APPOQUINIMINK WATERSHED ASSESSMENT
Streambank Erosion Inventory and Tidal Marsh Impairment Assessment Summary Report

May 2009

Prepared for:

Delaware Department of Natural Resources and Environmental Control
Division of Soil & Water Conservation
Sediment & Stormwater Program
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Appoquinimink Watershed Assessment

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and
Tidal Marsh Impairment Assessment

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Introduction

The Appoquinimink River Watershed drains approximately 30,200 acres (47 sq miles) in southern New Castle County. More than half of the watershed is in active agricultural cultivation and less than nine percent of the watershed remains forested. Most forested areas are located along the stream valleys, and very few large contiguous tracts of un-fragmented forest remain in the watershed. Urbanized areas account for approximately 21 percent of the watershed and include Middletown, historic Odessa, and Townsend. The remaining watershed area (approximately 17 percent) is open water and wetlands (Center for Watershed Protection 2005).

The expansive tidal wetlands at the mouth of the Appoquinimink River in conjunction with the Blackbird River to the south represent one of the largest intact marsh systems in Delaware. These wetlands serve as important habitat for wildlife and waterfowl, spawning grounds for fish and other aquatic species, and passive recreation for local birdwatchers at the St. Austine Wildlife Area. Most of the Appoquinimink watershed is on the 303(d) impaired list for either dissolved oxygen or nutrients (Center for Watershed Protection 2005).

The upland portion of the watershed is generally flat, but steep slopes can be found associated with stream valleys in the headwaters. The majority of soils are well-drained, deep, and of medium-coarse texture (Center for Watershed Protection 2005).

As development spreads south of the Chesapeake and Delaware Canal, the agricultural lands are rapidly converting into suburban residential uses. Hydrologic changes resulting from the urbanization of agricultural lands is resulting in increased flooding, stream channel erosion, water quality degradation, and degradation of wetlands and the extensive tidal marsh areas in the watershed (Center for Watershed Protection 2005).

Project Overview

This report provides a brief summary of field studies conducted to monitor severe streambank erosion and assess tidal marsh impairment. This work was part of a larger watershed planning effort to address and help to minimize the negative impacts to streams, water quality, and wetlands associated with the rapid development of the watershed. The streambank erosion inventory monitored, and further assessed, areas of severe erosion identified by the Center for Watershed Protection during their 2005 baseline assessment. The goal of the tidal marsh assessment was to identify indicators of impairment that can be used to monitor marsh health.

Streambank Erosion Inventory

A.D. Marble & Company conducted an inventory of severe streambank erosion to confirm previously identified reaches and to identify newly developing erosion problems. The stream survey was conducted within the Appoquinimink Watershed during April and May of 2007. The purpose of the survey was to identify any features or contributing factors of erosion within the watershed. This information can be used to better manage the watershed and protect it from further erosion due to encroaching development and agricultural practices. While conducting the inventory, A.D. Marble & Company made observations of other potential in-stream problems including evidence of upstream erosion (such as mid-channel sediment bars).

Site Selection

The surveys consisted of 15 data points, selected along sections of watercourses, that have been previously identified as locations in need of repair, or have poor physical habitat quality by the baseline assessment conducted by the Center for Watershed Protection (2005). Coordinates for these sites were estimated and input into a handheld Global Positioning System (GPS) receiver. The GPS was used to navigate to the previously inventoried site. The Streambank Erosion Inventory sites are shown on Figure 1.

Methodology

As was done in the 2005 baseline assessment, the Center for Watershed Protection's "Unified Stream Assessment" was used to evaluate the site conditions (Center for Watershed Protection 2004). The Severe Erosion Form (ER) was completed for comparison to the conditions found in 2005. The Unified Stream Assessment ER form assesses information on localized nick points and banks where erosion greatly exceeds average reach conditions. This data can then be used to identify eroded banks, generate a list of potential stream repair practices, develop stream erosion metrics, and generate planning maps. The data forms completed for this assessment can be found in Appendix A.

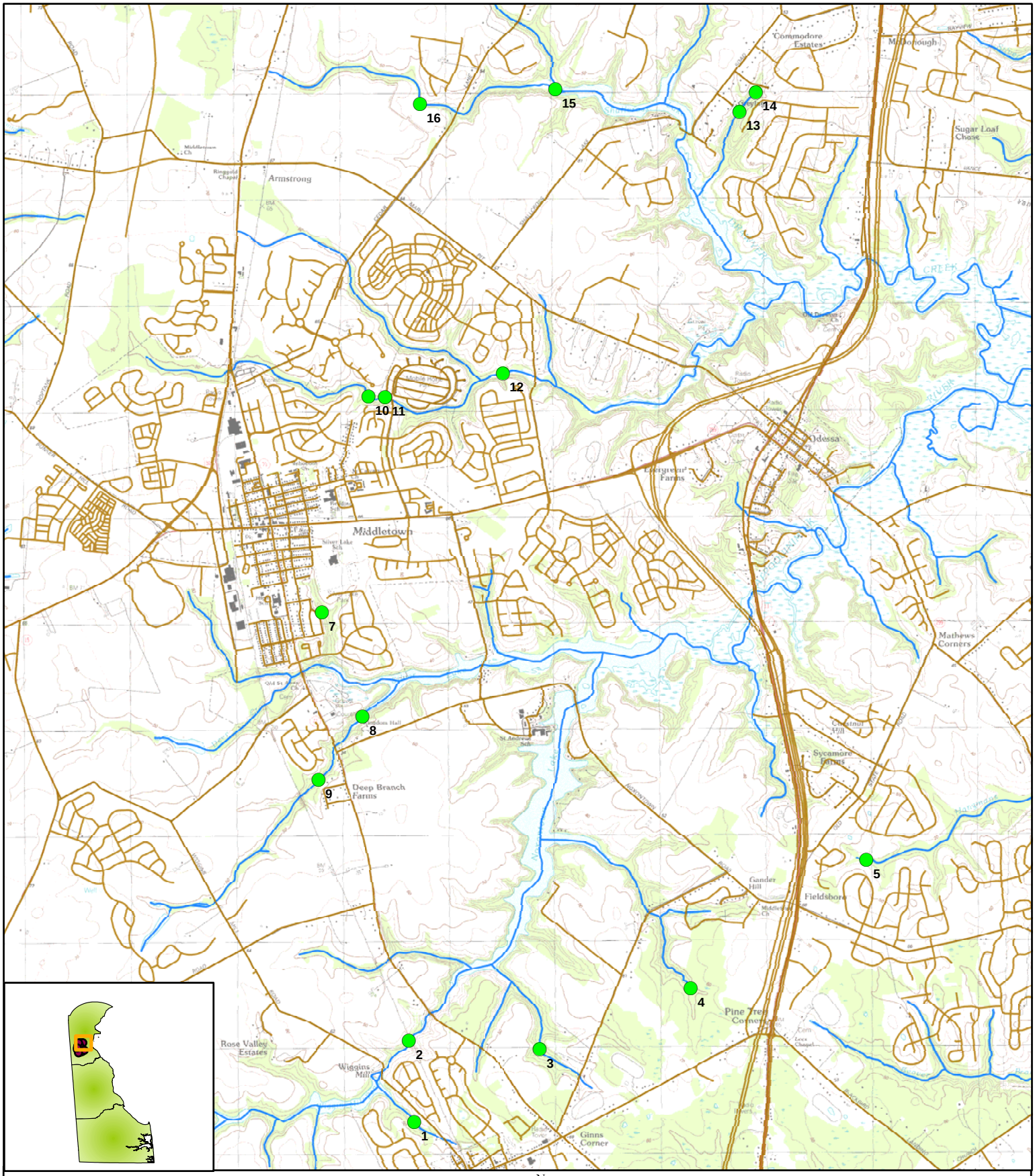
In addition to the Unified Stream Assessment ER forms, an assessment of erosion hazards and erosion stresses was made in order to estimate the rate of bank erosion at each site. The Bank Erosion Hazard Index (BEHI) and Near-Bank Stress (NBS) assessment developed by David Rosgen was used to estimate erosion rates (Rosgen 2002a and Rosgen 2002b). Rosgen's BEHI uses multiple bank characteristics to determine the erosion risk or potential of a stream bank to erode. Rosgen's NBS estimates potential energy distribution in the near bank area that may accelerate erosion. The field data forms are included in Appendix A. The results of the BEHI/NBS were compared to the North Carolina Streambank Erodibility Rate curves to determine total bank erosion from the sites (Rosgen 2002b).

In addition to the forms, general notes were recorded about the surrounding land-use at each data point. These notes are recorded on the ER forms in Appendix A.

Findings

Results of the surveys showed that increased run-off from agriculture and residential development has lead to increased bed and bank erosion. The 2007 ER results were generally consistent with those found in the 2005 assessment. The area at Site 6 has been re-graded as part of a recent residential development and no BEHI/NBS measurements were obtained. Site 9 was inaccessible at the time of the field assessment and no ER evaluation or BEHI/NBS measurements were taken. At Site 15, no severe erosion was

Streambank Erosion Inventory Sites



Feet

0 4,000 8,000

N

Sites

Source: Delaware DataMIL: 7.5 Minute Quadrangles for Middletown & Taylors Bridge; National Hydrography Dataset (NHD) DE Rivers and Streams; and Delaware Roads

observed and no BEHI/NBS data taken. At Sites 10 and 12, the erosion appears to be due to the downcutting of the gulley-like channel and not stress directly on the banks. Photographs of each streambank erosion inventory site are included in Appendix B.

The results of the BEHI/NBS assessment and streambank erosion estimate are presented in Table 1. These findings show that a significant amount of sediment can be removed from relatively small reaches of eroded streambanks. Excessive sedimentation is detrimental to aquatic and wetland systems in many ways. Sediment pollution also plays a role in nutrient impairment because of the nutrients often adsorbed to the sediment particles.

Table 1 – BEHI/NBS Assessment Results

Site	Total BEHI Score	Total NBS Score	Exposed Bank Area (height x Length) (ft^2)	Estimated Bank Erosion Rate (ft/yr)	Total Erosion (ft^3/yr)
1	Extreme	High	1,000	2.70	2,700
2	Moderate	High	396	0.25	99
3	Moderate	Very High	195	0.20	39
4	Moderate	High	15,000	0.17	255
5	High	Very High	300	0.40	120
7	High	Extreme	600	0.50	300
8	High	Low	320	0.10	32
10	High	Low	600	0.10	60
11	Moderate	High	66	0.16	11
12	Very High	Low	216	0.50	108
13	Moderate	High	140	0.16	22
14	High	High	270	0.26	70
16	Moderate	High	120	0.16	19

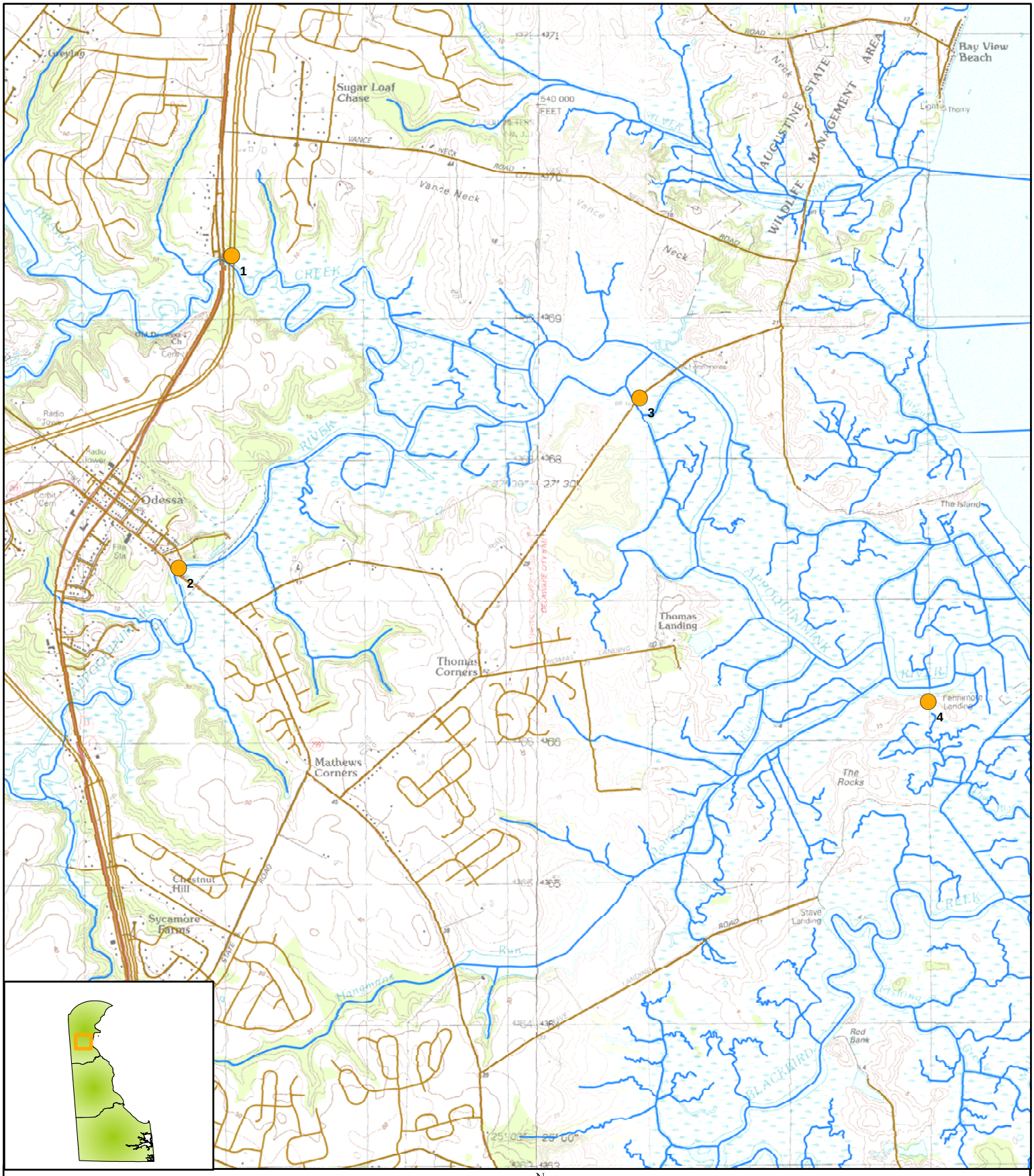
Tidal Marsh Impairment Assessment

A tidal wetland survey was conducted in October 2007 using Delaware's "Rapid Assessment" (Jacobs 2006), and "Protocols for Performing Mid-Atlantic Tidal Fringe Wetland Assessment" (DNREC 2006). The purpose of the survey was to compare "pristine" sections of tidal marsh with "impacted" sections to determine if any indicators of stress could be identified. This information is to be used to better manage the watershed and protect it from impacts due to encroaching development and agricultural practices.

