Resource Assessment and
Watershed Level Plan for Agriculture in the
McKenzie Brook Watershed,
Addison County, Vermont

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Vermont

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Background and Purpose of Plan

These watershed plans were developed by NRCS in Vermont to address the need for more effective practice implementation of conservation plans on agricultural lands in the Lake Champlain Basin. Past conservation practice implementation efforts have been broad in scope and have not resulted in any significant improvements in water quality. In response to the pending new phosphorus TMDL for Lake Champlain and due to the availability of increased NRCS funding for the next five years, NRCS in Vermont has decided to use a more strategic and focused process for conservation practice implementation. Under this new process NRCS will collaborate with the Vermont Department of Environmental Conservation (VTDEC) to contribute information to the agricultural sections of Tactical Basin Plans (TBP's). These agricultural watershed plans will provide a comprehensive inventory of land use and resource conditions in each of the targeted watersheds. This information will then be used by local NRCS staff and partners working in each watershed to identify and target specific farms and fields for further resource assessment and for the development of practice alternatives.

Local Watershed Teams will be initially established by NRCS in each watershed, but eventually they will be directed by an appropriate local partner to bring all agricultural partners together to work in a coordinated and strategic effort. The Local Watershed Teams will determine the length of the project for each watershed and what amount of phosphorus reduction they would like to achieve during that time period. These Teams will also identify objectives to meet their goals and a detailed action plan supporting these objectives. The timeline and amount of practice implementation may be determined to some extent by the amount of funds likely to be available and the staff available to implement the Local Watershed Team Action Plan.

These watershed plans will also include the results of an analysis to establish phosphorus reduction goals (in lbs/yr) for each of the targeted watersheds using existing EPA tools such as the EPA HUC-12 Tool for the Lake Champlain Basin. The percent reduction in phosphorus load identified by EPA for the larger HUC-8 watershed will be used to calculate the required phosphorus load reduction for each HUC-12 watershed. Currently, EPA has proposed phosphorus reduction goals for our four targeted watersheds that range from 35 to 83 percent, although at this time the TMDL is not finalized and these reduction goals could still change.

Based on the required reduction for each of the targeted watersheds, an example conservation practice scenario will be developed. This scenario will include a suite of individual practices, and systems of practices, that when implemented will reduce phosphorus loading from the agricultural lands by the required amount for each of the targeted watersheds. The new EPA Scenario Tool will be used to develop this example suite of practices that meet the TMDL goal for agriculture in each of the watersheds. The Local Watershed Teams will modify this list of selected practices and the amount applied based on their more detailed assessment of the watershed and their locally developed goals. The amount of estimated phosphorus reduction from implemented practices will be tracked on an annual basis. It is important to note that the phosphorus reduction amounts achieved by these specific practices are an estimate based on some fairly general modeling assumptions. These modeled loading reductions can be helpful in establishing goals for a watershed and for the tracking of progress. However, these numbers are not necessarily accurate in a way that they could be used for regulatory purposes.

Resource Inventories

A variety of watershed land and farm assessments were undertaken in order to provide resource condition information on a watershed scale to the Local Watershed Teams, NRCS staff and partners. These various data layers can be used individually or in combination with each other to help the Local Watershed Teams and conservation planners to target areas for further on the ground assessment and then if appropriate, conservation practice implementation. Due to the large extent of information that could be potentially developed and the short time frame in which the data is needed, we have prioritized the development of the data layers to some extent based on feedback from local NRCS staff.

For each data layer a short narrative will describe the data set, briefly how it was generated, show a watershed wide map of the data, a more detailed example map, and some tabular or graphical summary data when appropriate. Suggestions will also be provided how this data layer might be used in conjunction with other data layers. All applicable NRCS offices will be provided GIS based electronic files of each data layer for them to use in their more detailed assessments.

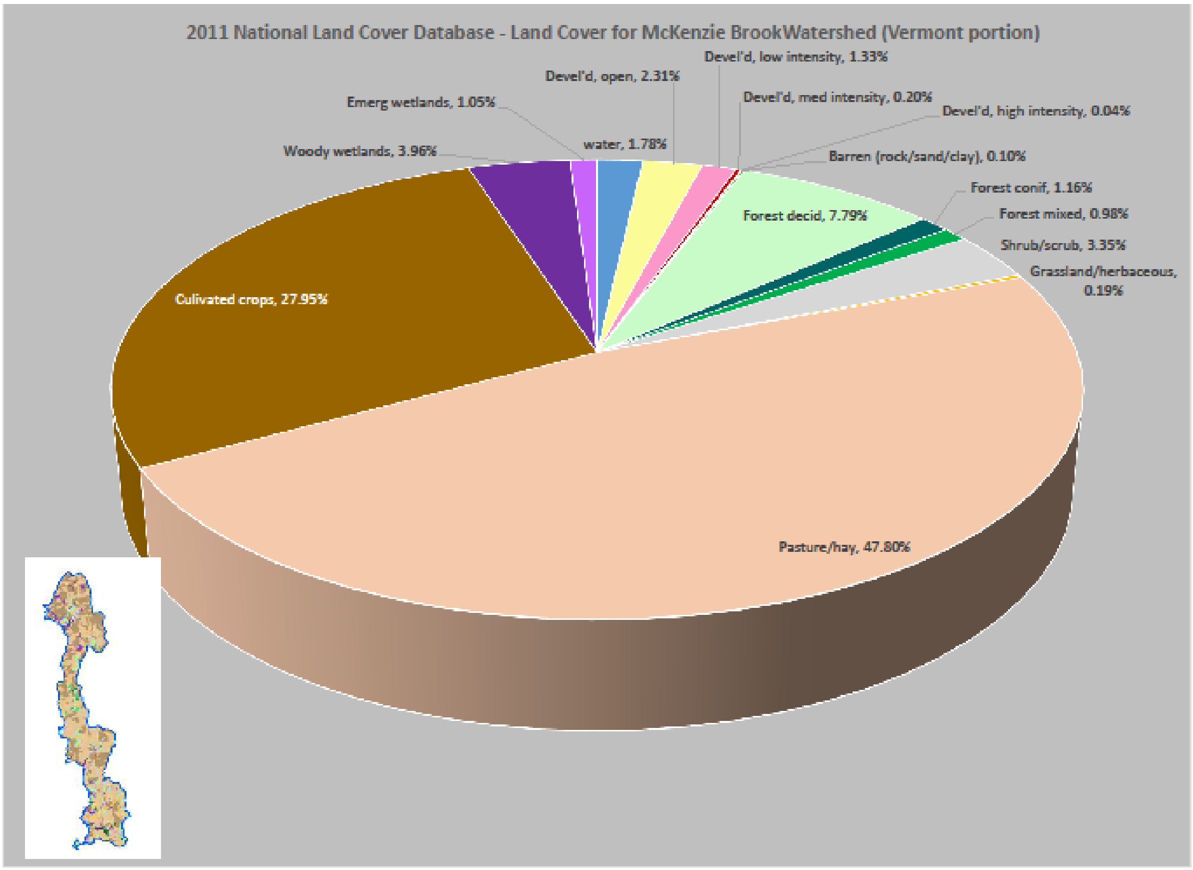
Watershed Overview

The McKenzie Brook Watershed is located in southwestern Addison County Vermont. Since McKenzie Brook is a lake direct HUC-12 it includes drainage areas on the New York side of the Lake (including McKenzie Brook). There are two major tributaries that drain into Lake Champlain on the Vermont side: Hospital Creek and Whitney Creek. On the Vermont side the watershed extends from Hospital Creek in the north to, but not including, East Creek in the south. The total watershed area in Vermont is 21,221 acres. The area of the Lake that the McKenzie Brook Watershed drains to (South Lake A) has some of the highest total phosphorus concentrations of any Lake segment. The phosphorus target for this section of Lake is 25 ug/l.

Figure 1 – Map of the McKenzie Brook Watershed

The McKenzie Brook Watershed is very rural with a significant amount of land in agriculture. Data from the National Cropland Database (NCD 2011, Figure 2) estimates that 28% of the watershed is in annual cropland and 48% is in pasture or hayland, for a total of 76% in agriculture. Only about 10% of the watershed is forested and about 5.5% of the watershed is in a developed use. The McKenzie Brook watershed is probably one of the most intensive agricultural watersheds in Vermont.

Figure 2 – Landcover in the McKenzie Brook Watershed, 2011 NCD



<u>Farmsteads</u>

The Farmstead Maps show the location of each active farmstead within the McKenzie Brook Watershed. The identification of farmsteads was conducted by visual interpretation of the 2014 NAIP imagery. Farmstead boundaries were based on the visual identification of structures and heavily disturbed ground surface. As can be seen in Figure 3, there were a total of 47 active farmsteads identified in the McKenzie Brook Watershed in 2014. There is one LFO in the watershed, 10 of the farms are MFOs' and the remaining 33 farmsteads are small farms. These maps can be used to ensure that all farmsteads in the watershed are reviewed on the ground for potential waste management issues and to help identify farmsteads with potential resource concerns such as improperly constructed and/or maintained heavy use areas.

Figure 3 – Farmstead Locations in the McKenzie Brook Watershed

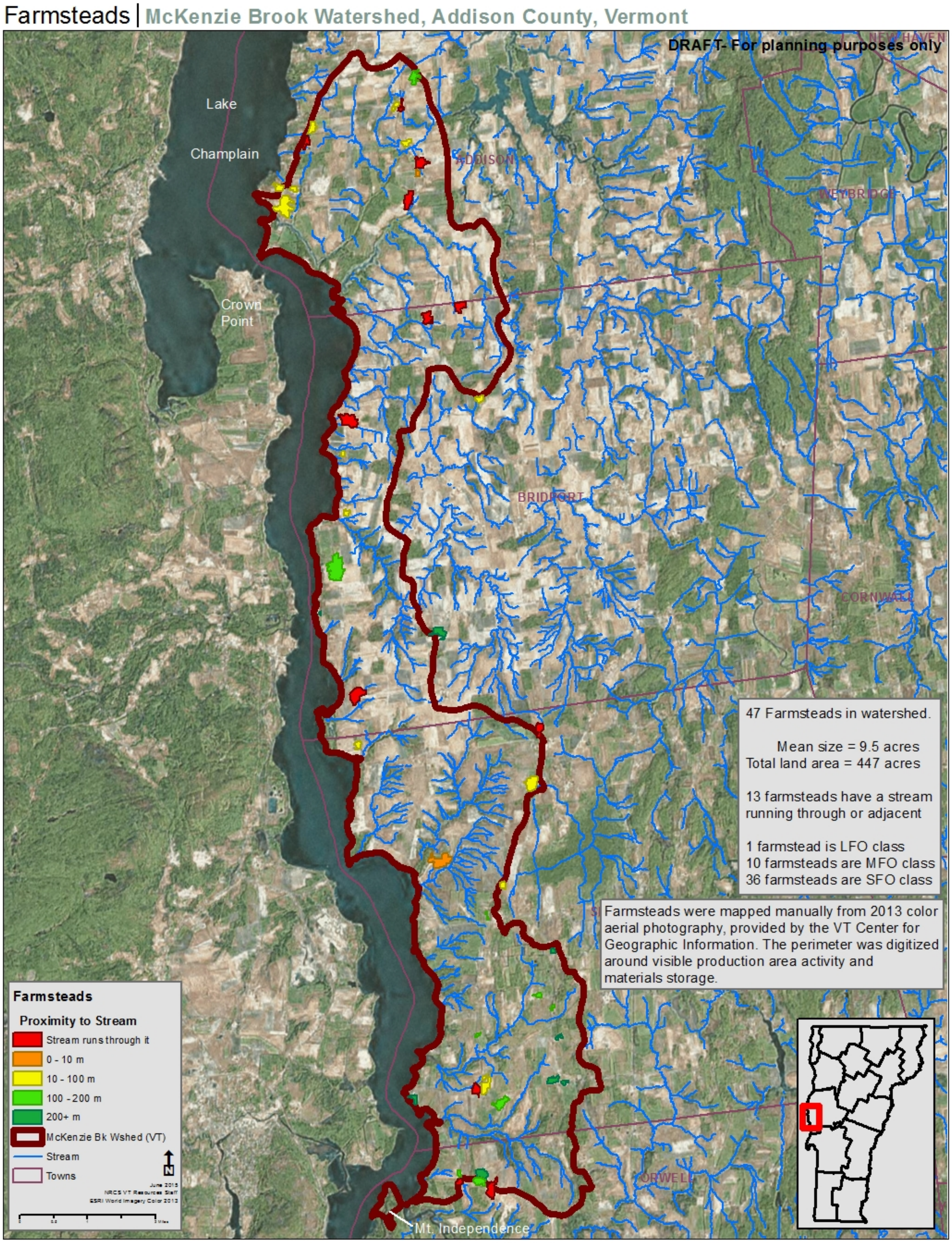
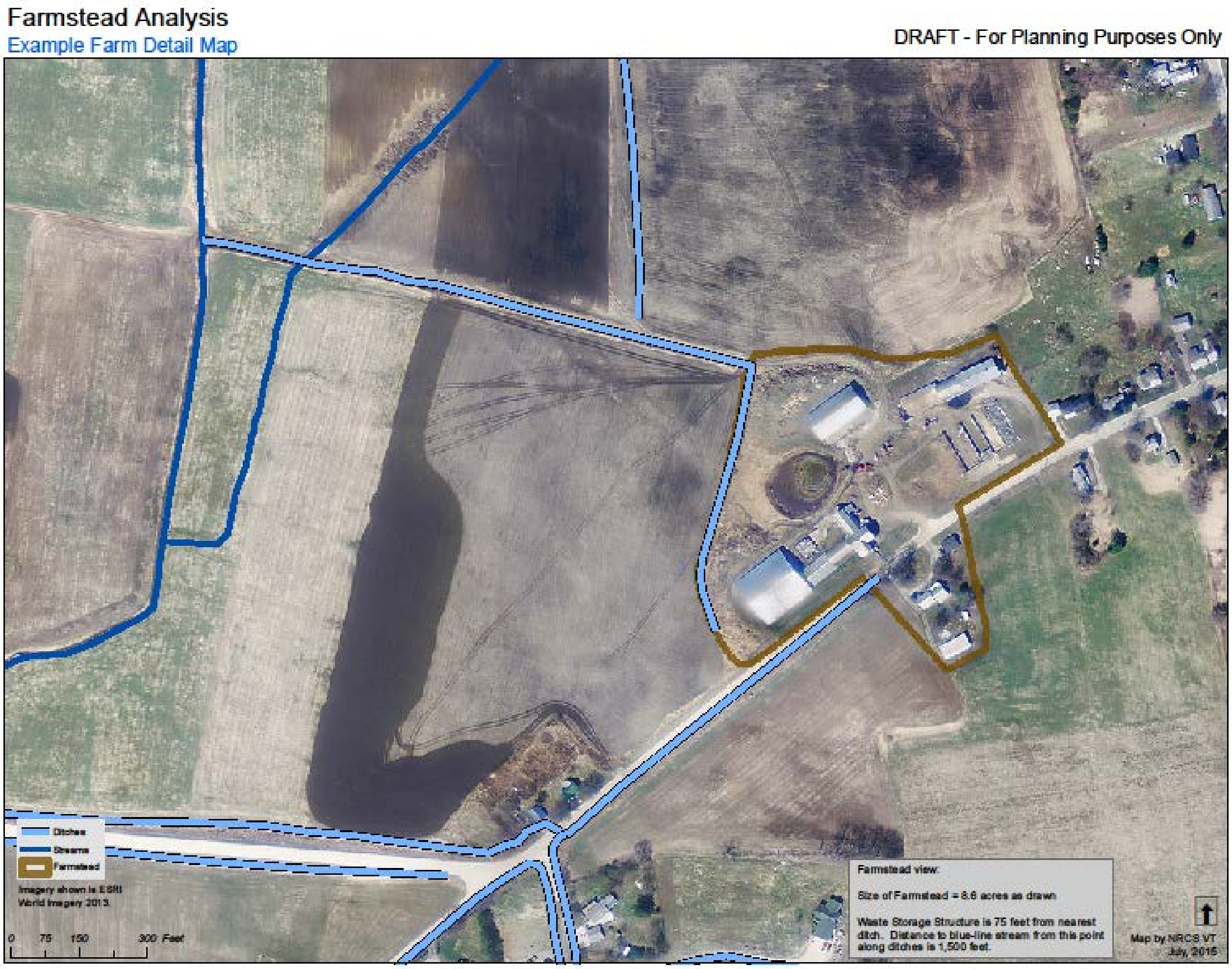


Figure 4 shows an example Farmstead Map for a location that has several barns, a manure storage facility and some heavy use areas, but shows no visible resource concerns. The close proximity of the manure pit to a surface ditch might warrant an onsite visual assessment of any potential resource concerns.

