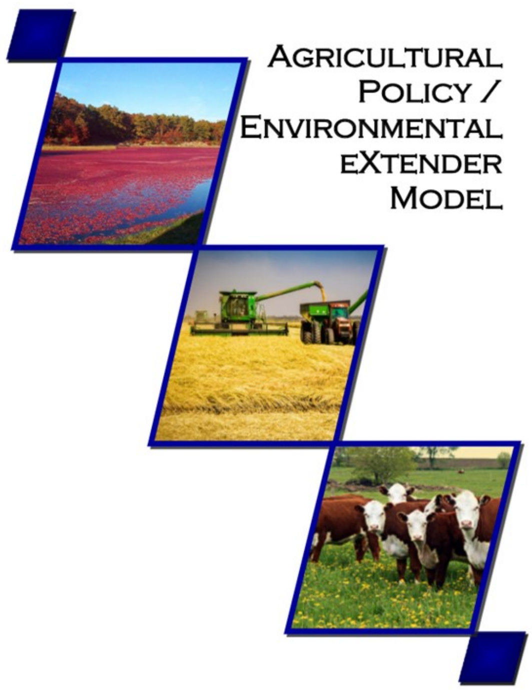
Recommendations for Valuation Criteria and Comparison of Evaluation Tools

STONE ENVIRONMENTAL



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Contents

Table of Tables

1. Introduction

The Vermont Agency of Agriculture, Food, and Markets (VTAAFM) is currently engaged in a pilot program that will inform the establishment of a voluntary program that encourages and supports local agricultural producers to achieve environmental and agricultural excellence. The Vermont Environmental Stewardship Program (VESP) aims to advance water quality improvements through social recognition of farmers who maintain a high level of environmental stewardship. The evaluation of environmental stewardship focuses on several key indicators: nutrient management, sediment and erosion control, soil health, air quality, carbon sequestration, and pasture health.

The goal of this project is to compare the outputs of two potential tools for use in the VESP to evaluate farm-specific environmental stewardship. Outputs from the Natural Resources Conservation Service (NRCS) tool, the Resource Stewardship Evaluation Tool (RSET) were compared to outputs from the United States Department of Agriculture's (USDA's) Agricultural Policy/Environmental Extender Model (APEX). Both USDA tools model environmental stewardship based on site-specific characteristics (i.e. soils, slope, climate) and agronomic management of the field (i.e. nutrient applications, tillage, crop rotation, cover crops, buffers). The RSET model compares indexed results to national thresholds, whereas the APEX model outputs quantitative results (i.e. kg/ha). The outputs compared include phosphorus losses, nitrogen losses, erosion, soil carbon, and organic matter.

The currently underway pilot program includes eight farms across the state for which on-farm natural resource assessments were conducted to evaluate environmental stewardship. Fields from these eight farms were selected by VTAAFM to be included in this tool comparison effort. In order to account for a broad range of field practices and soil types, additional acreage outside of these eight farms was also selected by VTAAFM for inclusion.

Based on evaluation of results and comparison of the two tools/models, VTAAFM will select a tool for use in VESP. This report documents the development of APEX models for the selected farm fields, describes the recommended valuation criteria, and present the results of the comparison of the two tools/models. The second phase of this project will develop a scope of work and budget for required modifications to the selected tool so that it can meet the needs of the VESP.

1.1. Resource Stewardship Evaluation Tool (RSET)

The Resource Stewardship Evaluation Tool (RSET) is the web-based platform designed to aid NRCS staff in conducting a resource stewardship evaluation (RSE) to support conservation planning under the Resource Stewardship Framework. Six major natural resource concerns or objectives are included in an RSE: Soil Management, Water Quality (Sediment and Nutrients), Water Quality (Pest Management), Water Quantity, Air Quality, and Habitat Health. Each of these resource concerns is assessed based on multiple key indicators. For each key indicator, a stewardship level conservation planning threshold is also determined based on the specific vulnerability of the site. The thresholds are based on NRCS planning criteria and indicate when management is adequate to address the established site vulnerability level.

An RSET evaluation requires the user to identify a planned land unit (PLU, e.g. a farm field with common land use and single owner) and enter information to the PLU characteristics and management operations. The evaluation uses soils and climate information to establish the site-specific stewardship thresholds on the PLU. As the thresholds are based on site specific characteristics (soil leaching potential and soil runoff potential), these values can vary across fields. RSET inventories cropping system information, management decisions, and conservation practices to evaluate the PLU and compare indexed results to national stewardship thresholds.

1.2. Agricultural Policy / Environmental EXtender Model (APEX)

The Agricultural Policy / Environmental Extender Model (APEX, Gassman et al., 2009; Steglich et al., 2016; BREC, 2020) is a physically based hydrologic and water quality model designed for addressing environmental and water quality impacts of agronomic practices at the field to small watershed scale. The model represents field-specific land/soil conditions, as well as agronomic management practices, and predicts off-field surface and sub-surface (tile drain) transport of soluble and particulate nutrients and pesticides. APEX accounts for the balance of nutrients in the soil and the response of crop growth to nutrient deficiencies. The APEX model provides the capability to examine the impacts of agronomic practices, including best management practices (BMPs), on physical processes leading to sediment and nutrient loss.

The Farm-Phosphorus Reduction Planner (or Farm-PREP) is a web-based APEX model interface developed by Stone Environmental and Texas A&M. Farm-PREP has been specifically designed to optimize land and nutrient management options at the farm scale to achieve load reductions established in the Lake Champlain phosphorus total maximum daily load (TMDL) (Stone, 2018). Farm-PREP helps farmers and/or planners objectively quantify farm-specific reductions in phosphorus losses resulting from conservation practices and identify field by field agronomic practices that allow them to achieve a targeted reduction in phosphorus losses. Data inputs required to run APEX have been customized and streamlined in Farm-PREP, so as to reflect common agronomic management in Vermont. Several recently completed projects have focused on the improvement and continued development of Farm-PREP. One of these expanded the geographical extent of Farm-PREP to encompass the entire Vermont portion of the Lake Champlain Basin, as well as focused on increasing stakeholder confidence and acceptance, creating a knowledgeable user community, and committing to continued technical support of the application through 2022. Another effort verified and improved the calibration of the APEX model executed by Farm-PREP using monitoring data from a selection of edge-of-field and tile drain monitoring sites in Vermont and New York. That work also developed model parameterizations for several innovative manure technologies and evaluated the impacts of simulated implementation of manure technologies on model-predicted phosphorus losses. In this work, Farm-PREP was used to aid in setting up the field-specific APEX models for comparison to RSET.

1.3. Objectives

The broad goal of this project is to assist VTAAFM in selecting a tool that meets the needs of the VESP program and to build a scope and budget for required modifications. The objective of the first phase is to recommend valuation criteria and compare the outputs of the two tools, RSET and APEX.

This report describes Phase 1, Tool Comparison and Recommended Valuation Criteria, of the "Comparison of Stewardship Evaluation Tools for the Vermont Environmental Stewardship Program." This comprised several sub phases, including compilation of data for fields to be simulated, initial set up of the APEX models for each field, subsequent refinement of APEX models, and field-by-field comparison of tool outputs.

2. Data Compilation and APEX Model Development

RSET evaluations were conducted by the Vermont Association of Conservation Districts, funded by NRCS, and the results provided to Stone for use in this project. APEX models corresponding to each field and scenario were developed as part of this effort. The compilation of necessary data inputs and APEX model development are described in the following sections.

2.1. Data Compilation

Eight farms were selected and enrolled in the VEST pilot program prior to the start of this effort. Extensive information necessary to complete a stewardship assessment for each farm, including agronomic and land use data, was already compiled for application of the RSET tool to these farms and technical staff had already entered the necessary information into RSET for fields in the VESP Pilot. In order to account for a broad range of field practices and soil types, additional acreage outside of these eight farms was also selected by VTAAFM for inclusion in this work. VTAAFM, in coordination with conservation planners, collected the required information for these additional fields and also entered the data into RSET.

Due to limitations on the time required for Stone to gain access to the information via RSET directly, the State compiled and provided the necessary information to run APEX for selected fields on the eight pilot farms and additional acreages. Stone worked with VTAAFM to develop a data input template that would streamline the compilation and transfer of input data, and support entry of data into Farm-PREP for development of the initial APEX input files for the selected fields. Shapefiles were also provided for each farm and field for use in acquiring physical field and soil characteristics via the use of Farm-PREP.

A total of 54 fields across eleven farms were selected for evaluation using RSET and APEX. These fields capture a range of soil types (A – D hydrologic groups), slope, crop rotations, tillage practices, and manure/nutrient application practices. Crop rotations included continuous corn, continuous hay, corn-hay, soy-hay, and mixed vegetables. Several types and mixes of hay were represented including alfalfa, alfalfa – timothy, alfalfa – grass hay, perennial grass – legume, and red clover. Table A1 and Table A2 in Appendix A provide a summary of characteristics of each field.

Each field was simulated under a 'current' scenario as well as using an associated TMDL scenario, for a total of 108 evaluations. There were 6 standardized TMDL scenarios (permanent corn, well drained; permanent corn, poorly drained; corn/hay, well drained; corn/hay poorly drained; permanent hay, well drained; and permanent hay, poorly drained) that represented agronomic practices assumed in the Lake Champlain TMDL SWAT modeling (Tetra Tech, 2015). Each field was assigned a TMDL scenario that most closely matched the dominant soil and current crop rotation. In RSET, this means the current and TMDL scenarios for any field could score differently but typically had the same threshold value for each key indicator area. In APEX, inputs describing the physical and spatial field characteristics of the current and TMDL scenarios were the same, while operations inputs and conservation practices (as well as grazing parameters for pasture fields) were customized for each scenario.

2.2. APEX Setup in Farm-PREP

APEX input files for each field model were initially developed using Farm-PREP. Shapefiles provided by VTAAFM were uploaded to delineate the fields and obtain the spatial data (such as soils information and topography) and weather data required for APEX. Farm-PREP queries well established datasets (such as NRCS SSURGO data and National Weather Service (NWS) station data) (Stone, 2018) when determining these model inputs. Farm-PREP identifies and selects weather data from the closest NWS station for which data is available.

Field-specific crop rotation and agronomic practices were initially entered based on the 'current' management scenario, by selecting the closest possible options in Farm-PREP relative to the field information provided. This included entry of manure and commercial fertilizer application amounts (where manure was entered in terms of lbs P2O5/ac). For all initial farm set ups, Vermont default liquid manure was selected to represent manure nutrient characteristics. Vermont default liquid manure is an option if Farm-PREP, based on nutrient content values in the Nutrient Recommendations for Field Crops in Vermont (2004) and Stone (2020a; 2020b). Soil test information, including pH, Al, and phosphorus (P) was also entered in Farm-PREP to inform the parameterization of APEX soil input files (Stone, 2018). For fields on which buffers or filter strips were implemented, buffer/filter strip dimensions were described via Farm-PREP.

Farm-PREP was then used to generate the necessary input files for each field. Section 2.3 describes customizations made to APEX models generated through Farm-PREP to better represent information collected about each field.

2.3. Refined APEX Simulations

APEX inputs for fields with agronomic management practices that differ from the options provided by Farm-PREP were refined outside of the Farm-PREP interface. This included customization of crop rotations, tillage practices, and fertilizer/manure applications on some fields.

Relatively few modifications were made to operations schedules. Rotation lengths were modified for some fields; for example, fields that were in 3-year corn, 3-year hay rotations were entered into Farm-PREP as 3-yr corn, 4-yr hay, and subsequently modified. Operation schedules for soy-hay rotations were also generated outside the Farm-PREP interface. In addition, pasture fields were modified to include no tillage or cuttings and the specified grass mix.

Commercial fertilizer applications were entered through Farm-PREP and required no customization. However, manure application rates and manure nutrient contents were customized for all fields to simulate the application of the specified amount of P2O5 as well as nitrogen (N). The specified amount of P2O5 applied and the Vermont default liquid manure characteristics were used as the basis for this calculation. The mineral and organic N fractions were adjusted to achieve the specified amount of N applied.

As grazing is currently not an option in Farm-PREP, pasture fields were parameterized largely outside the Farm-PREP interface. As stated above, operation schedules were customized to include no tillage or cuttings and the specified grass mix. The operation schedule input file was also modified to include the start and stop records for field-specific grazing rotations. The start, duration, time between, and end of grazing rotations were provided as data inputs for each field. In addition, APEX requires an input file to specify grazing parameters including number of animals, fraction of the day that grazing occurs, grazing rate, daily manure production, and daily urine production. Aside from manure and urine production, field-specific input values were available for these parameters. Grazing rates were calculated based on estimated forage removed and the total time a field was grazed for each field under the current scenario. For TMDL scenarios, grazing rates for each animal type were based on values from Chapter 4 of the NRCS Agricultural Waste Field Handbook (2008). Where necessary, values were scaled by animal units determined using the animal weights provided in the data input spreadsheet provided by VTAAFM. For both current and TMDL scenarios, daily manure and urine rates were determined based on values in the NRCS Handbook.