Site Selection

DNREC identified two tidal marsh sites based on the presence of a known disturbance or impairment and other two sites in an undisturbed area to serve as a benchmark for comparison. The site locations were provided by DNREC on a watershed map. The selected sites are shown on Figure 2.

Tidal Marsh Impairment Assessment Sites



0 4,000 8,000 Feet

N

Sites

Source: Delaware DataMIL: 7.5 Minute Quadrangles for Middletown & Taylors Bridge; National Hydrography Dataset (NHD) DE Rivers and Streams; and Delaware Roads

Methodology

The "Delaware Rapid Assessment" (Jacobs 2006) and "Mid-Atlantic Tidal Fringe Wetland Assessment" (DNREC 2006) were used for the study. These methods use multiple sub-plots at each data-point to establish vegetation diversity, vegetative cover, water chemistry, and macro-invertebrate abundance. Data sheets from the wetlands assessment are included in Appendix C. Photographs taken at each sampling site are included in Appendix D.

Because there was no stream channel associated with any of the sample sites selected, the use of the Environmental Protection Agency's Rapid Bioassessment Protocols was inappropriate and not used.

Findings

Results of the survey failed to reveal any indicators that show impact to tidal wetlands. No evidence of increased populations of invasive plant species, decrease in macro-invertebrate diversity, or decrease in water quality was observed for either "impacted" wetland. There are several potential reasons for this: 1) the "pristine" wetlands used as the reference may be equally impaired; 2) the methodologies used may not be robust enough to pick up the differences; or 3) the sample size may have been too small to identify differences.

References

Center for Watershed Protection. 2004. Unified Stream Assessment: A User's Manual; Version 1.0. Ellicott City, MD.

Center for Watershed Protection. 2005. Appoquinimink River Watershed Baseline Assessment. Elliott City, MD.

Delaware Department of Natural Resources and Environmental Control. 2006. Draft Field Protocols for Performing Mid-Atlantic Tidal Fringe Wetland Assessment; Version 1.0. Delaware Department of Natural Resources and Environmental Control. Dover, DE.

Jacobs, A.J. 2006. Delaware Rapid Assessment; Version 3.1. Delaware Department of Natural Resources and Environmental Control. Dover, DE.

Rosgen, D.L. 2002a. A Practical Method of Computing Streambank Erosion Rate. Wildland Hydrology, Pagosa Springs, CO.

Rosgen, D.L. 2002b. River Assessment and Monitoring: Field Guide. Wildland Hydrology, Pagosa Springs, CO.

List of Preparers

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Role in Project	Project Management, Technical Review

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Experience	1 year
Role in Project	Report Production

Appendices

Appendix A

Streambank Assessment Datasheets

Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (DP 1)	**DATE:** 4/24/07	**ASSESSED BY:** RK, AK
SURVEY REACH:	**TIME:** ___:___ AM/PM	**PHOTO ID** (CAMERA-PIC #): /# 1-6
SITE ID: (*Condition #*) ER-___	*START* LAT ___°___'___" LONG ___°___'___" LMK ___ *END* LAT ___°___'___" LONG ___°___'___" LMK ___	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☐ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☐ Bank scour
- ☐ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☒ Both (*looking downstream*)

LOCATION: ☐ Meander bend ☒ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*)	LT 50 ft	and/or RT 50 ft	Bottom width ___ ft
Bank Ht	LT 10" ✗	and/or RT 10" ✗	Top width 5'3" ✗
Bank Angle	LT 90 °	and/or RT 80 °	Wetted Width ___ ft

BFW: 7'6

LAND OWNERSHIP: ☐ Private ☐ Public ☒ Unknown

LAND COVER: ☐ Forest ☐ Field/Ag ☒ Developed:

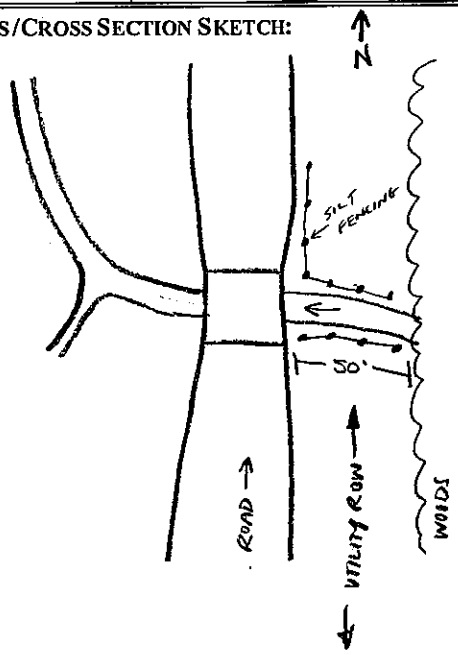
POTENTIAL RESTORATION CANDIDATE: ☐ No ☐ Grade control ☐ Bank stabilization ☐ Other:

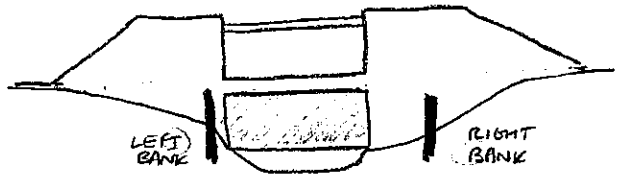
THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☒ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	(3)	2	1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	(5)	4	3	2	1

NOTES/CROSS SECTION SKETCH:





- PERENNIAL STREAM
- UTILITY CROSSING STREAM FOR LOCAL HOUSING DEVELOPMENT TO NORTHEAST.
- SILT FENCING ALONG BOTH SIDES TO PREVENT SILTATION, CONSTRICTING STREAM
- STREAM DEPTH: 3"
- BANKS ARE SANDY, SOME HERBACEOUS VEGETATION (PHRAGMITES, SKUNK CABBAGE, SOFT RUSH, GRASS)
- LOW GRADIENT, LOW FLOW
- SUBSTRATE IS SANDY

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: APPOQUINIMINK W.S. (DP 1) Reach: Cross Section: Date: 4/24/07 Crew: RK, AK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	1.0	VERY LOW
10"	10"	1		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		10	EXTREME
0	0			
Weighted Root Density				
Root Density (%) D	D*(C/A)		10	EXTREME
0	0			
Bank Angle				
Bank Angle (degrees)			6.5	HIGH
80 - 90				
Surface Protection				
Surface Protection (%)			9.0	VERY HIGH
10				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			SAND 10	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			46.5	EXTREME

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: Very Low	Low	Moderate	High	Very High	Extreme
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO (DP1) Location: Date: 4/24/07 Crew: RK AK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High NO
		Extensive deposition (continuous, cross channel). NBS = Extreme. NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress
	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)
Level IV	7	Velocity Gradient (ft/s/ft)		Near-Bank Stress	

Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Dominant Near-Bank Stress
High

channel cross-section

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (D.P. 2)	**DATE:** 4 / 24 / 07	**ASSESSED BY:** RK, AK
SURVEY REACH:	**TIME:** ___:___ AM/PM	**PHOTO ID** (CAMERA-PIC #): /# 7-10
SITE ID: (*Condition #*) ER-_____	*START* **LAT** ___°___'___" **LONG** ___°___'___" **LMK** _____ / *END* **LAT** ___°___'___" **LONG** ___°___'___" **LMK** _____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown
☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☒ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☒ RT ☐ Both (*looking downstream*)
LOCATION: ☒ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:
DIMENSIONS:

Length (*if no GPS*)	LT 36 ft	and/or RT 36 ft	Bottom width 4.8 ft
Bank Ht	LT 4 ft	and/or RT 7 ft	Top width _____ ft
Bank Angle	LT 45 °	and/or RT 70 °	Wetted Width _____ ft

BFH: 1'
BFW: 9.9
DEPTH: <

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown
LAND COVER: ☐ Forest ☐ Field/Ag ☐ Developed:

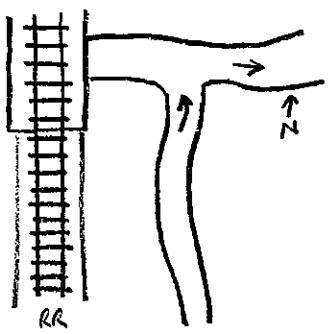
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization ☐ No ☐ Other:

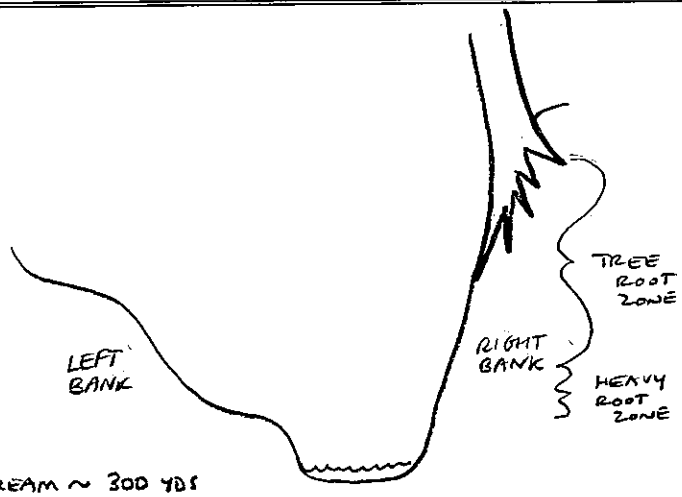
THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☒ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	3	2	(1)
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	4	3	(2)	1

NOTES/CROSS SECTION SKETCH:





- PERENNIAL STREAM ?
- RESIDENTIAL NEIGHBORHOOD UPSTREAM ~ 300 YDS
- BANKS DENSELY ROOTED, SOMEWHAT VEGETATED (BEECH, MULTIFLORA ROSE, HERBACEOUS VEG.)
- STREAM HEAVILY SILTED W/ SILT, SAND, RAILROAD WASH, SOME ISOLATE GRAVEL AREAS
- MOSS ON BANK ABOVE BFH
- SOME SEDIMENT A RESULT OF BACKWASH FROM MAIN STREAM
- SURROUNDING AREA FORESTED, RR TRACKS W/IN 50' OF STREAM W/ STEEP EMBANKMENT (VEGETATED)

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: APPOQUINIMINK W.S. (DP 2) Reach: Cross Section: Date: 4/24/07 Crew: RK, AK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	10	EXTREME
7	1	7		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		1	VERY LOW
7	1			
Weighted Root Density				
Root Density (%) D	D*(C/A)		2.2	LOW
75	75			
Bank Angle				
Bank Angle (degrees)			5.0	MODERATE
70				
Surface Protection				
Surface Protection (%)			1.9	VERY LOW
80				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			20.1	MODERATE

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: Very Low	Low	Moderate	High	Very High	Extreme
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0; no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO W.S. (OP 2) Location: Date: 4/24/07 Crew: RK, AK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High yes
		Extensive deposition (continuous, cross channel). NBS = Extreme NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress

Level III	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)	Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Level IV	7	Velocity Gradient (ft/s/ft)	Near-Bank Stress

Dominant Near-Bank Stress
High

channel cross-section
channel sedimentation

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (D.P. 3)	DATE: 4 / 24 / 07	ASSESSED BY: RK, AK
SURVEY REACH:	TIME: ___:___ AM/PM	PHOTO ID (CAMERA-PIC #): /# 11-16
SITE ID: (Condition #) ER-___	START LAT ___° ___' ___" LONG ___° ___' ___" LMK ___ / END LAT ___° ___' ___" LONG ___° ___' ___" LMK ___	GPS: (Unit ID)

PROCESS: ☐ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☒ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☒ Bank scour
- ☐ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☐ LT ☒ RT ☐ Both (looking downstream)

LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (if no GPS)	LT ___ ft	and/or RT 60 ft	Bottom width ___ ft
Bank Ht	LT ___ ft	and/or RT 3'3"	Top width ___ ft
Bank Angle	LT ___ °	and/or RT 90 °	Wetted Width ___ ft

BFH: 2'3
BFW: 17'
DEPTH: 2"

LAND OWNERSHIP: ☒ Private ☐ Public ☐ Unknown

LAND COVER: ☒ Forest ☐ Field/Ag ☐ Developed:

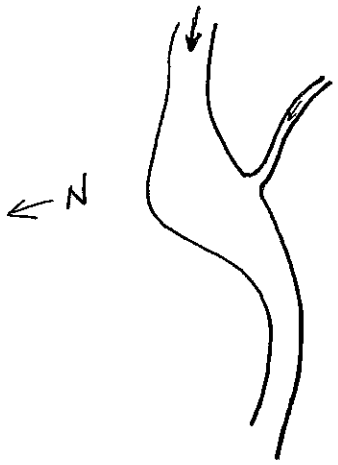
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization ☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☒ >100ft

EROSION SEVERITY (circle#) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	3	(2) 1
ACCESS:	Good access: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	Fair access: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		Difficult access. Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	4	(3)	2 1

