Nitrogen and Phosphorus Reduction Estimates

Mudford Farm

Pre-BMP Annual Delivered Loads to Tidal Waters

Landuse	Acres	TN Load (lbs/yr)	TP Load (lbs/yr)
Conservation Tillage Cropland	151.4	3052.9	143.9
Warm Season Grass Buffers	0	0	0
Warm Season Grass Wildlife Habitat	0	0	0
Wetlands	0	0	0
TOTAL	151.4	**3052.9**	**143.9**

Post-BMP Annual Delivered Loads to Tidal Waters

BMPs Applied:

- Warm Season Grass Wildlife Habitat – 30.1 acres
- Warm Season Grass Buffers – 28.8 acres
    - Treats 64.9 acres of cropland for nitrogen (all eligible acres of cropland that drain towards existing buffers; 10 acres of cropland are not eligible to be treated due to the drainage divide)
    - Treats 57.6 acres of cropland for phosphorus
- Wetlands – 17.7 acres (14.3 of which have an upland benefit)
    - Treats 57.3 acres of cropland for nitrogen
    - Treats 28.6 acres of cropland for phosphorus

Landuse	Acres	TN Load (lbs/yr)	TP Load (lbs/yr)
Conservation Tillage Cropland*	74.9	734.2	39.0
Warm Season Grass Buffers	28.8	225.8	2.4
Warm Season Grass Wildlife Habitat	30.1	235.9	2.5
Wetlands	17.7	51.8	1.9
TOTAL	151.4	**1247.8**	**45.7**

* Load reduction is the result of a reduction in acres and upland treatment by buffers

Summary

Nitrogen

Landuse	Pre-BMP TN Delivered Load (lbs/yr)	Post-BMP TN Delivered Load (lbs/yr)	TN Reduction (lbs/yr)	TN Credit Value ($/lb/yr)	Total Annual TN Credit Value
Conservation Tillage Cropland	3052.9	734.2	-	-	-
Warm Season Grass Buffers	0.0	225.8	-	-	-
Warm Season Grass Wildlife Habitat	0.0	235.9	-	-	-
Wetlands	0.0	51.8	-	-	-
TOTAL	**3052.9**	**1247.8**	**1805.1**	**$10**	**$18,051.07**

Phosphorus

Landuse	Pre-BMP TP Delivered Load (lbs/yr)	Post-BMP TP Delivered Load (lbs/yr)	TP Reduction (lbs/yr)	TP Credit Value ($/lb/yr)	Total Annual TP Credit Value
Conservation Tillage Cropland	143.9	39.0	-	-	-
Warm Season Grass Buffers	0.0	2.4	-	-	-
Warm Season Grass Wildlife Habitat	0.0	2.5	-	-	-
Wetlands	0.0	1.9	-	-	-
TOTAL	**143.9**	**45.7**	**98.3**	**$5**	**$491.38**

Assumptions and Caveats:

- The acreages used in this report were primarily based on the acreages provided in the NRCS map. Where it was necessary to sub-divide NRCS fields, Google Earth was used to estimate acreage within those fields.
- The 5 ac homesite in Field 6 is assumed to be cropland at this time.
- The 10.3 acre wetland mitigation site (Field 4) is not included in these calculations.
- WSI recommends retirement of Field 2 (2.5 acres). In the calculations it is assumed that Field 2 will not receive fertilizer except for establishment, so it is counted as Warm Season Grass Wildlife Habitat.
- The 1 ac pocket wetland in Field 5 is not deemed to service a watershed area beyond the wildlife habitat area, so it does not provide an upland benefit.
- It was assumed that 10 acres of cropland (northeast portion of Field 6) were not affected by buffers or wetlands located on the site due to the drainage divide.
- It was assumed that wetlands and grass buffers are multiplicative BMPs, meaning that they can both treat the same upland acres. This follows CBP protocol.
- The pocket wetlands within the Warm Season Grass Buffer (Field 13, Field 18, Field 21, and a portion of Field 16) are not credited at this time. This area does not appear to be dominated by hydric soils. However, credit could be given for the pocket wetlands if they could be accurately delineated.

- The following CBP landuses were used to determine the load/acre:
    - Conservation Tillage Cropland – low till (While no manure is used on this land, in this model segment all low till is termed by CBP as “low till with manure”)
    - Warm Season Grass Buffer and Wildlife Habitat – hay without nutrients (Based on CBP protocol)
    - Wetlands – forest (Based on CBP protocol)
- These calculations consider Field 3 (3.9 ac) to be cropland, although WSI recommends that this land be converted to warm season grasses.