3. Methodology

3.1. Output Selection and Valuation Criteria

Outputs from APEX and RSET were selected to represent each of the specified focus areas: phosphorus loss, nitrogen loss, erosion, soil carbon, and organic matter. Table 1 shows the suggested outputs selected to represent these focus areas from each tool, as well as their source (e.g. output file).

Table 1: Recommended RSET and APEX Output Comparison.

Focus Area	APEX Output[1]	APEX Output File and Variable ID	RSET Output/Key Indicator Score and Threshold[2]	RSET Report File
Phosphorus losses	Total P in runoff (kg/ha)	.STR, QP+YP	Surface Phosphorus Loss	Evaluation Point Details
Nitrogen losses	Total N in runoff (kg/ha)	.STR, QN+YN	Surface Nitrogen Loss	Evaluation Point Details
Erosion	Sediment yield (t/ha)	.STR, Y	Sediment in Surface Water	Evaluation Point Details
	Sediment yield (t/ha)	.STR, Y	Water Erosion	Evaluation Point Details
	Sediment yield (t/ha)	.STR, Y	Sheet and Rill Erosion	Resource Concern Point Details
Soil carbon	Change in soil organic carbon (% change in plow layer[3] between beginning and end of simulation)	.ACY, OCPD	Soil Carbon (crop) or Land Health (pasture)	Evaluation Point Details
Organic matter	Change in organic matter (difference in t/ha in root zone[4] between beginning and end of simulation)	.STR, DWOC	Organic Matter Depletion	Resource Concern Point Details

[1]The annual average value of 30-year APEX simulation will be used for each of the outputs listed.
[2]Selected RSET results are the score values associated with the specified outputs, where scores are assigned based on current conditions and not time dependent.
[3]Plow layer is simulated as top 15 cm.
[4]Root zone represents the depth to which roots extend, which varies based on simulated crop type and growth.

In RSET, there are three different key indicators related to erosion: Sediment in Surface Water, Water Erosion, and Sheet and Rill Erosion. While all of these were compiled, the Sediment in Surface Water value was selected for comparison to the erosion/sediment loss output in APEX.

In the case of soil carbon, RSET reports a key indicator score for either Soil Carbon (cropped fields) or a Land Health (pasture fields) in the evaluation point details. Either Soil Carbon or Land Health is the key indicator for the Resource Concern area Organic Matter Depletion. For pasture fields, the Organic Matter Depletion score is the same as the Land Health score. However, for cropped fields, the Organic Matter Depletion score is represented by the total Soil Management score from the evaluation point details, which includes the score assigned for Soil Carbon. In APEX, the user can select output related to the amount of soil carbon at various depths corresponding to soil layers, as well as change in organic matter over the entire root zone. There is also a direct relationship between soil carbon and organic matter, therefore these outputs represent similar processes and outputs in APEX. In APEX, soil organic carbon content, referred to as "OCPD" is expressed in % (calculated as weight organic carbon / weight soil * 100) and represents the percent organic carbon in the plow layer (top 15 cm). OCPD can be converted to organic matter by multiplying its value by 1.72. For comparison to RSET soil carbon results, we have taken the difference between OCPD at the beginning and end of the simulation (where a positive value indicates an increase in soil carbon in the plow layer). Another APEX measure of organic carbon, "DWOC", is the change in soil carbon within the entire root zone, calculated in APEX in t/ha and converted to t/ac for comparison in this work. Because of the overlap in the organic matter/soil carbon outputs, both in RSET and APEX, the direct comparison of organic matter outputs, separate to soil carbon, did not seem like an appropriate comparison. Additionally, no corresponding threshold value was available for RSET outputs in the resource concern areas. Therefore, change in organic matter (DWOC) will be compiled from APEX simulations but not used in subsequent comparisons of results.

It is important to note that RSET outputs are indexed scores. They are designed to indicate whether the level of management is sufficient to meet a site's inherent risk. Risk is site specific and determined based on erodibility potential, soil leaching potential, and soil runoff potential (determined using NRCS tools and based on simplified soil loss criteria, R Factor class, and modified Soil Vulnerability Index). Each key indicator area is associated with a unique threshold value. When an RSET score is below a planning threshold, it indicates that more mitigation is needed and when an RSET score meets or is above a planning threshold, no additional mitigation is needed. APEX is a process-based model that simulates physical processes and outputs are quantitative predictions of the results of those processes. These models/tools are significantly different in their approach to site evaluation and based on initial tests of this approach as well as feedback from NRCS staff (Bagdon, personal communication, November 18, 2020), it was determined that direct comparison of their outputs (as in a ranking approach) is not valid. However, the following sections present several simplistic approaches for comparing the outputs of the tools that are as closely as possible aligned with their intended use.

3.2. Comparison Approaches

The objective of this comparison was to determine the level of agreement between RSET and APEX in terms of site evaluation and whether agronomic practices and management of a site meets the necessary requirements to ensure environmental stewardship goals are met. Several approaches were considered and are described in the following sections of this report.

3.2.1. Comparison of Percentile Ranking

One approach for comparing the results of these tools was to use a percentile ranking. RSET scores would be sorted and ranked. APEX results corresponding to the same focus area would be sorted and ranked independently. The rankings would then be compared, for example using scatter plots, to determine whether the rankings were correlated. This would be done for each focus area independently.

For this approach, it was determined that RSET scores would not be used directly. The indexed scores are designed to be used in conjunction with a site's threshold value, which can differ by site based on inherent risk. In this approach, the RSET ranking was based on the percent of relative threshold achieved for each area (e.g. RSET score/RSET threshold * 100). Since no threshold value was available for organic matter, this output could not be evaluated using this calculation.

This proposed approach assumes that there would be some collinearity between RSET score (percent of relative threshold) and APEX output. It also requires that a mathematical relationship exist between the RSET scores and levels of contaminant loss or change in soil carbon/organic matter. Neither assumption is valid. RSET scores are not representative of any quantitative determination of a physical process, as is the case in APEX. Therefore, the expectation that the ranking of scores across multiple fields would show some correlation is not reasonable. This approach was therefore dropped and not included in this report.

3.2.2. Evaluation of Congruency

In the context of this work, the goal is to evaluate agreement (or non-agreement) between the tools in terms of site evaluation and whether environmental stewardship goals are met. For this purpose, 'congruency' tests were conducted to determine whether the two tools agreed in their indication of whether a field scenario would meet determined planning thresholds.

For RSET outputs, the score for each key indicator selected for that focus area was compared to the corresponding site-specific threshold. For example, if the RSET score for surface phosphorus loss exceeds the assigned threshold value, the field scenario passes. If the RSET score is below the threshold, the field scenario fails to meet the planning threshold and does not pass. Again, RSET threshold values are site specific, as well as specific to the key indicator.

While site-specific threshold values in RSET are determined based on their risk potential, they are designed to represent national conservation planning thresholds. These are shown in Table 2 for each focus area and were used to determine whether APEX results for specific field scenario results indicated that planning thresholds had been met. For example, if total phosphorus loss for a field scenario was less than or equal to 3 lbs/ac, it passes. Otherwise, if total phosphorus loss is greater than 3 lbs/ac, it does not pass.

Table 2. National Thresholds Used for Evaluation of APEX Results.

Key Indicator	National Threshold
Phosphorus losses	≤3 lbs P /ac
Nitrogen losses	≤15 lbs N /ac
Erosion	≤2 tons /ac

Key Indicator	National Threshold
Soil carbon	Steady or increasing
Organic matter	Steady or increasing

For each field scenario (both current and TMDL scenarios on each field), the results of whether a field passes or did not pass the appropriate threshold were compared for each focus area. For each field scenario, if both APEX and RSET indicated that the field 'passed', or both APEX and RSET indicated the field 'did not pass', the models were 'Congruent.' If either predicted a pass, while the other did not, they were considered 'Not Congruent'.

3.2.3. Evaluation of Directional Behavior

Another approach for assessing whether APEX and RSET were similar in their evaluation of a site, was to look at the TMDL scenario results relative to the current scenario results for each field. This would indicate whether changes in management and implemented conservation practices impacted the results of RSET and APEX in the same direction (i.e., higher or lower concern). For both RSET and APEX, the difference between the current and TMDL scenario results was calculated (for each field and each focus area output). If, for example, this test determined that phosphorus losses were higher in the TMDL scenario for a field and the RSET score for surface phosphorus loss was lower for the TMDL scenario, this test was 'Congruent' for this field.

Note that in this analysis, the RSET percent relative to threshold (as described in Section 3.2.1) was used. This meant that for phosphorus, nitrogen, and sediment, congruent results meant the change in tool output was in the opposite direction, with an increase in RSET scores being equivalent to a reduction in APEX-predicted field losses. For soil carbon and organic matter, the direction was the same. If soil carbon increased between current and TMDL scenarios, this was considered congruent with an increase in RSET percent relative to threshold between current and TMDL scenarios for that field.

4. Comparison of APEX and RSET Results

The following sections describe the field-specific outputs from each model/tool and the results of the comparison between these two sets of results.

4.1. Tool Results

Outputs specified in Table 1 were compiled from RSET reports (provided by VTAAFM) and extracted from APEX simulations. APEX outputs were converted into units corresponding to RSET planning thresholds (lbs/ac for phosphorus, nitrogen, and carbon/organic matter; ton/ac for sediment).

A summary of field scenario results is shown in Table 3 while results for each output described in Section 3.1 for both RSET and APEX are included in Table B1 through Table B8 in Appendix B.

Table 3. Summary of Field Results.

Focus Area	Metric	APEX		RSET				
		Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
Surface Phosphorus Loss	Minimum	0.06	0.05	-29.75	-6.37	45	-50	-14
	Median	0.88	0.95	75.89	77.41	60	140	138
	Maximum	6.33	17.82	104.5	109.5	60	209	224
Surface Nitrogen Loss	Minimum	0.17	0.51	52.50	13.63	30	100	21
	Median	3.50	7.65	85.75	59.50	65	157	118
	Maximum	28.61	66.71	120.38	112.25	65	401	374
Sediment in Surface Water[2]	Minimum	0.00	0.00	45.00	10.00	10	0	0
	Median	0.18	0.34	90.00	70.00	40	303	175
	Maximum	4.26	15.63	142.50	145.00	40	1425	1450
Soil Carbon	Minimum	-1.61	-1.95	30.00	15.00	30	86	0
	Median	-0.06	0.09	56.75	50.00	35	150	143
	Maximum	1.74	0.70	80.00	72.50	60	225	242
Organic Matter	Minimum	-19.65	-35.12	35.00	0.00	N/A[1]	N/A[1]	N/A[1]
	Median	-2.56	-3.26	94.50	86.00	N/A[1]	N/A[1]	N/A[1]
	Maximum	33.56	22.59	100.00	100.00	N/A[1]	N/A[1]	N/A[1]
Water Erosion[2]	Minimum	0.00	0.00	45.00	10.00	10	88	25
	Median	0.21	0.34	70.00	70.00	20	313	233
	Maximum	4.26	15.63	107.50	110.00	60	1075	1100
Sheet and Rill Erosion[2]	Minimum	0.00	0.00	43.00	15.00	N/A[1]	N/A[1]	N/A[1]
	Median	0.21	0.34	100.00	100.00	N/A[1]	N/A[1]	N/A[1]
	Maximum	4.26	15.63	100.00	100.00	N/A[1]	N/A[1]	N/A[1]

[1]No thresholds were available for these RSET key indicators.
[2]APEX outputs did not distinguish between Sediment in Surface Water, Water Erosion, and/or Sheet and Rill Erosion. The APEX watershed sediment yield was considered representative of all these key indicators.

4.2. Tool/Model Comparison

The following sections present the results of two approaches for comparing the results of RSET and APEX on a field by fields basis and evaluate the level of agreement between the two tools/models.

4.2.1. Evaluation of Congruency

This analysis determined the rate of congruency between RSET and APEX for each field scenario based on whether RSET scores met site specific thresholds and whether APEX met national quantitative thresholds. Field by field result of this congruency test are provided in Table C1, Appendix C, for each focus area output. Table 4 provides the agreement/congruency rates for all fields, as well as for grouped field scenarios. Across the fields the rates of congruency for phosphorus loss, nitrogen loss, sediment in surface water, and soil carbon were 70%, 80%, 93%, and 58%, respectively. Table 4 presents the congruency rates for each focus area (except organic matter because no RSET threshold exists for organic matter) across all fields, as well as congruency rates within specific groupings of fields (e.g. current verses TMDL and crop verses pasture).

Table 4. Summary of APEX RSET Congruency Test Results.

