historically, the region contained vast acreages of native grassland and savannas with scattered trees and shrub cover, which was maintained by fire. Today, that acreage has been replaced with non-native grasses (e.g., tall fescue, orchardgrass and bermudagrass), agricultural crops, forest cover and suburban development. As a result, several wildlife species dependent upon quality early successional habitat have experienced significant declines in population.

Historically, mixed grassland savannas were prevalent across the Mid-South. This scene in southeast Tennessee was a high-graded oak-hickory stand through most of the 20th century until it was cleared of all but a few select trees. After timber removal, the area has been maintained with fire. Note the big and little bluestem – they were **not** planted, but arose naturally from the seedbank, remaining viable after at least 80 years. In addition, this site has never been sprayed. When invasive, non-native species (e.g., tall fescue, crabgrass, johnsongrass, bermudagrass) are not present, native plants can colonize an area easily and herbicide applications are often not necessary.

Nwsg can be used to enhance early successional cover for species such as bobwhite quail, cottontail rabbit, field sparrow, Henslow's sparrow, grasshopper sparrow, indigo bunting, prairie warbler, dickcissel, eastern meadowlark, loggerhead shrike, American kestrel, northern harrier and others. Fields of nwsg and associated forbs (broadleaf herbaceous plants) are also used by wild turkeys for nesting and brood rearing and by white-tailed deer for bedding and escape cover. **Nwsg are established for wildlife primarily because of the structure of cover provided**. Suitable cover is more often a limiting factor for species such as quail, rabbits and grassland songbirds than food. Nwsg are not planted as food plots.

Importance of open structure

Because most nwsg grow in "bunches," open space at ground level can be provided when bunches are not too dense. An open structure at ground level allows mobility for small wildlife (e.g., quail, rabbits, sparrows and young turkeys) through the field. Dense vegetation and thatch build-up (such as that presented by perennial cool-season grasses) inhibits movement and makes finding food (seed and invertebrates) difficult. When these conditions prevail, the number of animals an area can support is reduced, leading to stagnant or declining populations.

Sparse stands of nwsg with an open structure at ground level are obviously attractive for brood rearing, but they are also used for nesting – one bunch of nwsg represents a potential nesting site – if the field has not been burned or disced in the past year. Birds and rabbits use senescent (dead) leaves of previous years' growth to construct and line nests. An attractive characteristic of nwsg is that senescent leaves and stems remain erect into the following growing season. This reduces thatch build-up, provides protective cover through winter and allows birds, such as Henslow's and field sparrows, dickcissels and indigo buntings, to nest above ground amongst the senescent stems the following spring.

Although moderately dense stands of nwsg may not be as attractive for brooding, they are used for nesting and escape cover. Obviously, these stands may have more potential as nesting sites than sparse stands, but they also offer more protective cover, especially during winter. Extremely dense stands, however, inhibit movement of some small animals and become less attractive. At this point, management is needed to thin the stand.

This is what a field planted for wildlife should look like in early June. Sparse nwsg, abundant forbs (ragweed, partridge pea) and open ground space provide the optimum structure for brooding and a seed source for fall and winter.

Bobwhite quail nest situated at the base of a 2-year-old bunch of broomsedge. Note how the senescent leaves from last year are used to construct the nest.

Importance of forbs and shrubs

An open structure at ground level also enables the seedbank (seed in the top few inches of soil) to germinate. Arising from the seedbank are plants such as ragweed, blackberry, partridge pea, beggar's-lice, pokeweed, native lespedezas and annual sunflowers. Forb cover is critical in making a field of nwsg most attractive to wildlife. These plants provide an excellent canopy of brood-rearing cover for quail and wild turkeys; quality forage for deer, rabbits and groundhogs; and later produce seed and soft mast that is an important source of energy through summer and into fall and winter for many wildlife species. Scattered brush and small trees also can make a field of nwsg and associated forbs more attractive to wildlife, particularly bobwhites and several spe-

Forbs (e.g., blackberries, partridge pea and ragweed) provide excellent brooding cover and a source of seed for bobwhites and other species.

cies of songbirds. Bobwhites often use brushy cover as a "covey headquarters" during fall and winter. Indigo buntings, dickcissels, yellow-breasted chats, cardinals, prairie warblers, white-eyed vireos, eastern kingbirds, loggerhead shrikes and others use scattered clumps of shrubs and small trees for perching and nesting. Many of these shrubs and small trees also offer a valuable food source for many birds and mammals. Examples include American crabapple, wild plum, hawthorn, sumac, wild cherry, persimmon, elderberry, hazelnut, witch-hazel, dogwoods, Carolina buckthorn, viburnums and devil's walkingstick.

Winter cover

Nwsg provide quality cover during winter if the grasses are not previously bushhogged or otherwise destroyed. Fields of nwsg are often magnets for rabbits, over-wintering songbirds and deer. This can be especially critical for small wildlife at a time when quality cover is at a premium. Tall nwsg, such as big bluestem, indiangrass and switchgrass, are especially valuable as their stems "lodge" (remain somewhat upright, leaning against each other), continuing to provide cover even after winter rains, snow and wind. Deer seek out nwsg fields on cold, clear days because they can remain hidden in the tall grasses, yet are able to absorb the sun's warm rays. In low-lying bottomlands that periodically flood in winter, fields of switchgrass (especially the Kanlow variety) can attract large numbers of ducks when shallowly flooded.

Taller nwsg species (e.g., big bluestem, indiangrass and switchgrass) provide excellent cover in winter because their stems "lodge," creating usable space for wildlife. Here, a rabbit finds a winter home. This type of structure is not available in cool-season grass fields.

PROBLEMS ASSOCIATED WITH TALL FESCUE AND OTHER PERENNIAL COOL-SEASON GRASSES

There are many problems associated with tall fescue and other perennial cool-season grasses, both for wildlife and livestock. Problems for livestock are associated with an endophyte fungus found within tall fescue that is highly toxic. Cattle consuming tall fescue (either grazing or as hay) often experience poor weight gains, reduced conception rates, intolerance to heat, failure to shed the winter hair coat, elevated body temperature and loss of hooves. Problems with horses are more severe, especially 60–90 days prior to foaling. Fescue toxicity in horses often leads to abortion, prolonged gestation, difficulty with birthing, thick placenta, foal deaths, retained placentas, reduced (or no) milk production and death of mares during foaling. As a forage, tall fescue and other perennial grasses (e.g., orchardgrass) are

Fields of tall fescue are common throughout the Mid-South. This is poor wildlife habitat and, for many species, it might as well be covered in asphalt.

least preferred by white-tailed deer among cool-season forages. Cottontail rabbits had lower weights and smaller litters in tall fescue habitats. When fed a diet of tall fescue seed, bobwhites exhibited cloacal swelling, which ultimately led to increased mortality. Undoubtedly, many of the toxic effects from tall fescue on wildlife that consume the seed or foliage are unknown.

This is the structure presented in a field of tall fescue (and other perennial cool-season grasses) for a quail chick, sparrow, turkey poult or young rabbit 4–5 inches tall. If you were 5 inches tall and had to travel through this, where would you go? To the edge – and that's where small wildlife are forced to go. Tall fescue has displaced more wildlife habitat in the Mid-South than any other practice.

Known problems of tall fescue for wildlife are associated more with the structure created by the growth habit. Other introduced cool-season perennial grasses (e.g., orchardgrass, bromegrasses, timothy and Kentucky bluegrass) also develop sub-optimal growing conditions (dense growth and deep thatch) near ground level, making travel and foraging difficult for many wildlife species (especially ground birds). The dense growth structure and thatch layer not only prevent birds from picking seed up off the ground, but also prevent seeds in the seedbank from germinating. Thus, vegetative diversity and weed seed available as food are drastically reduced. Cool-season grasses also provide poor winter cover for wildlife because of a lack of overhead structure.

Cool-season perennial grasses (especially tall fescue and bromegrass) are very competitive. When grown in association with nwsg, perennial cool-season grasses will, over time, lead to reduced coverage of nwsg and make the field less attractive to wildlife. When grown in association with clovers in a firebreak or forage food plot, tall fescue, orchardgrass and bromegrasses will dominate the site within 18 months, leaving little or no clover available for forage.

MANAGING NATIVE WARM-SEASON GRASS FIELDS FOR WILDLIFE

A field of nwsg is no better than the technique(s) used to manage it. If not managed correctly, nwsg can become rank and unattractive to many wildlife species. Management is needed to set back succession and create the vegetative composition and structure desired. **An open structure at ground level within a nwsg field is determined largely by the density of grass bunches and stand management, especially burning**. If the field is not disturbed periodically by prescribed burning or discing, an open structure at ground level will not be maintained.