NOTES/CROSS SECTION SKETCH:



- PERENNIAL STREAM
- SANDY/SILT BOTTOM, SOME SMALL GRAVEL AREAS
- HEAVY SAND/SILT DEPOSIT ON LEFT BANK INSIDE BEND
- SMALL TRIBUTARY ENTERING STREAM ALONG LEFT BANK
- HEAVY DENSE ROOTING ABOVE BANK FULL HEIGHT
- RIGHT BANK HEAVILY UNDERCUT
- SMALL TREES SURROUNDING AREA (RED MAPLE)
- SOME PASTURE UPSTREAM

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: Appoquinimink W.S. (DP 3) Reach: Cross Section: Date: 4/24/07 Crew: RK, AK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	5.5	MODERATE
3.25	2.25	1.44		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		1.8	LOW
2.6	0.8			
Weighted Root Density				
Root Density (%) D	D*(C/A)		3.5	LOW
70	60			
Bank Angle				
Bank Angle (degrees)			7.9	HIGH
90				
Surface Protection				
Surface Protection (%)			2.8	LOW
70				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			21.5	MODERATE

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: Very Low	Low	Moderate	High	Very High	Extreme
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	Low	Moderate	High	Very High	Extreme
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO (DP 3) Location: Date: 4/24/07 Crew: RK, AK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High yes
		Extensive deposition (continuous, cross channel). NBS = Extreme. NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress
	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)
Level IV	7	Velocity Gradient (ft/s/ft)		Near-Bank Stress	

Dominant Near-Bank Stress
Very High

channel crosssection
Channel Sedimentation

Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (DP 4)	DATE: 4/24/07	ASSESSED BY: RK AK
SURVEY REACH:	TIME: ___:___ AM/PM	PHOTO ID (CAMERA-PIC #): /# 17-22
SITE ID: (Condition #) ER-___	START LAT ___°___'___" LONG ___°___'___" LMK ___ / END LAT ___°___'___" LONG ___°___'___" LMK ___	GPS: (Unit ID)

PROCESS: ☐ Currently unknown
☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☒ Aggrading ☐ Slope failure
☒ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both (*looking downstream*)
LOCATION: ☐ Meander bend ☒ Straight section ☐ Steep slope/valley wall ☐ Other:
DIMENSIONS:

Length (*if no GPS*)	LT 500 ft	and/or RT ___ ft	Bottom width 14.5 ft
Bank Ht	LT 30 ft	and/or RT ___ ft	Top width ___ ft
Bank Angle	LT 70 °	and/or RT ___ °	Wetted Width ___ ft

BFH: 1'3"
BFW: 41
DEPTH: 3'

LAND OWNERSHIP: ☒ Private ☐ Public ☐ Unknown
LAND COVER: ☒ Forest ☒ Field/Ag ☐ Developed:

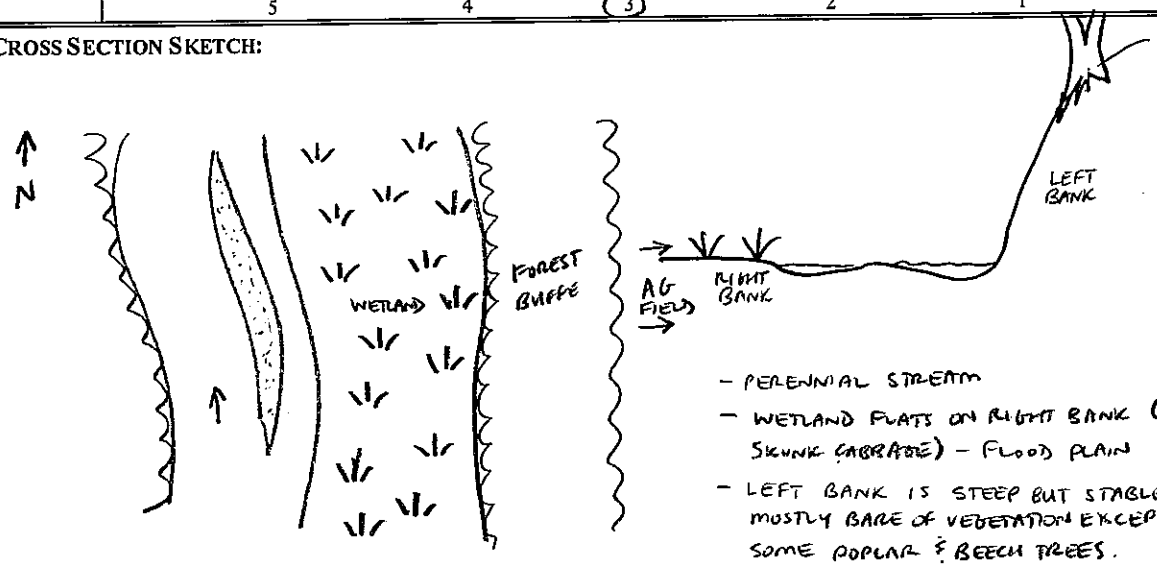
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☒ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	3	2	(1)
ACCESS:	Good access: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		Fair access: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		Difficult access. Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	4	(3)	2	1

NOTES/CROSS SECTION SKETCH:



- PERENNIAL STREAM
- WETLAND FLATS ON RIGHT BANK (SEDGE, SKUNK CABBAGE) - FLOOD PLAIN
- LEFT BANK IS STEEP BUT STABLE. MOSTLY BARE OF VEGETATION EXCEPT FOR SOME POPLAR & BEECH TREES.
- SMALL FORESTED BUFFER TO WEST THEN RESIDENTIAL
- SMALL FORESTED / SCRUB SHRUB RIPARIAN BUFFER TO EAST THEN AGRICULTURAL.
- SUBSTRATE SANDY SILT W/ SOME GRAVEL
- HEAVY AGGRADATION / SEDIMENT DEPOSIT IN STREAM BED & RIGHT BANK

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: APPOQUINIMINK NS (DP 4) Reach: Cross Section: Date: 4/24/07 Crew: RK, AK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	10	EXTREME
30	1.25	24		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		1.7	VERY LOW
28	0.93			
Weighted Root Density				
Root Density (%) D	D*(C/A)		7.5	HIGH
20	18.6			
Bank Angle				
Bank Angle (degrees)			5.0	MODERATE
70				
Surface Protection				
Surface Protection (%)			4.2	MODERATE
50				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			28.4	MODERATE

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: Very Low	Low	Moderate	High	Very High	Extreme
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO (DP4) Location: Date: 4/24/07 Crew: RK, AK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High Yes
		Extensive deposition (continuous, cross channel). NBS = Extreme. NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress
	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)
Level IV	7	Velocity Gradient (ft/s/ft)		Near-Bank Stress	

Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Dominant Near-Bank Stress
High

channel sedimentation

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (DP 5)	**DATE:** 5 / 25 / 07	**ASSESSED BY:** RK
SURVEY REACH:	**TIME:** ___:___ AM/PM	**PHOTO ID** (CAMERA-PIC #): /# 20-24
SITE ID: (*Condition #*) ER-____	*START* LAT ___°___'___" LONG ___°___'___" LMK ____ *END* LAT ___°___'___" LONG ___°___'___" LMK ____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☒ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☒ Bank scour
- ☐ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☒ LT ☐ RT ☐ Both (*looking downstream*)

LOCATION: ☒ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*)	LT 60 ft	and/or RT ____ ft	Bottom width ____ ft
Bank Ht	LT 5 ft	and/or RT ____ ft	Top width ____ ft
Bank Angle	LT 90 °	and/or RT ____ °	Wetted Width ____ ft

WIDTH: 3
DEPTH: 3-1'
BFH: 2'
BFW: 12'

LAND OWNERSHIP: ☒ Private ☐ Public ☐ Unknown

LAND COVER: ☒ Forest ☒ Field/Ag ☐ Developed:

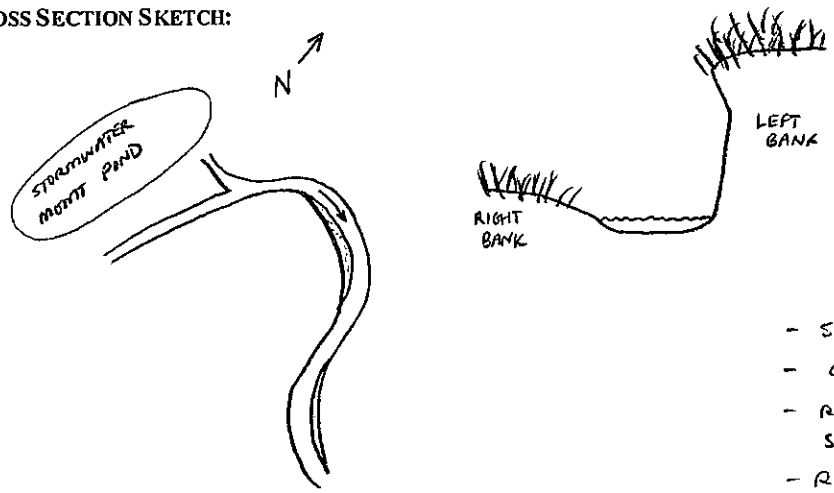
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization ☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☒ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☒ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	(3)	2	1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	4	(3)	2	1

NOTES/CROSS SECTION SKETCH:



- PERENNIAL?
- SUBSTRATE: SILT/SAND/GRAVEL
- SOIL PROFILE:
  - 1-32" - SILT LOAM
  - 32-44" - SANDY LOAM
  - 44"+ - CLAY LOAM
- AG FIELDS TO SOUTHWEST AND NORTHEAST
- RESIDENTIAL TO NORTHWEST
- SLOW, SHALLOW STREAM
- CLOSE TO HEADWATER
- RECEIVES OVERFLOW FROM STORMWATER MGMT POND
- ROOT DEPTH: 2' DENSITY: 30%
- SMALL RIPARIAN BUFFER (MULTIFLORA ROSE, SWEETGUM RED MAPLE, WILLOW, ASH)
- BANK DEGRADATION SLOW

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: APPOQUINIMINK WS. (DP 5) Reach: Cross Section: Date: 5/25/07 Crew: RK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	8.5	VERY HIGH
5	2	2.5		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		5.0	MODERATE
2	0.4			
Weighted Root Density				
Root Density (%) D	D*(C/A)		8.2	VERY HIGH
30	12			
Bank Angle				
Bank Angle (degrees)			7.9	HIGH
90				
Surface Protection				
Surface Protection (%)			5.9	MODERATE
30				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			35.5	HIGH

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: Very Low	Low	Moderate	High	Very High	Extreme
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO (DP 5) Location: Date: 5/25/07 Crew: RK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High yes
		Extensive deposition (continuous, cross channel). NBS = Extreme NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress
Level IV	7	Velocity Gradient (ft/s/ft)		Near-Bank Stress	

Dominant Near-Bank Stress
Very High

Channel Cross section
Channel Sedimentation

Level III	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)	Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (D.P. 6)	DATE: 4/24/07	ASSESSED BY: RK, AK
SURVEY REACH:	TIME: ___:___ AM/PM	PHOTO ID (CAMERA-PIC #): /# 76-79
SITE ID: (Condition #) ER-____	START LAT ___°___'___" LONG ___°___'___" LMK ____ / END LAT ___°___'___" LONG ___°___'___" LMK ____	GPS: (Unit ID)

PROCESS: ☒ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☐ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☐ Bank scour
- ☐ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both *(looking downstream)*

LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length *(if no GPS)*	LT_____ft	and/or RT_____ft	Bottom width _____ft
Bank Ht	LT_____ft	and/or RT_____ft	Top width _____ft
Bank Angle	LT_____°	and/or RT_____°	Wetted Width _____ft

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown **LAND COVER:** ☐ Forest ☐ Field/Ag ☐ Developed:

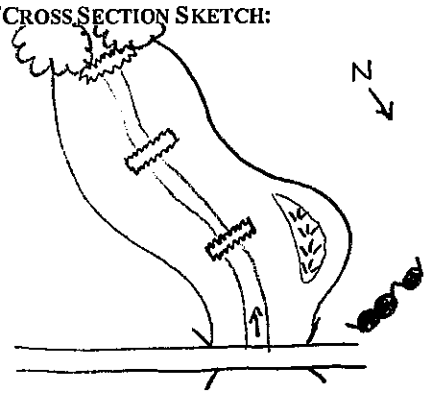
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization ☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☒ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY (circle#) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	(3)	2	1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	(5)	4	3	2	1

NOTES/CROSS SECTION SKETCH:



- EPHEMERAL STORMWATER DRAINAGE AREA W/IN RESIDENTIAL DEVELOPMENT
- NEWLY PLANTED, BUT NO STORMWATER MGMT STRUCTURES.
- SOME NETTING / RIP-RAP / HAY BALES BUT FLOW GOES AROUND AND CUTS INTO GROUND
- HEAVY SILT LOAD
- STREAM BELOW HAS WOODED BUFFER
- NO DEFINED BED / BANK - NO MEASUREMENT WERE OBTAINED

REPORTED TO AUTHORITIES ☐ YES ☐ NO

Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (DATA PT 7)	**DATE:** 4 / 25 / 07	**ASSESSED BY:** RK, AK
SURVEY REACH:	**TIME:** ___:___ AM/PM	**PHOTO ID** (CAMERA-PIC #): /# 35-36, 39-52
SITE ID: (*Condition-#*) ER-_____	*START* LAT ___°___'___" LONG ___°___'___" LMK _____ / *END* LAT ___°___'___" LONG ___°___'___" LMK _____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☒ Sed. deposition
- ☐ Bed scour
- ☒ Bank failure
- ☐ Bank scour
- ☒ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☒ LT ☐ RT ☐ Both (*looking downstream*)

LOCATION: ☒ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS: BANK FULL HEIGHT: 3' BANK FULL WIDTH: 40' DEPTH: 10"