Process Used to Determine

Nitrogen and Phosphorus Reduction Estimates

Load Calculation Process

The acreages used in this report were primarily based on the acreages provided in the NRCS map. Where it was necessary to sub-divide NRCS fields, Google Earth was used to estimate acreage within those fields.

Pre-BMP Nutrient Loads

To determine the pre-BMP nutrient loads, it was assumed that all of the acres on the farm (Fields 1-21 in the NRCS report) were Conservation Tillage Cropland, with the exception of the wetland mitigation site (Field 4). The wetland mitigation site and its associated acres were not included in any of the calculations for this report. The Conservation Tillage Cropland acres were assigned an annual per acre load for nitrogen and phosphorus delivered to tidal waters. The load numbers are from the Chesapeake Bay Program (CBP) and are specific to the land-river segment in which the farm is located (A24035EU0_3722_0000). For these calculations, Conservation Tillage Cropland was considered to be equivalent to the Chesapeake Bay Program's low till (lwm) landuse (while no manure is used on this land, in this model segment all low till is termed by CBP as "low till with manure"). Annual nitrogen and phosphorus loads were then calculated by multiplying the number of acres by the assigned load.

Post-BMP Nutrient Loads

The Best Management Practices (BMPs) that were credited in this report were warm season grass buffers, warm season grass wildlife habitat, and wetlands. All three of these BMPs involve a landuse change. In order to apply the necessary landuse changes, all of the acres that were designated as either warm season grass buffers or warm season grass wildlife habitat were converted from Conservation Tillage Cropland (CBP landuse- low till) to the CBP landuse "Hay without Nutrients (hyo)" and all of the acres that were designated as wetlands were converted from Conservation Tillage Cropland (CBP landuse – low till) to the CBP landuse "Forest (for)". The landuse conversions for these BMPs are based on current CBP protocol. All of the remaining acres were considered to be Conservation Tillage Cropland (CBP Landuse – low till).

Each landuse was then assigned an annual per acre load for nitrogen and phosphorus delivered to tidal waters. The load numbers used were from the Chesapeake Bay Program (CBP) and they are specific to the land-river segment in which the farm is located (A24035EU0_3722_0000). Annual nitrogen and phosphorus loads were then calculated by multiplying the number of acres by the assigned load.

In addition to the landuse conversion, two of the BMPs (grass buffers and wetlands) treat the upgradient upland acres. In order to give credit for this reduction, a nitrogen reduction efficiency was applied to four upland Conservation Tillage Cropland acres and a phosphorus reduction efficiency was applied to two upland Conservation Tillage Cropland acres for each acre of grass buffer or wetlands that

were established. The reduction efficiencies are specific to the BMP (grass buffer or wetland) and the hydrogeomorphic region in which the farm is located (CPDN). These efficiencies are from the CBP BMP protocol. Due to the location of the specific buffers and wetlands, not all of the buffer and wetland acres had upland cropland acres that were draining into them. Therefore, not all buffer/wetland acres were credited with having an upland benefit. Those areas not credited as having an upland benefit are labeled in the map that is included in this report. All warm season grass buffers that do not have an upland benefit were considered to be warm season grass wildlife habitat in the acreage totals. In addition, it was assumed that 10 acres of cropland (northeast portion of Field 6) was not affected by buffers or wetlands located on the site due to the drainage divide.

In order to calculate the load reduction that resulted from the impact that the grass buffers and wetlands had on the associated upland acres, the following was determined: number of upland acres that received a nitrogen reduction from grass buffers, number of upland acres that received a phosphorus reduction from grass buffers, number of upland acres that received a nitrogen reduction from wetlands, and number of upland acres that received a phosphorus reduction from wetlands. A fraction reduction was then calculated for nitrogen and phosphorus for each BMP using the following formula:

$$\text{Fraction Reduction} = \frac{\text{Acres affected by BMP}}{\text{Total acres in Landuse}} * \text{Efficiency (\% reduction)}$$

Next, a pass through factor for each BMP and nutrient species (TN or TP) was calculated. The pass through factor represents the percent of the nutrient load that remains after the BMP reduction. The pass through factor is calculated using the following formula:

$$\text{Pass Through Factor} = 1 - (\text{Fraction Reduction})$$

A separate pass through factor was calculated for each BMP since grass buffers and wetlands are considered by CBP to be multiplicative BMPs, which means that they can both treat the same upland acre. Since both BMPs are applied to the same landuse (Conservation Tillage Cropland), an overall pass through factor for that landuse was then calculated. To determine the overall pass through factor for nitrogen on Conservation Tillage Cropland, the nitrogen pass through factor for grass buffers was multiplied by the nitrogen pass through factor for wetlands. The same was then done for phosphorus. Next, these overall pass through factors were multiplied by the nitrogen and phosphorus loads for the Conservation Tillage Cropland acres. This provided an estimate of the annual nitrogen and phosphorus loads for the Conservation Tillage Cropland acres after the specified BMPs have been applied. The annual loads from the wetland acres (CBP Landuse – forest), the warm season grass buffer acres (CBP Landuse – hay without nutrients), and the warm season grass wildlife habitat (CBP Landuse – hay without nutrients) did not change from the loads that were previously calculated since they were not affected by the BMP efficiencies. The process described here for crediting BMP reduction efficiencies follows CBP protocol.