Figure 4 – Example Farm Scale Farmstead Map

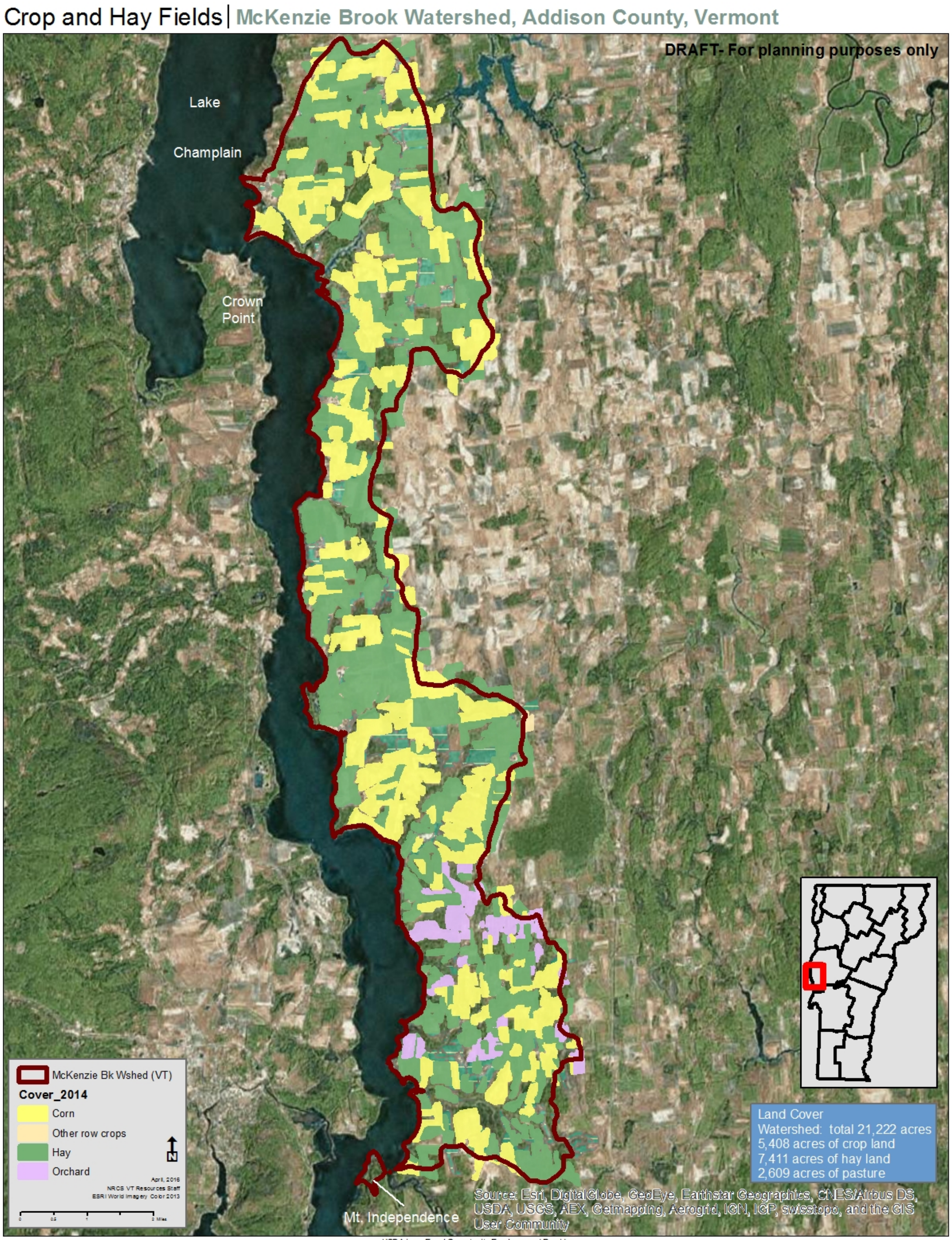


Annual Cropland and Hayland

One of the basic pieces of information need for agricultural watershed planning is the extent and types of land cover in the watershed. Annual cropland and hayland were visually identified in the McKenzie Brook Watershed using 2014 NAIP imagery. As such the land cover is a "snapshot in time" since many crop and hay fields are rotated between annual crops, such as corn, and hay.

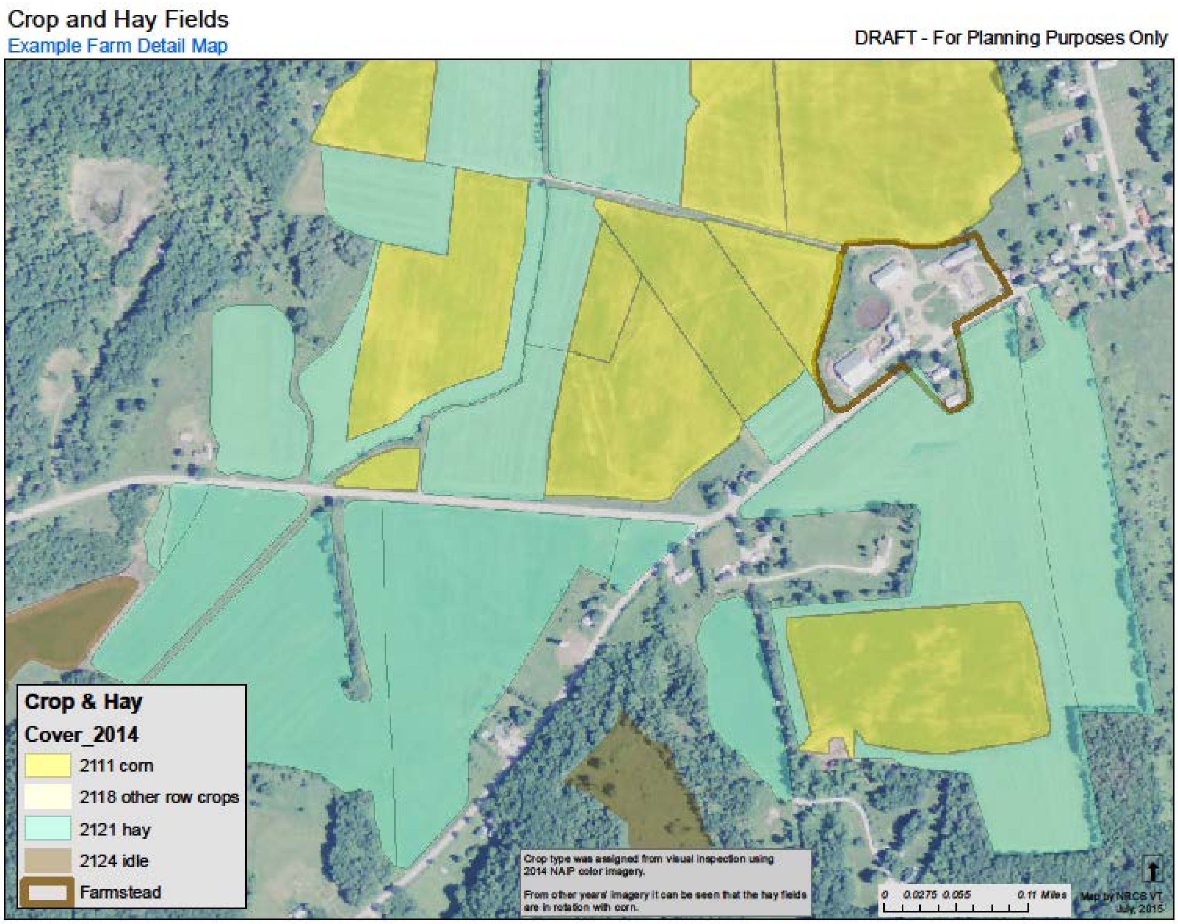
Figure 5 shows the location and extent of corn land and hayland in the McKenzie Brook Watershed. There was a total of 5,523 ac. of annual crops (mostly corn) and 7169 ac. of hay in the McKenzie Brook Watershed in 2014. This comprises a total of 60% of the 21,222 ac. watershed. Pasture in the watershed has not been mapped at this time.

Figure 5 – Location and Extent of Annual Cropland and Hayland in the McKenzie Brook Watershed



Field scale maps can be produced by conservation planners are working in the watershed. Figure 6 shows an example of a field scale map for annual cropland and hayland. The Annual Cropland and Hayland Maps can be used alone or overlain with other several data layers such as the Erosion and Runoff Risk Potential to evaluate specific fields for erosion and runoff risk. It is important to remember that these Annual Cropland and Hayland Maps represent land cover in 2014 and many of these fields may be in a corn/hay rotation.

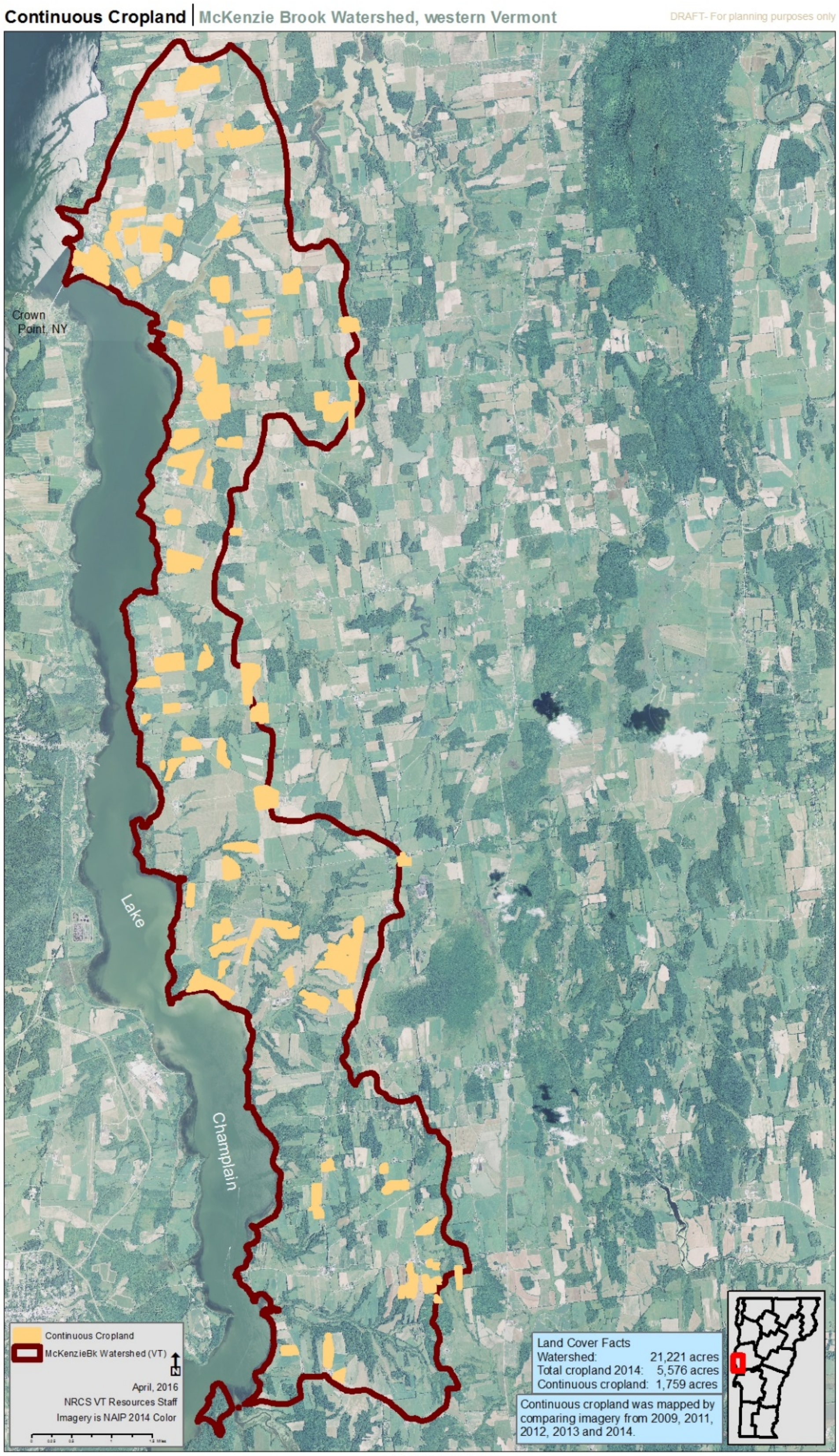
Figure 6 – Example Field Scale Map of Annual Cropland and Hayland



An additional analysis was performed to identify farm fields continuously planted to annual crops such as silage corn (Figure 7). These fields were visually identified using five years of aerial imagery (2009, 2011, 2013, and 2014). There is an estimated 1,759 acres of continuous cropland identified in the McKenzie Brook Watershed (32% of total cropland). The remaining cropland is in rotation, mostly with hay.

Fields in continuous annual crops are likely to exhibit a number of resource concerns. These fields may have higher erosion rates, depleted organic matter, and higher nutrient application rates, among other concerns. For this reason these fields should be prioritized for more detailed onsite evaluations. Any fields identified as continuous cropland and have a high Erosion and Runoff Risk Potential should be considered as especially vulnerable to significant resource concerns.

Figure 7 – Map of Cropland in Continuous Annual Tillage



Cropland and Steep Slope Adjacency

The streams and rivers in the McKenzie Brook Watershed are fairly deeply incised without a significant amount of available floodplain. This results in steep slopes along the waterways up to the edges of adjacent fields. These areas are prone to the development of gully erosion due to the steep slopes and the erosive nature of the soils in the watershed. These gullies often first form in the woods or on non-ag land adjacent to fields and then with time head cut into the crop fields.

The map in Figure 8 depicts areas of steep slopes (>8%) that are adjacent to cropland in the McKenzie Brook Watershed. These maps were developed using DEM data and a flow accumulation model. As part of the field assessment these areas should be visually checked to identify any areas with significant gully erosion. Individual field scale maps such as the one shown in Figure 9 can be developed for this purpose.