Length (*if no GPS*)	LT 100 ft	and/or RT _____ ft	Bottom width _____ ft
Bank Ht	LT 6 ft	and/or RT _____ ft	Top width _____ ft
Bank Angle	LT 90 °	and/or RT _____ °	Wetted Width _____ ft

LAND OWNERSHIP: ☐ Private ☒ Public ☒ Unknown

LAND COVER: ☒ Forest ☐ Field/Ag ☒ Developed:

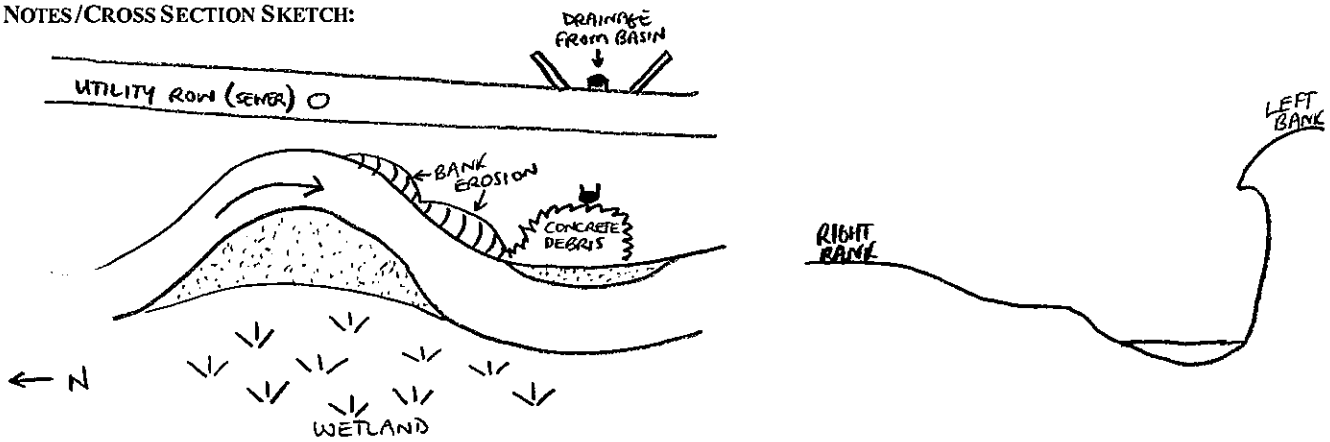
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization ☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☒ Yes (Describe): STREAM BANK EROSION APPROACHING SEWER LINE

EXISTING RIPARIAN WIDTH: ☒ ≤25 ft (LEFT) ☐ 25 - 50 ft ☐ 50-75ft ☒ 75-100ft (RIGHT) ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	(4)	3	2 1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	(5)	4	3	2 1

NOTES/CROSS SECTION SKETCH:



- FORESTED STREAM CORRIDOR BETWEEN 2 NEIGHBORHOODS.
- STORMWATER BASIN OUTFALL ALONG (L) BANK, DISCHARGES INTO CRUSHED CONCRETE DEBRIS.
- UTILITY ROW (SEWER) WITHIN 10' OF ACTIVELY ERODING BANK.
- HEAVY SAND/SILT/GRAVEL DEPOSITS ON INSIDE OF BENDS.
- ACTIVELY ERODING BANK HAS LITTLE ROOT DENSITY
- SUBSTRATE IS SAND/SILT/GRAVEL
- LOCAL RESIDENT SAID STREAM HAS DETERIORATED SEVERELY OVER PAST 10-20 YRS (CHANNEL WIDENED, WATER LEVEL LOWERED)

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: APPDQUINIMINK W.S. (D.P.7) Reach: Cross Section: Date: 4/25/07 Crew: RK, AK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	7.9	HIGH
6	3	2		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		3.0	LOW
4	.67			
Weighted Root Density				
Root Density (%) D	D*(C/A)		7.5	HIGH
30	19.8			
Bank Angle				
Bank Angle (degrees)			7.9	HIGH
90				
Surface Protection				
Surface Protection (%)			7.9	HIGH
15				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			34.2	HIGH

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential					
			Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: Location: DP 7 Date: 4/25/07 Crew: RK, AR

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High yes
		Extensive deposition (continuous, cross channel). NBS = Extreme yes
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme no

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress

Level III	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)	Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Level IV	7	Velocity Gradient (ft/s/ft)	Near-Bank Stress

Dominant Near-Bank Stress
Extreme

Channel cross section
Excessive sedimentation

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (D.P. 8)	DATE: 4/24/07	ASSESSED BY:
SURVEY REACH:	TIME: ___:___ AM/PM	PHOTO ID (CAMERA-PIC #): /# 23-27
SITE ID: (Condition #) ER-_____	START LAT ___°___'___" LONG ___°___'___" LMK _____ END LAT ___°___'___" LONG ___°___'___" LMK _____	GPS: (Unit ID)

PROCESS: ☐ Currently unknown
☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☒ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☐ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☒ Both (*looking downstream*)
LOCATION: ☐ Meander bend ☒ Straight section ☐ Steep slope/valley wall ☐ Other:
DIMENSIONS:

Length (*if no GPS*)	LT 80 ft	and/or RT 80 ft	Bottom width _____ ft
Bank Ht	LT 2 ft	and/or RT 2 ft	Top width _____ ft
Bank Angle	LT 80 °	and/or RT 90 °	Wetted Width _____ ft

BFH: 1'
BFW: 3'6

LAND OWNERSHIP: ☐ Private ☐ Public ☒ Unknown
LAND COVER: ☒ Forest ☐ Field/Ag ☐ Developed:

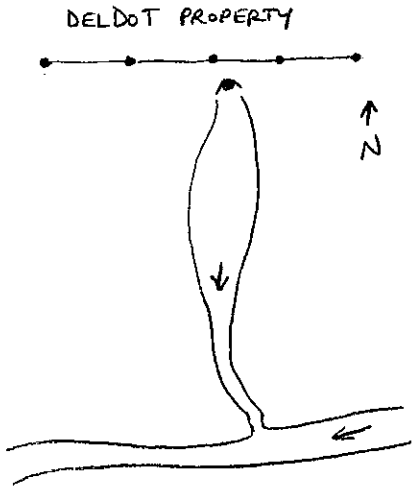
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization
☐ No ☐ Other:

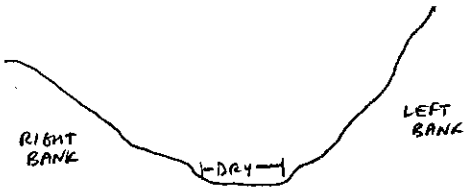
THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☒ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	3	2	1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	4	3	2	1

NOTES/CROSS SECTION SKETCH:





- EPHEMERAL DRAINAGE AREA
- WOODY VEGETATION W/ HERBACEOUS VEGETATION (BEECH, MAPLE, CHERRY)
- BELOW DELDOT YARD OUTFLOW. APPEARS TO HAVE A HEAVY FLOW WHEN IT RAINS
- HEADCUTTING EVIDENT
- SOME SLIGHT BANK UNDERCUTTING
- SUBSTRATE: SILTY-SANDY, SOME GRAVEL.

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: Appoquinimink W.S. (DP 8) Reach: Cross Section: Date: 4/24/07 Crew: RK, AK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	7.9	HIGH
2	1	2		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		3.9	LOW
1	0.5			
Weighted Root Density				
Root Density (%) D	D*(C/A)		8.5	VERY HIGH
20	10			
Bank Angle				
Bank Angle (degrees)			7.7	HIGH
85				
Surface Protection				
Surface Protection (%)			2.3	LOW
75				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			30.3	HIGH

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: *Very Low*	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO. (DP B) Location: Date: 4/24/07 Crew: AK, RK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High NO
		Extensive deposition (continuous, cross channel). NBS = Extreme NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress

Level III	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)	Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Level IV	7	Velocity Gradient (ft/s/ft)	Near-Bank Stress

Dominant Near-Bank Stress
Low

Channel cross section

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPO (DP9)	**DATE:** 4/24/07	**ASSESSED BY:** RK, AK
SURVEY REACH:	**TIME:** ___:___ AM/PM	**PHOTO ID** (CAMERA-PIC #): /#
SITE ID: (*Condition-#*) ER-_____	*START* LAT ___°___'___" LONG ___°___'___" LMK _____ *END* LAT ___°___'___" LONG ___°___'___" LMK _____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☐ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☐ Bank scour
- ☐ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both (*looking downstream*)

LOCATION: ☐ Meander bend ☒ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*)	LT 50 ft	and/or RT 50 ft	Bottom width _____ ft
Bank Ht	LT 1 ft	and/or RT 1 ft	Top width _____ ft
Bank Angle	LT 10 °	and/or RT 10 °	Wetted Width _____ ft

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown

LAND COVER: ☐ Forest ☐ Field/Ag ☐ Developed:

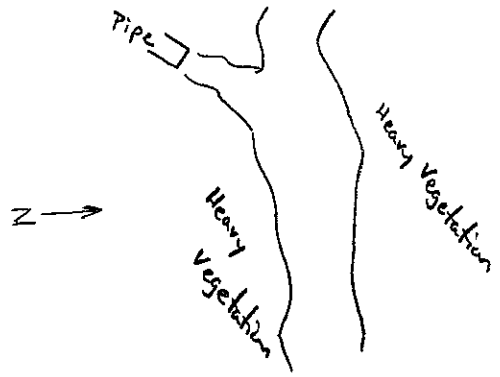
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization ☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☒ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	3	(2) 1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	4	(3)	2 1

NOTES/CROSS SECTION SKETCH:



REPORTED TO AUTHORITIES ☐ YES ☐ NO

Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK W.S. (D.P. 10)	DATE: 4 / 25 / 07	ASSESSED BY: RK, AK
SURVEY REACH:	TIME: ___:___ AM/PM	PHOTO ID (CAMERA-PIC #): /# 53-59
SITE ID: (Condition #) ER-___	START LAT ___°___'___" LONG ___°___'___" LMK ___ / END LAT ___°___'___" LONG ___°___'___" LMK ___	GPS: (Unit ID)

PROCESS: ☐ Currently unknown
- ☒ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☒ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☐ Bank scour
- ☒ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☒ Both (*looking downstream*)

LOCATION: ☐ Meander bend ☒ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*)	LT 50 ft	and/or RT 50 ft	Bottom width ___ ft
Bank Ht	LT ___ ft	and/or RT ___ ft	Top width ___ ft
Bank Angle	LT ___ °	and/or RT ___ °	Wetted Width ___ ft

LAND OWNERSHIP: ☐ Private ☐ Public ☒ Unknown

LAND COVER: ☒ Forest ☐ Field/Ag ☐ Developed:

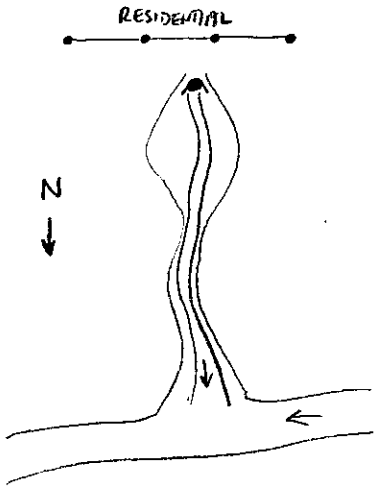
POTENTIAL RESTORATION CANDIDATE: ☐ No ☐ Grade control ☐ Bank stabilization ☐ Other:

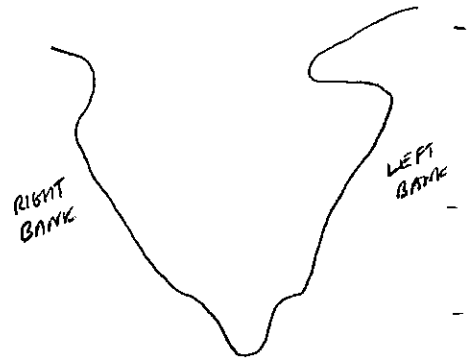
THREAT TO PROPERTY/INFRASTRUCTURE: ☐ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☒ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	(5)	4	3	2	1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	(5)	4	3	2	1

NOTES/CROSS SECTION SKETCH:





- EPHEMERAL DRAINAGE CHANNEL ORIGINATING AS AN OUTFALL FROM NEARBY NEIGHBORHOOD.
- CHANNEL FLOWS DOWN HILLSIDE AND DISSIPATES INTO A WETLAND AND EVENTUALLY INTO A PERENNIAL STREAM.
- SEDIMENT LOAD FROM OUTFALL IS HIGH AND IS BEING DEPOSITED INTO THE WETLAND AREA.
- SAND / GRAVEL SUBSTRATE

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: APPOQUINIMINK W.S. (D.P. 10) Reach: Cross Section: Date: 4/25/07 Crew: RK, AK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	10	EXTREME
3	1	3		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		5.7	MODERATE
1	0.33			
Weighted Root Density				
Root Density (%) D	D*(C/A)		8.5	VERY HIGH
30	9.9			
Bank Angle				
Bank Angle (degrees)			5.0	MODERATE
70				
Surface Protection				
Surface Protection (%)			5.9	MODERATE
30				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			35.1	HIGH

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: Very Low	Low	Moderate	High	Very High	Extreme
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	Low	Moderate	High	Very High	Extreme
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO (DP 10) Location: Date: 4/24/07 Crew: RK, AK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High NO
		Extensive deposition (continuous, cross channel). NBS = Extreme NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress
	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)
Level IV	7	Velocity Gradient (ft/s/ft)		Near-Bank Stress	

Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Dominant Near-Bank Stress
Low

Down cutting Gully

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (DATA POINT 11)	**DATE:** 4 / 25 / 07	**ASSESSED BY:** RK, AK
SURVEY REACH:	**TIME:** ___:___ AM/PM	**PHOTO ID** (CAMERA-PIC #): /# 60-65,