Chesapeake Bay Program (CBP) Landuse Loads and BMP Efficiencies

The CBP edge of stream (EOS) landuse loads and BMP efficiencies that were used for the calculations in this report are as follows:

CBP Landuse	EOS TN Load*	EOS TP Load*
Low-till**	20.2 lb/acre/yr	1.0 lb/acre/yr
Hay without Nutrients	7.8 lb/acre/yr	0.1 lb/acre/yr
Forest	2.9 lb/acre/yr	0.1 lb/acre/yr

*EOS loads are for the land-river segment A24035EU0_3722_0000
**While no manure is used on this farm's land, in this model segment all low till is termed by CBP as low till with manure

The loads for the Forest landuse and the Hay without Nutrients landuse are the Edge of Stream (EOS) loads from the CBP Phase 5.2 No BMP Scenario. The Phase 5.2 No BMP Scenario does not provide an EOS load for the Low-till landuse. This load was calculated by determining the percent reduction from the High-till with Manure landuse load to the Low-till landuse load in the Phase 5.2 Calibration Scenario, and then applying this percent reduction to the High-till with Manure landuse load in the Phase 5.2 No BMP Scenario.

For the land river segment in which the farm is located (A24035EU0_3722_0000), the CBP delivery factor to tidal waters for TN and TP is 1. This means that the edge of stream load is equivalent to the delivered load to tidal waters.

BMP	TN Reduction Efficiency**	TP Reduction Efficiency**
Wetland Restoration and Creation*	25%	50%
Grass Buffer*	46%	42%

**Reduction efficiencies are for the CPDN hydrogeomorphic region
**For each acre of Wetland Restoration and Creation or Grass Buffers, 4 upland acres are treated for TN and 2 upland acres are treated for TP

Farm Acres (Post-BMP)

Field numbers correspond to the NRCS map. Where it was necessary to sub-divide NRCS fields, Google Earth was used to estimate acreage within those fields.