	Percent of Fields that Show Agreement for each Model Output (%)			
Field	**Surface Phosphorus Loss**	**Surface Nitrogen Loss**	**Sediment in Surface Water**	**Soil Carbon (Change)**
All field scenarios	70	80	93	58
Crop fields	76	83	93	59
Pasture fields	50	68	89	55
Current crop field scenarios	84	95	95	37
Current pasture field scenarios	64	100	89	73
TMDL crop field scenarios	67	70	91	84
TMDL pasture field scenarios	36	36	N/A[1]	36

[1]No RSET scores were available for this key indicator and group of field scenarios.

Overall, congruency rates show relatively good agreement. Congruency was generally highest for sediment, and similarly high for nitrogen in some groups. Soil carbon showed the lowest congruency rate across all the field scenarios and were particularly low for the TMDL pasture field scenarios. Congruency rates were higher for cropped fields (as opposed to pasture fields) in all focus areas. For cropped fields, the congruency rates for phosphorus, nitrogen, sediment, and soil carbon were 76%, 83%, 93%, and 59%, respectively, and 50%, 68%, 89%, and 55%, respectively, for pasture fields (Table 4). The group with the lowest congruency rates were the TMDL pasture field scenarios.

For most cropped fields where this test showed incongruent results for phosphorus loss, it was the case that APEX results showed phosphorus loss of < 3 lbs/ac but RSET scores were below the threshold indicating they did not meet stewardship thresholds (except GMD5 current and BS7 TMDL fields). These were mostly permanent corn or corn/hay rotations on low runoff soils, in some cases with buffers implemented. While these sites were not assigned enough RSET points to meet stewardship thresholds, APEX-simulated phosphorus losses were below the national threshold.

In the case of the current GMD5 field and TMDL BS7 field, APEX predicted phosphorus losses higher than the national threshold where RSET awarded scores that did meet stewardship thresholds. The GMD5 current field scenario was also the only cropped field for which the models/tools were incongruent in all focus areas. This was a field in permanent corn silage rotation, with a cover crop, on C/D soils (modeled as D soils) with a 5% slope. This field received commercial P and N applications in the spring and manure applications (simulated as injected) in the fall. No buffer or filter strip was implemented, but RSET inputs included 'other conservation practices.' This field had the highest APEX phosphorus loss of all cropped fields. It was also the only permanent corn rotation on poorly drained soils with no buffer or filter strip implemented. However, in RSET this field received enough points (in part for implementing no till practices and cover cropping that contributed to residue points) that resulted in the field meeting its thresholds for each key indicator area for phosphorus, nitrogen, sediment in surface water, and soil carbon. Similarly, BS7 was a corn-hay rotation on D soils with 1% slopes. Phosphorus losses were only slightly above the threshold for the BS7 TMDL scenario. With APEX, higher P and N loss was generally associated with higher runoff soils, higher soil test P, higher nutrient applications, and in some cases the absence of a buffer or filter strip.

For pasture fields, where this test showed incongruent results in the case of phosphorus, it was mostly because APEX predicted higher phosphorus losses than the national threshold, where RSET awarded points sufficient to meet stewardship criteria. Most of the incongruent pasture results were for the TMDL scenarios, where continuous grazing of milk cows was simulated through the grazing season (184 days with no rest periods). For these field scenarios, the driving factor in higher phosphorus losses was the length of continuous grazing. In the case of the current pasture scenarios that were incongruent because they predicted higher than threshold phosphorus losses (G1, G2, G3, and SB2;see Table B1 and Table C1 for APEX phosphorus losses and congruency results, respectively), these were fields on D soils with slopes of 12%, 15%, 19%, and 14%, respectively, where additional nutrients were applied. In RSET, many of the pasture field scenarios are awarded crop residue, cover cropping, and nutrient management points that result in phosphorus and nitrogen thresholds being met, but it is unclear at this point what practices are contributing to those scores.

APEX models were set up to simulate conventional and conservation tillage, as well as cover cropping, however no adjustments to parameters affecting crop residue were modified. Incorporating additional inputs that customize crop residue and yield could affect results of congruency tests and improve agreement between the two models. Buffers and filter strips were also simulated in APEX, but not all conservation practices that may contribute to RSET scoring were simulated in APEX, particularly for pasture (e.g. if P application was part of a multi-crop P application [crop fields], or implementation of a grazing plan, fence, watering facility, and other structural BMPs [grazing fields]). Additionally, for pasture fields, no cover cropping was explicitly simulated in APEX beyond the crop growth and cessation simulation of a perennial grass legume mix.

The APEX output used for comparing soil carbon in this effort was the change in soil carbon, calculated as the difference between soil carbon in the plow layer (top 15 cm) in year 1 (start) of the simulation and soil carbon in the plow layer in year 30 (end) of the simulation. This was selected because it was thought to best represent soil carbon dynamics that might be affected by changes in management and conservation practices, and therefore be most closely aligned with

RSET output. However, soil carbon outputs can be modified in APEX to reflect soil carbon at various depths/soil layers or for the entire root zone. Evaluation of soil carbon at alternative depths could potentially affect the results of this analysis. Additionally, while most fields showed a gradual annual change in soil carbon that was consistent with the difference between year 1 and year 30, this was not always the case. Particularly for fields with crop and hay rotations, soil carbon may go up in some years and down in others. Therefore, the duration of the APEX simulation and approach for calculating change in soil carbon may have impacted the congruency tests for some fields such that if a different simulation duration was selected, the result may be different. Furthermore, no effort to date has targeted calibration of soil carbon or nitrogen in APEX for Vermont conditions and characteristics. A recently completed project included calibration of APEX phosphorus losses based on monitoring data in Vermont and New York but did not include any effort to calibrate for other nutrients (Stone, 2020b). It should also be noted that while APEX has been tested extensively in Vermont as part of the Farm-PREP development efforts, this testing has to date focused on cropland, with pasture simulations only recently evaluated as part of this RSET comparison project. An area of important future research would be more extensive evaluation of APEX pasture simulations in Vermont, with comparisons with monitoring data being ideal.

It should also be noted that APEX results were compared to national threshold values (Table 2). This work did not evaluate whether these thresholds were appropriate for Vermont conditions and standard practices or whether implementation of TMDL scenarios ensured that Vermont TMDL goals would be achieved.

4.2.2. Evaluation of Directional Behavior

This analysis determined whether RSET and APEX showed the same directional change between current and TMDL scenarios on each field. For each output, the difference between the current and TDML scenarios was calculated. For RSET, this was based on the percent of relative threshold. If for example, APEX indicated increased phosphorus loss between the current and TMDL scenario, and RSET indicated a lower percent of relative threshold (site is farther from meeting threshold), these results were considered congruent. For several fields, it was the case that the RSET score for a key indicator area did not change between the current and TMDL scenario. However, it was rare that APEX simulated 0 change between scenarios, as APEX simulation results are sensitive to small input changes. In some cases, APEX shows a small change in output while RSET shows no change and this was still reported as incongruent in this analysis. Therefore, this directional test was also re-evaluated for each field such that if there was no difference in the RSET score for a key indicator area between the current and TMDL scenario, that field was considered 'congruent.' This alternative interpretation of congruence recognizes that RSET results have considerably lower sensitivity to input assumptions that compared to APEX.

Agreement rates for this test across all fields, crop fields, and pasture fields, using both the original assumptions and modified assumptions described above, are shown in Table 5. In Appendix D, Table D1 shows the difference between the current and TMDL scenario results for both APEX and RSET. Table D2 shows the results of the directional test for each field using both the original assumptions and assuming congruency where there is no difference in RSET output between current and TMDL scenarios. Where the change in RSET scores was 0, using the modified assumptions, those fields would also be considered congruent. Across the fields and using the original assumptions, rates of agreement for phosphorus, nitrogen, sediment in surface water, soil carbon, and organic matter depletion were 67%, 72%, 61%, 67%, and 61%, respectively. Assuming no change in RSET score was equivalent to a congruent result, these rates were 76%, 76%, 78%, 80%, and 83% for phosphorus, nitrogen, sediment in surface water, soil carbon, and organic matter depletion, respectively.

Table 5. Summary of APEX RSET Directional Test Results.

Field	Percent of Fields that are Directionally Consistent for each Model Output (%)				
	Surface Phosphorus Loss	Surface Nitrogen Loss	Sediment in Surface Water	Soil Carbon (Change)	Organic Matter Depletion (Change)[1]
All field scenarios	67	72	61	67	61
Crop fields	70	79	58	58	51
Pasture fields	55	45	N/A[2]	100	100
All field scenarios[3]	76	76	78	80	83
Crop fields[3]	79	84	74	74	79
Pasture fields[3]	64	45	N/A[2]	100	100

[1]No RSET threshold was available for organic matter depletion, therefore this analysis used the RSET score directly for this key indicator. For other key indicators, the percent relative to threshold was used.
[2]No RSET scores were available for sediment in the case of the TMDL pasture scenarios, therefore comparison could not be conducted for this group.
[3]The second set of rates are calculated assuming that if RSET values do not change between the current and TMDL, it is 'congruent' for that field.

As with the congruency tests for whether field scenarios did or did not meet threshold values, the rates of agreement across the fields were similarly high. Rates were higher for crop than pasture fields in the case of phosphorus and nitrogen loss, but higher for pasture fields in the case of soil carbon and organic matter depletion. For pasture fields, the rate of agreement for nitrogen was clearly lower than other focus areas. As mentioned previously, APEX has not been calibrated for nitrogen or carbon and an effort to further look at the nitrogen dynamics, particularly in relation to grazing, could improve agreement in this group.

Also similar to the congruency tests in Section 4.2.1, no single factor was found that accounted for fields that did not agree. However, in most cases, incongruent results can be explained by examination of specific field characteristics and the RSET scoring details. For example, for CP3, this test (Table D2) showed that APEX simulated a decrease in sediment loss between the current and TMDL scenario (indicating an improved sediment loss scenario, although not by a significant margin). RSET showed a lower percent of relative threshold score for the TMDL scenario (indicating the scenario was further from meeting the planning threshold). The TMDL field scenario received crop residue points for the first year only of the hay rotation (1 of four years), while in the current field scenario, points were assigned for crop residue in each year of the hay rotation (3 years). It's likely this resulted in a higher score for the sediment in surface water key indicator area in the current vs TMDL scenario.

Another example of non-agreement was BS5, where this analysis showed incongruency in all focus areas (Table D2). This was a permanent hay (alfalfa-grass hay) rotation, assigned the corn/hay, poorly drained TMDL scenario. APEX predicted higher P, N, and sediment losses and lower rate of soil carbon and organic matter depletion with the current verses TMDL scenarios. However, RSET scores were higher for the current scenario. While the current scenario implemented a filter strip, it also had no cover crop and generally higher applications of P and N. It seems that the implementation of conservation practices resulted in higher scores for the current scenario in

RSET, while even with simulating the filter strip, higher nutrient applications, and lack of cover crop results in higher losses in APEX.

HB3 is a grazing field for which results of this directional analysis were congruent for sediment, soil carbon, and organic matter, but not in agreement for phosphorus or nitrogen. APEX simulations showed higher phosphorus and nitrogen losses from the TMDL scenario in comparison to the current scenario (representing an incongruent result with RSET). The current scenario was awarded nutrient management points in RSET, however it is unclear exactly the basis for assigning these points. This field was noted to have a nutrient management plan and fence installed, neither of which are simulated in APEX. The TMDL scenario represented continuous grazing (verses rotated grazing incorporating rest periods) with a stocking rate of 2 animals per acre (verses 3.5 animals/acre on under current conditions). Table 6 shows sequential modifications to the current operations schedule in comparison to the TMDL scenario for HB3, which indicate that the continuous grazing simulated in the TMDL scenario was the most significant factor in the difference between TMDL and current scenarios.

In general, APEX is more sensitive to changes in certain physical-based inputs and assumptions, such as application rates and cover cropping. Additionally, some RSET inputs are not being accounted for in APEX, such as whether a grazing or nutrient management plan has been established, structural BMPs implemented, and certain other farm-wide practices in place. This likely accounts for some differences in the results of these models/tools.

Table 6. Sequential Modifications to HB3 Operations.