SITE ID: (*Condition-#*) **ER-**_____

START **LAT** ___°___'___" **LONG** ___°___'___" **LMK** _____

END **LAT** ___°___'___" **LONG** ___°___'___" **LMK** _____

GPS: (*Unit ID*)

PROCESS: ☐ Currently unknown

☐ Downcutting ☐ Bed scour
☐ Widening ☐ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☐ Slope failure
☒ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☒ LT ☐ RT ☐ Both (*looking downstream*)

LOCATION: ☒ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS: BANK FULL WIDTH: 18' BANK FULL HEIGHT: 1' DEPTH: ~ 3'

Length (*if no GPS*) LT 66 ft and/or RT _____ ft
Bank Ht LT 1 ft and/or RT _____ ft
Bank Angle LT 90 ° and/or RT _____ °

Bottom width _____ ft
Top width _____ ft
Wetted Width _____ ft

LAND OWNERSHIP: ☐ Private ☐ Public ☐ Unknown

LAND COVER: ☐ Forest ☐ Field/Ag ☐ Developed:

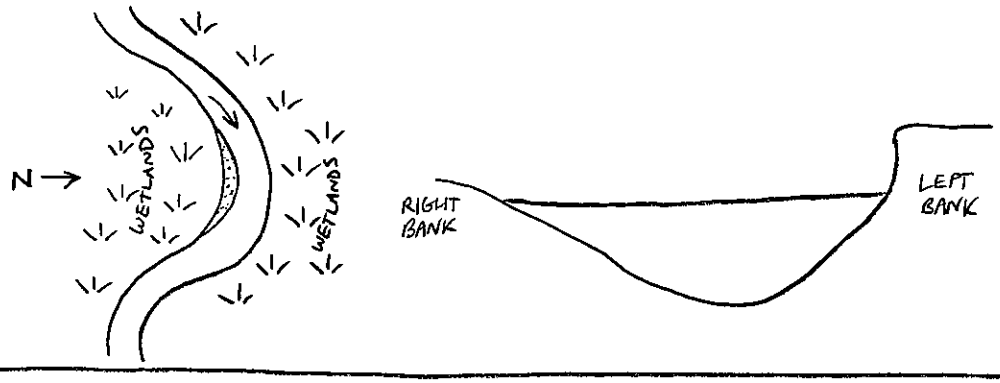
POTENTIAL RESTORATION CANDIDATE: ☐ No ☐ Grade control ☐ Bank stabilization ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☒ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☒ 75-100ft ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure	Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4 3	2 1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.	**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	4 3	2 1

NOTES/CROSS SECTION SKETCH:



- SLOW, MEANDERING STREAM IN FORESTED WETLAND AREA
- BENDS APPEAR STABLE
- REMNANT BEAVER POND?
- SANDY / SILT / GRAVEL SUBSTRATE
- WIDE FLOOD PLAIN
- BRAIDED CHANNELS DOWNSTREAM
- RESIDENTIAL AREAS TO NORTH AND SOUTH

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: Appoquinimink W.S. (D.P. 11) Reach: Cross Section: Date: 4/25/07 Crew: RK, AK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	1.0	LOW
4	4	1		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		6.4	HIGH
1	.25			
Weighted Root Density				
Root Density (%) D	D*(C/A)		8.2	VERY HIGH
50	12.5			
Bank Angle				
Bank Angle (degrees)			7.9	HIGH
90				
Surface Protection				
Surface Protection (%)			3.5	MODERATE
60				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			27	MODERATE

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: Very Low	Low	Moderate	High	Very High	Extreme
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)
Boulders (Banks composed of boulders have low bank erosion potential)
Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points if sand is exposed to erosional processes)
Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: Location: Date: Crew:

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High NO
		Extensive deposition (continuous, cross channel). NBS = Extreme NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress

Level III	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)	Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Level IV	7	Velocity Gradient (ft/s/ft)	Near-Bank Stress

Dominant Near-Bank Stress
High

Channel cross section

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (DP 12)	**DATE:** 4/25/07	**ASSESSED BY:** RK, AK
SURVEY REACH:	**TIME:** ___:___ AM/PM	**PHOTO ID** (CAMERA-PIC #): /# 70-75 -
SITE ID: (*Condition-#*) ER-_____	*START* LAT ___°___'___" LONG ___°___'___" LMK _____ *END* LAT ___°___'___" LONG ___°___'___" LMK _____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☐ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☐ Bank scour
- ☒ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☐ LT ☒ RT ☐ Both (*looking downstream*)

LOCATION: ☐ Meander bend ☒ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*)	LT_____ft	and/or RT 24 ft	Bottom width _____ft
Bank Ht	LT_____ft	and/or RT 9 ft	Top width _____ft
Bank Angle	LT_____°	and/or RT 90 °	Wetted Width _____ft

BFH: 1.5
BFW: 5

LAND OWNERSHIP: ☐ Private ☐ Public ☒ Unknown

LAND COVER: ☐ Forest ☐ Field/Ag ☒ Developed:

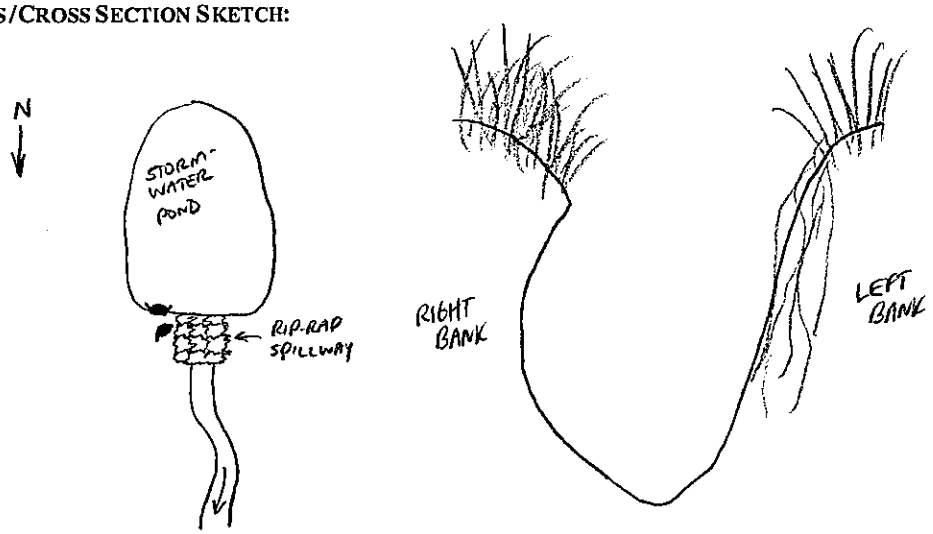
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization ☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☒ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☒ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	(5)	4	3	2	1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	(4)	3	2	1

NOTES/CROSS SECTION SKETCH:



- EPHEMERAL;
- DISCHARGE AREA FOR OUTFALL / SPILLWAY OF STORMWATER MGMT POND
- SUBSTRATE A MIX OF SAND / SILT / GRAVEL / COBBLE / BOULDERS
- RIGHT BANK HIGHLY EXPOSED W/ LITTLE VEGETATION OR ROOT SUPPORT
- LEFT BANK HAS HERBACEOUS VEGETATION. IT IS STEEP BUT STABLE
- SOIL PROFILE:
  - 0-7": ORGANIC
  - 7-36": SILT LOAM
  - 36-68": SANDY LOAM
  - 68+": GRAVEL

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: APPOQUINIMINK (DP 12) Reach: Cross Section: Date: 4/25/07 Crew: RK, AK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	10	EXTREME
9	1.5	6		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		5.7	MODERATE
3	0.33			
Weighted Root Density				
Root Density (%) D	D*(C/A)		8.5	VERY HIGH
30	9.9			
Bank Angle				
Bank Angle (degrees)			7.9	HIGH
90				
Surface Protection				
Surface Protection (%)			9.0	VERY HIGH
10				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			41.1	VERY HIGH

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: *Very Low*	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO (DP 12) Location: Date: 4/25/07 Crew: AK, RK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High NO
		Extensive deposition (continuous, cross channel). NBS = Extreme NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress
	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)
Level IV	7	Velocity Gradient (ft/s/ft)		Near-Bank Stress	

Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Dominant Near-Bank Stress
Low

Downcutting Gully

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (DP 13)	DATE: 5/24/07	ASSESSED BY: RK
SURVEY REACH:	TIME: ___:___ AM/PM	PHOTO ID (CAMERA-PIC #): /# 15-19
SITE ID: (Condition #) ER-___	START LAT ___°___'___" LONG ___°___'___" LMK ___ / END LAT ___°___'___" LONG ___°___'___" LMK ___	GPS: (Unit ID)

PROCESS: ☐ Currently unknown
☐ Downcutting ☐ Bed scour
☐ Widening ☑ Bank failure
☐ Headcutting ☐ Bank scour
☐ Aggrading ☒ Slope failure
☐ Sed. deposition ☐ Channelized

BANK OF CONCERN: ☒ LT ☐ RT ☐ Both *(looking downstream)*
LOCATION: ☒ Meander bend (SLIGHT) ☐ Straight section ☐ Steep slope/valley wall ☐ Other:
DIMENSIONS:

Length *(if no GPS)*	LT 20 ft	and/or RT ___ ft	Bottom width ___ ft
Bank Ht	LT 7 ft	and/or RT ___ ft	Top width ___ ft
Bank Angle	LT 60 °	and/or RT ___ °	Wetted Width ___ ft

WIDTH: 4
DEPTH: 3
BFH: 2
BFW: 33

LAND OWNERSHIP: ☐ Private ☐ Public ☒ Unknown
LAND COVER: ☒ Forest ☐ Field/Ag ☐ Developed:

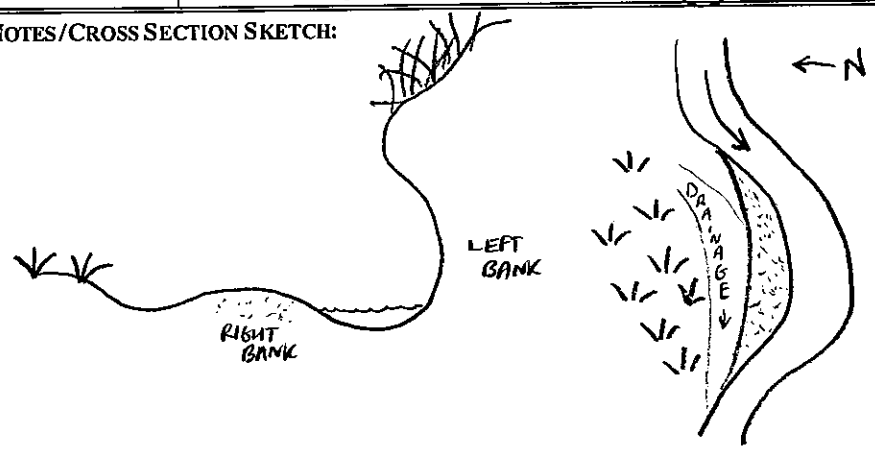
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization ☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☒ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☒ >100ft

EROSION SEVERITY (circle#) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	(3)	2	1
ACCESS:	Good access: Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		Fair access: Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		Difficult access. Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	4	(3)	2	1

NOTES/CROSS SECTION SKETCH:



- PERENNAL STREAM
- LOCATED IN A FORESTED AREA BETWEEN RESIDENTIAL NEIGHBORHOOD AN A DEVELOPING NEIGHBORHOOD.
- ROOT DEPTH: 7' DENSITY: 35%
- SUBSTRATE: SAND/SILT/COBBLE/GRAVEL
- LARGE SAND/GRAVEL BAR ON INSIDE OF BEND (W/ SOME VEGETATION)
- WETLAND OUTLET TO THE NORTHEAST
- STREAM IS SLOW & SHALLOW
- SANDY/SILT BANK
- GROUNDWATER RECHARGE ON LEFT BANK @ 1 FT.
- VEGETATION: MAPLE, POPLAR, JEWELWEED MULTIFLORA ROSE, SKUNK CABBAGE

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: Appoquinimink (DP 13) Reach: Cross Section: Date: 5/24/07 Crew: RK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	1.0	EXTREME
7	2	3.5		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		1.0	VERY LOW
7	1			
Weighted Root Density				
Root Density (%) D	D*(C/A)		5.5	MODERATE
35				
Bank Angle				
Bank Angle (degrees)			3.9	LOW
60				
Surface Protection				
Surface Protection (%)			5.9	MODERATE
30				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			26.3	MODERATE

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: Very Low	Low	Moderate	High	Very High	Extreme
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)
Boulders (Banks composed of boulders have low bank erosion potential)
Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)
Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)
Sand (Add 10 points if sand is exposed to erosional processes)
Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO (DP 13) Location: Date: 5/24/07 Crew: RK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High YES
		Extensive deposition (continuous, cross channel). NBS = Extreme NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress

Level III	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)	Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Level IV	7	Velocity Gradient (ft/s/ft)	Near-Bank Stress

Dominant Near-Bank Stress
High

Channel Crosssection
Channel Sedimentation

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (DP 14)	**DATE:** 5/24/07	**ASSESSED BY:** RK
SURVEY REACH:	**TIME:** ___:___ AM/PM	**PHOTO ID** (CAMERA-PIC #): /# 11-14
SITE ID: (*Condition #*) ER-____	*START* LAT ___°___'___" LONG ___°___'___" LMK ____ *END* LAT ___°___'___" LONG ___°___'___" LMK ____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☐ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☐ Bank scour
- ☒ Slope failure
- ☒ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☒ Both (*looking downstream*)

LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*)	LT ____ ft	and/or RT ____ ft	Bottom width ____ ft
Bank Ht	LT 2 ft	and/or RT 7 ft	Top width ____ ft
Bank Angle	LT 30 °	and/or RT 80 °	Wetted Width ____ ft

BFH: 2'
BFW: 7'
DEPTH: 6
WIDTH: 5

LAND OWNERSHIP: ☒ Private ☐ Public ☐ Unknown

LAND COVER: ☐ Forest ☐ Field/Ag ☒ Developed:

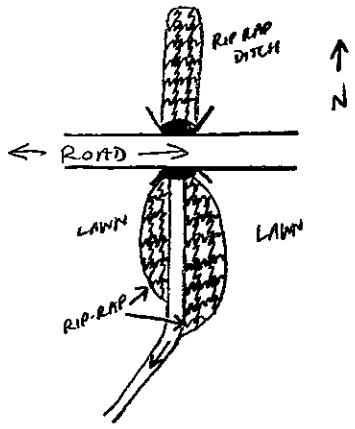
POTENTIAL RESTORATION CANDIDATE: ☐ No ☐ Grade control ☐ Bank stabilization ☐ Other:

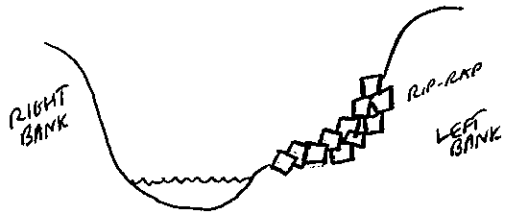
THREAT TO PROPERTY/INFRASTRUCTURE: ☒ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☒ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☐ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	3	(2) 1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	(4)	3	2 1

NOTES/CROSS SECTION SKETCH:





RIP RAP: ~ 75' ON LEFT
~ 50' ON RIGHT

- INTERMITTENT?
- CHANNELIZED SECTION IN LAWN AREA
- MAJORITY OF BANK EITHER RIP-RAP OR THICK HERBACEOUS GROUNDCOVER
- ROOT DEPTH: 4' DENSITY: 20 % (LARGE ROOTS)
- VEGETATION: JEWELWEED, MULTIFLORA ROSE, POPLAR, MAPLE
- SUBSTRATE: SAND / SILT / GRAVEL
- SLOW. HEAD WATER ON OTHER SIDE OF ROAD

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: APPOQUINIMINK (DP 14) Reach: Cross Section: Date: 5/24/07 Crew: RK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	10	EXTREME
7	2	3.5		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		3.5	LOW
4	0.57			
Weighted Root Density				
Root Density (%) D	D*(C/A)		8.3	VERY HIGH
20	11.4			
Bank Angle				
Bank Angle (degrees)			5.9	MODERATE
80				
Surface Protection				
Surface Protection (%)			5.0	MODERATE
40				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			32.7	HIGH

Bank Erosion Hazard Index

Erodibility Variable			Bank Erosion Potential: *Very Low*	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
	Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
	Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
		Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO (DP 14) Location: Date: 5/24/07 Crew: RK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High Yes
		Extensive deposition (continuous, cross channel). NBS = Extreme NO
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme NO

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress
	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)
Level IV	7	Velocity Gradient (ft/s/ft)		Near-Bank Stress	

Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Dominant Near-Bank Stress
High

Channel Sedimentation

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (D.P. 15)	DATE: 5/24/07	ASSESSED BY: RK
SURVEY REACH:	TIME: ___:___ AM/PM	PHOTO ID (CAMERA-PIC #): /# 1-4
SITE ID: (*Condition-#*) ER-_____	*START* LAT ___°___'___" LONG ___°___'___" LMK _____ *END* LAT ___°___'___" LONG ___°___'___" LMK _____	GPS: (*Unit ID*)

PROCESS: ☐ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☐ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☐ Bank scour
- ☐ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☐ LT ☐ RT ☐ Both (*looking downstream*)

LOCATION: ☐ Meander bend ☐ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*)	LT_____ft	and/or RT_____ft	Bottom width _____ft
Bank Ht	LT_____ft	and/or RT_____ft	Top width _____ft
Bank Angle	LT_____°	and/or RT_____°	Wetted Width _____ft

LAND OWNERSHIP: ☐ Private ☐ Public ☒ Unknown

LAND COVER: ☒ Forest ☐ Field/Ag ☐ Developed:

POTENTIAL RESTORATION CANDIDATE: ☐ No ☐ Grade control ☐ Bank stabilization ☐ Other:

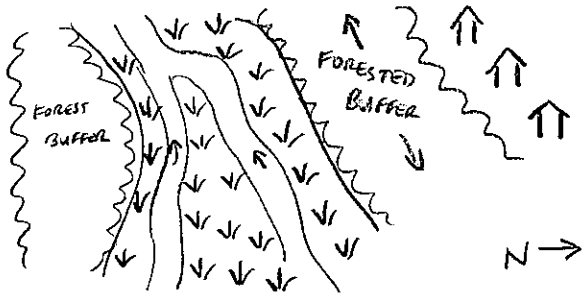
THREAT TO PROPERTY/INFRASTRUCTURE: ☒ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☒ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.		Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	3	2	1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.		**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	4	3	2	1

NOTES/CROSS SECTION SKETCH:

- LARGE WETLAND COMPLEX
- SLOW, SINUOUS CHANNELS
- BEAVER ACTIVITY
- BANKS WELL-ROOTED W/ HERBACEOUS VEG. & TREES (SKUNK CABBAGE, BEECH, MAPLE, ASH)
- SHALLOW (<1' DEEP), SLOW
- MUCKY BOTTOM
- NO EVIDENCE OF EROSION
- NO MEASUREMENTS TAKEN



REPORTED TO AUTHORITIES ☐ YES ☐ NO

Severe Bank Erosion **ER**

WATERSHED/SUBSHED: APPOQUINIMINK (DP 16)	**DATE:** 5 / 24 / 07	**ASSESSED BY:** RK
SURVEY REACH:	**TIME:** ___:___ AM/PM	**PHOTO ID** (CAMERA-PIC #): /# 5 - 10
SITE ID: (*Condition-#*) ER-_____	*START* **LAT** ___°___'___" **LONG** ___°___'___" **LMK** _____ *END* **LAT** ___°___'___" **LONG** ___°___'___" **LMK** _____	**GPS:** (*Unit ID*)

PROCESS: ☐ Currently unknown
- ☐ Downcutting
- ☐ Widening
- ☐ Headcutting
- ☐ Aggrading
- ☐ Sed. deposition
- ☐ Bed scour
- ☐ Bank failure
- ☒ Bank scour
- ☐ Slope failure
- ☐ Channelized

BANK OF CONCERN: ☐ LT ☒ RT ☐ Both (*looking downstream*)

LOCATION: ☐ Meander bend ☒ Straight section ☐ Steep slope/valley wall ☐ Other:

DIMENSIONS:

Length (*if no GPS*)	LT_____ft	and/or RT 30 ft	Bottom width _____ft
Bank Ht	LT_____ft	and/or RT 4 ft	Top width _____ft
Bank Angle	LT_____°	and/or RT 75 °	Wetted Width _____ft

BFH: 3'
BFW: 16
WIDTH: 13
DEPTH: 1'

LAND OWNERSHIP: ☒ Private ☐ Public ☐ Unknown

LAND COVER: ☒ Forest ☐ Field/Ag ☐ Developed:

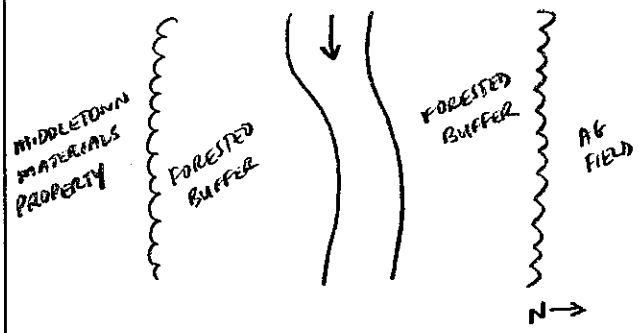
POTENTIAL RESTORATION CANDIDATE: ☐ Grade control ☐ Bank stabilization ☐ No ☐ Other:

THREAT TO PROPERTY/INFRASTRUCTURE: ☒ No ☐ Yes (Describe):

EXISTING RIPARIAN WIDTH: ☐ ≤25 ft ☐ 25 - 50 ft ☐ 50-75ft ☐ 75-100ft ☒ >100ft

EROSION SEVERITY (*circle#*) Channelized= ☐ 1	Active downcutting; tall banks on both sides of the stream eroding at a fast rate; erosion contributing significant amount of sediment to stream; obvious threat to property or infrastructure.	Pat downcutting evident, active stream widening, banks actively eroding at a moderate rate; no threat to property or infrastructure		Grade and width stable; isolated areas of bank failure/erosion; likely caused by a pipe outfall, local scour, impaired riparian vegetation or adjacent use.
	5	4	3	(2) 1
ACCESS:	**Good access:** Open area in public ownership, sufficient room to stockpile materials, easy stream channel access for heavy equipment using existing roads or trails.	**Fair access:** Forested or developed area adjacent to stream. Access requires tree removal or impact to landscaped areas. Stockpile areas small or distant from stream.		**Difficult access.** Must cross wetland, steep slope or other sensitive areas to access stream. Minimal stockpile areas available and/or located a great distance from stream section. Specialized heavy equipment required.
	5	(4)	3	2 1

NOTES/CROSS SECTION SKETCH:



- PERENNIAL STREAM
- AG FIELD TO NORTH
- SUBSTRATE: SILT/SAND/GRAVEL
- RIGHT BANK SOIL PROFILE: 1-15" SILT LOAM
  15-27" SILT CLAY
  27+" GRAVEL/SAND
- ROOT DEPTH: 2'
  DENSITY: 35%

VEGETATED BANKS:
MAPLE, BOX-ELDER,
SKUNK CABBAGE
MULTIFLORA ROSE

REPORTED TO AUTHORITIES ☐ YES ☐ NO

BEHI Form

Stream: Appoquinimink (DP 16) Reach: Cross Section: Date: 5/24/07 Crew: RK

Erodibility Variable/Value			Index	Bank Erosion Potential
Bank Height/Bankfull Height				
Bank Height (ft) A	Bankfull Height (ft) B	A/B	4.8	MODERATE
4	3	1.33		
Root Depth/Bank Height				
Root Depth (ft) C	C/A		3.9	LOW
2	0.5			
Weighted Root Density				
Root Density (%) D	D*(C/A)		7.7	HIGH
35	17.5			
Bank Angle				
Bank Angle (degrees)			5.5	MODERATE
75				
Surface Protection				
Surface Protection (%)			7.3	HIGH
20				
Materials: Upper-sandy loam. Lower-gravel with sand matrix			0	
Stratification: Boundary between sandy loam and gravel			0	
TOTAL SCORE:			29.3	MODERATE

Bank Erosion Hazard Index

Erodibility Variable		Bank Erosion Potential: Very Low	Low	Moderate	High	Very High	Extreme
Bank Height/ Bankfull Height	Value	1.0 - 1.1	1.11 - 1.19	1.2 - 1.5	1.6 - 2.0	2.1 - 2.8	>2.8
	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Root Depth/ Bank Height	Value	1.0 - 0.9	0.89 - 0.5	0.49 - 0.3	0.29 - 0.15	0.14 - 0.05	<0.05
	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Weighted Root Density	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 5.0	<5.0
	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Bank Angle	Value	0 - 20	21 - 60	61 - 80	81 - 90	91 - 119	>119
	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10
Surface Protection	Value	100 - 80	79 - 55	54 - 30	29 - 15	14 - 10	<10
	Index	1.0 - 1.9	2.0 - 3.9	4.0 - 5.9	6.0 - 7.9	8.0 - 9.0	10

Bank Materials

Bedrock (Bedrock banks have very low bank erosion potential)

Boulders (Banks composed of boulders have low bank erosion potential)

Cobble (Subtract 10 points. If sand/gravel matrix greater than 50% of bank material, then do not adjust)

Gravel (Add 5-10 points depending on percentage of bank material that is composed of sand)

Sand (Add 10 points if sand is exposed to erosional processes)

Silt/Clay (+ 0: no adjustment)

Stratification

Add 5-10 points depending on position of unstable layers in relation to bankfull stage

Total Score

Very Low	*Low*	*Moderate*	*High*	*Very High*	*Extreme*
5-9.5	10-19.5	20-29.5	30-39.5	40-45	46-50

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Estimating Near-Bank Stress (NBS)

Stream: APPO (DP 16) Location: Date: 5/24/07 Crew: RK

Level I	1	Transverse and/or central bars - short and/or discontinuous. NBS = High/Very High yes
		Extensive deposition (continuous, cross channel). NBS = Extreme no
		Chute cutoffs, down-valley meander migration, converging flow (Figure X). NBS = Extreme no

Level II	2	Radius of Curvature Rc (feet)	Bankfull Width W_{bkf} (feet)	Ratio Rc/W	Near-Bank Stress
	3	Pool Slope S_p	Average Slope S	Ratio S_p/S	Near-Bank Stress
	4	Pool Slope S_p	Riffle Slope S_{rif}	Ratio S_p/S_{rif}	Near-Bank Stress
Level III	5	Near-Bank Max Depth d_{nb} (feet)	Mean Depth d (feet)	Ratio d_{nb}/d	Near-Bank Stress

Level III	6	Near-Bank Max Depth d_{nb} (feet)	Near-Bank Slope S_{nb}	Near-Bank Shear τ_{nb} (lb/ft^2)	Mean Depth d (feet)	Average Slope S	Shear Stress τ (lb/ft^2)	Ratio τ_{nb}/τ	Near-Bank Stress

Level IV	7	Velocity Gradient (ft/s/ft)	Near-Bank Stress

Dominant Near-Bank Stress
High

Channel Sedimentation

Converting Values to a Near-Bank Stress Rating

Near-Bank Stress	Method Number 1	2	3	4	5	6	7
Very Low	N/A	>3.0	< 0.20	< 0.4	<1.0	<0.8	<1.0
Low		2.21 - 3.0	0.20 - 0.40	0.41 - 0.60	1.0 - 1.5	0.8 - 1.05	1.0 - 1.2
Moderate		2.01 - 2.2	0.41 - 0.60	0.61 - 0.80	1.51 - 1.8	1.06 - 1.14	1.21 - 1.6
High	See (1) Above	1.81 - 2.0	0.61 - 0.80	0.81 - 1.0	1.81 - 2.5	1.15 - 1.19	1.61 - 2.0
Very High		1.5 - 1.8	0.81 - 1.0	1.01 - 1.2	2.51 - 3.0	1.20 - 1.60	2.01 - 2.3
Extreme		< 1.5	> 1.0	> 1.2	> 3.0	> 1.6	> 2.3

Methods for Estimating Near-Bank Stress

1. Transverse bar or split channel/central bar creating NBS/high velocity gradient: **Level I - Reconnaissance.**
2. Channel pattern (Rc/W): **Level II - General Prediction.**
3. Ratio of pool slope to average water surface slope (S_p/S): **Level II - General Prediction.**
4. Ratio of pool slope to riffle slope (S_p/S_{rif}): **Level II - General Prediction.**
5. Ratio of near-bank maximum depth to bankfull mean depth (d_{nb}/d_{bkf}): **Level III - Detailed Prediction.**
6. Ratio of near-bank shear stress to bankfull shear stress (t_{nb}/t_{bkf}): **Level III - Detailed Prediction.**
7. Velocity profiles/Isovels/Velocity gradient: **Level IV - Validation.**

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Appendix B

Stream Site Photographs

Photograph 1: Data Point 1. Upstream view facing east.