Figure 8 – Steep Slopes Adjacent to Cropland in the McKenzie Brook Watershed

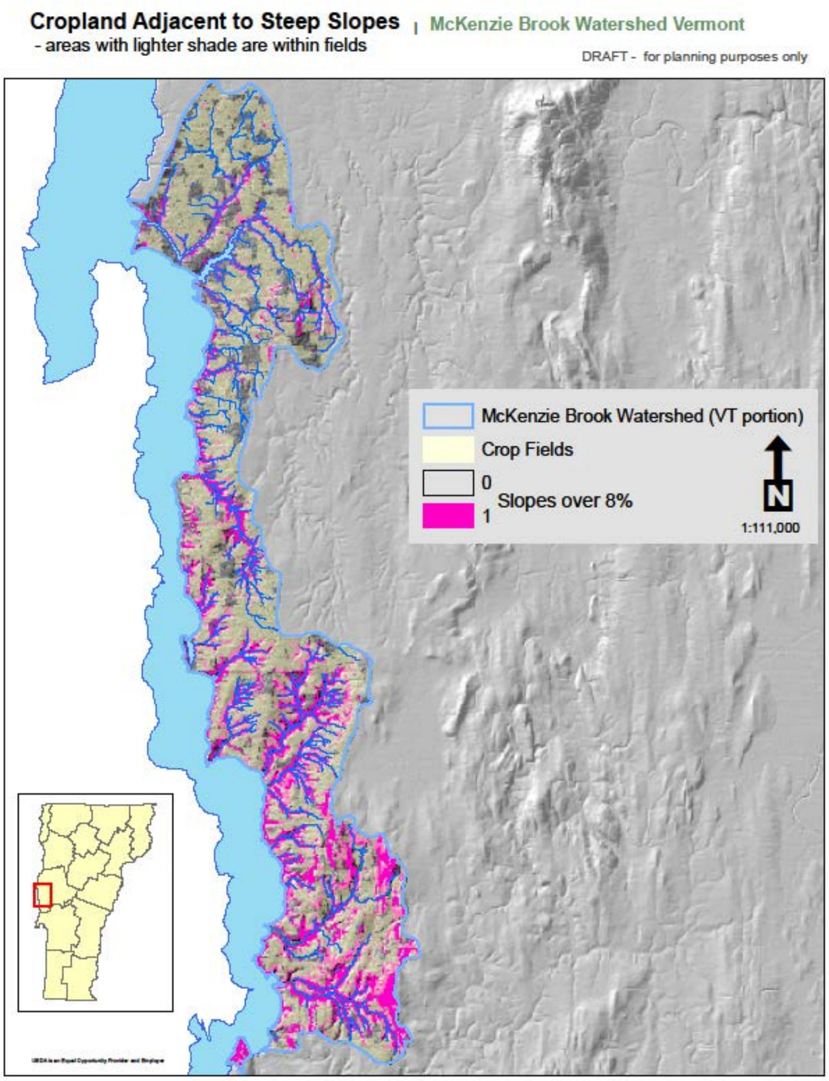
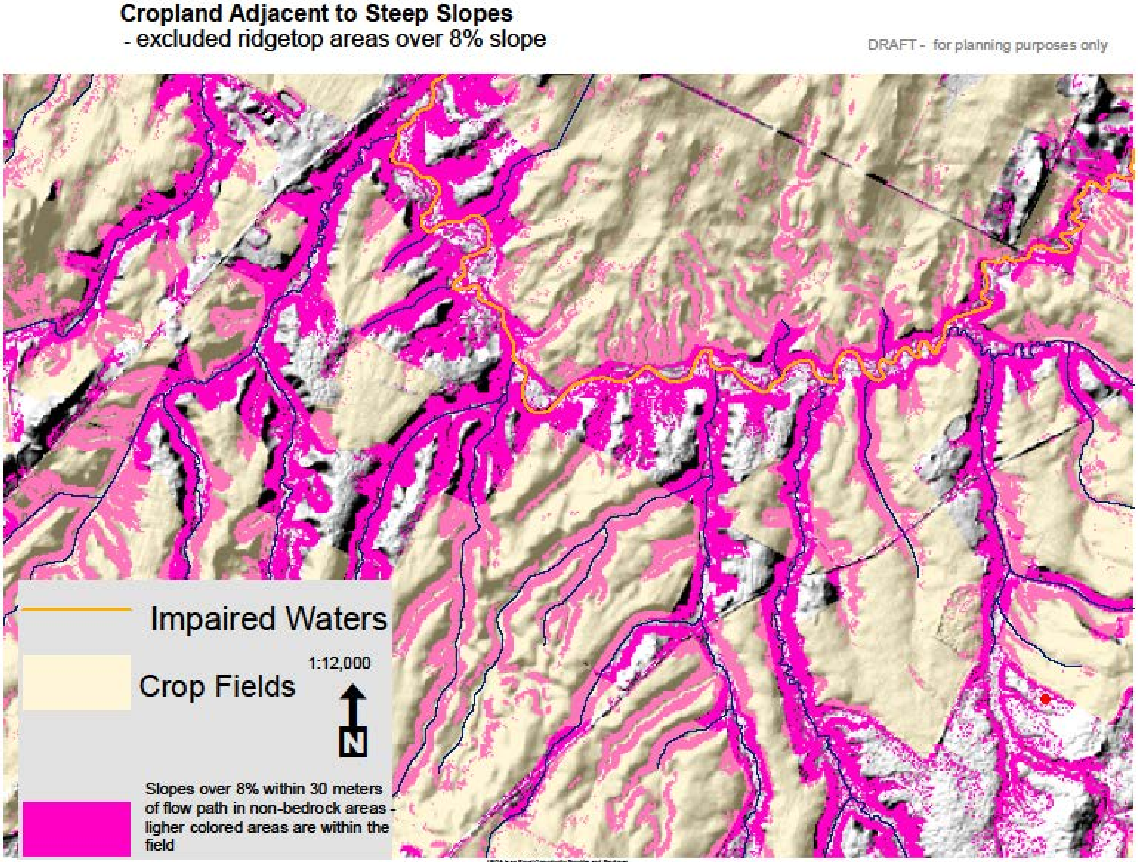


Figure 9 – Filed Scale Map of Areas of Steep Slope that are Adjacent to Cropland



<u>Wetland Restoration</u>

The Restorable Wetland data layer was developed by a variety of government agencies and private consultants in 2007. The main data input layers were: Hydric Soils, Land-use / Land-cover data from 2002 showing open land, slopes under 5%, and National Wetland Inventory data showing disturbed wetlands. Once appropriate restoration sites had been delineated using GIS analysis, these areas were then run through a prioritization model that ranked the sites based their potential to retain phosphorus. Four prioritization categories for restoration were chosen: highest, high, moderate, and low. For further details on how the data layer was developed refer to the "Lake Champlain Wetland Restoration Plan" report.

Since this data is now 9 years old, land use changes have occurred over this time period. The data was edited to remove sites that contained house sites. The e911 "esites" data for 2015 was used to remove those areas that now show homes within the restorable wetlands. Additionally, State Land that was also excluded from the data layer, since it is likely a functional wetland and not in private ownership. The extent and location of potentially restorable wetland areas is shown in Figure 10. These areas are located on private land and may have historic significant drainage and other modifications. These areas would only be available for restoration under a voluntary restoration program such as the Wetland Reserve Easement Program. Using field scale maps such as in Figure 11, it will be necessary for on-site investigation to insure that they are eligible and capable of being restored to natural wetland conditions.

Figure 10 - Watershed Scale Map of Potentially Restorable Wetlands

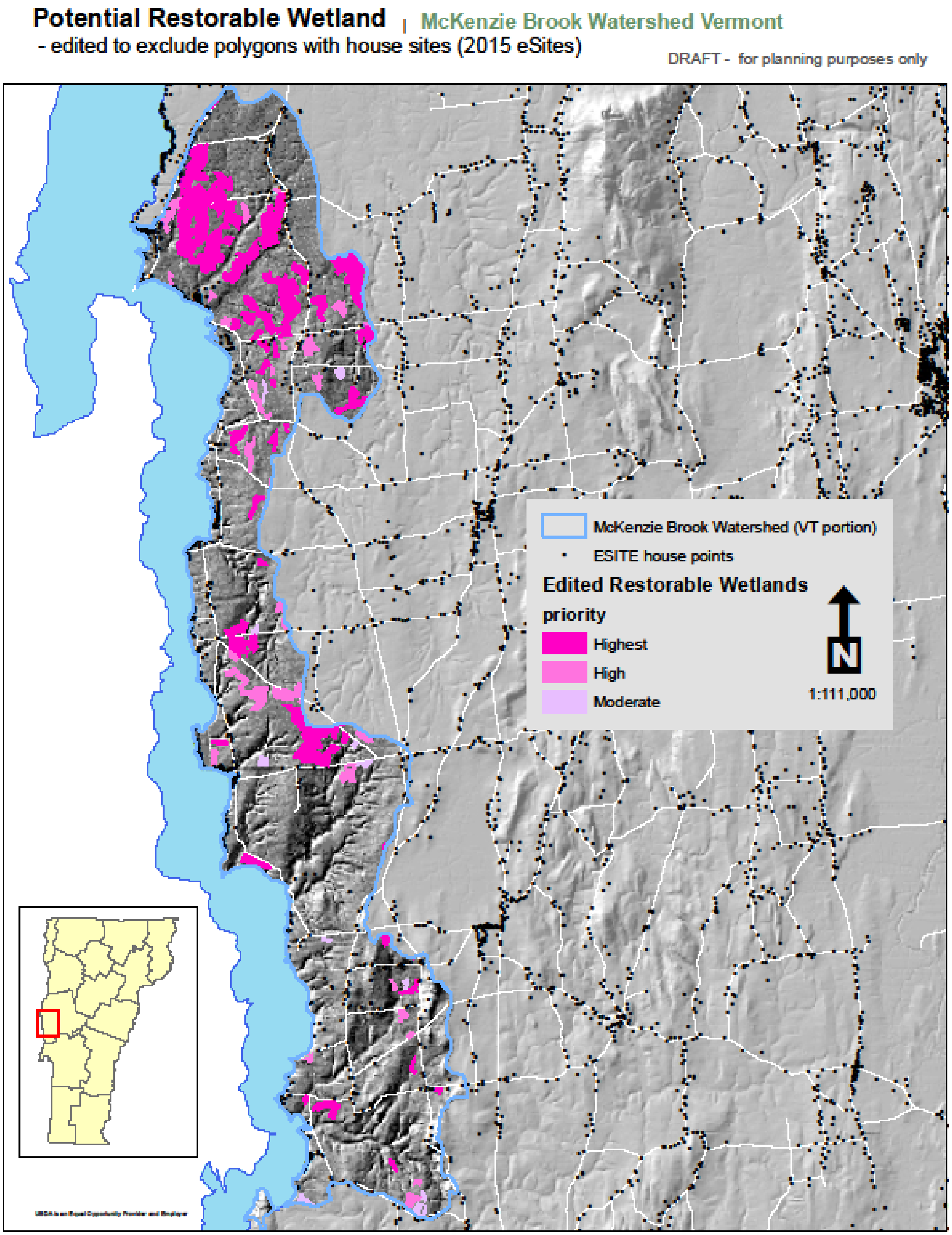
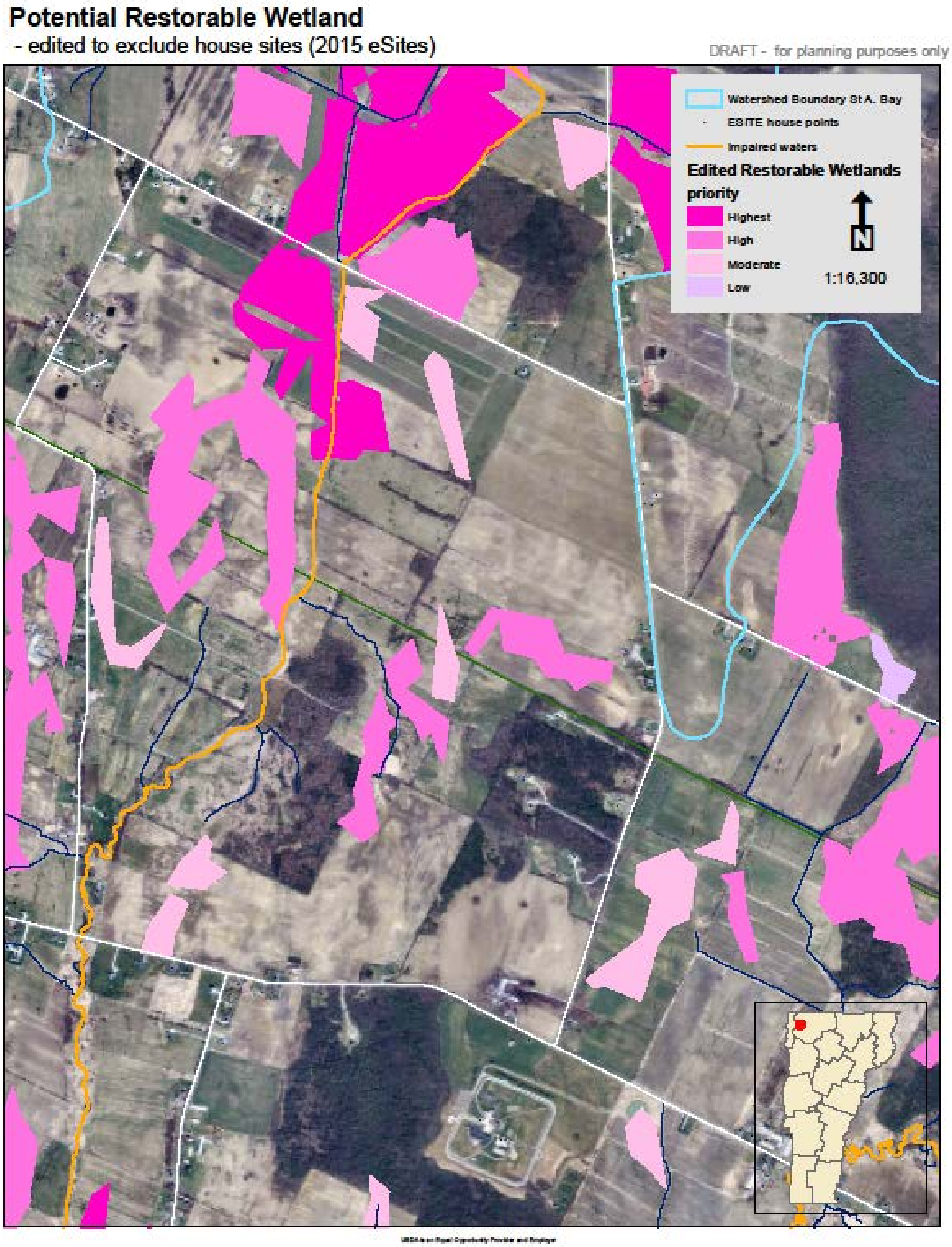
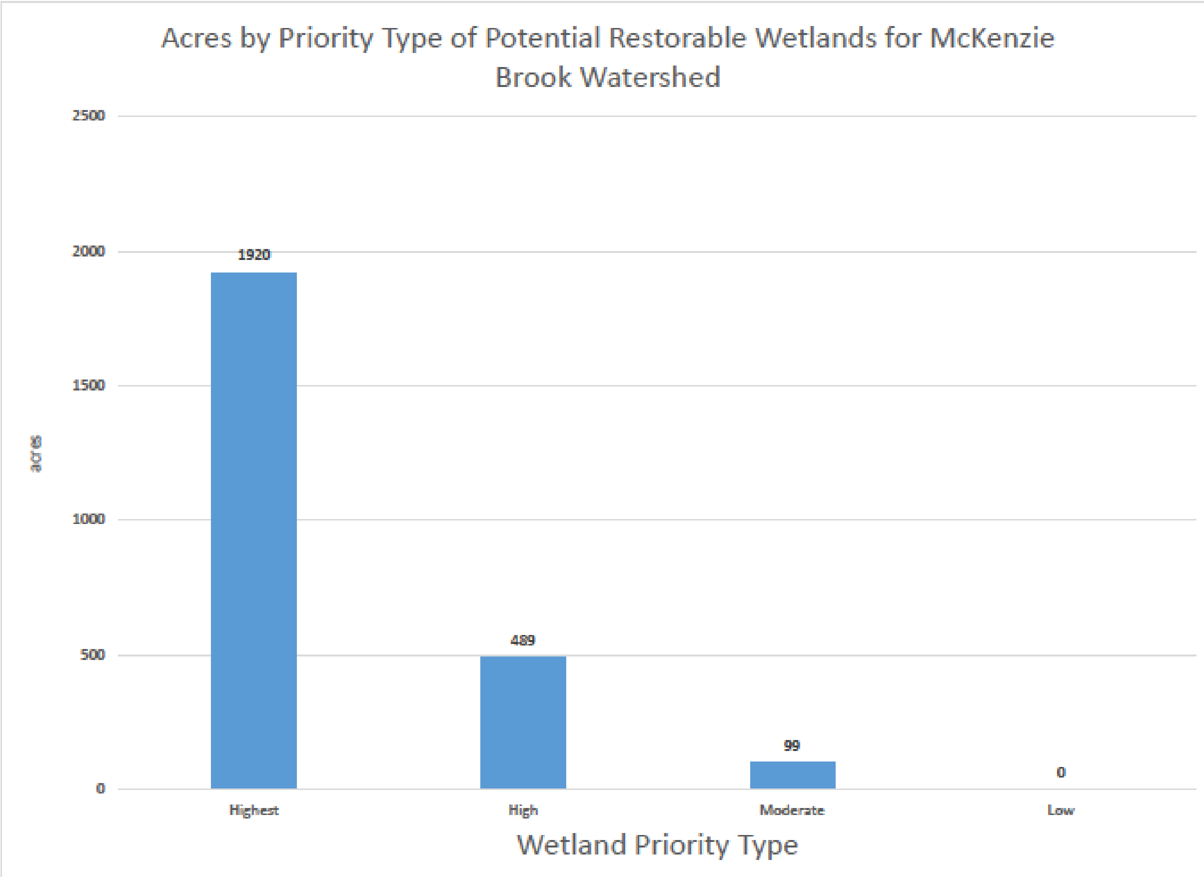


Figure 11 - Example Field Scale map of Potentially Restorable Wetlands



The map in Figure 10 identifies over 2,500 ac. of potentially restorable wetland in the McKenzie Brook Watershed. As can be seen in Figure 12 over three quarters of this area (2,400 ac.) is categorized as having the highest restoration potential. The site specific restoration data as shown in Figure 11 could be overlain with crop and hayland data or other information such as tract information to further assess its viability for restoration.