Modification	Current					TMDL				
	Soluble P (lbs/ac)	Sediment P (lbs/ac)	Total P (lbs/ac)	PL Carbon (% Change)	RZ Organic Matter (t/ac Change)	Soluble P (lbs/ac)	Sediment P (lbs/ac)	Total P (lbs/ac)	PL Carbon (% Change)	RZ Organic Matter (t/ac Change)
Original inputs	1.50	1.96	3.46	0.39	25.45	1.19	2.59	3.78	0.19	12.13
Same N and P applied (0)	0.87	1.37	2.23	0.35	22.82	-	-	-	-	-
Continuous grazing (no rest periods)	1.34	6.57	7.90	0.44	28.31	-	-	-	-	-
Same fraction of the day	1.06	4.69	5.75	0.35	21.71	-	-	-	-	-
Same number of cows	1.19	2.59	3.78	0.19	12.13	-	-	-	-	-

4.2.2.1. Further Examination of Hay Fields

It was observed that for some of the permanent hay fields, comparison of phosphorus and nitrogen losses between the TMDL and current scenarios differed from what would have been expected based on nutrient applications alone (Table 7). For example, the HB1 TMDL scenario received significantly more additional phosphorus and nitrogen than the HB1 current scenario (64 lbs/ac vs 0 lbs/ac and 308 lbs/ac vs 0 lbs/ac for phosphorus and nitrogen on TMDL and current scenarios, respectively). However, the HB1 TMDL scenario showed lower phosphorus and nitrogen loss than the current scenario. One of the factors accounting for this was the difference in operation schedules for TMDL vs current scenarios, mostly the difference in grass species/mixes. APEX simulates explicit crop-specific nutrient uptake, which is dependent on nutrient availability (including via nutrient applications) as well as weather and soil conditions, all which affect crop growth, residues, and nutrient loss. This can mean that different grass species and mixes use more nitrogen or phosphorus than others, thereby altering these processes and making an evaluation of only nutrient application insufficient in explaining nutrient losses. For example, the assigned HB1 TMDL scenario was permanent hay, represented by a red clover and fescue grass mix, and the current scenario was simulated as only red clover hay. Table 8 shows sequential modifications to the APEX models that account for the difference in results between the two scenarios. Other factors that contribute to differences in nutrient losses and erosion are number of cuttings (for hay rotations) and nutrient applications (timing and amounts of N vs P). The last row in Table 8 shows the results of comparing only the impact of nutrient applications (all other operations were made consistent). Soluble phosphorus increases as a result of additional phosphorus and nitrogen applications, however sediment phosphorus and total phosphorus decreases. This is due to reduced nutrient stress and increased crop growth (indicated in Table 8 by N stress, P stress, and Yield values, respectively). Increased crop growth and yields also translate to higher residue values, which reduce erosion and sediment phosphorus loss. Again, it should also be noted that for many of the fields in Table 7, directional results described in the above section for phosphorus and/or nitrogen were congruent.

Table 7. Permanent Hay Results.

Field	Crop Description	APEX P Loss (lbs/ac)		P2O5 Applied (lbs/ac)		APEX N Loss (lbs/ac)		N Applied (lbs/ac)	
		TMDL	Current	TMDL	Current	TMDL	Current	TMDL	Current
BS2	Alfalfa-grass hay	0.97	2.92	64.00	73.00	12.12	13.38	308.00	131.00
BS5	Alfalfa-grass hay	0.35	1.48	48.00	54.00	3.91	6.38	132.00	126.00
CP5	Hay (perennial grass-legume mix)	0.17	0.06	64.00	5.00	0.95	0.56	308.00	21.00
CP7	Hay (perennial grass-legume mix)	0.30	0.16	64.00	5.00	2.18	1.46	308.00	21.00
G4	Hay (perennial grass-legume mix)	0.34	0.21	64.00	6.40	4.67	1.70	308.00	4.20
G5	Hay (perennial grass-legume mix)	0.53	0.38	64.00	6.40	7.87	3.12	308.00	4.20
GMD2	Alfalfa-grass hay	0.45	0.98	48.00	64.00	4.08	6.36	132.00	111.00
GMD4	Alfalfa-grass hay	0.18	0.22	64.00	67.00	5.69	2.16	308.00	112.00
HB1	Hay (red clover)	0.37	0.92	64.00	0.00	5.07	7.44	308.00	0.00
HB2	Hay (alfalfa)	0.28	0.31	64.00	28.00	4.60	3.51	308.00	78.00
HB5	Hay (red clover)	0.18	0.36	64.00	48.00	3.89	2.19	308.00	46.00
HB6	Hay (alfalfa)	0.27	0.38	64.00	48.00	4.75	2.25	308.00	46.00
NM2	Alfalfa-grass hay	0.12	0.10	64.00	88.00	2.23	0.62	308.00	162.00
NW6	Hay (alfalfa-timothy)	0.05	0.10	64.00	97.00	0.51	0.17	308.00	77.00
SB1	Hay (perennial grass-legume mix) Grazed	0.73	0.60	64.00	71.00	7.42	3.61	308.00	118.00

Table 8. Sequential Modifications to HB1 Operations.

Modification	Current							TMDL						
	Soluble P (lbs/ac)	Sediment P (lbs/ac)	Total P (lbs/ac)	PL Carbon (% Change)	Yield (t/ac)	N Stress (days)	P Stress (days)	Soluble P (lbs/ac)	Sediment P (lbs/ac)	Total P (lbs/ac)	PL Carbon (% Change)	Yield (t/ac)	N Stress (days)	P Stress (days)
Original inputs	0.04	0.88	0.92	0.13	3.81	7	45	0.02	0.35	0.37	0.27	8.19	22	76
Remove buffer	0.02	1.17	1.20	0.03	3.91	8	47	-	-	-	-	-	-	-
Same P applied (0)	-	-	-	-	-	-	-	0.01	0.13	0.14	0.06	5.77	15	171
Same N applied (0)	-	-	-	-	-	-	-	0.05	0.11	0.16	0.28	8.41	83	10
Same N and P applied (0)	-	-	-	-	-	-	-	0.02	0.12	0.14	0.08	5.87	38	143
Same grass species	-	-	-	-	-	-	-	0.03	1.19	1.21	0.04	4.29	6	46
Same number of cuttings	-	-	-	-	-	-	-	0.02	1.17	1.20	0.03	3.92	8	47
Original nutrient application[1]	-	-	-	-	-	-	-	0.11	0.88	0.99	0.17	5.35	0	4

[1]Shows direct comparison of impact of nutrient applications (all else the same).

5. Conclusions

This effort compared the results of two tools for conducting site evaluations to assess environmental stewardship levels. RSET is an index-based tool based on simplified assumptions designed to assess whether a site meets planning thresholds that reflect the inherent site risk. APEX is a process-based model that simulates quantitative movement and losses of sediment, nutrients, and chemicals in the environment. While it proved difficult to directly compare outputs from these models, as RSET scores were not indicative of a quantitative amount of contaminant loss, two tests were conducted to assess agreement in RSET and APEX output in terms of whether or not a site met stewardship goals in each of the focus areas (surface phosphorus loss, surface nitrogen loss, sediment in surface water, soil carbon, and organic matter).

One of these analyses looked at agreement ('congruency') rates between RSET and APEX as to whether or not a site met threshold values. For RSET, threshold values for each key indicator area are site specific and based on determined site risk. APEX outputs were alternatively compared to quantitative national threshold values. It was not part of this scope to evaluate whether national thresholds were appropriate for Vermont field conditions and practices or whether achievement of national thresholds would result in improved water quality outcomes. The second analyses looked at agreement in whether the two tools demonstrated a similar directional change between current and TMDL scenarios. Meaning, if a current scenario on a field showed lower phosphorus losses than the corresponding TMDL scenario in APEX, did RSET assign the current scenario a higher score than the TMDL scenario (indicating a higher percent of relative threshold was achieved).

The results of both these tests showed relatively high rates of agreement in most focus areas. In the congruency tests that examined whether field scenarios met threshold values, congruency rates were highest for phosphorus and soil erosion. Agreement was also higher for crop fields than pasture. Similarly, in the tests that examined directional behavior, agreement was higher for crop fields than for pasture, particularly in the case of nitrogen.

While agreement between the tools was generally good, inputs and assumptions are handled differently in the tools. No single reason or attribute accounted for all incongruent results, however APEX is likely more sensitive to changes in physical processes (e.g. nutrient application rates, implementation of cover cropping, and soil and slope characteristics), while RSET scores can be impacted by practices not represented in APEX (e.g. establishment of grazing plans or structural conservation practices). Additionally, it appears that crop residue points can have a significant impact on RSET scores, and it is still somewhat unclear how those points are assigned. While crop rotation, cover cropping, and tillage practices were simulated in APEX (which are factors that contribute to residue points in RSET), no adjustments were made to APEX models to account for differences in crop residue specifically, particularly harvest practices.

Additional efforts could be undertaken to improve agreement in these models, as well as an evaluation of whether national threshold values are appropriate for Vermont fields. Calibration of nitrogen losses and changes in soil carbon in APEX using local monitoring data could improve performance of the model with respect to these outputs. Further evaluation of grazing parameterization and animal manure characteristics could also result in an improved representation of the impacts of grazing, particularly with respect to animals other than dairy cows.

The next phase of this project is to work with VTAAFM to select a tool for use in the VESP program and make recommendations for modifications to that tool to best meet the needs of the program.

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Appendix A – Field Characteristics

Table A1 Field Characteristics of Cropped Fields.

Field	Soil Test P (ppm)	Soil	Slope (%)	Crop Rotation	Years in Rotation	Spring Manure?	Spring Fertilizer P?	Spring Fertilizer N?	Fall Manure?	Fall Fertilizer N?	Buffer type	TMDL Scenario
TMDL Baseline - Permanent Corn, Poorly Drained	N/A	N/A	N/A	Permanent Corn Silage	continuous	No	Yes	Yes	Yes	No	None	N/A
TMDL Baseline - Permanent Corn, Well Drained	N/A	N/A	N/A	Permanent Corn Silage	continuous	Yes	Yes	Yes	Yes	No	None	N/A
TMDL Baseline - Corn/Hay, Poorly Drained	N/A	N/A	N/A	Corn Silage/Hay (Alfalfa - Grass Hay)	2/4	No	Yes	Yes	Yes	Yes	None	N/A
TMDL Baseline - Corn/Hay, Well Drained	N/A	N/A	N/A	Corn Silage/Hay (Alfalfa - Grass Hay)	4/4	Yes	Yes	Yes	Yes	Yes	None	N/A
TMDL Baseline - Permanent Hay, Poorly Drained	N/A	N/A	N/A	Permanent Hay (Perennial Grass - Legume)	continuous	No	No	No	No	Yes	None	N/A
TMDL Baseline - Permanent Hay, Well Drained	N/A	N/A	N/A	Permanent Hay (Perennial Grass - Legume)	continuous	No	No	No	No	Yes	None	N/A
CP3	No Test	B	5.5	Corn Silage/Hay (Perennial Grass-Legume)	3/3	Yes	No	No	No	Yes	Riparian herbaceous	Corn/Hay - WD
CP4	No Test	B	10.8	Corn Silage/Hay (Perennial Grass-Legume)	3/3	Yes	No	No	No	Yes	Riparian herbaceous	Corn/Hay - WD
CP5	2.5	B	6.5	Permanent Hay (Perennial Grass-Legume)	continuous	No	No	No	No	Yes	None	Perm Hay - WD
CP6	0.65	A	5.1	Corn Silage/Hay (Perennial Grass-Legume)	3/3	Yes	No	No	No	Yes	None	Corn/Hay - WD

Field	Soil Test P (ppm)	Soil	Slope (%)	Crop Rotation	Years in Rotation	Spring Manure?	Spring Fertilizer P?	Spring Fertilizer N?	Fall Manure?	Fall Fertilizer N?	Buffer type	TMDL Scenario
CP7	0.65	B	9.2	Permanent Hay (Perennial Grass-Legume)	continuous	No	No	No	No	Yes	None	Perm Hay - WD
G4	4.5	C	9.6	Permanent Hay (Perennial Grass-Legume)	continuous	No	No	No	No	Yes	None	Perm Hay - WD
G5	4.5	C/D	9.5	Permanent Hay (Perennial Grass-Legume)	continuous	No	No	No	No	Yes	None	Perm Hay - WD
GMG1	41.6	B	9.4	Mixed Vegetables	continuous	Yes	No	No	No	No	None	Perm Corn - WD
HB1	1.4	D	7	Permanent Hay (Red Clover)	continuous	No	No	No	No	No	Riparian forested	Perm Hay - WD
HB2	3.7	D	5.3	Permanent Hay (Alfalfa)	continuous	No	No	No	No	Yes	None	Perm Hay - WD
HB5	2	D	2.8	Permanent Hay (Red Clover)	continuous	No	No	No	No	Yes	Riparian forested	Perm Hay - WD
HB6	1.2	D	5.9	Permanent Hay (Alfalfa)	continuous	No	No	No	No	Yes	Riparian forested	Perm Hay - WD
NW2	122	B	4.2	Soybeans/Hay (Perennial Grass - Legume)	2/4	No	Yes	Yes	No	No	Filter strip	Corn/Hay - WD
NW3	42	A/D	1.5	Soybeans/Hay (Perennial Grass - Legume)	2/4	No	Yes	Yes	No	No	Riparian forested	Corn/Hay - WD
NW4	42	B	3.9	Soybeans/Hay (Perennial Grass - Legume)	2/4	No	Yes	Yes	No	No	Riparian forested	Corn/Hay - WD
NW5	31	B	1.3	Corn Silage/Hay (Alfalfa-Timothy Hay)	4/5	Yes	No	Yes	Yes	Yes	Riparian forested	Corn/Hay - WD