Burning

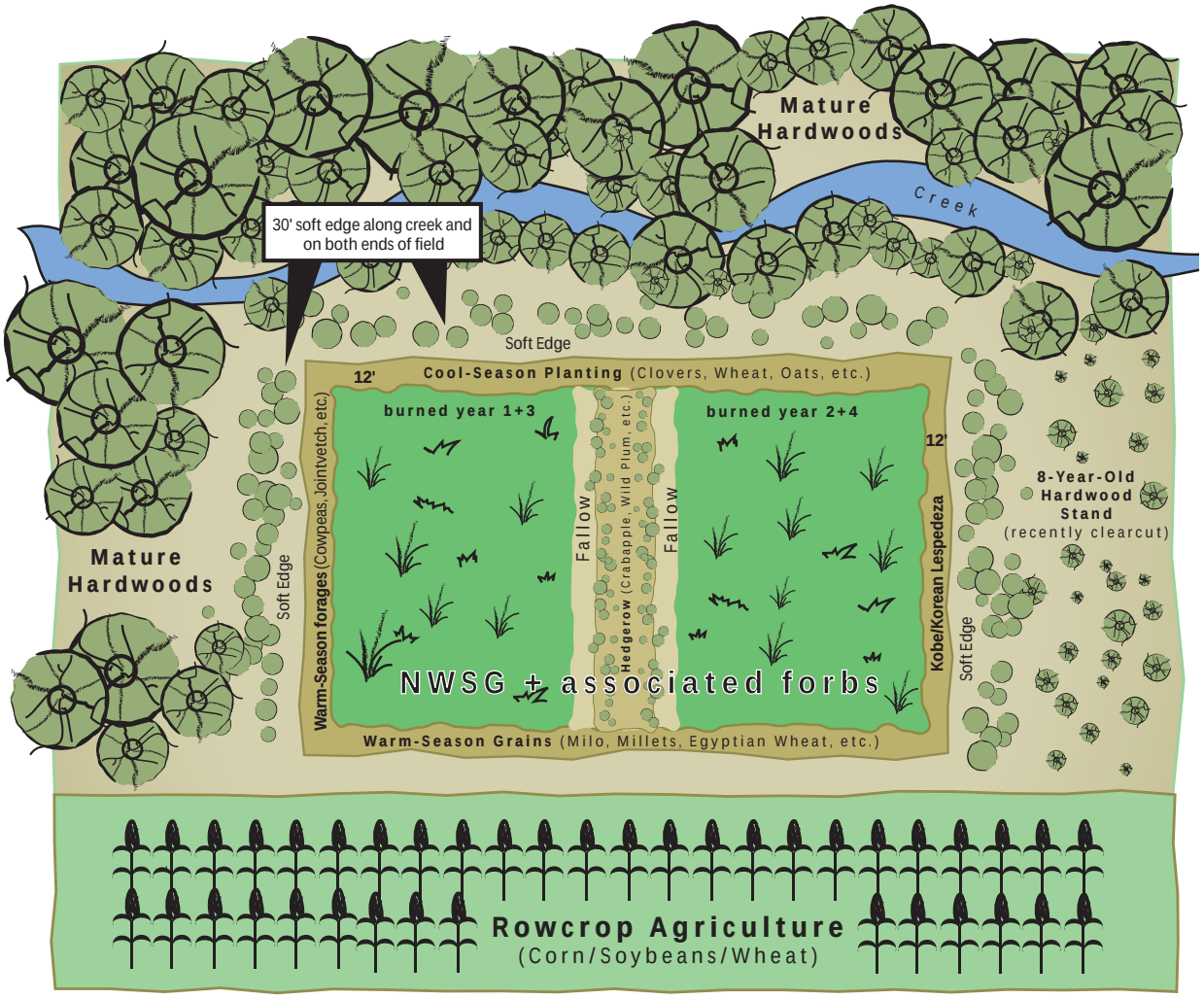
Prescribed fire reduces litter buildup, sets back succession, increases nutrient availability and stimulates herbaceous growth. Fields are most often burned in late winter, just before spring green-up. This reduces winter cover only for a short time and does not disrupt nesting birds and rabbits. If woody succession is a problem, fields can be burned just after bud break to kill woody competition. Prescribed fire in late summer/early fall can be used when nwsg have become too dense and additional forb growth is desired. Burning at this

time also can be used to reduce woody succession, if completed before leaf senescence. Using prescribed fire is efficient, effective, cheap and easy; however, planning and experience are necessary. Burning is controlled and objectives are met only when conducted under the appropriate conditions. State wildlife and forestry agencies and/or local chapters of Quail Unlimited often help landowners who need burning assistance.

Prescribed fire is contained by creating firebreaks (disced strips 10–30 feet wide) around the area to be burned. Firebreaks should be planted for increased food resources around nwsg fields. By planting various mixtures in different sections of the firebreak, a supplemental food source is available year-round. Other sections can be left fallow for weed growth. Examples of mixtures for firebreaks are on page 10. [For additional mixtures and planting information, refer to ***Growing and Managing Successful Wildlife Food Plots in the Mid-South***, UT Extension PB 1743.] Regardless of the mixture used, introduced perennial grasses (e.g., orchardgrass and tall fescue) should never be planted to a firebreak because of reasons stated previously.

Burning is strongly recommended to manage fields of nwsg. This series of pictures shows a nwsg field just before, during, immediately after and the growing season after burning. Burning stimulates growth, recycles nutrients to the soil and creates excellent early successional habitat.

Planting Mixtures for Firebreaks (rates are per acre)	
Cool-season mixture (annual) 25# wheat or oats 20# Austrian winter peas 10# crimson clover 3# arrowleaf clover **Cool-season mixture (perennial)** 25# wheat or oats 6# red clover 5# ladino white clover 2# birdsfoot trefoil	**Warm-season mixture (annual)** 20# soybeans 15# iron-clay cowpeas 10# buckwheat 5# browntop millet 5# grain sorghum (milo) **Warm-season mixture (annual)** 15# Kobe or Korean lespedeza 2# partridge pea



This diagram shows a field of nwsg and how it might be placed in arrangement with other cover types. Note how the firebreak is planted in different sections with various plantings to provide a supplemental food source throughout the year.

Discing

In some areas, it is difficult to burn because of smoke-management issues. Also, many landowners are reluctant to burn because of inexperience. In these situations, nwsg fields should be managed by discing. Discing sets back succession, increases open space at ground level, facilitates litter decomposition and stimulates the seedbank. Discing can be completed in blocks (≥ 1 acre) or strips (≥ 50 feet wide) oriented with the contour of the field (to prevent erosion). Undisced strips should be about twice as wide as disced strips. This allows one-third of the field to be disced each year.

This field is being managed by discing alternate strips in winter. This will provide brooding cover adjacent to nesting cover.

Discing at different times of the year affects vegetation composition, depending on site conditions and the seedbank present. For example, discing in the fall may produce a different suite of forbs than discing in spring. Discing in the fall also creates walking and shooting lanes for hunting quail or rabbits. A good way to determine the preferred time to disc and the seedbank response within individual fields is to disc strips at various times through the year. Disced areas can be interseeded with legumes and other forbs if needed. **Bushhogging (without burning or discing) is not a recommended practice for managing nwsg** because it increases the litter layer, makes travel through the field difficult for small wildlife and inhibits the seedbank from germinating. It is usually necessary, however, to bushhog before discing is possible. Bushhogging along a firebreak prior to burning also may be used to reduce flame heights.

Herbicide applications

Another management practice often necessary is herbicide applications. Strip spraying a grass-selective herbicide (e.g., Select♦) in late April using alternate spray nozzles can decrease grass density, create additional open space at ground level and stimulate the seedbank. Strip spraying should be conducted in patterns similar to those recommended for discing. Spot spraying or broadcast spraying other selective herbicides (see Appendix 1) may be necessary to reduce several problem grasses (e.g., crabgrass, tall fescue) and forbs (e.g., sericea lespedeza, thistles), as well as woody competition (e.g., sweetgum, winged elm). In all cases, herbicide labels should be read before use and followed closely with regard to restrictions, precautions, rates, recommended tank mixtures, surfactants and sprayer-cleaning recommendations.

Managing on rotation

Because structural requirements vary among wildlife species and among seasons, it is not recommended to set back succession on an entire field (depending upon field size) or on all fields (depending upon the number of fields and their proximity on a property) in one year. Instead, fields (or portions of) should be burned or disced on a 2- to 4-year rotation. For example, if brood habitat and forage quality are prime in a field the summer after a winter burn and nesting habitat is prime two or three years after a burn, then it is undesirable to burn all available habitat every year. Escape cover may be best three or four years after burning. Large individual fields can be managed by discing firebreaks and creating smaller sections within the field. Sections then can be managed on rotation. Smaller fields can be burned or disced entirely.

This landowner has gone out of his way to juxtapose different successional stages. Burning in a checkerboard fashion ensures quality brooding cover is adjacent to nesting cover. While burning half the field one year and the other half the following year is fine, burning sections such as this provides a very diverse structure across the field.

MANAGING THE ARRANGEMENT

When a property is managed specifically for wildlife, the most important consideration is matching the habitat types available to the preferred habitat composition and arrangement for the targeted species (see Appendix 2). Arranging cover, food and water in close proximity helps minimize travel and exposure for animals. Size, shape and *placement* of the field in the arrangement should be considered. When managing for bobwhites and other species with small home ranges (e.g., rabbits), all habitats needed to meet various seasonal requirements should be within a 40–50-acre area and, optimally, should be *juxtaposed* in close proximity. While the amount of nwsg acreage needed varies among wildlife species, quality early successional habitat should be well interspersed across the entire property.

Another important consideration is the surrounding properties (i.e., the surrounding landscape), especially for properties or landowner cooperatives less than 1,000 acres. If suitable habitat is lacking on surrounding properties for animals to immigrate to and emigrate from, it is possible the local population may become stagnant or begin to decline. It is also in these situations where predation can become a limiting factor. Predators are fully capable of identifying areas with an abundance of prey. Once located, predation rates can become artificially increased and limit small game populations, even where quality habitat exists.