Photograph 2: Data Point 1. Downstream view facing west.

Photograph 3: Data Point 1. Taken from Wiggins Mill Road. Stream overview facing south.

Photograph 4: Data Point 2. Downstream view facing north.

Photograph 5: Data Point 2. Upstream view facing south.

Photograph 6: Data Point 3. Upstream view of the right bank. Facing north east.

Photograph 7: Data Point 3. Upstream view of the left bank. Facing north east.

Photograph 8: Data Point 3. Downstream view of the left bank. Facing south west.

Photograph 9: Data Point 3. Downstream view of the right bank. Facing south east.

Photograph 10: Data Point 4. Downstream view. Facing north.

Photograph 11: Data Point 4. Upstream View. Facing south.

Photograph 12: Data Point 4. Upstream view of the left bank. Facing south.

Photograph 13: Data Point 4. Upstream view of right bank. Facing south.

Photograph 14: Data Point 5. Downstream view. Facing south.

Photograph 15: Data Point 5. Upstream view of the left bank. Facing north.

Photograph 16: Data Point 5. View of left bank. Facing northeast.

Photograph 17: Data Point 6. View of outflows. Facing north

Photograph 18: Data Point 6. Overall outflow area. Facing south.

Photograph 19: Data Point 6. Upstream of outflow. Facing north.

Photograph 20: Data Point 7. Downstream view. Facing south.

Photograph 21: Data Point 7. Upstream view. Facing north**.**

Photograph 22: Data Point 7. View of left bank. Facing northeast.

Photograph 23: Data Point 7. View of the right bank. Facing north.

Photograph 24: Data Point 7. View of left bank soil profile. Facing east.

Photograph 25: Data Point 7. View of outfall from basin storm water. Facing east.

Photograph 26: Data Point 7. View of manhole cover. Facing east.

Photograph 27. Data Point 8. Downstream view. Facing south**.**

Photograph 28: Data Point 8. Upstream view. Facing north.

Photograph 29. Data Point 9. Downstream view. Facing south.

Photograph 30: Data Point 9. Upstream view. Facing north.

Photograph 31: Data Point 9. View of heavy vegetation. Facing west.

Photograph 32. Data Point 9. Heavy vegetation. Facing east.

Photograph 33: Data Point 9. View of outfall pipe. Facing east**.**

Photograph 34: Data Point 10. View downstream. Facing north.

Photograph 35: Data Point 10. View of upstream outfall. Facing south**.**

Photograph 36: Data Point 11. View upstream. Facing east.

Photograph 37: Data Point 11. Downstream view. Facing northwest.

Photograph 38: Data Point 12. Upstream spillway. Facing south.

Photograph 39: Data Point 12. Downstream view of spillway. Facing north.

Photograph 40: Data Point 12. Soil profile of right bank. Facing east.

Photograph 41: Data Point 13. Downstream view. Facing west.

Photograph 42: Data Point 13. Upstream view. Facing east.

Photograph 43: Data Point 13. View of right bank. Facing north.

Photograph 44: Data Point 13. View of left bank. Facing south.

Photograph 45: Data Point 14. Upstream view. Facing north.

Photograph 46: Data Point 14. Downstream view. Facing south.

Photograph 47: Data Point 14. View of right bank. Facing west.

Photograph 48: Data Point 14. View of left bank. Facing east.

Photograph 49: Data Point 15. View facing north.

Photograph 50: Data Point 15. View facing east.

Photograph 51: Data Point 15. View facing south.

Photograph 52: Data Point 15. View facing west.

Photograph 53: Data Point 16. View facing north.

Photograph 54: Data Point 16. Downstream view. Facing east.

Photograph 55: Data Point 16. Right bank view. Facing south.

Photograph 56: Data Point 16. Upstream view. Facing west.

Appendix C

Tidal Marsh Assessment Datasheets

Delaware Rapid Assessment Data Sheet

Sample Plot: 1 Location: _____ Date: 9/20/07

Observers: Rob Kreamer and Brook Gable

HGM subclass: Estuarine Tidal Fringe
Reference or Assessment Site (circle one)
Natural, re-establishment, establishment rehabilitation or enhancement (circle one)
Watershed: Appoqinamink
Site Description: Downstream of SR1 on Drawyer Creek

Stressors:					
Habitat/Plant Community Category					
	Mowing	Farmed	Grazing	Forest Harvest	None
		Present		Not Present	
Excessive herbivory/pine beetle/gypsy moth				✓	
Presence of invasive species		✓ Phrag.			
Chemical defoliation				✓	
Managed or converted to pine				✓	
Burned				✓	
Trails				✓	
Garbage/dumping				✓	
Increased nutrients					
Direct application/runoff		✓			
Dense algal mats				✓	
Presence of nutrient indicator species		✓ Amaranthus			
Roads		✓			
Other				✓	
HydrologyCategory					
Ditching	Slight	Moderate		Severe	None
		Present		Not Present	
Channelized stream				✓	
Stream incision				✓	
Weir/dam/road				✓	

Stormwater inputs	✓	
Point source inputs		✓
Filling/ excavation	✓	
Microtopogarphy		✓
Excessive sedimentation		✓
Soil subsidence/root exposure		✓
Tidal restriction		✓
Other		✓
Buffer Category		
Development density		✓
Sewage disposal		✓
Roads	✓	
Landfill/waste disposal		✓
Channelized streams or ditches		✓
Agriculture		✓
Forest harvesting		✓
Piers, docks, moorings, and marinas		✓
Golf course		✓
Mowed areas		✓
Sand/gravel operation		✓
Other		✓

Mid-Atlantic Tidal Fringe Wetland Assessment

Sample Plot: 1 Location: _____ Date: 9/20/07

Water Quality:

pH: 8.92 Turbidity: 0.182

Conductivity: 10.14 mS/cm TDS: 6.02 g/L

Salinity: 6.2 ppt

Conditions:

	Quadrant			
	NW	NE	SE	SW
# of snails on vegetation	0	0	0	0
# of snails, crabs, mussels on substrate	0	0	0	0
Soil penetrometer	16"	11"	12"	12"
Vegetation volume	11 ml	14 ml	2 ml	11 ml

Vegetation Subplots Datasheet
Mid-Atlantic Tidal Fringe Wetland Assessment

Site # _ **Site Name** _____ **Date** __9___/_20__/__07___

Vegetation Zone: _____

Observers: ___ **Brook Gabel and Robert Kreamer**

(Cover estimated in 16 subplots (2 X 0.5 m) in Assessment Area) *Enter Midpoint*

			Subplot Number							
C	I	I. Species	1	2	3	4	5	6	7	8
	x	Unvegetated/Mudflat/Open Water	20	10	10	30	35	10		
	x	Spartina alterniflora (saltmarsh cordgrass)	50	50	50	60	40	50		
	x	Polygonum punctatum (dotted smartweed)						10	10	
	x	Amaranthus cannabinus (tidemarsh waterhemp)	30	20	40		20	30		
	x	Bidens cernua (Nodding Beggerticks)					5			
	x	Hibiscus mosceutos (Marsch Hibiscus)		20		10			10	
	x	Phragmites australis (common reed)							80	100
	x	Scirpus robustus (Saltmarsh bulrush)								

C= collected I = Identified

Invasive species (include the presence of invasives outside of AA but within the wetland)

Species Name (refer to NHP lists of invasive species; include presence of invasives outside of AA but within the wetland)	% Cover AA	% in Veg Zone
Phragmites australis (common reed)	20	75

Cover Classes	MidPt
0	0
<1%	0.5
1-5%	2.5
6-25%	15.5

Cover Classes	MidPt
26-50%	38
51-75%	63
76-99%	88.5
100%	100

Comments:

Vegetation Subplots Datasheet

Mid-Atlantic Tidal Fringe Wetland Assessment

Site # 1 **Site Name** _____ **Date** 9/20/07

Vegetation Zone: _____

Observers: Brook Gabel and Robert Kreamer

(Cover estimated in 16 subplots (2 X 0.5 m) in Assessment Area) Enter Midpoint

			Subplot Number							
C	I	I. Species	9	10	11	12	13	14	15	16
	x	Unvegetated/Mudflat/Open Water	10	30	10		30	20	10	10
	x	Spartina alterniflora (saltmarsh cordgrass)	80	40	10		50	40	50	60
	x	Polygonum punctatum (dotted smartweed)		10	60		10	20	30	30
	x	Amaranthus cannabinus (tidemarsh waterhemp)	10	15	10		10	20	30	30
	x	Bidens cernua (Nodding Beggerticks)								
	x	Hibiscus mosceutos (Marsch Hibiscus)								
	x	Phragmites australis (common reed)			10	100				
	x	Scirpus robustus (Saltmarsh bulrush)		5						

C= collected I = Identified

Comments:

Moderately diverse wetland plant community surrounded by Phragmites. Wetland complex is traversed by two roadways elevated through the wetland by fill material.

Cover Classes	MidPt
0	0
<1%	0.5
1-5%	2.5
6-25%	15.5

Cover Classes	MidPt
26-50%	38
51-75%	63
76-99%	88.5
100%	100

_____ Entered

_____ Checked

Delaware Rapid Assessment Data Sheet

Sample Plot: 2 Location: _____ Date: 9/20/07

Observers: Rob Kreamer and Brook Gable

HGM subclass: Estuarine Tidal Fringe
Reference or Assessment Site (circle one)
Natural, re-establishment, establishment rehabilitation or enhancement (circle one)
Watershed: Appoqinamink
Site Description: Downstream of Odessa on the Appoquinimink River

Stressors:					
Habitat/Plant Community Category					
	Mowing	Farmed	Grazing	Forest Harvest	None
		Present		Not Present	
Excessive herbivory/pine beetle/gypsy moth				✓	
Presence of invasive species		✓ Phrag.			
Chemical defoliation				✓	
Managed or converted to pine				✓	
Burned				✓	
Trails				✓	
Garbage/dumping				✓	
Increased nutrients					
Direct application/runoff		✓			
Dense algal mats				✓	
Presence of nutrient indicator species		✓ Amaranthus			
Roads		✓			
Other				✓	
HydrologyCategory					
Ditching	Slight	Moderate		Severe	None
		Present		Not Present	
Channelized stream				✓	
Stream incision				✓	
Weir/dam/road				✓	

Stormwater inputs	✓	
Point source inputs		✓
Filling/ excavation	✓	
Microtopogarphy		✓
Excessive sedimentation		✓
Soil subsidence/root exposure		✓
Tidal restriction		✓
Other		✓
Buffer Category		
Development density >2	✓	
Sewage disposal		✓
Roads	✓	
Landfill/waste disposal		✓
Channelized streams or ditches		✓
Agriculture		✓
Forest harvesting		✓
Piers, docks, moorings, and marinas		✓
Golf course		✓
Mowed areas		✓
Sand/gravel operation		✓
Other		✓

Mid-Atlantic Tidal Fringe Wetland Assessment

Sample Plot: 2 Location: _____ Date: 9/20/07

Water Quality:

pH: 9.22 Turbidity: 0.522

Conductivity: 9.96 mS/cm TDS: 5.80 g/L

Salinity: 6.0 ppt

Conditions:

	Quadrant			
	NW	NE	SE	SW
# of snails on vegetation	0	0	0	0
# of snails, crabs, mussels on substrate	0	0	0	0
Soil penetrometer	14"	7"	4"	7"
Vegetation volume	1 ml	3 ml	19 ml	7 ml

Vegetation Subplots Datasheet
Mid-Atlantic Tidal Fringe Wetland Assessment

Site # 52 **Site Name** _____ **Date** 9 / 20 / 07

Vegetation Zone: _____

Observers: Brook Gabel and Robert Kreamer

(Cover estimated in 16 subplots (2 X 0.5 m) in Assessment Area) *Enter Midpoint*

			Subplot Number							
C	I	I. Species	1	2	3	4	5	6	7	8
	x	Unvegetated/Mudflat/Open Water	10	30		20		5	10	50
	x	Spartina alterniflora (saltmarsh cordgrass)	70	10	10	10	70	20	40	20
	x	Polygonum punctatum (dotted smartweed)	15	30	70	20	10	35	20	
	x	Amaranthus cannabinus (tidemarsh waterhemp)	5	30	20		20	40	20	10
	x	Pontederia cordata (pickerelweed)				10			10	20
	x	Spartina patens (saltmeadow cordgrass)				30				
	x	Juncus roemerianus (black needlerush)				10				