Field	Soil Test P (ppm)	Soil	Slope (%)	Crop Rotation	Years in Rotation	Spring Manure?	Spring Fertilizer P?	Spring Fertilizer N?	Fall Manure?	Fall Fertilizer N?	Buffer type	TMDL Scenario
NW6	26	B	1	Permanent Hay (Alfalfa-Timothy Hay)	continuous	No	No	No	No	Yes	Filter strip	Perm Hay - WD
NW7	10	B	1.3	Permanent Corn Silage	continuous	Yes	No	Yes	Yes	No	Filter strip	Perm Corn - WD
SB1	1.7	C/D	12.6	Permanent Hay (Perennial Grass-Legume)	continuous	No	No	No	No	Yes	Filter strip	Perm Hay - WD
BV1	9.2	C	1.5	Permanent Corn Silage	continuous	No	No	Yes	Yes	No	Filter strip	Perm Corn - WD
BV2	4.45	D	1	Permanent Corn Silage	continuous	No	No	Yes	Yes	No	Filter strip	Perm Corn - PD
BV3	3.35	C/D	0.4	Corn Silage/Hay (Alfalfa-Grass Hay)	5/5	Yes	No	Yes	No	Yes	Filter strip	Corn/Hay - PD
BV4	4	D	0.9	Corn Silage/Hay (Alfalfa-Grass Hay)	5/5	No	No	Yes	Yes	Yes	Filter strip	Corn/Hay - PD
BS1	7.1	B	6.6	Permanent Corn Silage	continuous	No	Yes	Yes	Yes	No	Filter strip	Perm Corn - WD
BS2	2.5	D	11.1	Permanent Hay (Alfalfa -Grass Hay)	continuous	No	No	No	No	Yes	Riparian forested	Perm Hay - WD
BS3	2.9	D	9.5	Corn Silage/Hay (Alfalfa-Grass Hay)	1/8	No	Yes	Yes	Yes	Yes	Riparian herbaceous	Corn/Hay - WD
BS4	8.9	D	5.2	Corn Silage/Hay (Alfalfa-Grass Hay)	5/5	No	Yes	Yes	Yes	Yes	Riparian herbaceous	Corn/Hay - WD
BS5	7.9	D	3.4	Permanent Hay (Alfalfa -Grass	continuous	No	No	No	No	Yes	Filter strip	Perm Hay - PD

Field	Soil Test P (ppm)	Soil	Slope (%)	Crop Rotation	Years in Rotation	Spring Manure?	Spring Fertilizer P?	Spring Fertilizer N?	Fall Manure?	Fall Fertilizer N?	Buffer type	TMDL Scenario
				Hay)								
BS6	3.4	D	4.3	Corn Silage/Hay (Alfalfa-Grass Hay)	4/6	No	Yes	Yes	Yes	Yes	Filter strip	Corn/Hay - WD
BS7	3.1	D	1.3	Corn Silage/Hay (Alfalfa-Grass Hay)	7/3	No	Yes	Yes	Yes	Yes	Filter strip	Corn/Hay - PD
BS8	16.8	D	4.4	Corn Silage/Hay (Alfalfa-Grass Hay)	2/7	No	Yes	Yes	Yes	Yes	Filter strip	Corn/Hay - WD
BS9	6	D	3.5	Permanent Corn Silage	continuous	No	Yes	Yes	Yes	No	Filter strip	Perm Corn - PD
BS10	7.8	D	1.9	Permanent Corn Silage	continuous	No	Yes	Yes	Yes	No	Riparian herbaceous	Perm Corn - WD
GMD1	6.5	C/D	5.3	Permanent Corn Silage	continuous	No	Yes	Yes	Yes	No	Filter strip	Perm Corn - PD
GMD2	5.9	C/D	6.7	Permanent Hay (Alfalfa- Grass Hay)	continuous	No	No	No	No	Yes	Filter strip	Perm Hay - PD
GMD3	3.1	B/D	2.2	Permanent Hay (Alfalfa- Grass Hay)	continuous	No	No	No	No	Yes	Filter strip	Perm Hay - WD
GMD4	4.8	C/D	9.2	Permanent Corn Silage	continuous	No	Yes	Yes	Yes	No	Filter strip	Perm Corn - PD
GMD5	5	C/D	5	Permanent Corn Silage	continuous	No	Yes	Yes	Yes	No	None	Perm Corn - PD
GMD6	5	C/D	4.9	Permanent Corn Silage	continuous	No	Yes	Yes	Yes	No	Filter strip	Perm Corn - PD
NM1	9	C	3.8	Permanent Corn Silage	continuous	Yes	No	Yes	Yes	No	Riparian forested	Perm Corn - WD

Field	Soil Test P (ppm)	Soil	Slope (%)	Crop Rotation	Years in Rotation	Spring Manure?	Spring Fertilizer P?	Spring Fertilizer N?	Fall Manure?	Fall Fertilizer N?	Buffer type	TMDL Scenario
NM2	2	C	0.8	Permanent Hay (Alfalfa -Grass Hay)	continuous	No	No	No	No	Yes	Filter strip	Perm Hay - WD
NM3	15	B	2	Permanent Corn Silage	continuous	Yes	No	No	Yes	No	Riparian forested	Perm Corn - WD
NM4	13	B	4.4	Permanent Corn Silage	continuous	Yes	No	Yes	Yes	No	Filter strip	Perm Corn - WD

Table A2 Field Characteristics of Pasture Fields.

Field	Soil Test Phosphorus (ppm)	Soil	Slope (%)	Additional Nitrogen Applied?	Additional Phosphorus Applied?	Estimated Forage Removed per year	Animal Type	Hours Herd is Grazing Field (hours/day)	Total Grazing Time of Field (days/year)[1]	Riparian Forest Buffer
TMDL Baseline - Milk Cows	N/A	N/A	N/A	No	No	N/A[2]	Milk Cows	14	184	No
TMDL Baseline - Beef Cows	N/A	N/A	N/A	No	No	N/A[2]	Beef Cows	22	184	No
TMDL Baseline - Hogs & Pigs	N/A	N/A	N/A	No	No	N/A[2]	Swine	24[3]	0	No
TMDL Baseline - Poultry	N/A	N/A	N/A	No	No	N/A[2]	Poultry	24[3]	0	No
CP1	10.05	B	6.2	Yes	Yes	4	Milk Cows	16	38	Yes
CP2	15.4	A	4.5	Yes	Yes	4	Milk Cows	16	32	No
G1	6.3	C	12	Yes	Yes	2	Milk Cows	20	3	No
G2	6.3	C	14.6	Yes	Yes	2	Milk Cows	20	3	No
G3	3.6	C	19.4	Yes	Yes	2	Milk Cows	20	38	No
GMG2	No Test	D	7.4	No	No	4	Hogs & Pigs	24	14	No
GMG3	No Test	B	12	No	No	4	Poultry	24	14	No
HB3	1.9	D	5.9	Yes	Yes	2.25	Milk Cows	20	38	No
HB4	3.9	D	5.5	Yes	Yes	2.25	Milk Cows	24	38	Yes
NW1	6.7	A/D	5.9	Yes	No	4	Milk Cows	22	45	Yes
PL1	2.5	C	13.8	No	No	4	Milk Cows	22	34	No
SB2	0.7	D	13.6	Yes	Yes	3.6	Beef Cows	24	20	No

*[1]This is the total number of days of grazing (rotation length * number of rotations per season).*
[2]While forage removed was used to calculate a grazing rate for current scenarios, the NRCS handbook was used to establish grazing rates for TMDL scenarios (USDA, 2008).
[3]For the TMDL scenarios involving grazing of poultry and hogs/pigs, 24-hour grazing was assumed.

Appendix B – RSET and APEX Outputs

Table B1 APEX and RSET Results, Surface Phosphorus Loss.

Field	APEX (lbs/ac)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
CP3	0.15	0.45	45.42	30.42	45	101	68
CP4	0.26	0.90	44.08	30.32	45	98	67
CP5	0.06	0.17	74.5	74.5	50	149	149
CP6	0.15	0.07	60.42	30.53	45	134	68
CP7	0.16	0.30	74.5	74.5	45	166	166
G4	0.21	0.34	84.5	84.5	60	141	141
G5	0.38	0.53	84.5	84.5	60	141	141
GMG1	2.76	3.55	-29.75	-4.37	60	-50	-7
HB1	0.92	0.37	94.5	109.5	60	158	183
HB2	0.31	0.28	79.5	94.5	60	133	158
HB5	0.36	0.18	74.5	89.5	60	124	149
HB6	0.38	0.27	74.5	89.5	60	124	149
NW2	0.09	0.49	68.25	45.32	50	137	91
NW3	0.08	0.30	68.25	37.82	50	137	76
NW4	0.09	0.22	78	37.82	50	156	76
NW5	0.15	0.10	74.78	77.82	45	166	173
NW6	0.10	0.05	47	84.5	45	104	188
NW7	0.22	0.53	83.5	101	45	186	224
SB1	0.60	0.73	84.5	89.5	60	141	149
BV1	1.01	1.58	9.13	-6.37	45	20	-14
BV2	1.31	3.69	69.13	33.5	50	138	67
BV3	0.24	0.81	89.82	81.17	45	200	180
BV4	0.88	0.93	82.32	81.17	60	137	135
BS1	1.41	2.80	44.13	-6.37	50	88	-13
BS2	2.92	0.97	104.5	69.5	60	174	116
BS3	0.96	1.28	99.57	77.82	60	166	130
BS4	1.96	1.45	59.82	77.82	60	100	130
BS5	1.48	0.35	67	64.5	60	112	108
BS6	2.80	2.84	99.75	37.82	60	166	63

Field	APEX (lbs/ac)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
BS7	2.38	3.27	97.44	81.17	60	162	135
BS8	1.56	2.27	62.7	37.82	60	105	63
BS9	2.73	17.82	96.63	33.5	60	161	56
BS10	2.68	5.07	54.13	-6.37	60	90	-11
GMD1	1.56	12.04	94.13	33.5	60	157	56
GMD2	0.98	0.45	92	89.5	60	153	149
GMD3	2.12	12.77	94.13	33.5	45	209	74
GMD4	0.22	0.18	97	94.5	60	162	158
GMD5	4.73	13.80	86.63	33.5	50	173	67
GMD6	2.97	11.21	94.13	33.5	50	188	67
NM1	0.46	2.31	46.63	-6.37	45	104	-14
NM2	0.10	0.12	84.5	89.5	45	188	199
NM3	0.36	0.94	51.63	-6.37	45	115	-14
NM4	0.54	1.49	59.13	-6.37	45	131	-14
CP2	0.17	0.27	72	72	45	160	160
G1	5.00	3.56	72	87	60	120	145
G2	6.33	3.90	72	87	60	120	145
G3	5.39	4.54	77	87	60	128	145
GMG2	1.34	1.07	97	87	60	162	145
GMG3	0.18	0.18	97	87	60	162	145
HB3	3.46	3.78	52	87	60	87	145
HB4	3.15	3.78	52	87	60	87	145
NW1	0.53	2.87	97	77	50	194	154
PL1	0.88	3.07	97	87	60	162	145
SB2	3.26	5.36	82	87	60	137	145

Grey rows are pasture fields with grazing.

Table B2 Soluble and Sediment Phosphorus Loss, APEX Outputs.