Using nwsg when wildlife is a secondary objective to farming

Nwsg can be an integral part of a productive, profitable and environmentally sound farm operation. Most producers are interested in conserving natural resources, which includes providing adequate wildlife habitat. Sites not suitable for cropping can be targeted for nwsg establishment. Highly erodible soils, rocky soils, riparian buffers, field corners and other unproductive areas can be managed for wildlife, while dedicating better soils for production agriculture.

Recent research has shown creating field borders around crop fields can increase bobwhite and songbird populations. In fact, even on farms where exhaustive predator removal took place, bobwhite populations remained steady or declined, **unless field borders were established**. Researchers at North Carolina State University showed *predator* control alone did not work, unless *predation* was controlled by providing quality nesting and brood-rearing cover. Wildlife populations weren't the only things to increase – so did farm profits! By taking field borders out of production, lime, fertilizer, fuel, seed and herbicide costs were reduced. This coupled with the fact that borders along wooded areas naturally produce less yield (because of competition for nutrients and sunlight), helped increase crop profit margins.

Establishing nwsg borders (>30 feet wide) can provide excellent nesting, brooding and escape cover around fields. Using this practice alone will help increase local populations of quail and various songbirds.

Planting field borders (>50–120 feet wide) and "odd areas" to nwsg not only provides enhanced cover for wildlife, but also reduces runoff and increases infiltration, which improves water quality by trapping and preventing sediments, fertilizers, animal waste and pesticides from entering creeks and rivers. Interested landowners should contact their county USDA-NRCS office to learn of the many programs that provide cost-share and technical assistance to establish nwsg buffers, hay, pasture and wildlife habitat.

USING NATIVE WARM-SEASON GRASSES FOR LIVESTOCK FORAGE

Nwsg can provide excellent forage for livestock and, when properly managed, can still provide quality nesting and brood-rearing habitat. Nwsg are attractive as a forage crop because nwsg produce the majority of their growth during the summer, when cool-season grasses produce relatively little. Yields of two to five tons per acre of nwsg forage can be expected, depending on rainfall, soil type and other conditions. Crude protein can be as high as 16–17 percent, but normally is 8–12 percent at optimum harvest. Just as with any forage species, nutrient content of nwsg is influenced by plant maturity. As plants mature, percent protein and digestible energy decrease, while fiber content increases. Maximum tonnage and high forage quality do not occur at the same time. From a practical standpoint, all grass hay should be cut just before seedheads begin to emerge, whether warm- or cool-season.

Haying

Delayed harvest and exposure to the environment are major factors influencing hay quality; thus, nwsg have fewer problems in hay production than cool-season grasses because rain is less likely during summer. Once hay is cut, higher temperatures enable faster drying, resulting is less nutrient loss from respiration. Nwsg are similar in available protein and digestible nutrients as cool-season grasses, but the weather provides better haymaking conditions.

Nwsg can provide excellent hay for livestock. Here, Gene Hartman harvests approximately 7,000–8,000 pounds per acre of big bluestem and indiangrass hay. Gene makes sure to cut his hay just before it begins to seed out, ensuring optimum nutrition with the highest yield. One cutting per year allows plenty of grass re-growth before fall, leaving ample cover for wildlife during winter.

Excellent hay can be produced from single-species plantings or mixtures. Switchgrass and eastern gamagrass are often planted in pure stands and cut for the first time in June. Big and little bluestem are often planted with indiangrass and hayed for the first time in early July, which is advantageous to wildlife species nesting in May and June.

Grazing

The advantage of nwsg for grazing is similar to their advantage as a hay crop. During summer, high temperatures and limited rainfall cause cool-season grasses to be relatively unproductive, and pastures can be overgrazed. Overgrazing stresses the pasture even further, resulting in stand loss and increased weed pressure. By converting 25 percent of the pasture acreage to nwsg, animals may be grazed on actively growing forage during the summertime, which can provide higher-quality forage while allowing cool-season grasses to rest. This strategy reduces the need for hay, which can be required to supplement cool-season pasture during mid-summer.

Nwsg can offer excellent grazing opportunities for livestock. Grazing nwsg during summer can produce daily weight gains for cattle of more than 2 pounds. Grazing nwsg also allows cool-season paddocks to rest and minimize overgrazing. Nwsg should not be grazed regularly below 4 or 5 inches.

Cutting and grazing heights

Nutrient reserves can be limiting for nwsg if an adequate stubble height is not maintained or if overgrazing occurs. Nwsg should not be consistently grazed or cut below 4 or 5 inches; otherwise, yield and persistence may be reduced and increased weed problems will occur. If a stubble height of 6 inches is left, more leaf area will be present for rapid re-growth. If cut or grazed after early August, the ability of nwsg to rebuild carbohydrate reserves is limited, which can reduce next year's growth. This can lead to increased weed pressure, es-

pecially winter annuals. A controlled grazing program should be used to prevent overgrazing. Big bluestem, indiangrass, switchgrass and eastern gamagrass should be grazed when they reach approximately 12–18 inches or hayed when they reach 30 inches in height.

Fertilization, burning and weed control

Soil fertility is very important and soil testing is key to knowing lime and fertilizer requirements. Although nwsg are adapted to poor soil fertility, they will respond to lime and fertilizer applications when appropriate (see ***pH and fertilizer recommendations*** on page 17). Burning rejuvenates nwsg and improves forage quality. Burning in late March and early April can help reduce invasion of cool-season grasses while stimulating nwsg growth. When managing pure grass stands, forb-selective herbicides (e.g., 2,4-D, Banvel®, Overdrive®) will help control problem broadleaf weeds. Local Extension offices can provide specific recommendations for herbicide applications. Read and follow all herbicide label recommendations and restrictions.

Maximizing forage production and wildlife habitat

Nwsg are hayed and grazed when many wildlife species are nesting and rearing young. Waiting until after the nesting season to hay or graze will result in poor-quality forage, especially if switchgrass or eastern gamagrass is used. Because big and little bluestem and indiangrass flower later in the growing season (July through early August), they may be most appropriate to use when wildlife is a primary consideration. Including little bluestem in the mixture is especially important for nesting cover.

Another important consideration for wildlife is to cut or graze the stand only once per year. A second cutting can reduce winter cover for wildlife and render the field similar to a field of cool-season grasses. Rotational haying and grazing is another way to improve wildlife habitat in an nwsg forage system. By resting (i.e., excluding livestock and refraining from haying) a different portion of a field every year, additional wildlife habitat is made available.

Top five reasons establishment efforts fail:

1) Planted too deep
   - bluestems, indiangrass, switchgrass and sideoats grama should not be planted any deeper than ¼ inch
2) Inadequate weed control
   - existing sod must be killed prior to planting; post-emergence competition can be limiting factor
3) Planted too late
   - mid-April to early June is the ideal planting window
4) Drill not calibrated and/or PLS not calculated
   - these are absolutely necessary
5) No patience!
   - landowners often have a perfect stand, but just don't realize what it should look like

ESTABLISHING NATIVE WARM-SEASON GRASSES

The benefits of nwsg cannot be realized until establishment is successful. Unfortunately, some landowners' attempts to establish nwsg have failed and it is widely acknowledged that establishing nwsg can be slow, especially if certain steps are not taken. Reasons for inconsistent success vary, but the most common include drilling (or covering) seed too deep (> ¼ inch), inadequate weed control and planting too late in the growing season. Recent equipment innovations and information concerning the use of various herbicides have helped increase the success of establishment efforts.

Competition control

Nwsg do not compete well with non-native grasses (e.g., tall fescue, bermudagrass, crabgrass, johnsongrass), so it is critical to control these competitors (as well as problem broadleaf plants) prior to planting. Most often, a glyphosate herbicide (e.g., Roundup♦, Gly-4 Plus♦) is used to kill existing cover.

Perennial cool-season grasses (e.g., tall fescue and orchardgrass) – spray in the fall prior to planting with a glyphosate herbicide (two quarts per acre).

Roundup♦-only applications in the spring have been less than successful. However, by tank-mixing 2 quarts of Roundup♦ with 8 ounces of Plateau♦ and 2 pints of Methylated Seed Oil (or 22 ounces of Journey♦ with 1 1/2 quarts of Roundup♦), a spring herbicide application can be successful. Before existing sod is sprayed, the field should be burned, hayed, grazed or mowed and allowed to re-grow 6–10 inches. This ensures the herbicide comes in contact with an actively growing plant, not dead thatch from the previous year's growth. After killing cool-season grasses, expect warm-season competitors (e.g., johnsongrass, crabgrass) to emerge from the seedbank.

Herbicide applications are often necessary when establishing nwsg. Existing sod must be sprayed before planting. Pre-emergence applications are usually necessary at planting. Post-emergence applications are often necessary for adequate weed control.

Johnsongrass, crabgrass and broadleaf control – Spray during the growing season prior to planting with a glyphosate herbicide or a grass-selective herbicide. This will help reduce the seedbank, but there will be some residual growth the following growing season. Thus, **a pre-emergence application of an imazapic herbicide, such as Plateau♦ (6–8 ounces per acre) or Journey♦ (16–20 ounces per acre), is strongly recommended when planting bluestems, indiangrass or sideoats grama to provide adequate control for several weeks after planting. When planting switchgrass or eastern gamagrass, a pre-emergence application of OutRider® (2 ounces per acre) should control johnsongrass and many broadleaf competitors**.