Figure 12 - Summary of Potentially Restorable Wetland Classes



Erosion and Runoff Risk Potential

A GIS model was constructed to estimate the risk of erosion and runoff from farm fields based on four factors. The factors included were the K value, hydrologic soil group and flooding potential of the soil map unit, as well as the slope, based on Digital Elevation Model (DEM) data. The categories in the Erosion and Runoff Potential Maps are meant to represent the relative risk of sheet and rill erosion and runoff occurring from specific fields or portions of fields without any consideration of the current cropping system or conservation practices used on the field. As can be seen in Figure 13 a moderate portion of the fields in the McKenzie Brook Watershed have been identified having a high or very high risk for erosion and runoff. The majority of these high risk fields are located in the southern portion of the watershed. Figure 14 provides an example of the type of field level maps that can be produced from this data. It is important to note that in many situations it is only a portion of a field that is identified as having high or very high risk.

Figure 13 - Watershed Scale Map of Erosion and Runoff Risk Potential

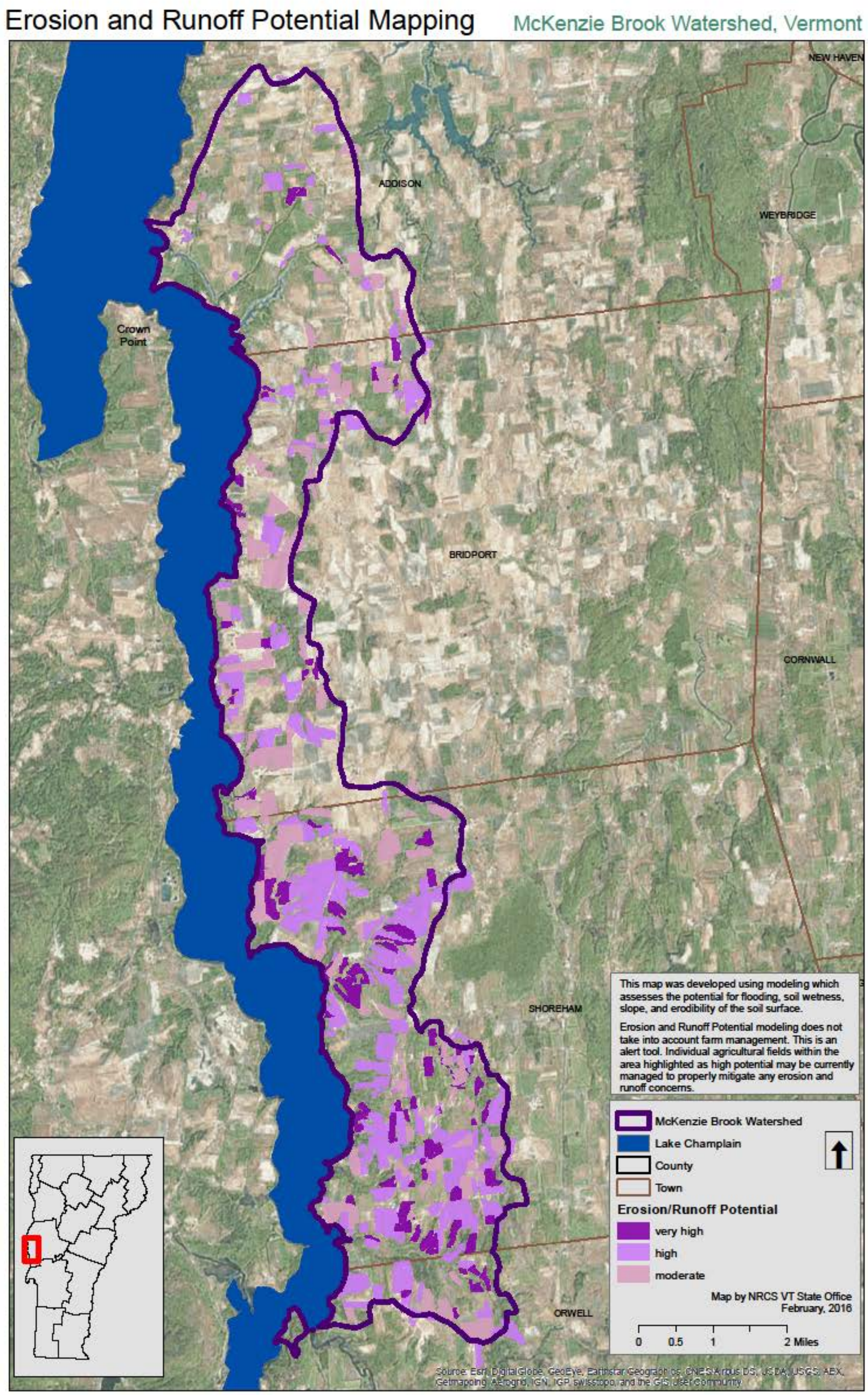
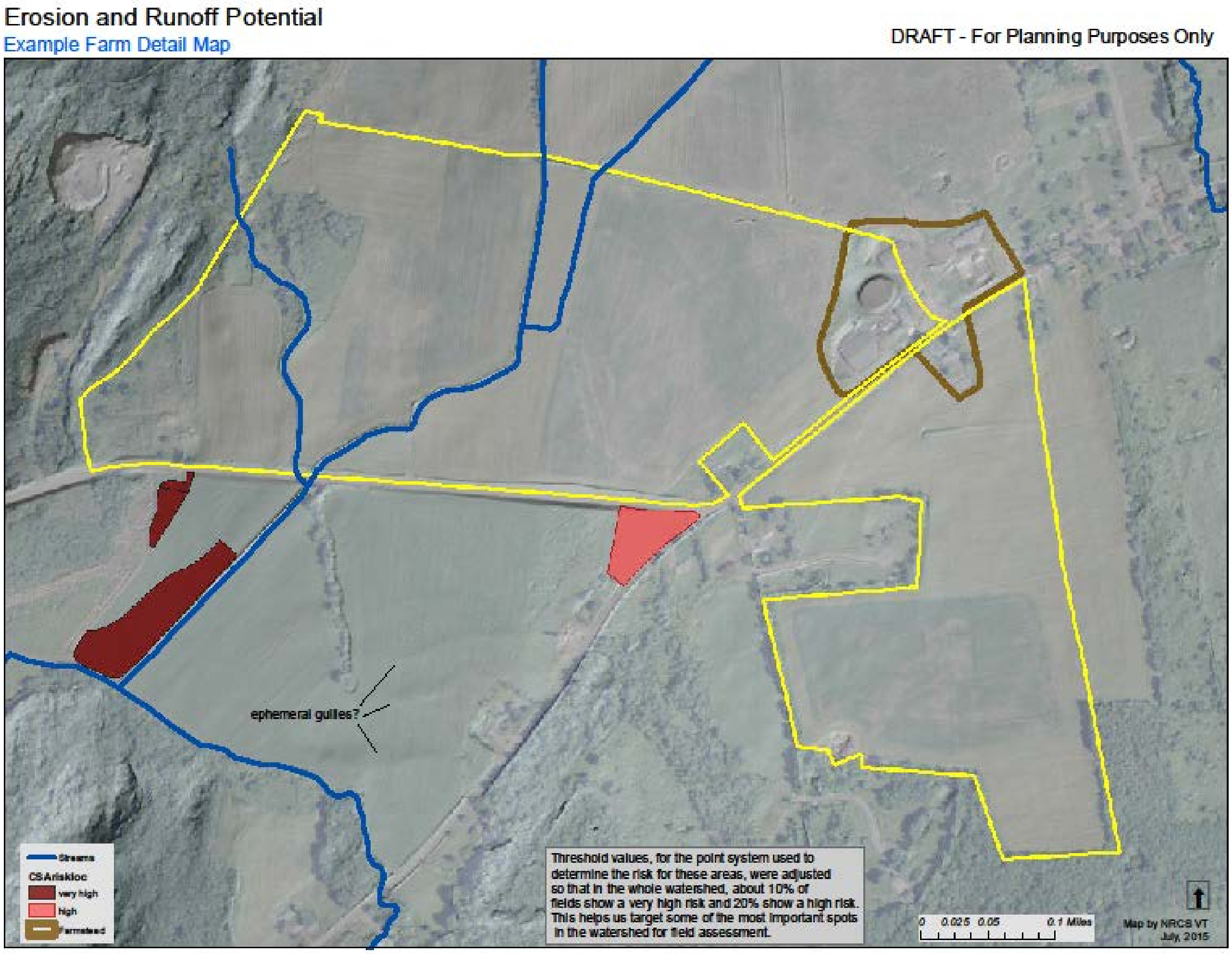


Figure 14 - Example Field Scale Erosion and Runoff Risk Potential Map



Farm Ditches

Field ditches are common on agricultural land throughout the Lake Champlain Basin in Vermont. These waterways have the potential to readily transport both sediment and nutrients to streams and rivers. Under the new Required Agricultural Practices recently passed by the State Legislature these ditches will likely be required to have a 10 ft wide vegetated buffer adjacent to them. As such it will become important to know the location of these ditches to ensure that the farmer has opportunities to install buffers. Figure 15 shows the location of fields in the McKenzie Brook Watershed that have either interior ditches or ditches adjacent to them. Of the 1,042 crop and hay fields in the McKenzie Brook Watershed about 374 of them appear to have a ditch of some type. We are currently developing ditch network maps for the McKenzie Brook Watershed. Once completed this mapping will allow for the production of field scale maps showing ditch locations as shown in Figure 16.

Figure 15 - Map of Fields with Ditches in the McKenzie Brook Watershed

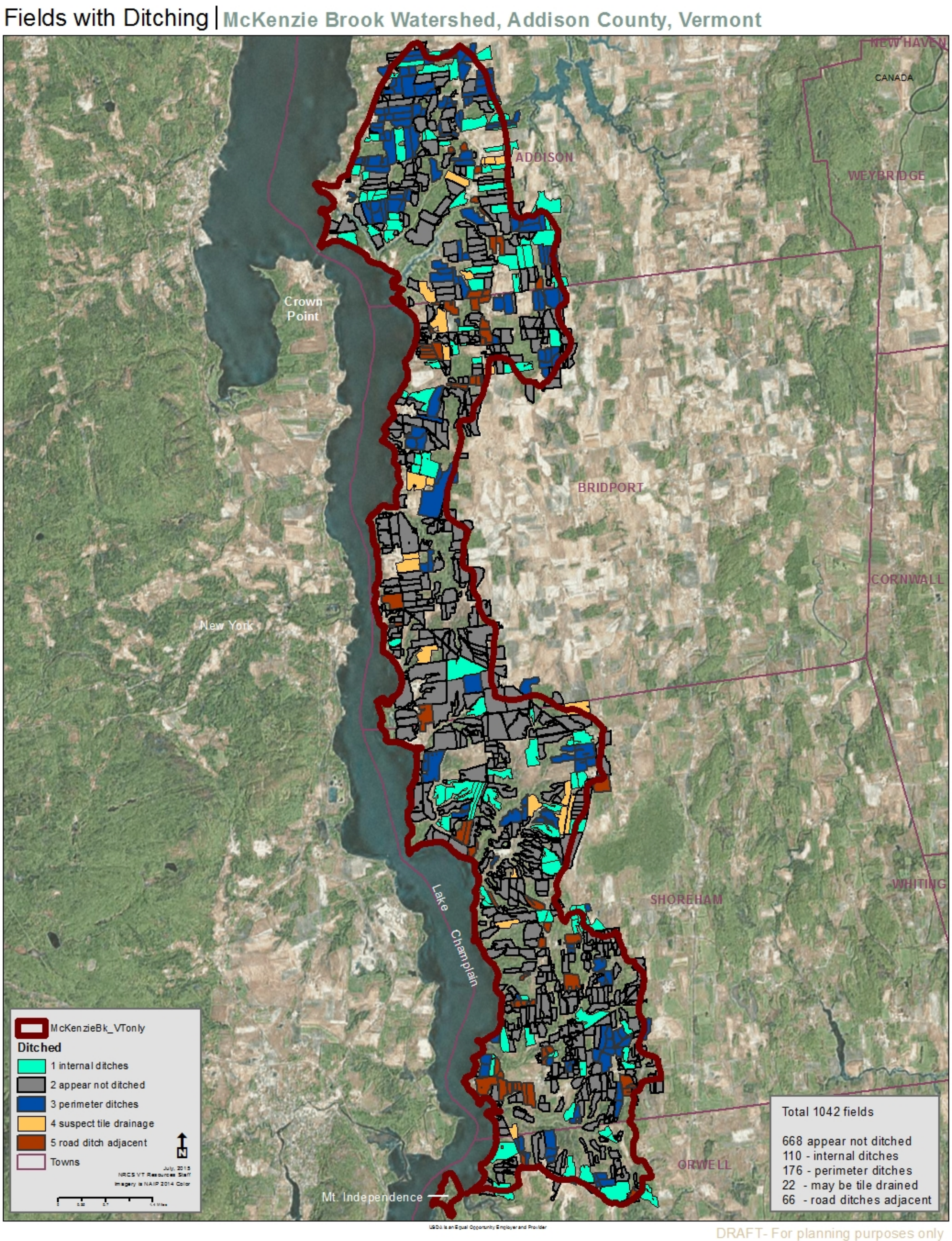
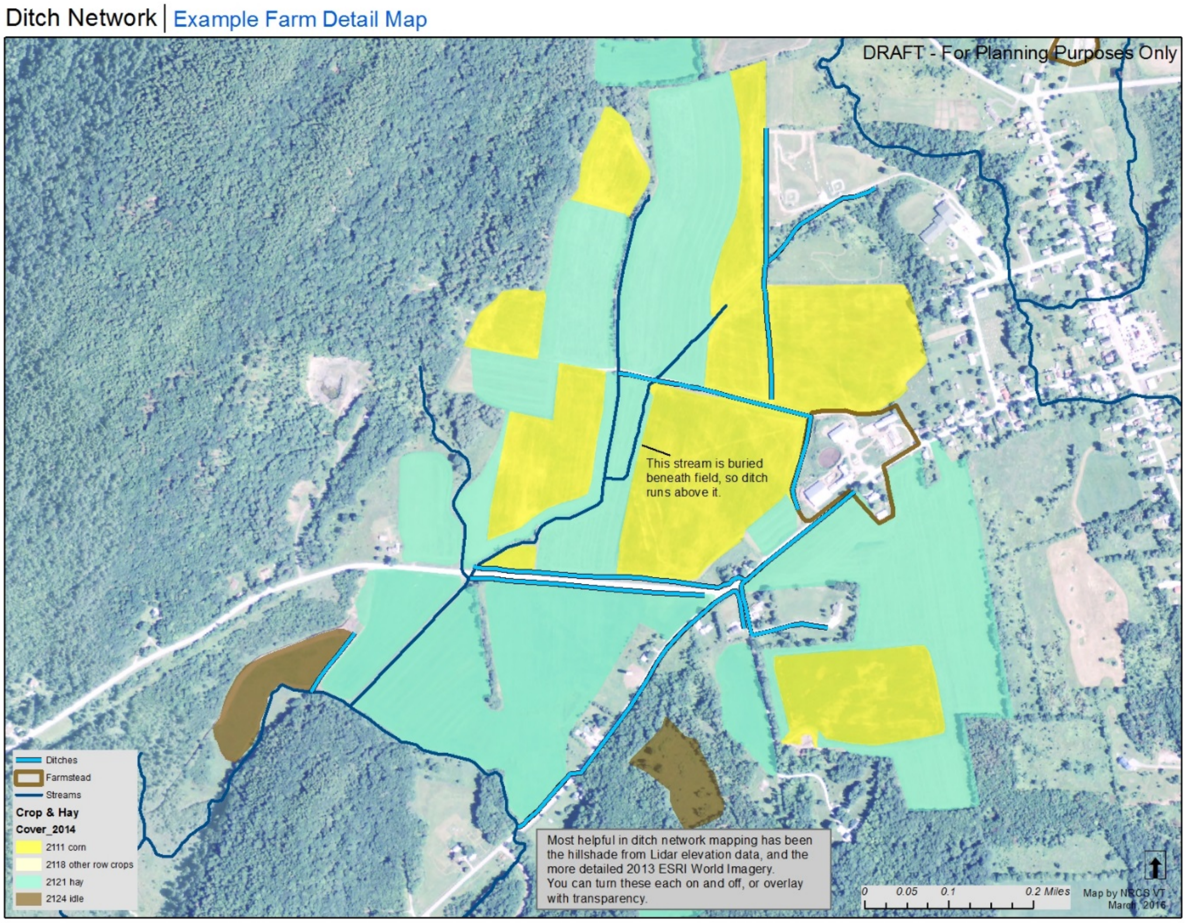