Field	Current			TMDL		
	Soluble P (lbs/ac)	Sediment P (lbs/ac)	Total P (lbs/ac)	Soluble P (lbs/ac)	Sediment P (lbs/ac)	Total P (lbs/ac)
CP3	0.02	0.13	0.15	0.09	0.35	0.45
CP4	0.02	0.24	0.26	0.12	0.79	0.90
CP5	0.00	0.06	0.06	0.00	0.16	0.17
CP6	0.00	0.15	0.15	0.01	0.06	0.07
CP7	0.00	0.16	0.16	0.01	0.30	0.30
G4	0.04	0.17	0.21	0.04	0.30	0.34
G5	0.06	0.32	0.38	0.06	0.47	0.53
GMG1	0.17	2.59	2.76	0.23	3.31	3.55
HB1	0.04	0.88	0.92	0.02	0.35	0.37
HB2	0.04	0.26	0.31	0.02	0.25	0.28
HB5	0.09	0.28	0.36	0.01	0.17	0.18
HB6	0.10	0.29	0.38	0.03	0.24	0.27
NW2	0.04	0.04	0.09	0.20	0.29	0.49
NW3	0.01	0.07	0.08	0.13	0.17	0.30
NW4	0.02	0.07	0.09	0.09	0.13	0.22
NW5	0.01	0.14	0.15	0.05	0.05	0.10
NW6	0.01	0.09	0.10	0.01	0.04	0.05
NW7	0.01	0.20	0.22	0.05	0.47	0.53
SB1	0.02	0.58	0.60	0.02	0.71	0.73
BV1	0.31	0.70	1.01	0.49	1.09	1.58
BV2	0.54	0.77	1.31	1.20	2.49	3.69
BV3	0.09	0.15	0.24	0.36	0.45	0.81
BV4	0.65	0.23	0.88	0.35	0.58	0.93
BS1	0.22	1.19	1.41	0.23	2.56	2.80
BS2	1.06	1.86	2.92	0.08	0.89	0.97
BS3	0.14	0.82	0.96	0.32	0.96	1.28
BS4	1.17	0.79	1.96	0.51	0.93	1.45
BS5	0.91	0.57	1.48	0.08	0.26	0.35
BS6	0.75	2.05	2.80	0.89	1.94	2.84
BS7	1.00	1.38	2.38	0.90	2.37	3.27
BS8	0.89	0.66	1.56	1.35	0.92	2.27

Field	Current			TMDL		
	Soluble P (lbs/ac)	Sediment P (lbs/ac)	Total P (lbs/ac)	Soluble P (lbs/ac)	Sediment P (lbs/ac)	Total P (lbs/ac)
BS9	0.98	1.75	2.73	2.25	15.56	17.82
BS10	1.49	1.19	2.68	1.49	3.58	5.07
GMD1	0.17	1.40	1.56	0.97	11.07	12.04
GMD2	0.25	0.74	0.98	0.03	0.42	0.45
GMD3	0.33	1.79	2.12	1.19	11.58	12.77
GMD4	0.05	0.18	0.22	0.01	0.17	0.18
GMD5	0.45	4.28	4.73	1.36	12.44	13.80
GMD6	0.24	2.73	2.97	0.97	10.24	11.21
NM1	0.03	0.43	0.46	0.15	2.16	2.31
NM2	0.01	0.10	0.10	0.01	0.11	0.12
NM3	0.03	0.32	0.36	0.12	0.82	0.94
NM4	0.01	0.52	0.54	0.05	1.44	1.49
CP2	0.00	0.16	0.17	0.00	0.27	0.27
G1	0.84	4.15	5.00	0.76	2.80	3.56
G2	0.97	5.36	6.33	0.84	3.06	3.90
G3	0.83	4.56	5.39	0.77	3.78	4.54
GMG2	0.72	0.62	1.34	0.52	0.55	1.07
GMG3	0.03	0.14	0.18	0.09	0.09	0.18
HB3	1.50	1.96	3.46	1.19	2.59	3.78
HB4	1.42	1.73	3.15	1.19	2.59	3.78
NW1	0.04	0.48	0.53	0.88	2.00	2.87
PL1	0.32	0.56	0.88	0.45	2.62	3.07
SB2	0.24	3.01	3.26	0.80	4.56	5.36

Grey rows are pasture fields with grazing.

Table B3 APEX and RSET Results, Surface Nitrogen Loss.

Field	APEX (lbs/ac)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
CP3	1.10	3.43	52.5	31.33	30	175	104
CP4	1.79	5.81	59.5	31.13	30	198	104
CP5	0.56	0.95	72	72	35	206	206
CP6	0.76	0.66	52.5	31.13	30	175	104
CP7	1.46	2.18	72	52	30	240	173
G4	1.70	4.67	82	67	65	126	103
G5	3.12	7.87	82	67	65	126	103
GMG1	14.58	18.58	65.25	20.63	65	100	32
HB1	7.44	5.07	87	102	65	134	157
HB2	3.51	4.60	82	67	65	126	103
HB5	2.19	3.89	72	87	65	111	134
HB6	2.25	4.75	72	87	65	111	134
NW2	0.46	2.03	59.25	31.13	35	169	89
NW3	0.69	5.57	59.25	31.13	35	169	89
NW4	0.58	1.92	80	56.13	35	229	160
NW5	0.53	1.36	112	31.13	30	373	104
NW6	0.17	0.51	80.75	67	30	269	223
NW7	0.62	3.07	74.75	112.25	30	249	374
SB1	3.61	7.42	67	67	65	103	103
BV1	2.87	9.35	85.38	13.63	30	285	45
BV2	6.39	18.39	95.38	43.5	35	273	124
BV3	2.12	6.64	90.75	59.5	30	303	198
BV4	2.84	5.81	90.75	59.5	65	140	92
BS1	5.12	14.48	105.38	13.63	35	301	39
BS2	13.38	12.12	97	72	65	149	111
BS3	7.08	15.00	92	31.13	65	142	48
BS4	4.99	13.06	92	31.13	65	142	48
BS5	6.38	3.91	85.75	82	65	132	126
BS6	13.44	18.68	87	31.13	65	134	48

Field	APEX (lbs/ac)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
BS7	7.77	15.12	85.75	59.5	65	132	92
BS8	3.50	12.13	85.75	31.13	65	132	48
BS9	9.24	62.38	106.63	43.5	65	164	67
BS10	6.94	21.43	115.38	13.63	65	178	21
GMD1	11.25	63.17	100.38	43.5	65	154	67
GMD2	6.36	4.08	90.75	82	65	140	126
GMD3	11.60	55.01	100.38	43.5	30	335	145
GMD4	2.16	5.69	90.75	67	65	140	103
GMD5	28.61	66.71	96.63	43.5	35	276	124
GMD6	20.22	62.11	100.38	43.5	35	287	124
NM1	3.05	17.84	116.63	13.63	30	389	45
NM2	0.62	2.23	87	67	30	290	223
NM3	1.51	5.91	111.63	13.63	30	372	45
NM4	2.21	9.76	120.38	13.63	30	401	45
CP2	0.25	0.64	72	57	30	240	190
G1	7.15	17.25	72	92	65	111	142
G2	9.26	18.87	72	92	65	111	142
G3	11.56	24.12	72	92	65	111	142
GMG2	4.34	7.38	102	92	65	157	142
GMG3	0.83	1.75	102	92	65	157	142
HB3	9.37	16.56	82	92	65	126	142
HB4	7.65	16.53	82	92	65	126	142
NW1	2.84	11.77	72	62	35	206	177
PL1	5.30	16.99	102	92	65	157	142
SB2	14.24	16.21	77	92	65	118	142

Grey rows are pasture fields with grazing.

Table B4 APEX and RSET Results, Sediment in Surface Water.

Field	APEX (t/ac)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
CP3	0.08	0.26	50	70	10	500	700
CP4	0.22	0.71	70	70	10	700	700
CP5	0.04	0.03	70	70	20	350	350
CP6	0.14	0.05	50	70	10	500	700
CP7	0.12	0.10	70	70	10	700	700
G4	0.16	0.12	70	70	40	175	175
G5	0.24	0.19	70	70	40	175	175
GMG1	4.26	4.79	45	47.5	40	112.5	118.75
HB1	1.13	0.09	70	90	40	175	225
HB2	0.16	0.06	70	70	40	175	175
HB5	0.28	0.03	70	90	40	175	225
HB6	0.18	0.07	70	90	40	175	225
NW2	0.02	0.11	65	70	20	325	350
NW3	0.08	0.06	65	70	20	325	350
NW4	0.08	0.08	90	70	20	450	350
NW5	0.07	0.02	90	70	10	900	700
NW6	0.00	0.00	85	70	10	850	700
NW7	0.01	0.30	95	145	10	950	1450
SB1	0.18	0.24	70	70	40	175	175
BV1	0.13	1.11	122.5	27.5	10	1225	275
BV2	0.15	2.11	122.5	10	20	612.5	50
BV3	0.01	0.26	85	70	10	850	700
BV4	0.02	0.38	85	70	40	212.5	175
BS1	0.68	4.05	122.5	27.5	20	612.5	137.5
BS2	0.48	0.26	90	70	40	225	175
BS3	0.56	1.15	90	70	40	225	175
BS4	0.31	0.86	90	70	40	225	175
BS5	0.06	0.05	85	70	40	212.5	175
BS6	0.58	0.80	90	70	40	225	175

Field	APEX (t/ac)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
BS7	0.25	0.99	85	70	40	212.5	175
BS8	0.28	0.66	85	70	40	212.5	175
BS9	0.34	8.88	127.5	10	40	318.75	25
BS10	0.43	3.24	142.5	27.5	40	356.25	68.75
GMD1	0.76	14.74	122.5	10	40	306.25	25
GMD2	0.17	0.13	85	70	40	212.5	175
GMD3	1.10	15.63	122.5	10	10	1225	100
GMD4	0.02	0.03	85	70	40	212.5	175
GMD5	3.54	13.37	107.5	10	20	537.5	50
GMD6	1.97	12.77	122.5	10	20	612.5	50
NM1	0.23	3.46	127.5	27.5	10	1275	275
NM2	0.01	0.01	90	70	10	900	700
NM3	0.08	0.65	127.5	27.5	10	1275	275
NM4	0.16	2.10	142.5	27.5	10	1425	275
CP2	0.00	0.00	100		10	1000	0
G1	0.89	0.94			40	0	0
G2	1.27	1.50			40	0	0
G3	2.07	2.68	70		40	175	0
GMG2	0.17	0.18	100		40	250	0
GMG3	0.06	0.08	100		40	250	0
HB3	0.29	0.63	120		40	300	0
HB4	0.20	0.58	120		40	300	0
NW1	0.10	0.30	120		20	600	0
PL1	0.27	0.88	110		40	275	0
SB2	0.11	1.18	110		40	275	0

Grey rows are pasture fields with grazing.

Table B5 APEX and RSET Results, Soil Carbon.

Field	APEX (% change in soil organic carbon over 30 years in the top 15 cm)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
CP3	-0.26	0.09	45	50	30	150	167
CP4	-0.26	0.09	50	50	30	167	167
CP5	-0.36	-0.10	50	50	35	143	143
CP6	-0.15	0.34	40	50	30	133	167
CP7	-0.14	0.28	50	50	30	167	167
G4	0.15	0.58	50	50	35	143	143
G5	-0.23	0.19	50	50	35	143	143
GMG1	-0.31	-0.22	30	35	35	86	100
HB1	0.08	0.67	50	65	35	143	186
HB2	0.35	0.69	50	50	35	143	143
HB5	0.32	0.64	50	65	35	143	186
HB6	0.42	0.70	50	65	35	143	186
NW2	0.26	0.29	47.5	50	35	136	143
NW3	-0.30	-0.05	47.5	50	35	136	143
NW4	0.17	0.30	65	50	35	186	143
NW5	-0.27	0.01	65	50	30	217	167
NW6	-0.07	0.10	57.5	50	30	192	167
NW7	-0.35	-0.51	42.5	72.5	30	142	242
SB1	0.15	0.10	50	50	35	143	143
BV1	0.12	-0.12	52.5	20	30	175	67
BV2	-0.09	-0.52	52.5	15	35	150	43
BV3	0.22	-0.18	57.5	50	30	192	167
BV4	0.49	0.29	57.5	50	35	164	143
BS1	-0.41	-0.58	52.5		35	150	0
BS2	-0.88	0.32	65	50	35	186	143
BS3	0.40	0.32	60	50	35	171	143
BS4	0.08	0.31	60	50	35	171	143
BS5	-0.69	0.21	57.5	50	35	164	143

Field	APEX (% change in soil organic carbon over 30 years in the top 15 cm)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
BS6	-1.36	-1.28	60	50	35	171	143
BS7	-0.90	-1.27	57.5	50	35	164	143
BS8	0.53	0.32	57.5	50	35	164	143
BS9	-1.61	-1.95	55		35	157	0
BS10	-0.13	-0.31	62.5		35	179	0
GMD1	-0.85	-1.20	52.5		35	150	0
GMD2	-0.46	0.02	57.5	50	35	164	143
GMD3	-0.79	-1.06	52.5	15	30	175	50
GMD4	0.10	0.64	57.5	50	35	164	143
GMD5	-0.55	-1.27	45		35	129	0
GMD6	-0.49	-1.11	52.5		35	150	0
NM1	-0.10	-0.35	60	20	30	200	67
NM2	-0.05	0.20	60	50	30	200	167
NM3	-0.32	-0.45	60	20	30	200	67
NM4	-0.29	-0.43	67.5	20	30	225	67
CP2	0.08	-0.28	68	43	60	113	72
G1	0.49	0.28	66	43	60	110	72
G2	0.46	0.10	56	43	60	93	72
G3	0.32	0.10	53	43	60	88	72
GMG2	1.60	0.06	77	43	60	128	72
GMG3	1.37	0.49	79	43	60	132	72
HB3	0.97	0.48	78	43	60	130	72
HB4	1.05	0.51	78	43	60	130	72
NW1	1.74	-0.40	56	43	60	93	72
PL1	0.67	-0.14	77	43	60	128	72
SB2	1.09	-0.21	80	43	60	133	72

Grey rows are pasture fields with grazing.

Table B6 APEX and RSET Results, Organic Matter Depletion.