Bermudagrass control – Burn the field in late winter and allow bermudagrass to re-grow. Spray bermudagrass as it begins to flower with imazapyr (24 ounces of Arsenal® AC per acre with two pints of Methylated Seed Oil). Research by the Georgia Department of Natural Resources found imazapyr very effective in controlling bermudagrass; however, it is virtually impossible to eliminate bermudagrass entirely with a single spraying. Patience and persistence are required. The field should be checked for bermudagrass re-growth through the *following* growing season after the initial treatment and spot-sprayed as necessary. The next growing season (two years after initial treatment), the field should be ready to plant nwsg.

Mechanical control – Another practice is to mow non-desirable broadleaf weeds before they flower and seed. Shading limits growth of nwsg considerably and prolonged shading can kill them. The mower (or bushhog) should be set relatively high so nwsg are not clipped any more than necessary. Mowing weeds is less successful than herbicide applications, but nwsg (including switchgrass and eastern gamagrass) will often out-compete non-desirable plants during the second growing season.

Seedbed preparation

Once the competition has been controlled, the seedbed should be prepared before planting. If the seed is to be drilled, a firm and "clean" seedbed, free of deep thatch and other material, is desired. This is best accomplished by burning. If the dead material on the field is sparse and only a few inches high, no preparation may be necessary. If the seed is to be topsown, the seedbed should be prepared by conventional tillage techniques. If the soil needs amending, it is best to do so before plowing/discing to ensure the lime and fertilizer are well-incorporated.

pH and fertilizer recommendations

Although nwsg are adapted to nutrient-deficient soils low in pH, soil fertility is important and soil testing is recommended to determine pH and nutrient availability. This is particularly important when growing nwsg for livestock forage. For optimum growth on pasture or hayfields, pH should be raised to 6.0–6.5, P and K brought to medium or high levels (31–120 and 161–320 pounds available per acre, respectively) and up to 60 pounds of N should be applied in April/May and after cutting hay or after removing livestock from the paddock. An application of N at planting is not necessary (when growing nwsg for wildlife) or recommended (when growing nwsg for livestock forage) because of weed competition. However, if bluestems and/or indiangrass are planted and an imazapic herbicide is applied pre-emergence, 15–30 pounds of N per acre may be added once the grasses are 4–6 inches high if adequate moisture is available. When planting pure stands of switchgrass or eastern gamagrass, N should not be applied until the stand is established and weeds controlled. When planting nwsg solely for wildlife, lime and fertilizer are not normally needed unless pH is below 5.0.

Seed quality and estimating PLS

Buying quality seed is an important consideration when establishing nwsg. Seed purity commonly runs 50–70 percent because of an inordinate amount of inert material (stems, leaves and other debris) and the germination rate may be only 50–60 percent. Therefore, it is critical to plant according to percentage of pure live seed (PLS), which is determined from information on the seed tag.

PLS is calculated as follows:

Seed: Indiangrass (Osage)

Pure seed: 67.62%	Germination: 64.00%
Other crop: 0.05%	Firm/Dormant: 22.00%
Weed Seed: 0.42%	Total Germination: 86.00%
Inert: 26.23%	Noxious Weeds: NONE
Origin: MISSOURI	Test date: 28 December 2003

[67.62% (pure seed) □ 86.00% (total germination)] √ 100 = 58.15% PLS. To plant 6 lbs. PLS per acre: [6 lbs (desired rate) √ 58.15 (PLS)] □ 100 = 10.32. Therefore, approximately 10 lbs of bulk material from the seed bag should be planted.

Seed dormancy

Switchgrass and eastern gamagrass tend to have a high dormancy rate. Germination can be improved by treating the seed. Switchgrass seed can be wet-chilled by soaking it in a mesh sack overnight and allowing it to drip-dry the following morning. The seed then should be stored in a cool location (e.g., a cellar or walk-in cooler set at approximately 40–45^0 F) for at least two weeks. For best germination, remove seed from chill treatment and allow to air dry with a fan blowing over the seed until seed flows freely. Plant immediately. Eastern gamagrass requires a six-week chilling process. The best option for planting eastern gamagrass is to buy cold-stratified seed direct from a seed dealer and plant immediately upon receiving shipment.

Planting date and methods

Nwsg should be planted mid-April through early June. Later plantings can be successful, but germination and growth may be reduced, as rain is less dependable in June and July. Seed may be top-sown or drilled, but **should not be planted any deeper than ¼ inch**. In fact, when drilled, at least one-third of the seed should be obvious on top of the planting furrow. The exception to this rule is eastern gamagrass, which should be planted approximately 1 inch deep. Drilling is usually the preferred method for planting nwsg (especially larger fields). As mentioned under ***Competition control*** on page 15, **a pre-emergence herbicide application at planting is strongly recommended** to ensure adequate weed control.

Planting with a no-till drill designed for nwsg seed is highly recommended. Do not drill seed any deeper than ¼ inch! In fact, as much as 30 percent of the seed should be obvious on top of the planting furrow.

Drilling – For even grass distribution and a continuous, solid stand, nwsg planted for haying or grazing should be planted with a drill. When drilling bluestems or indiangrass, a drill with a specialized seed box containing "picker wheels" is necessary or the fluffy seed of these grasses lodge in the seed chute. These drills often are available for use through state wildlife agencies, soil conservation districts, the Natural Resources Conservation Service and some local chapters of Quail Unlimited. Switchgrass can be planted with a conventional drill. Any drill, however, must be calibrated before planting. Eastern gamagrass is usually planted with a corn planter in rows 18–24 inches apart, but some producersß like to plant rows only 12 inches apart to reduce stool size and make stems more upright so haying is easier.

Broadcasting – Nwsg fields intended for wildlife habitat can be established successfully by broadcast seeding. When planting bluestems and indiangrass, a broadcast seeder with picker wheels (similar to those found in drills designed for fluffy seed) is helpful; otherwise, some type of carrier (pelletized lime, fertilizer, cracked corn, cottonseed hulls) is needed to distribute the seed. Prior to broadcasting, it is **critical** to thoroughly prepare the seedbed and cultipack after seeding to ensure firm seed-to-soil contact and improve germination rate.

Seeding rates and mixtures

Seeding rates depend upon landowner objectives. If sown for wildlife, a sparse stand of grasses with abundant forbs and adequate bare ground is desired. If sown for hay or pasture, a denser stand without forbs and less bare ground is desired. Thus, a relatively light seeding rate (4–6 pounds PLS per acre) is recommended when establishing nwsg for wildlife and a heavier seeding rate (8–12 pounds PLS) is recommended when establishing hayfields or pasture.

Tall mixtures provide cover for ground-nesting birds, as well as those that nest above-ground (e.g., dickcissel, field sparrow, Henslow's sparrow and red-winged blackbird). Tall mixtures also provide excellent cover for brood rearing and escaping predators. In addition, sufficient structure is present in tall nwsg fields for deer to bed during the day and excellent cover is available through winter for many wildlife species. Short mixtures provide quality nesting cover for ground-nesting birds and can provide attractive brood-rearing cover. Selected forbs should be added to wildlife mixtures to enhance brood habitat, invertebrate availability, seed production, forage and/or aesthetic value. Planted forbs are intended to complement the forb community that should arise naturally from the seedbank. Forbs most often added to nwsg mixtures include partridge pea, Illinois bundleflower, roundhead lespedeza, perennial sunflowers, purple prairieclover, purple coneflower, black-eyed susan, blazing star and lance-leaved coreopsis.

Tall mixtures of nwsg usually include some combination of big bluestem, indiangrass and switchgrass. These stands can provide excellent cover for nesting, brooding and foraging, as well as winter and escape cover.

Seeding mixture (lbs PLS per acre)	**Objectives & Considerations**
Wildlife – tall grass mixture 1.5 lbs big bluestem 1.5 lbs indiangrass 1.0 lb little bluestem 0.5 lb switchgrass 1.0 lb native forbs	Nesting cover Brooding cover Winter cover
Wildlife – short grass mixture 3.0 lbs little bluestem 1.0 lb sideoats grama 0.5 lb indiangrass 1.0 lb native forbs	Nesting cover Brooding cover
Forage – 3.5 lbs big bluestem 3.5 lbs indiangrass 3.0 lbs little bluestem	Hayed after primary nesting season Imazapic can be used for competition control
Forage – 8–10 lbs switchgrass	Wet-chill seed before planting Seed with conventional equipment
Forage – 10–12 lbs eastern gamagrass	Buy cold-stratified seed Plant with corn planter with rows 12–24 inches apart

Species and mixtures for livestock forage are generally determined by preference and potential problems with competitive weeds. For example, pure stands of switchgrass or eastern gamagrass can provide excellent forage for livestock. However, if crabgrass and/or johnsongrass are prevalent, a mixture of big and little bluestem and indiangrass might be a better choice, because an imazapic herbicide can be used to help ensure successful establishment.

Short mixtures of nwsg usually are dominated by little bluestem, broomsedge and/or sideoats grama. These stands can provide excellent cover for nesting, brooding and foraging.

Evaluating success – what to expect

Nwsg develop relatively slowly during the year of establishment. Most of the first-year plant growth is root development. Leaf and stem growth may not reach more than 2 feet high by the end of the first growing season. Typically, it is not until the second growing season that most nwsg develop considerable aboveground biomass, flower and produce seed. However, if the correct planting procedures are followed and soil moisture is not limiting, excellent growth will occur during the year of establishment, with considerable aboveground biomass and extensive flowering.