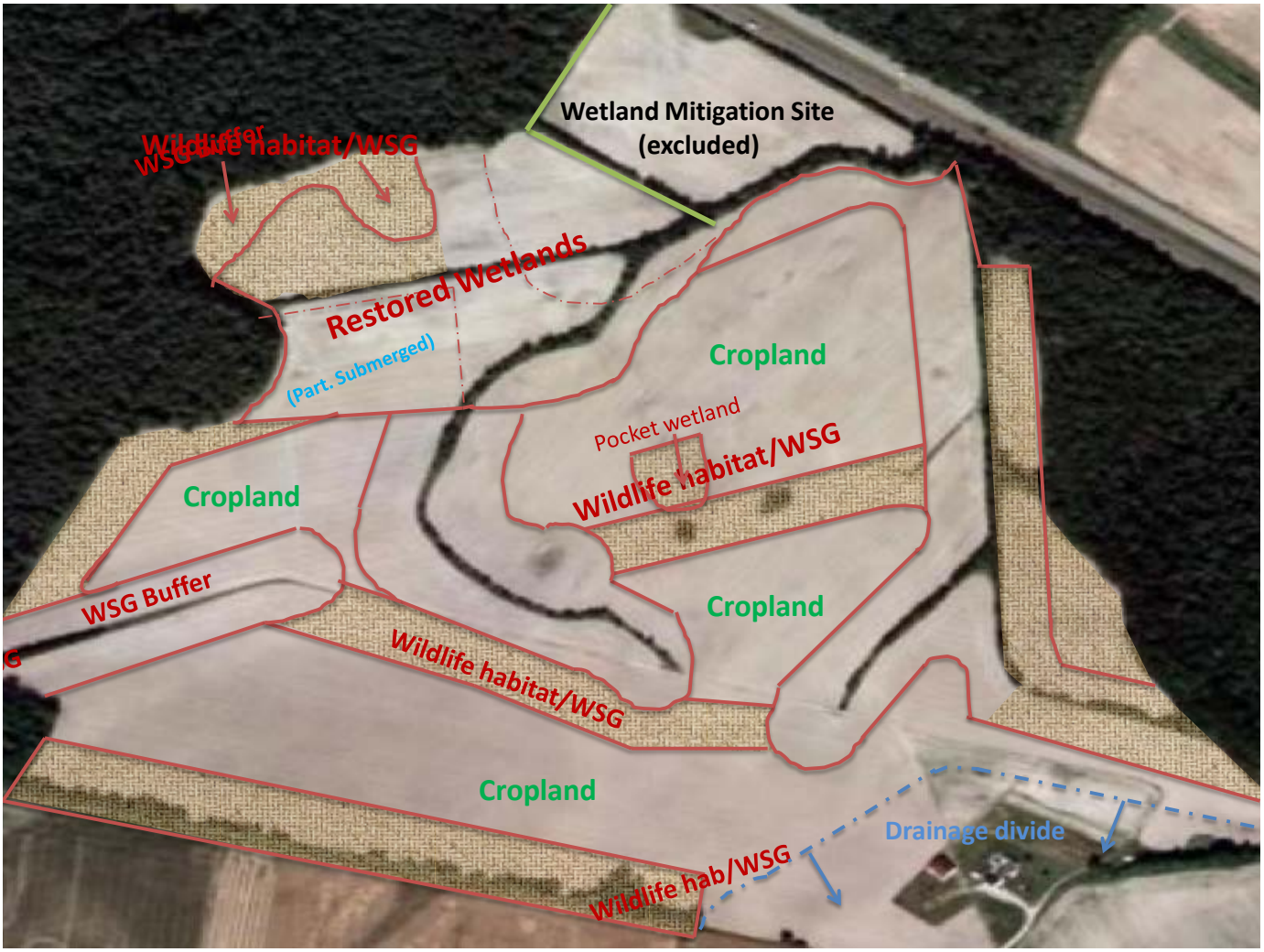
Field	Acres	Land Type	Notes
1	3.5	WSG Wildlife Habitat	
2	2.5	WSG Wildlife Habitat	
3	3.9	Conservation Tillage Cropland	
4	-	Wetland Mitigation Site (excluded)	Excluded
5	25.1	Conservation Tillage Cropland	Estimated (= Field 5 - Field 5 Wetland - Field 5 WSG Wildlife Habitat)
5	1.6	WSG Wildlife Habitat	Estimated (80' by 895')
5	1.0	Wetland (No Upland Benefit)	Estimated WSI field measurement
6	38.4	Conservation Tillage Cropland	
7	6.1	Wetland	Estimated (= Field 7 - Field 7 Wetland (no up. ben) - Field 7 WSG Habitat)
7	2.4	Wetland (No Upland Benefit)	Estimated (160' x 640')
7	2.9	WSG Wildlife Habitat	Estimated (200' x 640')
8	7.5	Conservation Tillage Cropland	
9	10.0	WSG Wildlife Habitat	Estimated (= Field 9 - Field 9 WSG Buffer)
9	1.9	WSG Buffer	Estimated (100' x 840')
10	3.5	WSG Wildlife Habitat	Estimated (= Field 10 - Field 10 WSG Buffer)
10	2.0	WSG Buffer	Estimated (100' x 875')
11	4.3	Wetland	
12	1.6	Wetland	
13	4.1	WSG Buffer	
14	3.9	WSG Wildlife Habitat	
15	1.5	Wetland	
16	0.8	Wetland	Estimated (125' x 280')
16	0.9	WSG Buffer	Estimated (= Field 16 - Field 16 Wetland)
17	3.8	WSG Buffer	Estimated (= Field 17 - Field 17 WSG Wildlife Habitat)
17	2.1	WSG Wildlife Habitat	Estimated (125' x 745')
18	5.6	WSG Buffer	
19	5.4	WSG Buffer	
20	4.0	WSG Buffer	
21	1.1	WSG Buffer	
TOTAL	151.4		

NRCS Map


Plan Map
Customer(s): BIOPHILIA FOUNDATION
District: QUEEN ANNE'S SOIL CONSERVATION DISTRICT
Agency: USDA-NRCS
Assisted By: Patrick Vincent Barry
State and County: MD, QUEEN ANNE'S
Legal Description: Farm 14, Tract 18
ROUTE 301
Tract 18
Farm 14
Millington road
Legend
Practices (polygons)
Practice name
Field Border
Filter Strip
Shallow Water Development and Management
Wetland Creation
Conspian
Ditch Plug
690
0
690
1,380
2,070
2,760
Feet
N

WSI Map

= Warm Season Grass area or Wetland area that does not treat any upland acres



*Delineated areas not intended to be to exact scale