Field	APEX (t/ac change in organic matter over 30 years in root zone)		RSET (index score)	
	Current	TMDL	Current	TMDL
CP3	-7.42	0.14	90	100
CP4	-7.51	0.00	100	100
CP5	-3.61	3.53	86	86
CP6	-7.79	0.17	80	100
CP7	-2.59	6.38	100	100
G4	-6.44	0.70	86	86
G5	-0.74	7.09	86	86
GMG1	-13.07	-9.57	35	60
HB1	4.05	21.84	100	86
HB2	11.39	22.25	86	86
HB5	8.89	21.10	100	86
HB6	11.94	22.59	100	
NW2	-1.68	0.23	82	86
NW3	-6.32	-2.85	82	86
NW4	-3.06	1.06	100	86
NW5	-18.59	-13.14	100	100
NW6	-14.74	-8.78	100	100
NW7	-19.65	-24.90	85	40
SB1	6.05	5.56	100	86
BV1	3.89	0.77	100	40
BV2	1.90	-7.40	90	26
BV3	6.06	-4.31	100	100
BV4	12.54	6.19	99	86
BS1	-6.16	-10.67	90	0
BS2	-3.88	11.19	100	86
BS3	14.05	10.66	100	86
BS4	4.77	10.35	100	86
BS5	-8.10	9.42	99	86

Field	APEX (t/ac change in organic matter over 30 years in root zone)		RSET (index score)	
	Current	TMDL	Current	TMDL
BS6	-9.80	-16.31		
BS7	-10.44	-19.02	99	86
BS8	16.32	10.17	99	86
BS9	-13.35	-34.91		
BS10	0.25	-4.93	100	0
GMD1	-5.66	-24.30	90	0
GMD2	-5.91	4.50	99	86
GMD3	-5.39	-18.93	100	30
GMD4	0.45	10.42	99	86
GMD5	-10.08	-28.61	78	0
GMD6	-14.03	-35.12	90	0
NM1	-11.87	-18.75	100	40
NM2	-9.97	-3.68	100	100
NM3	-7.48	-12.03	100	40
NM4	-2.54	-7.89	100	40
CP2	1.90	-8.01	68	43
G1	-1.36	-5.98	66	43
G2	-1.60	-8.69	56	43
G3	-3.91	-8.84	53	43
GMG2	27.64	-3.76	77	43
GMG3	25.34	3.20	79	43
HB3	25.45	12.13	78	43
HB4	25.80	13.07	78	43
NW1	33.56	-5.01	56	43
PL1	7.90	-6.82	77	43
SB2	23.51	-5.85	80	43

Grey rows are pasture fields with grazing.

Table B7 APEX and RSET Results, Water Erosion.

Field	APEX[1] (t/ac)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
CP3	0.08	0.30	50	72.81	10	500	728
CP4	0.22	0.80	70	73.75	10	700	738
CP5	0.04	0.03	70	70	20	350	350
CP6	0.14	0.05	50	71.88	20	250	359
CP7	0.12	0.10	70	70	20	350	350
G4	0.44	0.12	70	70	40	175	175
G5	0.59	0.19	70	70	40	175	175
GMG1	4.26	4.79	45	47.5	20	225	238
HB1	1.13	0.10	70	70	30	233	233
HB2	0.16	0.06	70	70	30	233	233
HB5	0.28	0.03	70	70	30	233	233
HB6	0.18	0.07	70	70	30	233	233
NW2	0.02	0.12	45	73.75	10	450	738
NW3	0.08	0.06	45	73.75	10	450	738
NW4	0.08	0.09	80	73.75	10	800	738
NW5	0.07	0.02	91.11	73.75	10	911	738
NW6	0.00	0.00	70	70	10	700	700
NW7	0.01	0.30	60	110	10	600	1100
SB1	0.25	0.24	70	70	40,20	175	350
BV1	0.13	1.11	107.5	27.5	20	538	138
BV2	0.15	2.11	107.5	10	10	1075	100
BV3	0.01	0.27	93.75	70	10	938	700
BV4	0.02	0.39	93.75	70	10	938	700
BS1	0.68	4.05	107.5	27.5	40	269	69
BS2	0.82	0.26	70	70	30	233	233
BS3	0.64	1.19	75.28	73.75	30	251	246
BS4	0.32	0.89	93.75	73.75	30	313	246
BS5	0.09	0.05	70	70	10	700	700
BS6	0.61	0.83	89	73.75	10	890	738

Field	APEX[1] (t/ac)		RSET (index score)				
	Current	TMDL	Current	TMDL	Threshold	Percent Relative to Threshold, Current	Percent Relative to Threshold, TMDL
BS7	0.26	1.01	103.25	70	10	1033	700
BS8	0.32	0.68	80.56	73.75	40	201	184
BS9	0.34	8.88	107.5	10	30	358	33
BS10	0.43	3.24	107.5	27.5	40	269	69
GMD1	0.76	14.74	107.5	10	20	538	50
GMD2	0.27	0.13	70	70	30	233	233
GMD3	1.10	15.63	107.5	10	10	1075	100
GMD4	0.03	0.03	70	70	20	350	350
GMD5	3.54	13.37	107.5	10	40	269	25
GMD6	1.97	12.77	107.5	10	20	538	50
NM1	0.23	3.46	107.5	27.5	10	1075	275
NM2	0.01	0.01	70	70	10	700	700
NM3	0.08	0.65	107.5	27.5	10	1075	275
NM4	0.16	2.10	107.5	27.5	10	1075	275
CP2	0.00	0.00	68	43	60	113	72
G1	0.89	0.90	66	43	60	110	72
G2	1.27	1.47	56	43	60	93	72
G3	2.07	2.63	53	43	60	88	72
GMG2	0.17	0.18	77	43	60	128	72
GMG3	0.06	0.08	79	43	60	132	72
HB3	0.29	0.62	78	43	60	130	72
HB4	0.20	0.57	78	43	60	130	72
NW1	0.10	0.29	56	43	60	93	72
PL1	0.27	0.87	77	43	60	128	72
SB2	0.11	1.14	80	43	60	133	72

Grey rows are pasture fields with grazing.

[1]Note the APEX output is the same as that for Sediment in Surface Water.

Table B8 *APEX and RSET Results, Sheet and Rill Erosion.*

Field	APEX[1] (t/ac)		RSET (index score)	
	Current	TMDL	Current	TMDL
CP3	0.08	0.30	100	100
CP4	0.22	0.80	100	100
CP5	0.04	0.03	100	100
CP6	0.14	0.05	100	100
CP7	0.12	0.10	100	100
G4	0.44	0.12	100	100
G5	0.59	0.19	100	100
GMG1	4.26	4.79	100	100
HB1	1.13	0.10	100	100
HB2	0.16	0.06	100	100
HB5	0.28	0.03	100	100
HB6	0.18	0.07	100	
NW2	0.02	0.12	100	100
NW3	0.08	0.06	100	100
NW4	0.08	0.09	100	100
NW5	0.07	0.02	100	100
NW6	0.00	0.00	100	100
NW7	0.01	0.30	100	100
SB1	0.25	0.24	100	100
BV1	0.13	1.11	100	83
BV2	0.15	2.11	100	60
BV3	0.01	0.27	100	100
BV4	0.02	0.39	100	100
BS1	0.68	4.05	100	42
BS2	0.82	0.26	100	100
BS3	0.64	1.19	100	100
BS4	0.32	0.89	100	100
BS5	0.09	0.05	100	100
BS6	0.61	0.83		
BS7	0.26	1.01	100	100
BS8	0.32	0.68	100	100

Field	APEX[1] (t/ac)		RSET (index score)	
	Current	TMDL	Current	TMDL
BS9	0.34	8.88	100	20
BS10	0.43	3.24	100	42
GMD1	0.76	14.74	100	30
GMD2	0.27	0.13	100	100
GMD3	1.10	15.63	100	60
GMD4	0.03	0.03	100	100
GMD5	3.54	13.37	100	15
GMD6	1.97	12.77	100	30
NM1	0.23	3.46	100	100
NM2	0.01	0.01	100	100
NM3	0.08	0.65	100	100
NM4	0.16	2.10	100	100
CP2	0.00	0.00	68	43
G1	0.89	0.90	66	43
G2	1.27	1.47	56	43
G3	2.07	2.63	53	43
GMG2	0.17	0.18	77	43
GMG3	0.06	0.08	79	43
HB3	0.29	0.62	78	43
HB4	0.20	0.57	78	43
NW1	0.10	0.29	56	43
PL1	0.27	0.87	77	43
SB2	0.11	1.14	43	60

Grey rows are pasture fields with grazing.

[1]Note the APEX output is the same as that for Sediment in Surface Water.

Appendix C – Threshold Congruency Results by Field Scenario

Table C1 APEX RSET Congruency Test Results by Field Scenario.

Field	Surface Phosphorus Loss	Surface Nitrogen Loss	Sediment in Surface Water	Soil Carbon (Change in)
CP3	Congruent	Congruent	Congruent	Not Congruent
CP4	Not Congruent	Congruent	Congruent	Not Congruent
CP5	Congruent	Congruent	Congruent	Not Congruent
CP6	Congruent	Congruent	Congruent	Not Congruent
CP7	Congruent	Congruent	Congruent	Not Congruent
G4	Congruent	Congruent	Congruent	Congruent
G5	Congruent	Congruent	Congruent	Not Congruent
GMG1	Not Congruent	Congruent	Not Congruent	Congruent
HB1	Congruent	Congruent	Congruent	Congruent
HB2	Congruent	Congruent	Congruent	Congruent
HB5	Congruent	Congruent	Congruent	Congruent
HB6	Congruent	Congruent	Congruent	Congruent
NW2	Congruent	Congruent	Congruent	Congruent
NW3	Congruent	Congruent	Congruent	Not Congruent
NW4	Congruent	Congruent	Congruent	Congruent
NW5	Congruent	Congruent	Congruent	Not Congruent
NW6	Congruent	Congruent	Congruent	Not Congruent
NW7	Congruent	Congruent	Congruent	Not Congruent
SB1	Congruent	Congruent	Congruent	Congruent
BV1	Not Congruent	Congruent	Congruent	Congruent
BV2	Congruent	Congruent	Congruent	Not Congruent
BV3	Congruent	Congruent	Congruent	Congruent
BV4	Congruent	Congruent	Congruent	Congruent
BS1	Not Congruent	Congruent	Congruent	Not Congruent
BS2	Congruent	Congruent	Congruent	Not Congruent
BS3	Congruent	Congruent	Congruent	Congruent
BS4	Not Congruent	Congruent	Congruent	Congruent
BS5	Congruent	Congruent	Congruent	Not Congruent
BS6	Congruent	Congruent	Congruent	Not Congruent
BS7	Congruent	Congruent	Congruent	Not Congruent
BS8	Congruent	Congruent	Congruent	Congruent
BS9	Congruent	Congruent	Congruent	Not Congruent
BS10	Not Congruent	Congruent	Congruent	Not Congruent
GMD1	Congruent	Congruent	Congruent	Not Congruent
GMD2	Congruent	Congruent	Congruent	Not Congruent
GMD3	Congruent	Congruent	Congruent	Not Congruent
GMD4	Congruent	Congruent	Congruent	Congruent
GMD5	Not Congruent	Not Congruent	Not Congruent	Not Congruent
GMD6	Congruent	Not Congruent	Congruent	Not Congruent