This is what you are looking for! This is a big bluestem seedling with its characteristic "fountain" appearance. Note the bare ground and lack of weeds germinating around the seedling. This is what should be expected from a properly applied pre-emergence herbicide.

Nwsg planted for wildlife **should be very sparse** during the year of establishment. Remember, bare ground space between bunches is desirable! "Weeds" may be numerous and should be expected. Many, hopefully most, of the "weeds" will be desirable forbs (as described earlier). Landowners planting nwsg should not expect the field to look like a field planted to cool-season grasses. Patience is necessary!

This field was planted in May 2000. By July, most people would consider this effort a failure. However, this rate of development is not unusual, especially with little rainfall in soil that has not been amended with lime and fertilizer. Remember, the structure will become more dense in the second year and bare ground space is desired!

Even with little rain and low nutrient availability, this amount of growth should be expected by the end of the first growing season (with proper weed control).

By the second growing season, excellent cover for wildlife was available and quail were found in the field regularly.

With adequate rainfall and nutrient availability, this amount of growth can be expected by the end of the first growing season.

CONCLUSION

Nwsg can provide excellent wildlife habitat. Converting perennial cool-season grass acreage to nwsg and establishing field borders around crop fields will help increase wildlife populations dependent upon early successional habitats. Nwsg also can produce high-quality forage for livestock. For producers interested in wildlife, nwsg are a much better alternative than non-native, warm-season grasses, such as bermudagrass, sorghum-sudan and the Old World bluestems.

Establishing and managing nwsg is quite different from cool-season grasses. However, **landowners should not be skeptical**. The advantages for wildlife and the quality of forage produced have been proven time and again throughout the Mid-South and in other regions as well. Technical assistance is as close as the county NRCS or Extension office. Advice and assistance is also available through state wildlife resources agencies. For comprehensive and detailed information on establishing and managing nwsg, ask for a copy of ***Native Warm-Season Grasses: Identification, Establishment and Management for Wildlife and Forage Production in the Mid-South***, available through UT Extension.

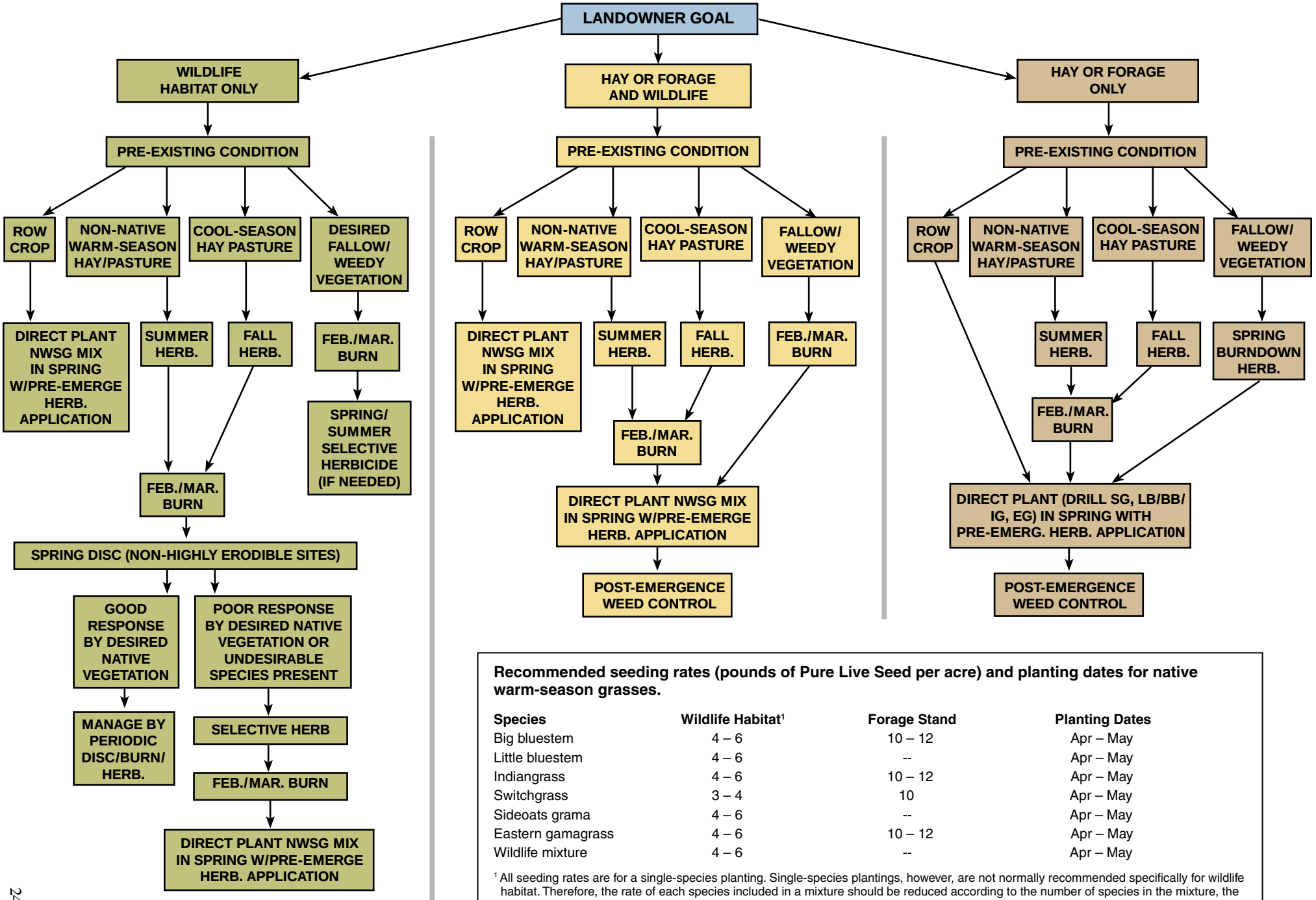
Appendix 1. Herbicide use guide for common native warm-season grass applications.

Herbicide	Use	Application Rate	Objectives/Considerations
Glyphosate (Roundup, Accord, Gly-4, others)	Eradicating tall fescue and other existing cover prior to nwsg establishment, or while nwsg are dormaant.	Fall – 1.5-2.0 qts/ac Spring – 2.0 qts/ac	Broad spectrum herbicide, not selective. Post-emergence only – no soil activity or residual control.
	Controlling woody saplings, sericea lespedeza, thistles, bermudagrass, dallisgrass, yellow nutsedge	2.5 – 4.0 qts/ac	Additional applications may be necessary. Better control may be realized by tank mixing with other herbicides.
Imazapic (Plateau)	Pre-emergence weed control when planting bluestems, indiangrass and sideoats grama.	6 – 8 oz/ac	Residual weed control for approximately 60 days. Contact state wildlife agency if unavailable through private distributor. Check label for tolerance of specific nwsg and select forbs.
	Eradicating tall fescue and other select cover to allow the seedbank to respond.	12 oz/ac	
	Post-emergence weed control of johnsongrass, crabgrass, cocklebur and others in established nwsg.	6-8 oz/ac	
Imazapic + Glyphosate (Journey)	Pre-emergence weed control when planting bluestems, indiangrass and sideoats grama. Also for eradicating tall fescue and other existing cover prior to nwsg establishment, or while nwsg are dormant.	11 – 32 oz/ac	May damage nwsg and forbs if applied after greenup. Residual weed control for approximately 60 days. Additional glyphosate is necessary to effectively kill tall fescue when using lower rates of Journey.
	Post-emergence weed control of johnsongrass, crabgrass, cocklebur and others in established nwsg.	11 oz/ac	
2,4-D	Controlling unwanted broadleaf plants, such as thistles & cocklebur.	1 – 4 pts/ac Post-emergence application	Will also kill desired legumes and other broadleaf plants. May damage nwsg seedlings.
Dicamba (Banvel, Clarity)	Controlling unwanted broadleaf plants and woody species.	2 – 4 pts/ac Pre- or post-emergence application	Will also kill desired legumes and other broadleaf plants.
Sulfosulfuron (OutRider)	Pre- and post-emergence control of johnsongrass and other weeds in nwsg (including switchgrass).	0.75 – 2.0 oz/ac Pre- or post-emergence application	Groundwater may be contaminated when used in areas where soils are permeable or shallow water table.
Triclopyr (Garlon 3A)	Controlling sericea lespedeza and other broadleaf plants in established nwsg.	1.0 qt/ac Post-emergence application	Apply in early summer when sericea is in early vegetative stage. Does not damage nwsg, but kills most broadleaf plants. Refer to label for rates to control other species.
	Controlling woody saplings	1 – 5 gal/ac; see label for various applications	High-volume and low-volume treatments require different rates.
Metsulfuron methyl (Escort, Cimarron)	Control of sericea lespedeza, bicolor lespedeza and other broadleaf plants.	0.1 – 2.0 oz/ac Post-emergence application	For sericea control, apply in bloom stage (August – September). Fall application may provide spring residual control. Does not affect grasses.
Imazapyr (Arsenal)	Control of woody saplings. Sometimes best accomplished with tank mixes of other herbicides.	See label for selected woody plants, application rates & mixes	Use as spot treatment where tree or shrub seedlings are invading.
Sethoxydim (Poast Plus)	Controlling undesirable cool-season grasses before nwsg emerge in spring. Reducing nwsg coverage when growth becomes too dense.	2 pts/ac Post-emergence application	When reducing nwsg density, use only every third spray nozzle (i.e., 1 open/2 closed).
Clethodim (Select)	Controlling undesirable cool-season grasses before nwsg emerge in spring. Reducing nwsg coverage when growth becomes too dense.	10 oz/ac Post-emergence application	When reducing nwsg density, use only every third spray nozzle (i.e., 1 open/2 closed).
Imazethapyr (Pursuit)	Controlling undesirable grass and broadleaf plants, including yellow nutsedge.	1 – 2 oz/ac Pre- or post-emergence application	Will not control legumes; thus, Pursuit can be sprayed over desirable legumes to control non-leguminous forbs.