Figure 16 - Example Field Scale Ditch Map

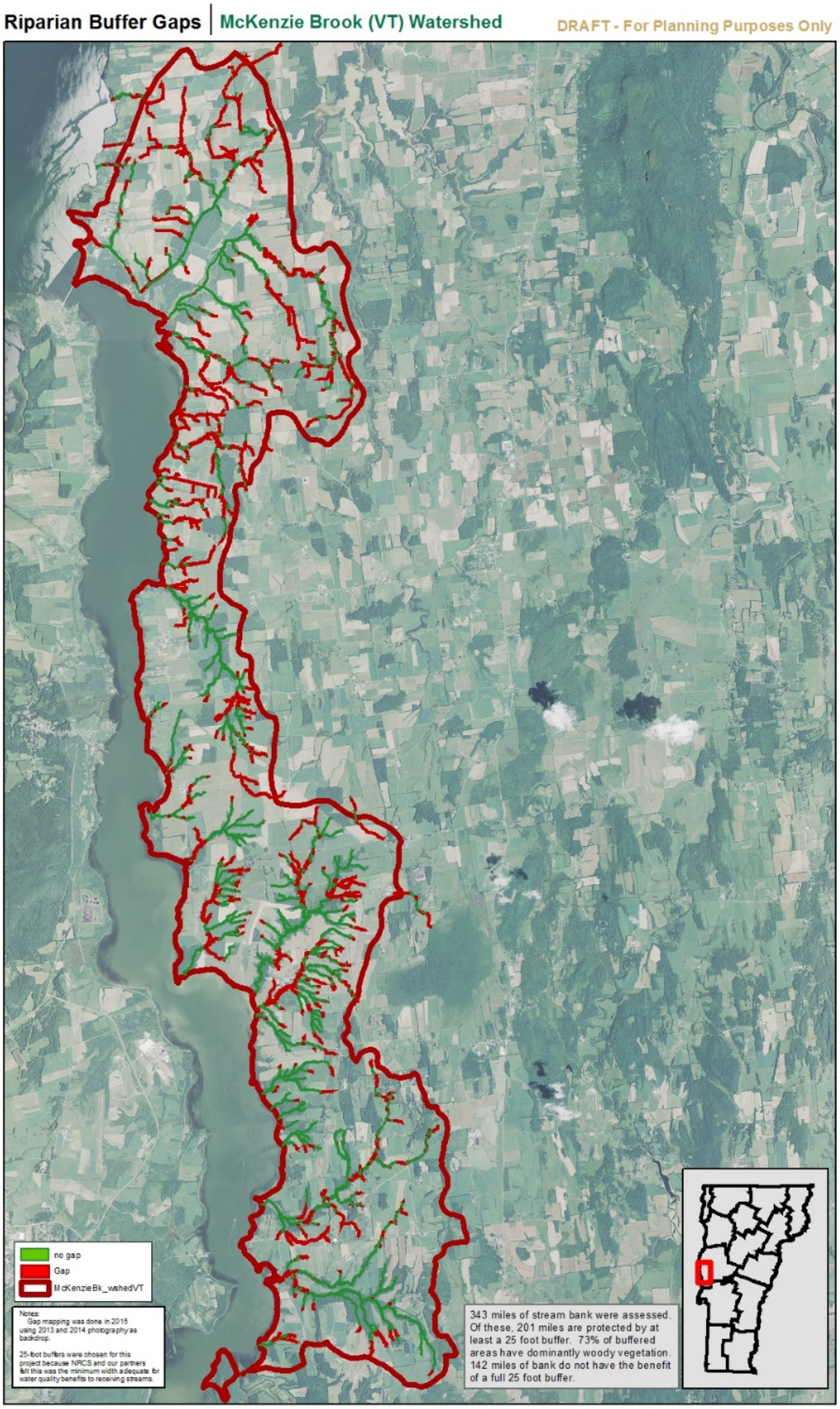


Riparian Buffer Gaps

Riparian corridors were evaluated in the McKenzie Brook Watershed to determine locations where adequate riparian buffers were lacking. The identification of these riparian buffer gaps was based on visual interpretation of 2014 aerial imagery and channel width information from the Vermont Department of Environmental Conservation (VTDEC) Rivers Program database. Riparian zones were evaluated to determine if at least a 25 foot wide vegetated buffer was present, either herbaceous or woody. Twenty-five feet was used as the minimum requirement since the NRCS practice standard for Filter Strip requires a minimum of 25 ft and the practice standard for Riparian Forest Buffer requires a minimum of 35 ft.

A total of 343 miles of streambank (both sides of the stream) were evaluated. Of these, 201 miles of streambank have an adequate buffer and 73% of these are woody buffers. However, it was estimated that 142 miles of streambank in the McKenzie Brook Watershed do not have an adequately vegetated riparian buffer. It may be useful to overlay the Riparian Buffer Map data with continuous cropland and/or the erosion and runoff risk potential data. These areas may exhibit greater rates of erosion and runoff and would be a priority for well vegetated riparian buffers.

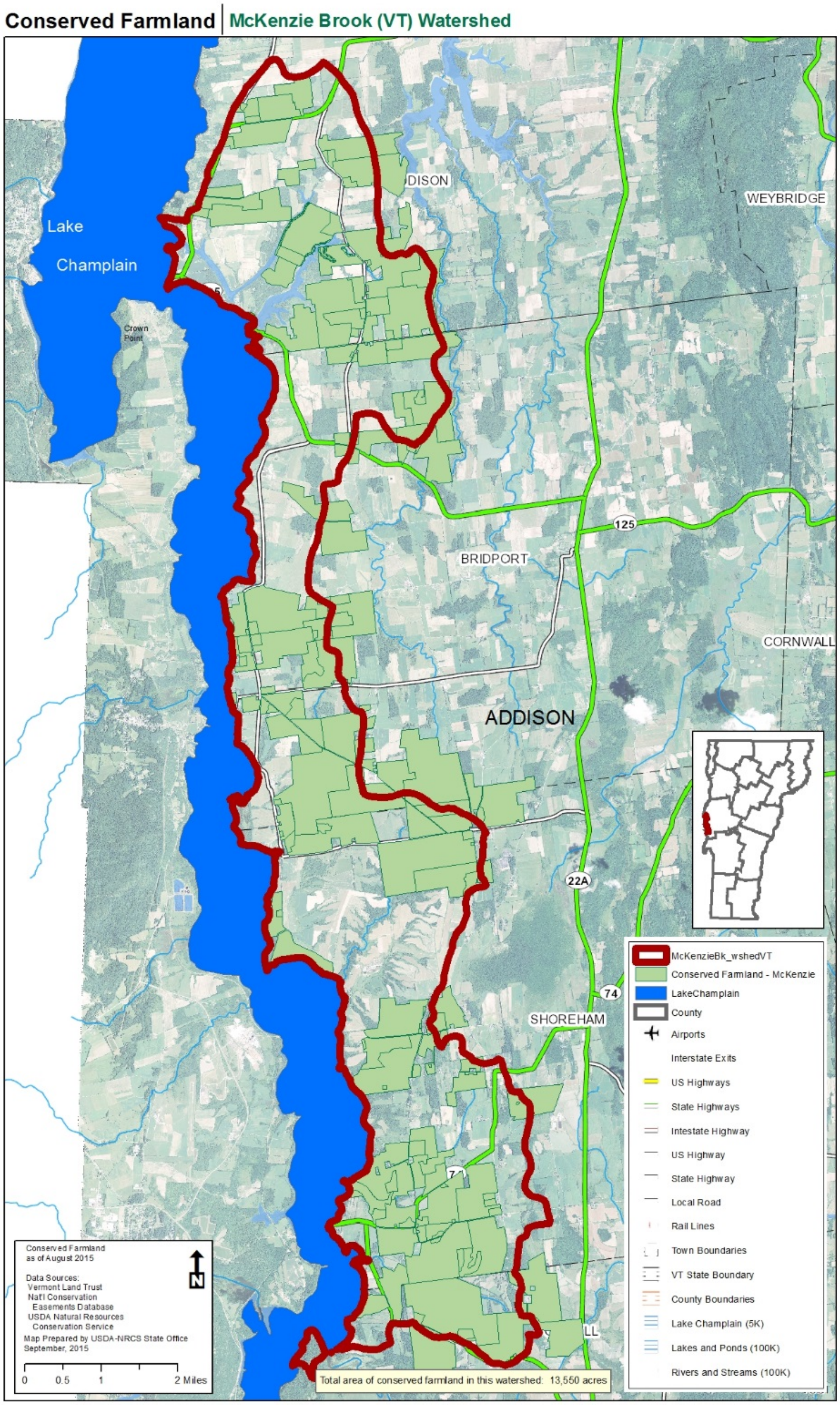
Figure 17 – Map of Riparian Buffer Gaps



Conserved Farmland

In partnership with other groups such as the Vermont Land Trust, the Vermont Housing and Conservation Board has operated a farmland conservation program in Vermont since 1987. NRCS has contributed significant funds to this program over the years through what is now called the Agricultural Easement Program. In some areas large, contiguous blocks of conserved farmland are forming. The map in Figure 18 shows conserved farmland in the McKenzie Brook Watershed. A total of 13,550 ac. of farmland have been conserved to date in this watershed. Conserved farmland maps can help direct funds and efforts of programs such as the Regional Conservation Partnership Program (RCPP) and other water quality initiatives.

Figure 18 – Conserved Farmland in the McKenzie Brook Watershed



Watershed Phosphorus Reduction and Practice Implementation Goals and Projected Costs

EPA has proposed phosphorus reduction goals for all the HUC-8 watersheds or lake segments in the Lake Champlain Basin. The current phosphorus reduction goal for the McKenzie Brook Watershed is 36% overall for all land uses. EPA has assigned a targeted reduction of 60% for agriculture in the Watershed. NRCS has attempted to use the TMDL goals and EPA developed tools to estimate phosphorus loads and reductions to the extent possible. This includes use of the new EPA HUC-12 Tool and the EPA BMP Scenario Tool. All costs are based on NRCS payment schedules, except for a couple of situations where estimated practice costs were developed (ex. average farmstead wide practice costs).

Watershed Phosphorus Reduction Goals for Agriculture

Watershed phosphorus reduction goals for agriculture were estimated using the EPA HUC-12 Tool. This tool provides an estimate of phosphorus loading for each land cover type at the HUC-12 level. Phosphorus loading from continuous corn, crop/hay rotation, continuous hay, pasture and farmland were totaled from the HUC-12 Tool to determine the total estimated phosphorus loading from agriculture. The needed amount of phosphorus reduction in lbs/yr was then estimated by multiplying the total agricultural load by the percentage reduction determined by EPA to be necessary for agriculture in the watershed. Table 1 provides the necessary load reductions for the four targeted watersheds. For the McKenzie Brook Watershed the total agricultural loading was estimated to be 43,246 lbs/yr, the reduction goal at this time was set to be 60%, and **the resulting agricultural phosphorus reduction goal for the McKenzie Brook Watershed was estimated to be 29,966 lbs/yr.** The McKenzie Brook Watershed has the highest P loading rate and P reduction goal of the four watersheds, by a factor of almost 2.

Table 1 – Agricultural Phosphorus Reduction Goals for the Four Targeted Watersheds

2016 Priority Watershed Estimated Ag Phosphorus Loadings and Targeted Reductions August, 2015 - Draft				
Watershed Name	**Watershed Area (acres)**	**Total Estimated Ag P Loading (lbs/yr)**	**TMDL Reduction Goal**	**Ag P Reduction Goal (lbs/yr)**
Rock River	22,743	19,248	83%**	15,976
Pike River	25,088	9,599	83%**	7,967
St. Albans Bay	33,515	23,047	35%	8,066
McKenzie Brook	21,222	43,276*	60%	25,965

*Total loading reduced 25% to remove loading from East Creek (included in the BMP Scenario Tool)		
** The Rock River and Pike River are part of the Missisquoi Direct watershed in the BMP Scenario Tool.		

<u>Individual Practice and Practice System Efficiencies</u>

The EPA Scenario Tool is a spreadsheet tool based on SWAT modelling of watersheds in the Lake Champlain Basin. It was developed by a private contractor under contract by EPA. Early on in the model development EPA convened a workgroup of local experts to help develop reduction efficiencies for conservation practices that are included in the SWAT model. These efficiencies and ones adjusted or produced by the model were then incorporated into the EPA Scenario Tool. As such the EPA Scenario Tool is subject to the same limitations as the SWAT model. Certain agricultural practices cannot be easily included in the SWAT model, including many farmstead related practices. Based on the SWAT modelling, efficiencies for a conservation practice vary based on factors such as cropping system, soil hydrologic group and slope.

Table 2 lists the agricultural conservation practices and systems of practices that are included in the EPA Scenario Tool and provides example efficiencies for each practice. It is important to consider when multiple practices are applied to the same field as a system since the individual efficiency of each practice will decrease as additional practices are added to the same field. These efficiencies will be adjusted as better information becomes available, such as results of the Edge of Field Monitoring Projects.

Table 2 - List of Available Ag Practice and Practice Systems in the EPA Scenario Tool and Example Practice Efficiencies*

1. Change in crop rotation	25%
2. Change in crop rotation and conservation tillage	63%
3. Change in crop rotation, grassed waterway, ditch buffer and riparian buffer**	84%
4. Change in crop rotation, grassed waterway riparian buffer	67%
5. Change in crop rotation and riparian buffer	56%
6. Conservation tillage	50%
7. Cover crop	28%
8. Cover crop, conservation tillage, grassed waterway, ditch buffer and riparian buffer	92%
9. Cover crop, conservation tillage and manure injection	64%
10. Cover crop and manure injection	28%
11. Ditch buffer	51%
12. Grassed waterway	25%
13. Grassed waterway and riparian buffer	56%
14. Manure injection and reduced manure P applied	5%
15. Reduced manure P applied	5%
16. Reduced manure P applied and grassed waterway	29%
17. Annual cropland to permanent grass	92%
18. Riparian buffer	41%

19. Livestock exclusion/fencing/grazing system 73%
20. Farmstead practices 85%

*BMP efficiencies vary with cropping system, soil type and slope
**Riparian forest buffers and grassed filter strips are both considered as riparian buffers
Note: These practice efficiencies should only be used for planning purposes and will change as better practice efficiency data is developed.

Existing Practice Implementation and Loading Reduction Estimates

NRCS has been working with farmers in The McKenzie Brook Watershed for an extended period of time. During this period farmers have signed contracts with NRCS to implement a variety of different conservation practices. Over time many of the early contracts have expired and some of the practices were either discontinued or not maintained. Table 3 provides information on practices that were installed in the McKenzie Brook Watershed with NRCS support over the 5 year period from 2010 – 2014. During this period practices were tracked to determine which specific years during that time period they were implemented. It cannot be determined which practices were continued after the contracted period.