Field	Surface Phosphorus Loss	Surface Nitrogen Loss	Sediment in Surface Water	Soil Carbon (Change in)
NM1	Congruent	Congruent	Congruent	Not Congruent
NM2	Congruent	Congruent	Congruent	Not Congruent
NM3	Congruent	Congruent	Congruent	Not Congruent
NM4	Congruent	Congruent	Congruent	Not Congruent
CP2	Congruent	Congruent	Congruent	Congruent
G1	Not Congruent	Congruent	nan	Congruent
G2	Not Congruent	Congruent	nan	Not Congruent
G3	Not Congruent	Congruent	Not Congruent	Not Congruent
GMG2	Congruent	Congruent	Congruent	Congruent
GMG3	Congruent	Congruent	Congruent	Congruent
HB3	Congruent	Congruent	Congruent	Congruent
HB4	Congruent	Congruent	Congruent	Congruent
NW1	Congruent	Congruent	Congruent	Not Congruent
PL1	Congruent	Congruent	Congruent	Congruent
SB2	Not Congruent	Congruent	Congruent	Congruent
CP3_TMDL	Not Congruent	Congruent	Congruent	Congruent
CP4_TMDL	Not Congruent	Congruent	Congruent	Congruent
CP5_TMDL	Congruent	Congruent	Congruent	Not Congruent
CP6_TMDL	Not Congruent	Congruent	Congruent	Congruent
CP7_TMDL	Congruent	Congruent	Congruent	Congruent
G4_TMDL	Congruent	Congruent	Congruent	Congruent
G5_TMDL	Congruent	Congruent	Congruent	Congruent
GMG1_TMDL	Congruent	Congruent	Not Congruent	Congruent
HB1_TMDL	Congruent	Congruent	Congruent	Congruent
HB2_TMDL	Congruent	Congruent	Congruent	Congruent
HB5_TMDL	Congruent	Congruent	Congruent	Congruent
HB6_TMDL	Congruent	Congruent	Congruent	Congruent
NW2_TMDL	Not Congruent	Not Congruent	Congruent	Congruent
NW3_TMDL	Not Congruent	Not Congruent	Congruent	Not Congruent
NW4_TMDL	Not Congruent	Congruent	Congruent	Congruent
NW5_TMDL	Congruent	Congruent	Congruent	Congruent
NW6_TMDL	Congruent	Congruent	Congruent	Congruent
NW7_TMDL	Congruent	Congruent	Congruent	Not Congruent
SB1_TMDL	Congruent	Congruent	Congruent	Congruent
BV1_TMDL	Not Congruent	Not Congruent	Congruent	Congruent
BV2_TMDL	Congruent	Not Congruent	Congruent	Congruent
BV3_TMDL	Congruent	Congruent	Congruent	Not Congruent
BV4_TMDL	Congruent	Not Congruent	Congruent	Congruent
BS1_TMDL	Not Congruent	Not Congruent	Not Congruent	nan
BS2_TMDL	Congruent	Congruent	Congruent	Congruent

Field	Surface Phosphorus Loss	Surface Nitrogen Loss	Sediment in Surface Water	Soil Carbon (Change in)
BS3_TMDL	Congruent	Congruent	Congruent	Congruent
BS4_TMDL	Congruent	Not Congruent	Congruent	Congruent
BS5_TMDL	Congruent	Congruent	Congruent	Congruent
BS6_TMDL	Not Congruent	Congruent	Congruent	Not Congruent
BS7_TMDL	Not Congruent	Congruent	Congruent	Not Congruent
BS8_TMDL	Not Congruent	Not Congruent	Congruent	Congruent
BS9_TMDL	Congruent	Congruent	Congruent	nan
BS10_TMDL	Congruent	Congruent	Congruent	nan
GMD1_TMDL	Congruent	Congruent	Congruent	nan
GMD2_TMDL	Congruent	Congruent	Congruent	Congruent
GMD3_TMDL	Congruent	Not Congruent	Congruent	Congruent
GMD4_TMDL	Congruent	Congruent	Congruent	Congruent
GMD5_TMDL	Congruent	Not Congruent	Congruent	nan
GMD6_TMDL	Congruent	Not Congruent	Congruent	nan
NM1_TMDL	Not Congruent	Congruent	Not Congruent	Congruent
NM2_TMDL	Congruent	Congruent	Congruent	Congruent
NM3_TMDL	Not Congruent	Not Congruent	Congruent	Congruent
NM4_TMDL	Not Congruent	Not Congruent	Not Congruent	Congruent
CP2_TMDL	Congruent	Congruent	nan	Congruent
G1_TMDL	Not Congruent	Not Congruent	nan	Not Congruent
G2_TMDL	Not Congruent	Not Congruent	nan	Not Congruent
G3_TMDL	Not Congruent	Not Congruent	nan	Not Congruent
GMG2_TMDL	Congruent	Congruent	nan	Not Congruent
GMG3_TMDL	Congruent	Congruent	nan	Not Congruent
HB3_TMDL	Not Congruent	Not Congruent	nan	Not Congruent
HB4_TMDL	Not Congruent	Not Congruent	nan	Not Congruent
NW1_TMDL	Congruent	Congruent	nan	Congruent
PL1_TMDL	Not Congruent	Not Congruent	nan	Congruent
SB2_TMDL	Not Congruent	Not Congruent	nan	Congruent

Grey rows are pasture fields with grazing.

Appendix D – Directional Congruency Results by Field

Table D1Results of Directional Tests for Each Field.

Field	Change in Surface Phosphorus Output (Current-TMDL)		Change in Surface Nitrogen Output (Current-TMDL)		Change in Sediment in Surface Water Output (Current-TMDL)		Change in Soil Carbon Output (Current-TMDL)		Change in Organic Matter Output (Current-TMDL)	
	APEX	RSET	APEX	RSET	APEX	RSET	APEX	RSET	APEX	RSET
CP3	-0.29	33	-2.33	71	-0.18	-200	-0.35	-17	-7.56	-10
CP4	-0.64	31	-4.02	95	-0.49	0	-0.35	0	-7.51	0
CP5	-0.11	0	-0.38	0	0.01	0	-0.26	0	-7.14	0
CP6	0.08	66	0.10	71	0.10	-200	-0.49	-33	-7.96	-20
CP7	-0.14	0	-0.72	67	0.02	0	-0.42	0	-8.97	0
G4	-0.13	0	-2.97	23	0.04	0	-0.43	0	-7.14	0
G5	-0.16	0	-4.75	23	0.06	0	-0.42	0	-7.83	0
GMG1	-0.79	-42	-4.00	69	-0.53	-6	-0.09	-14	-3.49	-25
HB1	0.55	-25	2.37	-23	1.04	-50	-0.59	-43	-17.79	14
HB2	0.03	-25	-1.09	23	0.10	0	-0.34	0	-10.86	0
HB5	0.18	-25	-1.70	-23	0.25	-50	-0.32	-43	-12.20	14
HB6	0.11	-25	-2.50	-23	0.11	-50	-0.28	-43	-10.65	100
NW2	-0.41	46	-1.57	80	-0.10	-25	-0.03	-7	-1.91	-4
NW3	-0.22	61	-4.88	80	0.03	-25	-0.25	-7	-3.47	-4
NW4	-0.13	80	-1.34	68	0.00	100	-0.13	43	-4.12	14
NW5	0.06	-7	-0.83	270	0.05	200	-0.28	50	-5.45	0
NW6	0.05	-83	-0.34	46	0.00	150	-0.17	25	-5.96	0
NW7	-0.31	-39	-2.45	-125	-0.28	-500	0.16	-100	5.25	45

Field	Change in Surface Phosphorus Output (Current-TMDL)		Change in Surface Nitrogen Output (Current-TMDL)		Change in Sediment in Surface Water Output (Current-TMDL)		Change in Soil Carbon Output (Current-TMDL)		Change in Organic Matter Output (Current-TMDL)	
	APEX	RSET	APEX	RSET	APEX	RSET	APEX	RSET	APEX	RSET
SB1	-0.13	-8	-3.81	0	-0.06	0	0.05	0	0.49	14
BV1	-0.57	34	-6.49	239	-0.98	950	0.24	108	3.12	60
BV2	-2.38	71	-12.00	148	-1.96	563	0.43	107	9.30	64
BV3	-0.57	19	-4.52	104	-0.25	150	0.40	25	10.37	0
BV4	-0.05	2	-2.98	48	-0.36	38	0.20	21	6.35	13
BS1	-1.38	101	-9.36	262	-3.37	475	0.17	150	4.50	90
BS2	1.95	58	1.26	38	0.22	50	-1.20	43	-15.07	14
BS3	-0.33	36	-7.92	94	-0.59	50	0.08	29	3.39	14
BS4	0.51	-30	-8.06	94	-0.55	50	-0.23	29	-5.58	14
BS5	1.13	4	2.47	6	0.01	38	-0.90	21	-17.52	13
BS6	-0.04	103	-5.24	86	-0.21	50	-0.08	29	6.51	0
BS7	-0.89	27	-7.35	40	-0.74	38	0.37	21	8.58	13
BS8	-0.71	41	-8.63	84	-0.38	38	0.21	21	6.15	13
BS9	-15.08	105	-53.14	97	-8.55	294	0.34	157	21.56	0
BS10	-2.38	101	-14.49	157	-2.81	288	0.18	179	5.18	100
GMD1	-10.48	101	-51.92	88	-13.98	281	0.35	150	18.63	90
GMD2	0.53	4	2.28	13	0.04	38	-0.48	21	-10.42	13
GMD3	-10.65	135	-43.41	190	-14.53	1125	0.27	125	13.55	70
GMD4	0.04	4	-3.52	37	-0.01	38	-0.54	21	-9.98	13

Field	Change in Surface Phosphorus Output (Current-TMDL)		Change in Surface Nitrogen Output (Current-TMDL)		Change in Sediment in Surface Water Output (Current-TMDL)		Change in Soil Carbon Output (Current-TMDL)		Change in Organic Matter Output (Current-TMDL)	
	APEX	RSET	APEX	RSET	APEX	RSET	APEX	RSET	APEX	RSET
GMD5	-9.07	106	-38.10	152	-9.83	488	0.72	129	18.52	78
GMD6	-8.24	121	-41.89	163	-10.81	563	0.62	150	21.09	90
NM1	-1.86	118	-14.79	343	-3.22	1000	0.25	133	6.89	60
NM2	-0.01	-11	-1.61	67	0.00	200	-0.25	33	-6.30	0
NM3	-0.58	129	-4.40	327	-0.57	1000	0.13	133	4.55	60
NM4	-0.95	146	-7.55	356	-1.94	1150	0.14	158	5.35	60
CP2	-0.11	0	-0.40	50	0.00	1000	0.36	42	9.91	25
G1	1.44	-25	-10.10	-31	-0.05	0	0.21	38	4.62	23
G2	2.43	-25	-9.61	-31	-0.22	0	0.36	22	7.09	13
G3	0.85	-17	-12.55	-31	-0.61	175	0.22	17	4.93	10
GMG2	0.28	17	-3.04	15	-0.02	250	1.54	57	31.40	34
GMG3	-0.01	17	-0.92	15	-0.02	250	0.88	60	22.14	36
HB3	-0.32	-58	-7.19	-15	-0.34	300	0.49	58	13.31	35
HB4	-0.63	-58	-8.88	-15	-0.38	300	0.54	58	12.74	35
NW1	-2.35	40	-8.93	29	-0.20	600	2.14	22	38.57	13
PL1	-2.19	17	-11.69	15	-0.61	275	0.81	57	14.72	34
SB2	-2.10	-8	-1.96	-23	-1.06	275	1.30	62	29.36	37

Grey rows are pasture fields with grazing.

RSET results presented here are the difference in percent of relative threshold, except for organic matter, which is the difference in the RSET score directly (no threshold was available for organic matter.

Table D2Results of Directional Tests for Each Field.

Field	Surface Phosphorus Loss		Surface Nitrogen Loss		Sediment in Surface Water		Soil Carbon		Organic Matter	
	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent
CP3	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent
CP4	Congruent	Congruent	Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent
CP5	Not Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent
CP6	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
CP7	Not Congruent	Congruent	Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent
G4	Not Congruent	Congruent	Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent
G5	Not Congruent	Congruent	Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent
GMG1	Not Congruent	Not Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent
HB1	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent
HB2	Congruent	Congruent	Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent
HB5	Congruent	Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent
HB6	Congruent	Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent
NW2	Congruent	Congruent	Congruent	Congruent	Not	Not	Congruent	Congruent	Congruent	Congruent

Field	Surface Phosphorus Loss		Surface Nitrogen Loss		Sediment in Surface Water		Soil Carbon		Organic Matter	
	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent
					Congruent	Congruent				
NW3	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
NW4	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent
NW5	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent
NW6	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent
NW7	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent	Congruent
SB1	Not Congruent	Not Congruent	Not Congruent	Congruent	Not Congruent	Congruent	Not Congruent	Congruent	Congruent	Congruent
BV1	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
BV2	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
BV3	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Not Congruent	Congruent
BV4	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
BS1	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
BS2	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent
BS3	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
BS4	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent
BS5	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent

Field	Surface Phosphorus Loss		Surface Nitrogen Loss		Sediment in Surface Water		Soil Carbon		Organic Matter	
	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent
BS6	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent
BS7	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
BS8	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
BS9	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Not Congruent	Congruent
BS10	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
GMD1	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
GMD2	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent
GMD3	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
GMD4	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent
GMD5	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
GMD6	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
NM1	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
NM2	Not Congruent	Not Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent
NM3	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
NM4	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
CP2	Not Congruent	Congruent	Congruent	Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent
G1	Congruent	Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Congruent

Field	Surface Phosphorus Loss		Surface Nitrogen Loss		Sediment in Surface Water		Soil Carbon		Organic Matter	
	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent	Result of Original Directional Agreement Test	Result of Test Assuming No Change in RSET Score = Congruent
G2	Congruent	Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
G3	Congruent	Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
GMG2	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
GMG3	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
HB3	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
HB4	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
NW1	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
PL1	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent
SB2	Not Congruent	Not Congruent	Not Congruent	Not Congruent	Congruent	Congruent	Congruent	Congruent	Congruent	Congruent

Grey rows are pasture fields with grazing.