Appendix 2. Major habitat types and arrangement preferred by selected wildlife.

Primary species managed	Percent nwsg and associated forbs	Arrangement of nwsg	Percent cool-season legumes and annual grains	Percent row cropland	Percent mast-producing hardwoods	Percent brushy cover (incl. 0–3-year-old hardwood and pine stands)
Bobwhite quail	20 – 80	Blocks ≥ 2 acres or strips ≥ 50’ wide	2; In firebreaks	5 – 50	5 – 20	20 – 50
Cottontail rabbit	10 – 80	Blocks 1 – 5 acres or strips ≥ 50’ wide	2; In firebreaks or small fields	5 – 50	10 – 40	20 – 50
Wild turkey	10 – 30	Blocks ≥ 2 acres	2 – 5; In firebreaks or fields	5 – 50	30 – 60	10 – 30
White-tailed deer	5 – 30	Blocks ≥ 2 acres	2 – 5; In firebreaks or fields	5 – 50	30 – 60	20 – 40
Grass/shrub songbirds (field sparrow, blue grosbeak, indigo bunting, yellow-breasted chat)	30 – 70	Blocks ≥ 5 acres or strips ≥ 50’	In firebreaks	<10	0	50 – 70
Grassland songbirds (grasshopper sparrow, Henslow’s sparrow, eastern meadowlark, dickcissel)	70 – 100	Blocks or complexes ≥ 100 acres	In firebreaks	<10	0	<20

Appendix 3. Flow chart for landowners planning to plant native warm-season grasses.



Recommended seeding rates (pounds of Pure Live Seed per acre) and planting dates for native warm-season grasses.

Species	Wildlife Habitat[1]	Forage Stand	Planting Dates
Big bluestem	4 – 6	10 – 12	Apr – May
Little bluestem	4 – 6	--	Apr – May
Indiangrass	4 – 6	10 – 12	Apr – May
Switchgrass	3 – 4	10	Apr – May
Sideoats grama	4 – 6	--	Apr – May
Eastern gamagrass	4 – 6	10 – 12	Apr – May
Wildlife mixture	4 – 6	--	Apr – May

[1] All seeding rates are for a single-species planting. Single-species plantings, however, are not normally recommended specifically for wildlife habitat. Therefore, the rate of each species included in a mixture should be reduced according to the number of species in the mixture, the composition preferred and the desired structure of the resulting stand.

Disclaimer: Use of brand or trade names in this publication is for clarity and information; it does not imply approval of the product to the exclusion of others, which may be of similar, suitable composition. Always be sure to read, understand and follow directions and precautions on herbicide labels before use. As herbicides, herbicide labels and their availability and recommendations may change, it is best to consult your local Extension agent for the latest recommendations on herbicide use.

Acknowledgements: The authors would like to thank Dan Beran (BASF Market Development Specialist), Greg Brann (Grazing Lands Specialist, NRCS), Steve Capel (Farm Wildlife Supervisor, Virginia Department of Game and Inland Fisheries), Steve Clubine (Grassland Biologist, Missouri Department of Conservation) and Wanda Russell (Senior Publication Editor, UT Institute of Agriculture) for reviewing a previous manuscript and providing constructive comments for improvement.

Photo credits:
Craig Harper, Mike Hansbrough, Steve Capel, Jimmy May and Dick Conley

Visit the UT Extension Web site at http://www.utextension.utk.edu/

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December 2004

05-0026 PB1746-35M-12/04 E12-4915-00-006-05

September, 2019 **FINAL REPORT**
Norman A. Berg National Plant Materials Center
Beltsville, MD

Native Warm Season Grass Varieties for the Mid-Atlantic

Shawn Belt

ABSTRACT

Native warm-season grasses are highly diverse and serve fundamental roles in many conservation plant mixes (e.g., for forage, biofuel, and wildlife habitat). However, evaluations comparing their performance are relatively few. This study's objective was to compare the performance or adaptability of 42 varieties of native warm-season grasses grown at Beltsville, Maryland from 2015 to 2017. Variation exists between species and varieties regarding establishment, performance, size, and timing of their phenological growth stages. Species evaluated include: eastern gamagrass, Indiangrass, big bluestem and switchgrass. Evaluations included survival percentage, green-up date, boot stage date, size at boot stage, flowering date, seed maturity date, and disease susceptibility.

In this study these varieties performed best: *Forage* - Big bluestem OZ-70 Germplasm, Suther Germplasm and 'Niagara'. Indiangrass 'Rumsey', Prairie View Germplasm and Coastal Germplasm. *Size* - Largest switchgrass varieties are Timber Germplasm, BoMaster and 'Kanlow'. *Wildlife Habitat* - Indiangrass varieties are Coastal Germplasm, Prairie View Germplasm and 'Americus'.

INTRODUCTION

Native warm-season grasses (NWSG) such as eastern gamagrass (*Tripsacum dactyloides)*, Indiangrass *(Sorghastrum nutans)*, big bluestem (*Andropogon gerardii)* and switchgrass (*Panicum virgatum)* are important in the Mid-Atlantic for summer forage, wildlife habitat, and potentially for biofuel production. NWSG are drought tolerant and typically long-lived perennials that develop deep roots. Some NWSG are beneficial in producing forage during the summer slump (July to September) when hot, dry conditions typically limit cool-season grass production. NWSG can produce 3 to 5.5 tons/acre of dry matter yield annually (Ugiansky, Vough 2013). In meadows, smaller NWSG increase plant diversity attracting diverse species of wildlife (Sarver 2010). Larger, late season NWSG produce more and higher quality summer forage. The long establishment period of 2 to 3 years may limit their use with producers and land owners. Comparative performance evaluations benefit producers and conservation planners in matching the right NWSG to the right use. The most suitable NWSG for pollinator plantings are likely those whose provenance is closest to the planting (Sarver, 2010). Smaller NWSG typically allow for a more physically diverse wildlife habitat; conversely, NWSG should also be sizeable enough to sustain prescribed burns in locations where maintenance burns are feasible.

Switchgrass and big bluestem tend to dominate plantings and should be used in moderation if at all (Sarver 2010). Indiangrass has less tendency to dominate and is a better choice for wildlife plantings.

MATERIALS AND METHODS

In 2008 and 2009, the National Plant Materials Center (NPMC) planted 20 plants of each variety on one-foot centers in twenty-foot-long rows with ten feet between blocks (Figure 1). Plugs received minimal irrigation during establishment. Lime was applied at planting to correct for low soil pH and soil tests were conducted every 2 years. No supplemental fertilizer was applied. Plots were mowed between the rows as needed, broadleaf weeds were controlled with spot herbicide applications, and NWSG were mowed to 8 inches in height after the first killing frost. From 2009 to 2015, plants were left to fully establish and mature.

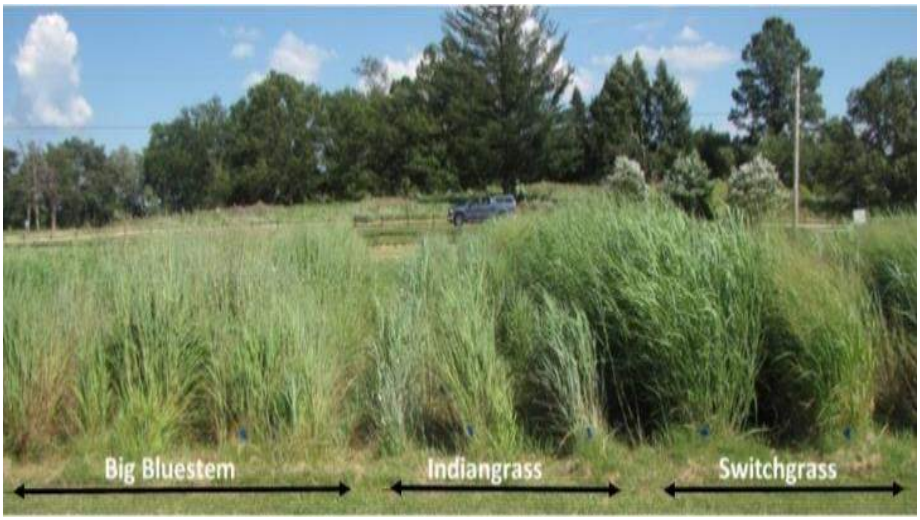

Figure 1. Native warm season grass evaluation plot, NPMC, Beltsville, MD.