The practices that were implemented to the greatest extent included diversion (8805 ft.), fence (6,492 ft.) and nutrient management (3,097 ac.). Table 3 also shows estimated phosphorus reductions as a result of the implementation of these practices. The largest phosphorus reductions resulted from, crop rotation (744 lbs/yr), nutrient management (345 lbs/yr) and prescribed grazing (341 lbs/yr). The total annual average reduction in phosphorus reduction which resulted in the implementation of these practices was 2048 lbs/yr. It is important to note that this is only 7% of the total P reduction (29,966 lbs/yr) for agriculture that will be required under the TMDL.

Many existing NRCS contracts with farmers include practices that are still planned for implementation in the near future. These planned practices are summarized in Table 4. This includes a lot of waste recycling (manure injection), grassed waterway and nutrient management. It also includes a significant amount of grazing related practices such as prescribed grazing (281 ac.) and pipeline (8,330 ft.).

Table 4 also summarizes the expected phosphorus reductions associated with the implementation of these practices over the lifespan of the practices. If implemented as planned, prescribed grazing would provide the greatest reduction (280 lbs P), followed by the crop rotation (212 lbs P) and waste recycling (manure injection = 126 lbs P). These recently implemented and planned practices should be considered when establishing practice implementation goals for the watershed. The total reduction estimated to be achieved from the implemented and planned practices is 2,816 lbs/yr. This amounts to 10% of the P reduction goal for agriculture that will be required under the TMDL.

Table 3 – NRCS Practices Implemented in the McKenzie Brook Watershed, 2010- 2014

NRCS Practices Implemented in the McKenzie Brook watershed (VT), 2010 - 2014									
Practice Group	practice code	practice name	Count of Practices Applied	Total Applied Amount	units	Estimated P Loading by Landcover* (lbs/ac/yr)	Total P Load from Untreated Acres (lb/yr)	Annual P Reduction from Treated Acres (lb/yr)	Cumulative P Reduced Over 5 Year Baseline* * (lbs)
Farmstead	313	Waste Storage Facility	7	7	no	3.35	223	178	1,782
	533	Pumping Plant	1	1	no				
	558	Roof Runoff Structure	2	2	no				
	560	Access Road	4	860	ft				
	561	Heavy Use Area Protection	5	0.5	sq ft				
	606	Subsurface Drain	7	4930	ft				
	629	Waste Treatment	1	1	no				
	634	Waste Transfer	4	4	no				
Agronomic (Crop & Hay Fields)	328	Conservation Crop Rotation	105	1334.9	ac	2.23	2,977	744	2,233
	329	Residue and Tillage Management, No-Till	7	57.1	ac	2.23	127	64	191
	340	Cover Crop	12	79.7	ac	2.23	178	50	149
	362	Diversion	17	8805	ft	NA			
	382	Fence	4	6492	ft	NA			
	391	Riparian Forest Buffer***	2	6.7	ac	2.23	299	123	1,225
	412	Grassed Waterway***	4	0.5	ac	2	1	9	91.4
	468	Lined Waterway or Outlet	2	100	ft	NA			
	557	Row Arrangement	45	485	ac	NA			
	578	Stream Crossing	1	1	no	NA			
	590	Nutrient Management	238	3096.8	ac	2.23	6,906	345	1,036
	620	Underground Outlet	11	3277	ft	NA			
	633	Waste Recycling	97	1748.5	ac	2.23	3,899	195	585
Grazing (Pasture)	528	Prescribed Grazing	27	342	ac	2.49	852	341	3,406
	516	Livestock Pipeline	5	5100	ft				
	575	Trails and Walkways	2	189	ft				
	614	Watering Facility	5	8	no				
*Land Use & P Load data from EPA HUC-12 Tool							Totals	2,048	10,699
**Used 3 years of practice implementation for agronomic, 10 years for structural and buffer practices									
***Assumed that buffer practices treated 20 acres for every acre of buffer									

Table 4 – NRCS Practices Planned for Implementation in the McKenzie Brook Watershed

NRCS Practices Planned for the McKenzie Brook (VT) Watershed, as of February 2015									
Practice Group	Practice Code	Practice Name	Number of Planned Practices	Total Planned Amount	Units	Estimated P Loading by Landcover* (lbs/ac/yr)	Total P Load from Untreated Acres (lb/yr)	Annual P Reduction from Treated Acres (lb/yr)	Cumulative P Reduced Over Life of Practice** (lbs)
Farmstead	313	Waste Storage Facility	1.0	1.0	no	3.35	32	27	271
	560	Access Road	1.0	100.0	ft				
	561	Heavy Use Area Protection	4.0	0.4	sq ft				
	606	Subsurface Drain	1.0	230.0	ft				
Agronomic	104	Nutrient Management Plan - Written	3.0	3.0	no	NA			
	328	Conservation Crop Rotation	33.0	379.7	ac	2.23	847	212	635
	329	Residue and Tillage Management, No-Till	1.0	5.0	ac	2.23	11	6	17
	340	Cover Crop	21.0	392.2	ac	2.23	875	110	329
	362	Diversion	1.0	100.0	ft	NA			
	412	Grassed Waterway***	3.0	0.5	ac	2.23	22	6	56
	557	Row Arrangement	4.0	16.4	ac	NA			
	578	Stream Crossing	1.0	1.0	no	NA			
	590	Nutrient Management	35.0	463.4	ac	2.23	1033	52	155
	620	Underground Outlet	1.0	100.0	ft	NA			
	633	Waste Recycling	78.0	1,132.7	ac	2.23	2526	126	379
Grazing (Pasture)	528	Prescribed Grazing	16.0	281.4	ac	2.49	701	280	2,803
	516	Livestock Pipeline	4.0	8,333.0	ft				
	614	Watering Facility	3.0	3.0	no				
*Land Use & P Load data from EPA HUC-12 Tool							Totals	818	4644.1
**Used lifespan of 10 years for constructed practices and prescribed grazing, used 3 years for agronomic practices									
***Assumed that buffer practices treated 20 acres for every acre of buffer									

Potential Phosphorus Load Reductions Associated with One Practice Scenario

A suite of individual practices and practice systems was develop as an example scenario that meets the required phosphorus reductions for agriculture in the McKenzie Brook Watershed. This example practice scenario was developed to provide additional guidance to the Local Watershed Team and is intended as an example for planning purposes only. The actual amount and type of practices identified and implemented by the Local Watershed Team will be different than the example provided here. The example does provide several pieces of useful information: it indicates the magnitude of the work that needs to be accomplished in order to meet the reduction goal, it provides a comparison of the effectiveness of different practices or practice systems, it provides information on the extent of available land area for different practices or practice systems and it provides one cost estimate of the necessary practices.

Table 5 provides summary information on land use in the McKenzie Brook Watershed, an example conservation practice scenario list, estimated extent of practice application, estimated phosphorus reductions by conservation practice and estimated costs. Some of the underlying assumptions built into this scenario include:

- 32% of the land in corn in 2014 was continuous corn,
- 30% of the land in hay in 2014 was continuous hay,
- this is the maximum reasonable amount of these conservation practices that could be implemented on farmland in this watershed,
- 90% of annually tilled cropland will planted to cover crops,
- overall, a little over 30% of the land in corn would use a conservation tillage-manure injection-cover crop system,
- the average cost of a grazing system that includes livestock exclusion is $50,000,
- the average cost of improvements necessary on a farmstead is $200,000.

It appears that the TMDL phosphorus reduction goal of 29,966 lbs/yr would not achievable using the level of practice implementation specified in Table 3. **This level of practice implementation would only achieve approximately 62% of the required phosphorus reduction in the watershed.** The cost of implementing this combination of practices to the extent identified would be approximately $13,879,000.

From Table 5 you can also see that the greatest reductions in phosphorus loading are achieved with livestock exclusion (5,592 lbs/yr), cover crops on annual cropland (2,772 lbs/yr), and conservation tillage systems (4,674 lbs/yr). This is largely a result of the large acreage available for implementation of these practices and the high reduction efficiency associated with livestock exclusion.

Table 5 – Example Practice Scenario with Phosphorus Reductions and Costs

McKenzie Brook - Practice Scenario to Meet TMDL Goal April 2015						
		Proposed TMDL Reduction Goal for Agricultural of 60% (estimated reduction of 26,000 lbs/yr)				
Cropping System		**No. of Acres**				
Corn in 2014		**5,576**				
Hay in 2014		**7,169**				
Pasture in 2014		**2,071**				
Farmstead in 2014		**447**	**47 HQ's**			
Cont. Corn*		**1,759**	*** From data 32% of corn in 2014 was continuous corn**			
Cont. Hay**		**2,151**	****Assumed 30% of the hay in 2014 was continuous hay**			
Corn-Hay Rotation***		**8,835**	***** Acres of corn/hay rotation equals the remainder from above**			
Scenario Components	**Selected BMP**	**No. of Acres Available**	**Percent of Total Acres**	**TP Load Reduction (lbs/yr)**	**Practice Cost per Acre**	**Total Cost**
Cont. Corn	Cover Crop-Conservation Tillage-Manure Injection	1,759	50%	739	$164	$432,714
Corn/Hay	Cover Crop-Conservation Tillage-Manure Injection	8,835	30%	1882	$164	$1,304,046.00
Cont. corn	Cover Crop	1,759	40%	387	$79	$277,922
Corn/Hay	Cover Crop	8,835	60%	2385	$79	$2,093,895
Cont. Corn	Crop Rotation	1,759	60%	507	$16	$50,659
Corn/Hay	Crop Rotation	8,835	50%	1590	$16	$212,040
Cont. Corn	Riparian Buffer	4	75%	12	$750	$2,250
Corn/Hay	Riparian Buffer	86	76%	211	$750	$48,750
Cropland	Grassed Waterays	302	76%	1104	$5,000	$1,150,000
Cont. Corn	Reduced Manure P (Nutrient Management and CAP)	1,759	75%	224	$19	$75,240
Corn/Hay	Reduced Manure P (Nutrient Management and CAP)	8,835	75%	660	$19	$376,200
Cont. Corn	Ditch Buffer	4	70%	18	$550	$0
Corn/Hay	Ditch Buffer	86	70%	253	$550	$0
Hay	Reduced P inputs and Injection	2,151	75%	161	$70	$338,100
Pasture	Livestock Exclusion	2,071	50%	2382	$50,000 ea.	$517,750
Pasture	Livestock Exclusion and Riparian Buffer (CREP)	2,071	50%	3210	N/A	$0
Farmstead	Waste Management Improvements	47 HQ's	49%	350	$200,000	$7,000,000
Total Reduction				**16,075**	**37% of Total Load**	
TMDL Target				**26,000**	**60% of Total Load**	
Total Watershed Load				**43,276**		
Total Cost						**$13,879,566**

Estimated Costs of P Reduction by Practice and System, and Costs per lb of Phosphorus

Important information for the Local Watershed Teams will be the cost of practice implementation. This information will be needed for the Teams to establish reasonable reduction goals for their local project and the timeline necessary to implement the project. The costs presented in Table 5 are the NRCS payments (based on 2015 payment schedules) to farmers to implement these practices and as such represent an average of 75% of the total cost. The greatest costs are for implementing reduced tillage systems ($1,736,000), cover crops ($2,371,000) and for farmstead practices ($7,000,000). The high cost for the reduced tillage systems and for cover crops is because of the large acreage available for implementation and because cover crops is an annual practices that NRCS can now pay up to 5 years of payments for. Farmstead costs are high because of the high cost of structural practices.

The total cost of using the practices in this scenario to meet the phosphorus reduction goals for agriculture is $13,880,000. This does not include any cost inflation factor if the implementation of practices is extended over a long time period. Another concern not addressed in this scenario is the relatively short time period for which NRCS can financially support annual practices such as cover crops. This scenario assumes only 5 years of financial support. Who will support the farmers to continue cover cropping after their NRCS contract expires and will they continue to implement these annual practices such as cover crops if there is no continued financial support for them.

One way to reduce the total cost of a project such as this one in the McKenzie Brook Watershed is to focus on implementing those practices where you get the greatest reduction of phosphorus per dollar. Table 6 shows the phosphorus reduction efficiencies of the different practices based on cost per pound of phosphorus. According to these calculations ditch buffers and crop rotations are the most cost effective practices in reducing phosphorus losses ($2 and $35/lb of P), while the farmstead practices are the least cost effective at over $5,000 per lb of P. However, there is no flexibility in the McKenzie Brook Watershed to maximize phosphorus reduction based on cost because the underlying assumption with this scenario was that it represented all reasonable practices that could be implemented by farmers and it still does not meet the TMDL goal.

Table 6 – Cost Efficiency of Available Conservation Practices

Agricultural Conservation Practice Efficiency in Cost Per Pound of Phosphorus Reduced			
Conservation Practice	NRCS Payment	Total Practice Cost	Practice Cost Efficiencey ($/lb P reduction)*
1. Change in crop rotation	$16	$21	$130
2. Change in crop rotation and conservation tillage	$51	$68	NA
3. Change in crop rotation, grassed waterway, ditch buffer and riparian buffer**	$50	$67	NA
4. Change in crop rotation, grassed waterway riparian buffer	$5,766	$7,688	NA
5. Change in crop rotation and riparian buffer	$769	$1,025	NA
6. Conservation tillage	$34	$45	NA
7. Cover crop	$79	$105	$550
8. Manure injection	$51	$68	NA
9. Cover crop, conservation tillage, grassed waterway, ditch buffer and riparian buffer	$6,413	$8,550	NA
10. Cover crop, conservation tillage and manure injection	$164	$219	$680
11. Cover crop and manure injection	$110	$147	NA
12. Annual crop to permanent hay	$209	$279	NA
13. Ditch buffer	$550	$733	$7**
14. Grassed waterway	$5,000	$6,666	$525
15. Grassed waterway and riparian buffer	$5,750	$7,666	NA
16. Manure injection and reduced manure P applied	$70	$93	NA***
17. Reduced manure P applied	$19	$25	$1,200
18. Reduced manure P applied and grassed waterway	$5,019	$6,692	NA
19. Riparian buffer	$750	$1,000	$39
20. Livestock Exclusion /Grazing system (estimated average)	$50,000	$66,666	$223
21. Farmstead practices (estimated average)	$200,000	$266,666	$20,771
*Based on the total NRCS cost			
**Ditch buffer efficiency currently set very high			
***Error in Model			

NEPA Concerns and Compliance

The National Environmental Policy Act of 1964 requires all federal agencies to conduct an environmental review of all federal actions. NRCS requires all agency planning activities to be in compliance with NEPA, this includes area-wide plans. The responsible federal agency is required to evaluate the individual and cumulative effects of the actions being proposed. Any project that has significant environmental impacts must be evaluated with an Environmental Assessment (EA) or Environmental Impact Statement (EIS) unless the activities are already covered under a categorical exclusion or by an existing EA or EIS.

NRCS utilizes a planning process that incorporates an evaluation of potential environmental impacts using an Environmental Evaluation checklist. NRCS also has categorical exemptions for a number of different activities that include many of our conservation practices. These categorical exemptions include conservation practices that reduce soil erosion, involve the planting of vegetation and/or restore areas to natural ecological systems.

The watershed plan for the McKenzie Brook Watershed calls for the accelerated implementation of conservation practices that have been used in the region for a number of years. This includes erosion control practices and field based practices that are covered by categorical exclusions, and a range of structural practices that are used to address waste management issues on the farmstead. These farmstead based practices are included in a Programmatic Environmental Assessment for the Environmental Quality Incentive Program A list of practices that are likely to be used to implement the plan are included in Table 7.