C= collected I = Identified

Invasive species (include the presence of invasives outside of AA but within the wetland)

Species Name (refer to NHP lists of invasive species; include presence of invasives outside of AA but within the wetland)	% Cover AA	% in Veg Zone
Phragmites australis (common reed)	0	5

Cover Classes	MidPt
0	0
<1%	0.5
1-5%	2.5
6-25%	15.5

Cover Classes	MidPt
26-50%	38
51-75%	63
76-99%	88.5
100%	100

Comments:

Vegetation Subplots Datasheet

Mid-Atlantic Tidal Fringe Wetland Assessment

Site # 2 **Site Name** _____ **Date** 9/20/07

Vegetation Zone: _____

Observers: Brook Gabel and Robert Kreamer

(Cover estimated in 16 subplots (2 X 0.5 m) in Assessment Area) *Enter Midpoint*

			Subplot Number							
C	I	I. Species	9	10	11	12	13	14	15	16
	x	Unvegetated/Mudflat/Open Water	20	30	10	10	10	50	20	70
	x	Spartina alterniflora (saltmarsh cordgrass)	75	45	30	30	40	20	30	10
	x	Polygonum punctatum (dotted smartweed)	5	20	60	40	20	20	40	
	x	Amaranthus cannabinus (tidemarsh waterhemp)		5		20	20		10	
	x	Pontederia cordata (pickerelweed)					10	10		20
	x	Spartina patens (saltmeadow cordgrass)								
	x	Juncus roemerianus (black needlerush)								
	x									
	x									

C= collected I = Identified

Comments:

Cover Classes	MidPt
0	0
<1%	0.5
1-5%	2.5
6-25%	15.5

Cover Classes	MidPt
26-50%	38
51-75%	63
76-99%	88.5
100%	100

_____ Entered

_____ Checked

Delaware Rapid Assessment Data Sheet

Sample Plot: 3 Location: _____ Date: 9/20/07

Observers: Rob Kreamer and Brook Gable

HGM subclass: Estuarine Tidal Fringe
Reference or Assessment Site (circle one)
Natural, re-establishment, establishment rehabilitation or enhancement (circle one)
Watershed: Appoqinamink
Site Description: Upstream of Sliver Run Road on the Appoquinamink River

Stressors:					
Habitat/Plant Community Category					
	Mowing	Farmed	Grazing	Forest Harvest	None
		Present		Not Present	
Excessive herbivory/pine beetle/gypsy moth				✓	
Presence of invasive species		✓ Phrag.			
Chemical defoliation				✓	
Managed or converted to pine				✓	
Burned				✓	
Trails				✓	
Garbage/dumping				✓	
Increased nutrients					
Direct application/runoff		✓			
Dense algal mats				✓	
Presence of nutrient indicator species		✓ Amaranthus			
Roads				✓	
Other				✓	
HydrologyCategory					
Ditching	Slight	Moderate		Severe	None
		Present		Not Present	
Channelized stream				✓	
Stream incision				✓	
Weir/dam/road				✓	

Stormwater inputs		✓
Point source inputs		✓
Filling/ excavation		✓
Microtopogarphy		✓
Excessive sedimentation		✓
Soil subsidence/root exposure		✓
Tidal restriction		✓
Other		✓
Buffer Category		
Development density	<1	
Sewage disposal		✓
Roads		✓
Landfill/waste disposal		✓
Channelized streams or ditches		✓
Agriculture	✓	
Forest harvesting		✓
Piers, docks, moorings, and marinas		✓
Golf course		✓
Mowed areas		✓
Sand/gravel operation		✓
Other		✓

Mid-Atlantic Tidal Fringe Wetland Assessment

Sample Plot: 3 Location: _____ Date: 9/20/07

Water Quality:

pH: 9.16 Turbidity: 0.097

Conductivity: 11.29 mS/cm TDS: 6.66 g/L

Salinity: 6.9 ppt

Conditions:

	Quadrant			
	NW	NE	SE	SW
# of snails on vegetation	0	0	0	0
# of snails, crabs, mussels on substrate	0	0	0	0
Soil penetrometer	10"	14"	17"	19"
Vegetation volume	10 ml	10 ml	5 ml	9 ml

Vegetation Subplots Datasheet
Mid-Atlantic Tidal Fringe Wetland Assessment

Site # 3 Site Name _____ Date __9___/_20__/__07___

Vegetation Zone: _____

Observers: ___ Brook Gabel and Robert Kreamer

(Cover estimated in 16 subplots (2 X 0.5 m) in Assessment Area) *Enter Midpoint*

			Subplot Number							
C	I	I. Species	1	2	3	4	5	6	7	8
	x	Unvegetated/Mudflat/Open Water	30	40	20	50	10	10		
	x	Spartina alterniflora (saltmarsh cordgrass)	20	40	40	30	40	60	40	40
	x	Polygonum punctatum (dotted smartweed)	20	10	20	5	20	30	30	30
	x	Amaranthus cannabinus (tidemarsh waterhemp)	10	10	20	10	20		30	20
	x	Phragmites australis (common reed)	20							
	x	Scirpus robustus (Saltmarsh bulrush)				5				10
	x	Pluchea purpurascens (Saltmarsh fleabane)								
	x	Spartina cynosuroides (Big cordgrass)					10			

C= collected I = Identified

Invasive species (include the presence of invasives outside of AA but within the wetland)

Species Name (refer to NHP lists of invasive species; include presence of invasives outside of AA but within the wetland)	% Cover AA	% in Veg Zone
Phragmites australis (common reed)	1	10

Cover Classes	MidPt
0	0
<1%	0.5
1-5%	2.5
6-25%	15.5

Cover Classes	MidPt
26-50%	38
51-75%	63
76-99%	88.5
100%	100

Comments:

Vegetation Subplots Datasheet

Mid-Atlantic Tidal Fringe Wetland Assessment

Site # 3 Site Name _____ Date 9/20/07

Vegetation Zone: _____

Observers: Brook Gabel and Robert Kreamer

(Cover estimated in 16 subplots (2 X 0.5 m) in Assessment Area) Enter Midpoint

			Subplot Number							
C	I	I. Species	9	10	11	12	13	14	15	16
	x	Unvegetated/Mudflat/Open Water	25	5	20	5	25			20
	x	Spartina alterniflora (saltmarsh cordgrass)	50	80	70	60	45	30	10	
	x	Polygonum punctatum (dotted smartweed)	10	15	5	30	10	30	30	
	x	Amaranthus cannabinus (tidemarsh waterhemp)	10		5		20	30	40	30
	x	Phragmites australis (common reed)								
	x	Scirpus robustus (Saltmarsh bulrush)				5				
	x	Pluchea purpurascens (Saltmarsh fleabane)	5							
	x	Spartina cynosuroides (Big cordgrass)						10	20	50

C= collected I = Identified

Comments:

Cover Classes	MidPt
0	0
<1%	0.5
1-5%	2.5
6-25%	15.5

Cover Classes	MidPt
26-50%	38
51-75%	63
76-99%	88.5
100%	100

_____ Entered

_____ Checked

Delaware Rapid Assessment Data Sheet

Sample Plot: 4 Location: _____ Date: 9/20/07

Observers: Rob Kreamer and Brook Gable

HGM subclass: Estuarine Tidal Fringe
Reference or Assessment Site (circle one)
Natural, re-establishment, establishment rehabilitation or enhancement (circle one)
Watershed: Appoqinamink
Site Description: Near mouth of the Appoquinimink at Fennimore Landing

Stressors:					
Habitat/Plant Community Category					
	Mowing	Farmed	Grazing	Forest Harvest	None
		Present		Not Present	
Excessive herbivory/pine beetle/gypsy moth				✓	
Presence of invasive species		✓ Phrag.			
Chemical defoliation				✓	
Managed or converted to pine				✓	
Burned				✓	
Trails				✓	
Garbage/dumping				✓	
Increased nutrients					
Direct application/runoff		✓			
Dense algal mats				✓	
Presence of nutrient indicator species		✓ Amaranthus Echinochloa			
Roads				✓	
Other				✓	
HydrologyCategory					
Ditching	Slight	Moderate		Severe	None
		Present		Not Present	
Channelized stream				✓	
Stream incision				✓	
Weir/dam/road				✓	

Stormwater inputs		✓
Point source inputs		✓
Filling/ excavation		✓
Microtopogarphy		✓
Excessive sedimentation		✓
Soil subsidence/root exposure		✓
Tidal restriction		✓
Other		✓
Buffer Category		
Development density		✓
Sewage disposal		✓
Roads		✓
Landfill/waste disposal		✓
Channelized streams or ditches		✓
Agriculture	✓	
Forest harvesting		✓
Piers, docks, moorings, and marinas		✓
Golf course		✓
Mowed areas		✓
Sand/gravel operation		✓
Other		✓

Mid-Atlantic Tidal Fringe Wetland Assessment

Sample Plot: 4 Location: _____ Date: 9/21/07

Water Quality:

pH: 9.01 Turbidity: 0.119

Conductivity: 14.28 mS/cm TDS: 7.90 g/L

Salinity: 8.2 ppt

Conditions:

	Quadrant			
	NW	NE	SE	SW
# of snails on vegetation	0	0	0	0
# of snails, crabs, mussels on substrate	0	0	0	2
Soil penetrometer	3"	5"	4"	3"
Vegetation volume	1 ml	7 ml	7 ml	5 ml

Vegetation Subplots Datasheet
Mid-Atlantic Tidal Fringe Wetland Assessment

Site # 34 **Site Name** _____ **Date** 9 / 20 / 07

Vegetation Zone: _____

Observers: Brook Gabel and Robert Kreamer

(Cover estimated in 16 subplots (2 X 0.5 m) in Assessment Area) *Enter Midpoint*

			Subplot Number							
C	I	I. Species	1	2	3	4	5	6	7	8
	x	Unvegetated/Mudflat/Open Water			10		5	20	40	20
	x	Spartina cynosuroides (Big cordgrass)	10	10	20	40	40	45	40	20
	x	Spartina alterniflora (saltmarsh cordgrass)			65	25	50	20		60
	x	Pluchea purpurascens (Saltmarsh fleabane)			5					
x	x	Aster tenuifolius (saltmarsh aster)				20				
	x	Phragmites australis (common reed)				5				
	x	Polygonum punctatum (dotted smartweed)				10				
	x	Scirpus robustus (Saltmarsh bulrush)					10	15	20	
	x	Typha angustinfolia (Narrow-leaved cattail)					5			
x	x	Atriplex patula (common orach)								
	x	Echinochola walteri (Walter's millet)								
	x	Amaranthus cannabinus (tidemarsh waterhemp)								

C= collected I = Identified

Invasive species (include the presence of invasives outside of AA but within the wetland)

Species Name (refer to NHP lists of invasive species; include presence of invasives outside of AA but within the wetland)	% Cover AA	% in Veg Zone
Phragmites australis (common reed)	1	5

Cover Classes	MidPt
0	0
<1%	0.5
1-5%	2.5
6-25%	15.5

Cover Classes	MidPt
26-50%	38
51-75%	63
76-99%	88.5
100%	100

Comments:

Vegetation Subplots Datasheet

Mid-Atlantic Tidal Fringe Wetland Assessment

Site # _ #4 **Site Name** _____ **Date** __9___/_20__/__07___

Vegetation Zone: _____

Observers: ___ **Brook Gabel and Robert Kreamer**

(Cover estimated in 16 subplots (2 X 0.5 m) in Assessment Area) *Enter Midpoint*

			Subplot Number							
C	I	I. Species	9	10	11	12	13	14	15	16
	x	Unvegetated/Mudflat/Open Water	10	10	5	5				
	x	Spartina cynosuroides (Big cordgrass)		5			50	30	60	10
	x	Spartina alterniflora (saltmarsh cordgrass)	90	85	90	65				
	x	Pluchea purpurascens (Saltmarsh fleabane)							10	
x	x	Aster tenuifolius (saltmarsh aster)			5			20		
	x	Phragmites australis (common reed)								
	x	Polygonum punctatum (dotted smartweed)				10		20	20	70
	x	Scirpus robustus (Saltmarsh bulrush)								20
	x	Typha angustinfolia (Narrow-leaved cattail)								
x	x	Atriplex patula (common orach)				20				
	x	Echinochola walteri (Walter's millet)					50	30		
	x	Amaranthus cannabinus (tidemarsh waterhemp)							10	

C= collected I = Identified

Comments:

AA not as inundated compared to other AA sites #1-3 due to elevation above water level

One large ditch drains the majority of AA that connects to ditch that divides the wetland from the upland agriculture.

Cover Classes	MidPt
0	0
<1%	0.5
1-5%	2.5
6-25%	15.5

Cover Classes	MidPt
26-50%	38
51-75%	63
76-99%	88.5
100%	100

_____ Entered

_____ Checked

Appendix D

Wetland Site Photographs

Photograph 1: View looking north from Data Point 1 (September 2007).

Photograph 2: View looking south from Data Point 1 (September 2007).

Photograph 3: View looking east from Data Point 1 (September 2007).

Photograph 4: View looking west from Data Point 1 (September 2007).

Photograph 5: View looking north from Data Point 2 (September 2007).

Photograph 6: View looking south from Data Point 2 (September 2007).

Photograph 7: View looking east from Data Point 2 (September 2007).

Photograph 8: View looking west from Data Point 2 (September 2007).

Photograph 9: View looking north from Data Point 3 (September 2007).

Photograph 10: View looking south from Data Point 3 (September 2007).

Photograph 11: View looking east from Data Point 3 (September 2007).

Photograph 12: View looking west from Data Point 3 (September 2007).

Photograph 13: View looking north from Data Point 4 (September 2007).

Photograph 14: View looking south from Data Point 4 (September 2007).

Photograph 15: View looking east from Data Point 4 (September 2007).

Photograph 16: View looking west from Data Point 4 (September 2007).