Data was collected weekly (May through September) from 2015 through 2017. Varieties were evaluated for survival in 2009-2011 and again in 2014-2015. Varieties were also evaluated for plant height and width at the boot stage, green up date, 75% boot stage date, 75% flowering date, and hard dough seed maturity. Basal area was calculated by multiplying height x width. Species evaluated were primarily NRCS plant materials releases (Table 1)

Table 1. Native Warm Season Grass varieties evaluated in Beltsville, MD, the origin of the variety, the year the material was released commercially, and the developer of the material.

	Variety*	Origin*	Year	Developer
Eastern Gama Grass	'Meadowcrest'	Beltsville, MD	2006	NY PMC
	'Highlander'	Montgomery Co., TN	2003	MS PMC
	'Pete'	KS and OK	1988	KS PMC
Big Bluestem	WV PMC (unreleased 9093698)	Kingwood, WV	N/A	WV PMC
	NJ PMC (unreleased 9094220)	South MA	N/A	NJ PMC
	Suther Germplasm	Cabarrus Co., NC	2002	NJ PMC
	'Niagara'	Erie Co., NY	1986	NY PMC
	NY PMC (unreleased 9046932)	New England composite	N/A	NY PMC
	Southlow Germplasm	Southern MI	2001	MI PMC
	Mammoth	KY composite	N/A	Roundstone Seed Co.
	OZ-70 Germplasm	Pawnee Co., NE	2004	MO PMC
	'Bonanza'	Pawnee derivation	2004	ARS NE
	'Goldmine'	Kaw derivation	2004	ARS NE
	'Roundtree'	Manhattan, KS	1950	MO PMC
	'Kaw'	Riley Co., KS	1950	KS PMC
	'Earl'	Parker Co., TX	1996	TX PMC
	'Bonilla'	Bonilla, SD	1986	ND PMC
Indianrass	NJ PMC (unreleased 9046933)	New England composite	N/A	NY PMC
	Coastal Germplasm	CT, RI & MA composite	2007	NJ PMC
	NY PMC (unreleased 591811)	NY	N/A	NY PMC
	Prairie View Germplasm	Central & Southern IN	2005	MI PMC
	Southlow MI Germplasm	Southern MI	2001	MI PMC
	'Americus'	AL & GA composite	2002	GA PMC
	'Rumsey'	Jefferson Co., IL	1983	MO PMC
	'Nebraska-54'	NE composite	1957	H. Hummel (private)
Switchgrass	High Tide Germplasm	Perryville, MD	2007	NJ PMC
	Timber Germplasm	NC	2009	NJ PMC
	'Shelter'	Pleasants Co., WV	1978	NY PMC
	'Carthage'	Carthage, NC	2006	NJ PMC
	'BoMaster'	Southeastern US	2006	ARS/NC State Univ.
	Southlow MI Germplasm	Southern MI	2001	MI PMC
	'Sunburst'	Union Co, SD	1983	SD AES
	'Cave-in-Rock'	Southern IL	1974	MO PMC
	'Shawnee'	Southern IL	1995	NE ARS
	'Dacotah'	Breien, ND	1989	ND PMC
	'Forestburg'	Sanborn Co., SD	1987	ND PMC
	'Trail Blazer'	NE composite	1984	Univ. of NE/ARS
	'Pathfinder'	NE, KS	1967	NRCS/ARS
	'Kanlow'	Wetumah, OK.	1963	KS PMC
	'Blackwell'	Blackwell, OK	1944	KS PMC
	'Alamo'	Frio River, TX	1978	TX PMC
	EG 1101	Improved Alamo (proprietary)	2009	Ceres Energy Co.
	EG 1102	Improved Kanlow (proprietary)	2009	Ceres Energy Co.

*Varieties listed in order of increasing distance from Beltsville, MD to origin.

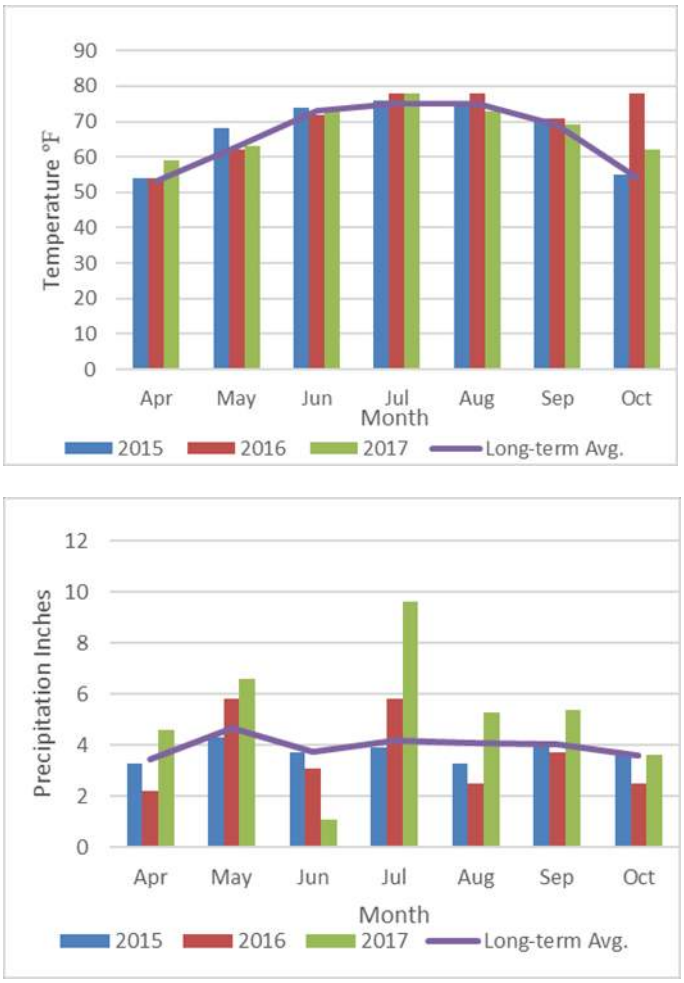

Figure 2. 2015 - 2017 Temperature and precipitation during the growing season for native warm season grass, Beltsville, MD.

RESULTS AND DISCUSSION

Survival and Adaptability.

After the two-year establishment period, all three eastern gamagrass varieties died and were removed. All three varieties were found to be infested with stalk borer larvae (*Papaipema nebris).* While the southern cornstalk borer is a known eastern gamagrass pest (Springer et al 2011), this was the first time the stalk borer was been documented affecting eastern gamagrass. The larvae probably migrated from nearby Conservation Reserve Program areas (Gesell and Calvin 2000). The stalk borer did not affect adjacent big bluestem, Indiangrass and switchgrass plants.

Overwintering survival evaluations of the remaining species occurred the spring following the first (2009 to 2010) and second growing seasons (2010 to 2011). All varieties had overwinter survival above 70%, except for switchgrass variety EG1101 which had only 40%. Switchgrass varieties 'Forestburg', 'Pathfinder', 'Trailblazer' and Southlow MI Germplasm performed poorly after establishment and were removed from the study in 2015. The upper Midwest varieties were not well adapted well to mid-Atlantic warm, humid growing conditions (Figure 2).

Boot Stage.

With proper management, NWSG provides large amounts of high quality and palatable summer forage. Producers are reticent to wait 2 to 3 years necessary for their establishment. As NWSG begin to flower and set seed, the stems contain more lignin decreasing palatability. Haying or grazing NWSG harvested prior to the boot stage allows for maximized biomass accumulation and palatability. Big bluestem and Indiangrass varieties varied in phenological response more than switchgrass. Most big bluestem and all Indiangrass were found to vary about 1000 growing degree days or about 5 weeks, whereas switchgrass started boot stage earlier and showed more uniform responses (Figure 3). Nine big bluestem varieties reached the boot stage in July and five in early August. All but two Indiangrass varieties booted in August. All switchgrass varieties booted over a two-week period in July. Later booting big bluestem varieties, OZ-70, Suther Germplasm and Niagara along with Indiangrass varieties 'Rumsey', Prairie View Germplasm and Coastal Germplasm may be a better summer forage than earlier booting switchgrass. 'Americus' Indiangrass booted regularly in October, much later than all other NWSG.