Table 7 - List of Practices and Practice Systems Likely to be Used to Implement the Rock River Watershed Plan
(CE = categorically excluded, EA = included in exiting environmental assessment)

1)	Change in crop rotation	CE
2)	Change in crop rotation and conservation tillage	CE
3)	Change in crop rotation, grassed waterway, ditch buffer and riparian buffer**	CE
4)	Change in crop rotation, grassed waterway riparian buffer	CE
5)	Change in crop rotation and riparian buffer	CE
6)	Conservation tillage	CE
7)	Cover crop	CE
8)	Cover crop, conservation tillage, grassed waterway, ditch buffer and riparian buffer	CE
9)	Cover crop, conservation tillage and manure injection	CE
10)	Cover crop and manure injection	CE
11)	Annual crop to permanent hay	CE
12)	Ditch buffer	CE
13)	Grassed waterway	CE
14)	Grassed waterway and riparian buffer	CE
15)	Manure injection and reduced manure P applied	CE
16)	Reduced manure P applied	CE
17)	Reduced manure P applied and grassed waterway	CE
18)	Annual cropland to permanent grass	CE
19)	Riparian buffer	CE
20)	Livestock exclusion/fencing/grazing system	CE
21)	Farmstead practices	EA

As mentioned above, as part of the planning process each planned practice will be evaluated individually and combination with other planned practices to ensure it meets the criteria of the categorical exclusions and any existing Environmental Assessments. Any significant negative practice impacts, either individually or cumulatively, will first try to be avoided, then minimized and/or mitigated to the extent possible, or eliminated from the individual farm plan if necessary.

It is not expected that the practices planned for implementation in the Rock River Watershed will necessitate an Environmental Assessment or an Environmental Impact Statement.

Local Watershed Team Actions and Outcomes

The McKenzie Brook Watershed Plan will be provided to the local NRCS office(s) working with farmers in the watershed. The Watershed Plan is not considered confidential and as such will be made available to all interested partners and the public. The Local Watershed Team also developed a number of products to guide and coordinate conservation practice implementation in the watershed.

<u>Field Scale Land Cover and Resource Maps</u>

These maps will be developed by the local NRCS office based on the spatial data layers provided to them and described in the Watershed Plan. The data layers may be used alone or overlain with layers as suggested in the Watershed Plan or as deemed necessary by the conservation planners. These maps will generally contain Personally Protected Information and will be considered confidential.

<u>Local Watershed Team Action Plan</u>

The McKenzie Brook Watershed Team was composed primarily of representatives of NRCS, FSA, UVM-Extension, VDEC and VAAFM. In addition there were several farmer representatives on the Local Watershed Team including members from the Champlain Valley Farmer Coalition.

The Local Watershed Team started the process by establishing 4 Key Strategies for successfully working with farmers to meet water quality goals. The four key strategies are farmer engaged conservation, outreach to farmers, technical assistance to farmers, and financial assistance to farmers

Logic diagrams were developed to capture a watershed outcomes and actions needed for each of the key strategies (see Figures 19 – 22). Then an Action Plan for the watershed was developed that identified the responsibility for each action and a timeline to complete the action as shown in Figure 23.

The Team also developed a five year implementation plan for the watershed. **As part of this plan the Team identified a phosphorus reduction goal that meets 50% of the TMDL goal for the watershed (13,000 lbs/yr) within 5 years.** Using information from the watershed plan, the group identified a suite of practices that could potentially meet this goal (Table 7). Practice implementation was distributed over a five year period and included high rates of implementation for practices such as conservation tillage systems, cover crops, crop rotations and ditch buffers. Annual costs of practices contracted ranged from $475,000 to $1,500,000 and totaled to over $6,300,000 for the five year period.

From Tables 3 and 4 it was estimated that conservation practices implemented or planned since 2010 would result in an estimated reduction of 2,328 lbs/year of phosphorus from the McKenzie Brook Watershed. The cumulative reduction in loading from the watershed would include some portion of this phosphorus reduction in addition to any reductions achieved during the 5 year project. As local planners work with farmers in the watershed they will verify that these practices have been maintained and that phosphorus loading reductions should be applied.

Tracking Database

An interim database will be developed to track practice implementation and estimated phosphorus reductions. This database will be updated at least annually and the results will be shared among partners and watershed farmers. This interim database will eventually be replaced by the "partner database" that is currently under development by the VAAFM and their consultant. Factsheets and media releases will be used to communicate progress in meeting the project goals to a wider audience.

Figure 19 – Conservation Actions and Outcomes

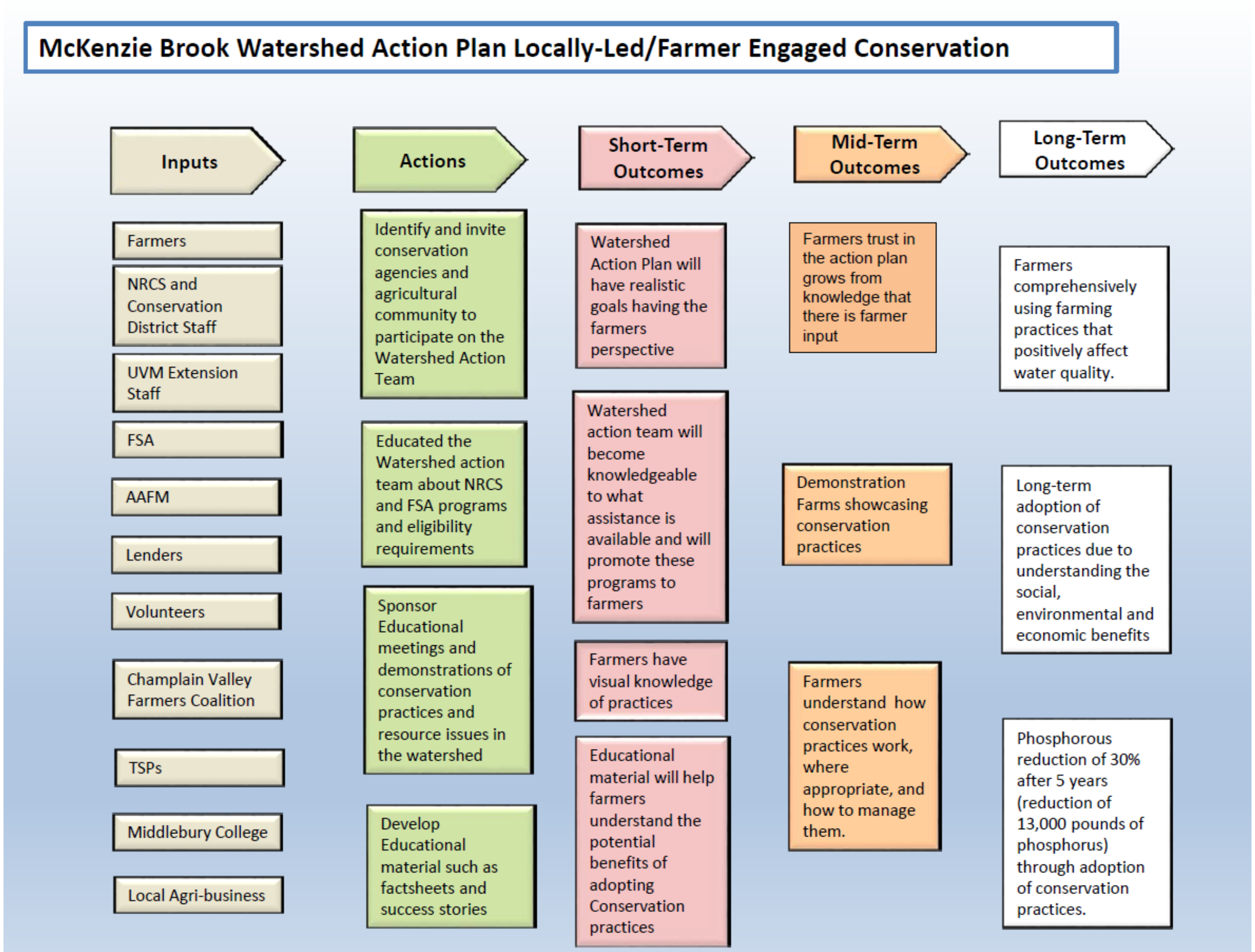


Figure 19 (continued)