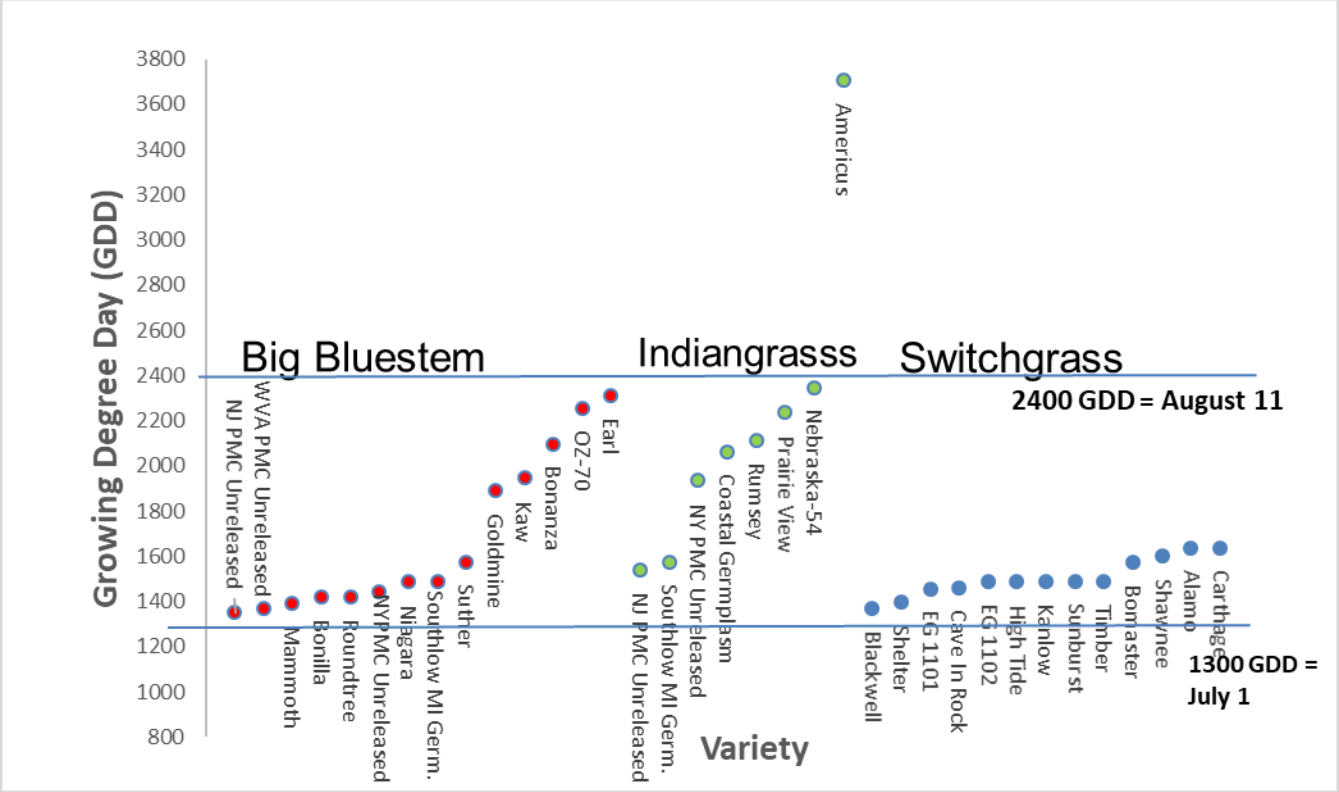

Figure 3. Boot Stage Timing - average (2015-2017) growing degree days (50º/86ºF) required to reach 75%boot stage of selected NWSG varieties.

Size.

NWSG size was measured at 75% boot stage. On average, switchgrasses were largest followed by big bluestem, then Indiangrass (Figure 4). Intervarietal variation was similar for each species, where the smallest to largest variety difference was about 200% in basal area, 750 in² to 1500 in² for Indiangrass. Diverse plant size and morphology are generally beneficial for associated animals and insects. Smaller NWSG are more useful in meadows creating perennial niches for animals and insects to use for nesting, protection from predators, and other uses while still

providing fuel for prescribed burns (Sarver 2010). Switchgrass and big bluestem tend to dominate plantings while Indiangrass is less apt to overshadow forbs.

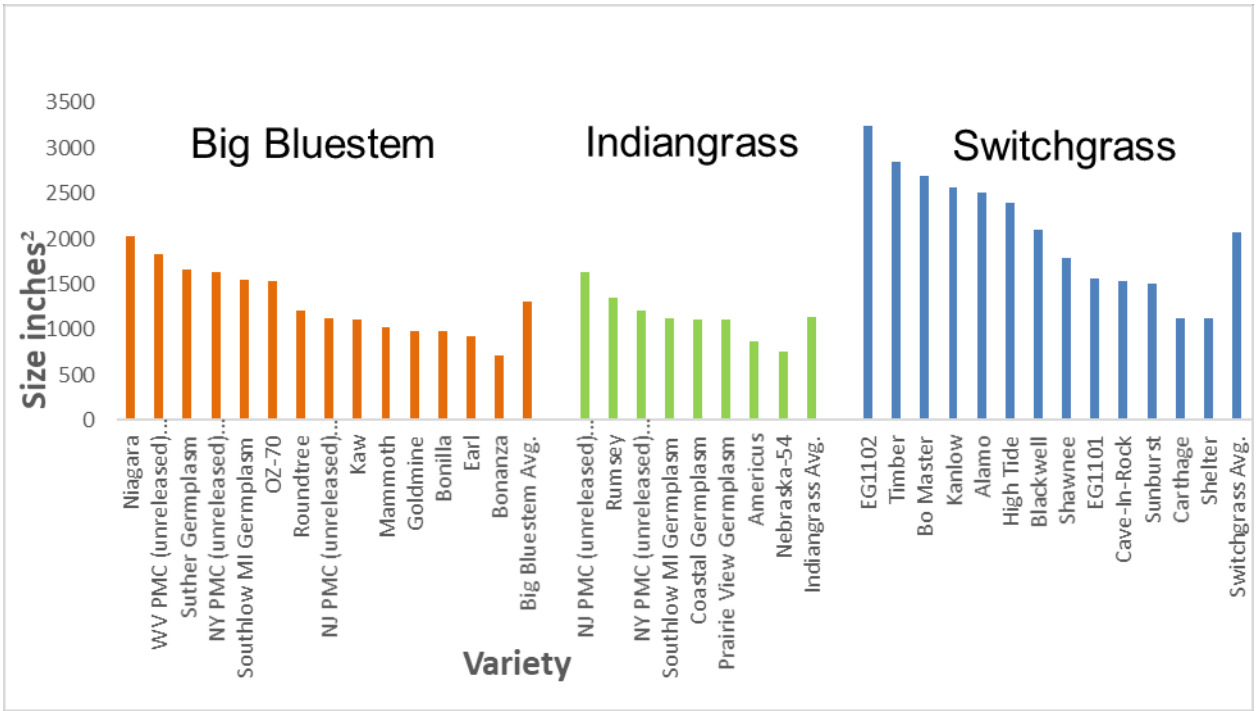

Figure 4. Average size (in.²) at 75% boot stage of selected NWSG varieties grown at Beltsville, MD (2015 to 2017).

CONCLUSIONS

We attempted to provide an overall qualifier for each variety by ranking it against all varieties within the same species separately for each trait (Table 2).

Forage.
The best NWSG for livestock forage is generally those that provide ample biomass, boot later, and are resilient to grazing pressure. Several varieties of each species may be promising for grazing in the mid-Atlantic. All switchgrass varieties booted in early July, earlier than big bluestem and Indiangrass (Figure 3) and unless actively managed the switchgrass varieties may become stemmy (Keyser 2013). Several later booting big bluestem and Indiangrass varieties may be promising for grazing by providing a later summer grazing window. Big bluestem varieties OZ-70, Suther Germplasm and Niagara boot later and are larger. Most of the later boot stage Indiangrass varieties tested averaged 1000-1500 in² in size, which is smaller than OZ-70.

Wildlife Habitat.
The smallest and most local Indiangrass varieties tested were Coastal Germplasm, Prairie View Germplasm and 'Americus'.

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AGENDA ITEM NO. F.1.

ITEM SUMMARY

DATE: 10/21/2021

TO: The AFD Advisory Committee

FROM: Josh Crump, Principal Planner

SUBJECT: 2022 Agricultural and Forestal District Renewal Process

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ATTACHMENTS:

	Description	Type
🗋	Memorandum	Cover Memo

REVIEWERS:

Department	Reviewer	Action	Date
AFD Advisory Group	Crump, Josh	Approved	10/13/2021 - 4:29 PM
AFD Advisory Group	Holt, Paul	Approved	10/14/2021 - 10:23 AM
Publication Management	Pobiak, Amanda	Approved	10/14/2021 - 10:49 AM
AFD Advisory Group	Secretary, AFD	Approved	10/14/2021 - 11:17 AM

M E M O R A N D U M

DATE: October 21, 2021

TO: The Agricultural and Forestal District Advisory Committee

FROM: Josh Crump, Principal Planner

SUBJECT: 2022 Agricultural and Forestal District Renewal Process

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As required by State Code, the County must review all established Agricultural and Forestal Districts (AFDs) prior to their expiration. During calendar year 2022, James City County and the AFD Advisory Committee will be conducting this review and during this time, districts must be renewed or they may be terminated; they may also be modified.

Prior to the start of the review process, the Board of Supervisors has asked staff to survey property owners regarding the preferred AFD term length (four-year renewal schedule or eight-year renewal schedule). Staff will be conducting this survey around October 2021-November 2021.

Starting in January 2022, the renewal process will begin with a notification to all AFD property owners advising the property owner that the AFD renewal period has begun. Property owners have the opportunity to withdraw their property from the subject AFD at any time during the renewal process. For all properties remaining in the AFD, the renewal proceeds through review by the AFD Advisory Committee, then the Planning Commission, and finally through the Board of Supervisors for final adoption. Reviews for 2022 AFD renewals will occur at the Committee's July meeting.

CURRENT AFD STATISTICS
The Board has adopted Ordinances establishing 13 AFDs:

- Armistead
- Barne's Swamp
- Carter's Grove
- Christensen's Corner
- Cranston's Pond
- Croaker
- Gordon Creek
- Gospel Spreading Church
- Hill Pleasant Farm
- Mill Creek
- Pate's Neck
- Wright's Island*
- Yarmouth Island

The majority of these are on a four-year renewal schedule, expiring on October 31, 2022.
*The Wright's Island District expires October 31, 2026.

DISCUSSION ITEMS
Staff will be happy to answer any questions regarding the process.

JP/md
2022AFDRenewal-mem