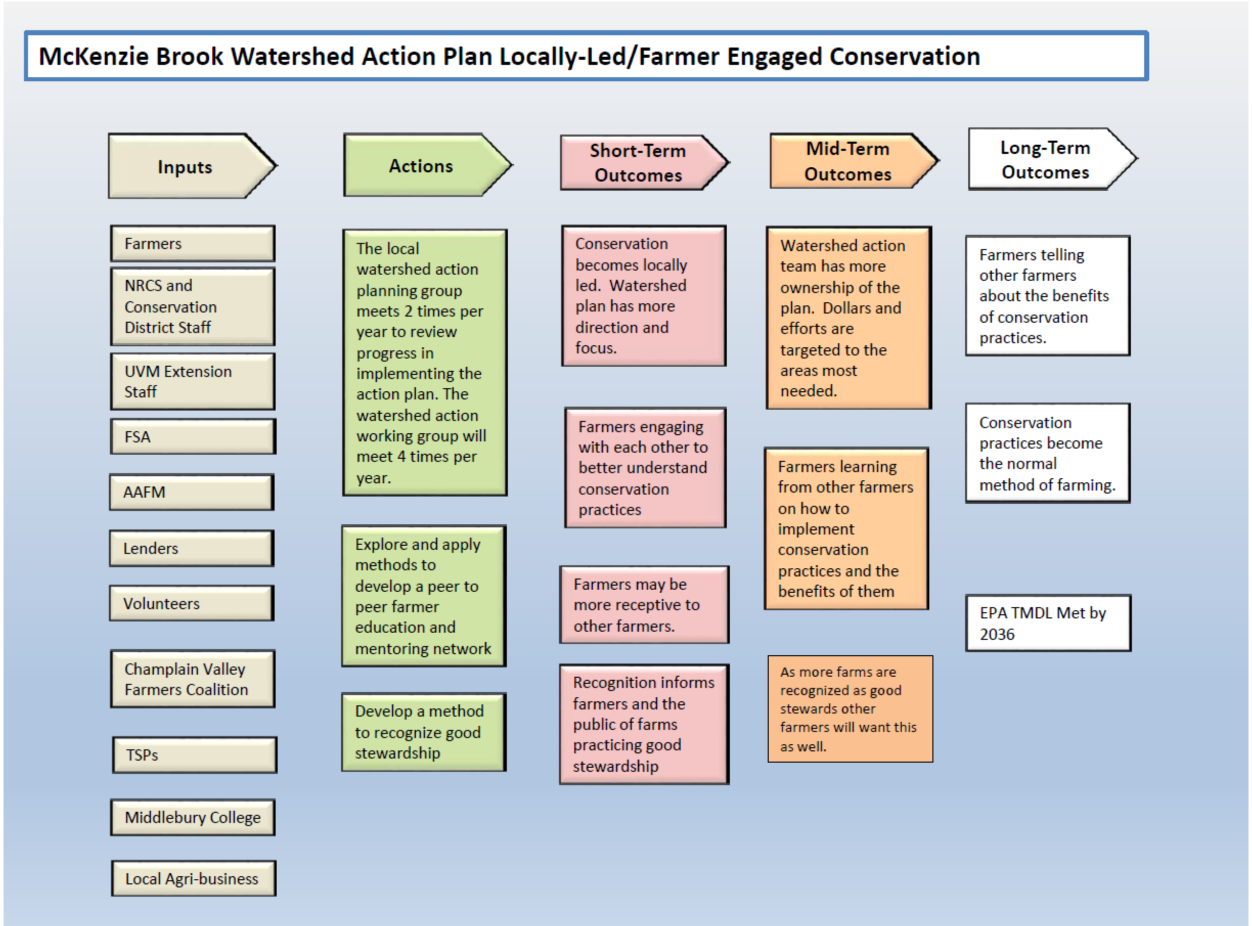


Figure 20 – Outreach Actions and Outcomes

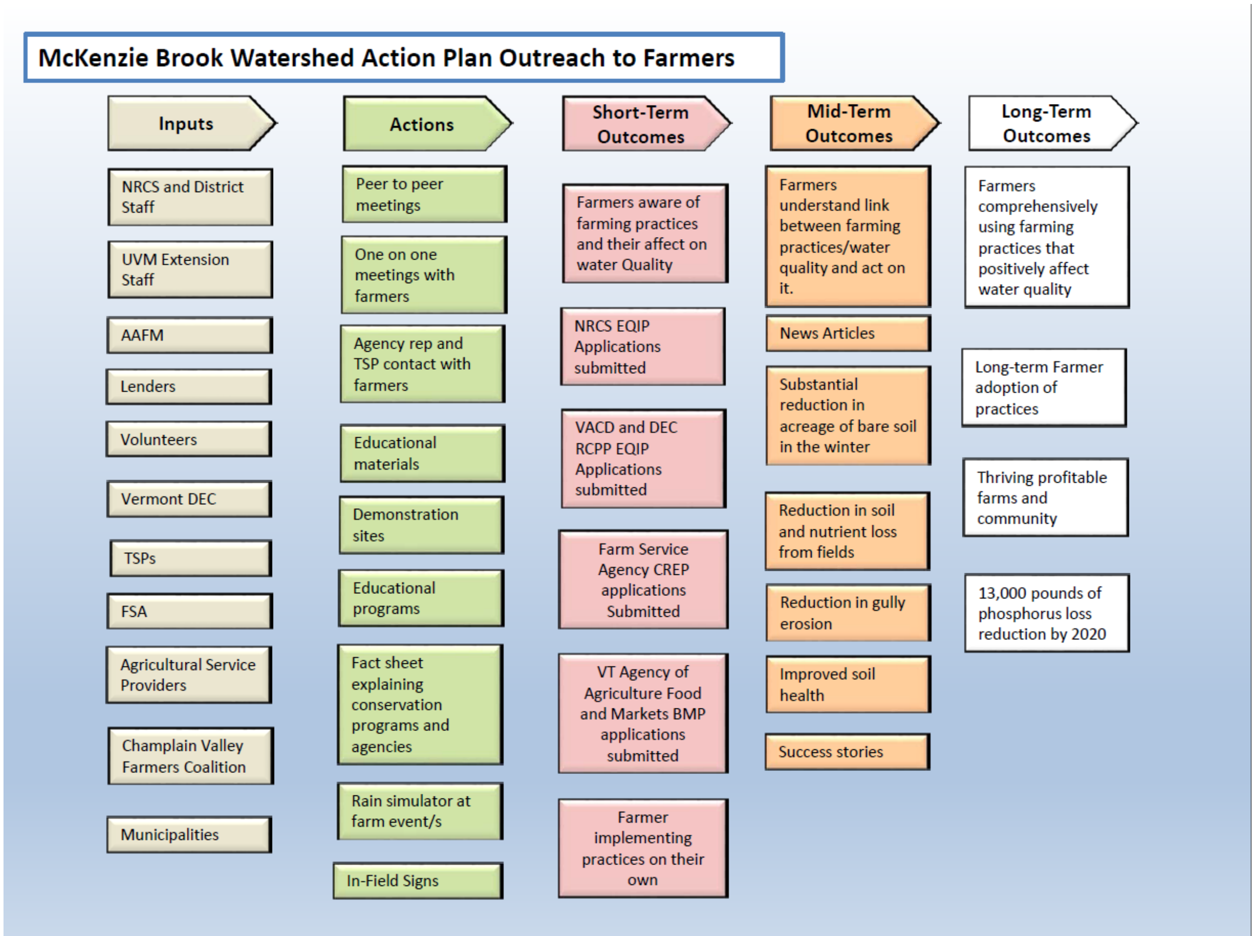


Figure 21 – Technical Assistance Actions and Outcomes

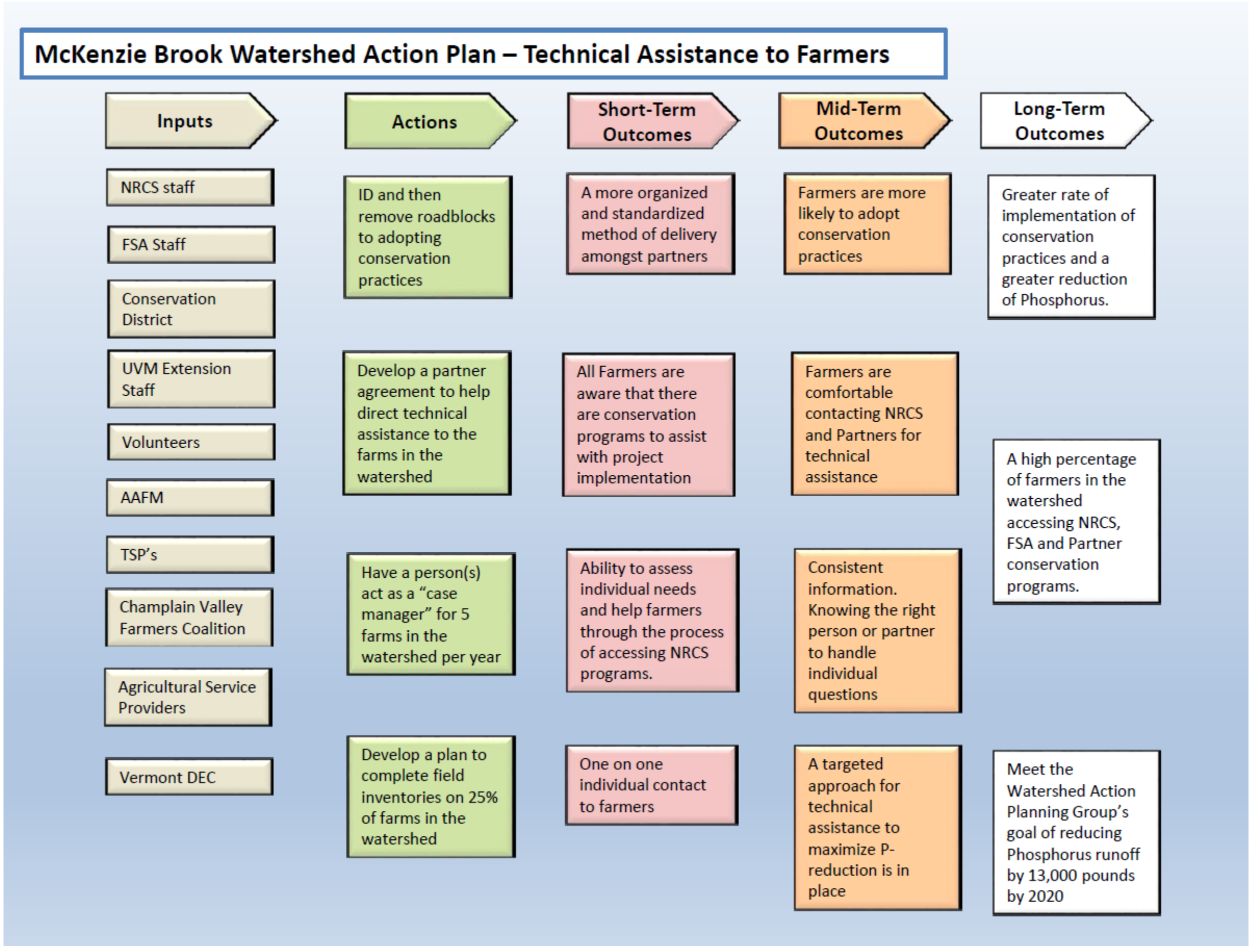


Figure 22 – Financial Assistance Actions and Outcomes

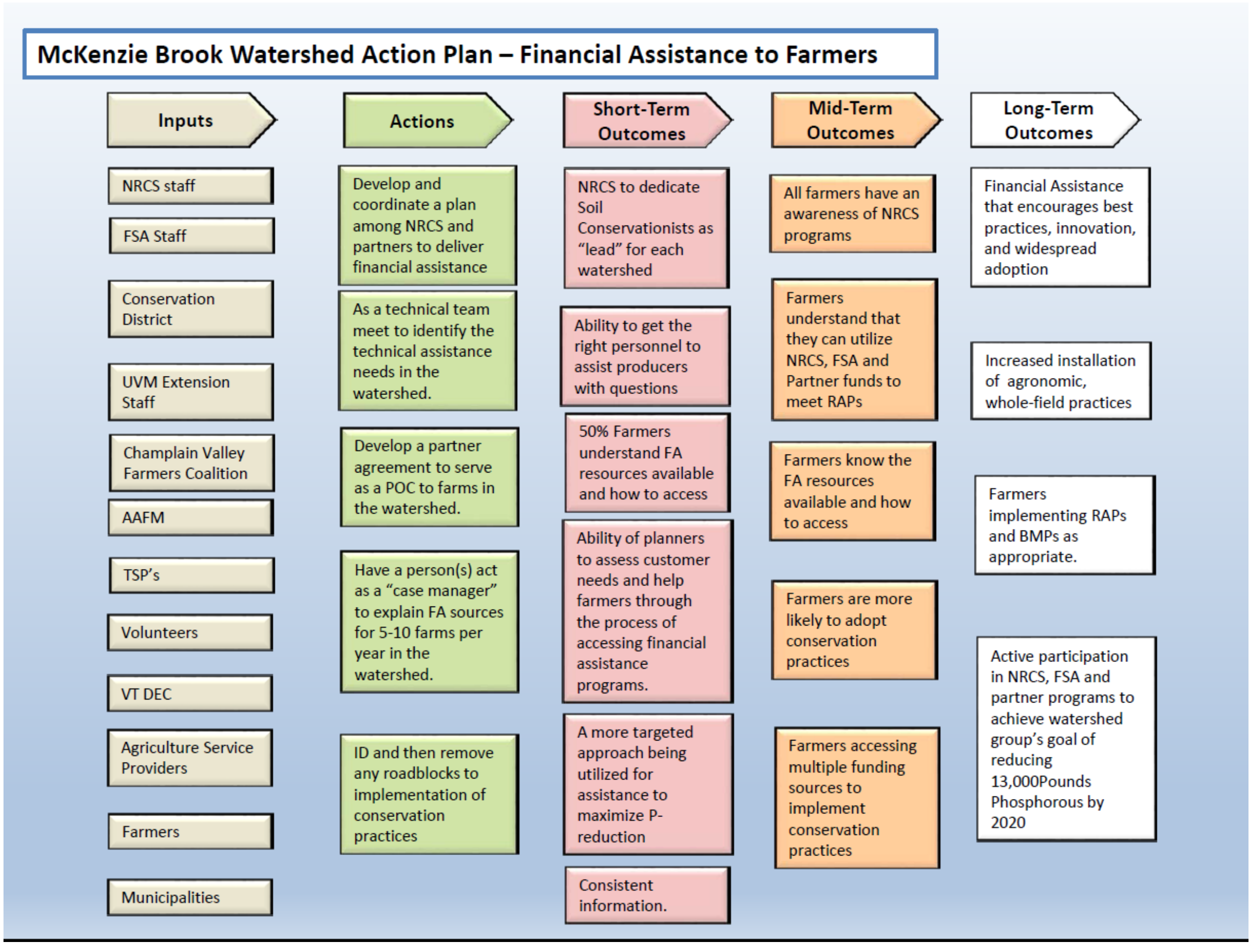


Figure 23 – Action Plan, Responsibility and Timeline

Action Plan for the McKenzie Brook Watershed Project				
Strategy I_ Locally-Led/Farmer Engaged Conservation				
Actions:	Description	Who is responsible?	When Begin	When End
Develop a watershed action team	Invite conservation agencies and agricultural community to watershed planning meetings to develop a strategic action plan for the McKenzie Brook Watershed	NRCS	08/01/15	04/30/16
Develop a method to recognize good stewardship	Provide a process to recognize good land stewardship and a way to have that recognized by the community	UVM ext, Champlain Valley Farmers Coalition and NRCS	06/01/16	12/31/17
Watershed planning group biannual meetings	Use this as a forum to show how we are moving towards meeting our goals, discuss success and areas that need improvement. Make adjustments to actions and desired outcomes	NRCS	04/01/16	12/31/17
Educate watershed action team on NRCS and FSA Programs	Provide a description of conservation programs and practices so that the watershed action team can better promote conservation programs.	NRCS	08/01/15	12/31/17
Peer to Peer education and mentoring	Farmers may be more receptive to having discussion about water quality objectives and solutions from another farmer	UVM ext, Champlain Valley Farmers Coalition	08/01/15	12/31/217

Educational meetings on conservation practices	Educational meetings are an important way to transfer technology, provide on the ground examples of practice implementation, and share new ideas.	UVM ext, Champlain Valley Farmers Coalition and NRCS to attend	08/01/15	12/31/17
Education material and success stories	Identify and contact two farmers in the watershed who are willing to be profiled in a public success story.	UVM ext and NRCS	06/01/16	12/31/17
Strategy 2: Technical Assistance to Farmers				
Actions:	Description	Who is responsible?	When Begin	When End
ID and then remove road blocks to adopting conservation practices.	Develop Action plan to implement the 4 key strategies through 12/31/2017	NRCS, UVM ext	01/12/16	04/30/16
Develop a plan for the delivery of technical assistance.	Develop a plan for the delivery of technical assistance to farmers in the McKenzie Brook Watershed	NRCS, UVM ext	01/12/16	04/30/16
Case management for 5 -10 farms- 2016	Serve as case manager for farmers regarding their NRCS EQIP contract application (including assisting them with completing the application form and associated documents necessary to be considered eligible for NRCS program benefits) especially related to agronomic practices (assist the participant in identifying fields for the application of cover crops, no-till, nutrient management plans and other practices). Assist NRCS with the certification of conservation practices including cover crops, no-till, and cropland buffers.	UVM ext	01/12/16	12/31/16
Case management for 5 - 10 farms- 2017	Same as above	UVM ext	01/12/16	12/31/17

Complete field inventories on 25% of the farms in the watershed	Track field inventories, practice contracting and implementation of farmers in the McKenzie Brook watershed especially as it relates to EQIP contracts, but should include practices farmers implement on their own.	NRCS, Conservation District, UVM Ext.	10/01/15	12/31/17
Strategy 3: Financial Assistance to Farmers				
Actions:	Description	Who is responsible?	When Begin	When End
Develop and coordinate a plan among NRCS and Partners to deliver financial assistance	Develop a plan for the delivery of financial assistance to farmers in the McKenzie Brook Watershed	NRCS, Conservation Districts and VAAFM and VT DEC	10/01/15	03/01/16
Identify technical assistance needs in the watershed	Develop a plan for the delivery of technical assistance to farmers in the McKenzie Brook Watershed	NRCS and UVM Ext	08/01/15	04/30/16
Develop a partner agreement to serve as a POC to farms in the watershed	To plan organize and deliver direct outreach and technical assistance to farmers in the Vermont Portion of the McKenzie Brook Watershed	UVM Ext	01/12/16	12/31/17
Have a person(s) act as a case manager to explain FA sources for 5-10 farms per year 2016	Access to FA can be a cumbersome process given the multiple state and federal agencies involved and differing program requirements. Having one point of contact to help go through the process will improve the process	UVM Ext, NRCS, Conservation District	10/01/15	12/31/17
Have a person(s) act as a case manager to explain FA sources for 5-10 farms per year 2017	same as above	UVM Ext, NRCS, Conservation District	01/01/17	12/31/17

ID and then remove any road blocks to the implementation of conservation practices.	ID and then remove any road blocks to the implementation of conservation practices.	NRCS, Conservation Districts and VAAFM, UVM Ext, and VT DEC	01/12/16	12/31/17
Strategy 4: Outreach and Education				
Actions:	Description	Who is responsible?	When Begin	When End
Develop and Implement McKenzie Brook Outreach and Education plan	NRCS and UVM Extension are to develop and track a McKenzie Brook watershed outreach and education plan to include target audiences, key messages, expected outcomes, and timeline with goal of ensuring that 95% of farmers in watershed are contacted regarding the EQIP program.	NRCS, Champlain Valley Farmers Coalition and UVM Ext	01/12/16	03/31/16
One-on One Contact with farmers. 2016	Initiate individual contact with 25% or farmers in the watershed to explain the water quality issues in the McKenzie Brook watershed and the goals of the watershed planning group as it relates to the EPA TMDL.	UVM Ext	01/12/16	12/31/16
One-on One Contact with farmers.2017	Same as above	UVM Ext	01/01/17	12/31/17
Collaborate with the Champlain Valley Farmers Coalition	Collaborate with the Champlain Valley Farmers Coalition to provide peer-to-peer farmer education and networking opportunities.	UVM ext with assistance of NRCS Middlebury Field Office	01/12/16	04/30/16

Farm Success Story 1	Identify and contact one McKenzie Brook watershed farmer who is willing to be profiled in published success stories with the intent of motivating other farmers to adopt conservation practices. Coordinate with the NRCS Public Affairs Specialist to develop outreach press release to the general public.	UVM ext with assistance from Amy Overstreet	08/01/16	12/31/16
Farm Success Story 2	Same as above	UVM ext with assistance from Amy Overstreet	01/01/17	09/30/17
Demonstration sites	Work with farmers within the McKenzie Brook watershed to establish demonstration farm sites for 10 conservation practices and outreach to other farms to have them visit these sites.	UVM Ext	01/12/16	01/12/17
Fact Sheet-1	1) A fact Sheet explain the McKenzie Brook Watershed Action Plan will be developed.	Amy Overstreet, Kim Peck, Laura DiPietro with review assistance from Middlebury NRCS Field Office	01/01/16	1-2/29/2016
Fact Sheet-2	2) A Fact Sheet explaining conservation programs offered by different agencies and technical assistance available will be developed.	Amy Overstreet, Kim Peck, Laura DiPietro with review assistance from Middlebury NRCS Field Office	04/01/16	06/30/16

In-Field Signs	In-Field Signs pointing attention to conservation practices will be designed, purchased and provided to farmers that have implemented practices.	Champlain Valley Farmers Coalition with placement by UVM ext. Amy Overstreet design, placing signs Middlebury NRCS Office	02/01/16	10/30/16
Educational Programs relating to water quality issues and conservation practices	Educational Programs relating to water quality issues and conservation practices to be held in the watershed or surrounding area. One per year.	UVM ext with assistance from Middlebury NRCS Field Office	01/12/16	12/31/17
Articles	Articles targeted to the general public related to watershed activities/successes (aggregated) to be written and distributed to the press. One or two per year.	Amy Overstreet with assistance from Middlebury Field Office and UVM ext.	01/12/16	12/31/17

Table 7 – Five Year Implementation Goals and Cost for the McKenzie Brook Watershed

McKenzie Brook - Five Year Project Goals
April 2015

Based on a Watershed Team Phosphorus Reduction Goal of 50% of the TMDL Targeted Reduction (estimated TMDL Target is 26,000 lbs/yr)

Cropping System	No. of Acres	
Corn in 2014	5,576	
Hay in 2014	7,169	
Pasture in 2014	2,071	
Farmstead in 2014	447	47 HQ's
Cont. Corn*	1,759	* From data 32% of corn in 2014 was continuous corn
Cont. Hay**	2,151	**Assumed 30% of the hay in 2014 was continuous hay
Corn-Hay Rotation***	8,835	*** Acres of corn/hay rotation equals the remainder from above

Scenario Components	Selected BMP	No. of Acres Available	Acres of Practice by Year and Total: 2016	2017	2018	2019	2020	Total Practice Acres Applied	Percent of Total Acres	Reduction (lbs/yr)	Practice Cost per Acre	Total Cost
Cont. Corn	Cover Crop-Conservation Tillage-	1,759	176	176	176	176	176	880	50%	739	$164	$432,763
Corn/Hay	Conservation Tillage-Manure Injection	8,835	451	530	530	530	530	2,571	29%	1826	$164	$1,265,128.80
Cont. corn	Cover Crop	1,759	176	200	300	200	200	1,076	61%	592	$79	$424,981
Corn/Hay	Cover Crop	8,835	800	1325	1325	1325	525	5,301	60%	2385	$79	$2,093,796
Cont. Corn	Crop Rotation	1,759	264	264	264	264	0	1,055	60%	507	$16	$50,659
Corn/Hay	Crop Rotation	8,835	884	884	884	884	884	4,418	50%	1590	$16	$212,040
Cont. Corn	Filter Strip	4	0	1	1	1	0	3	85%	13	$581	$1,975
Corn/Hay	Filter Strip	86	9	20	20	20	9	77	90%	251	$581	$44,853
Cropland	Grassed Waterays	302	0	0	30	30	30	91	30%	435	$5,000	$453,000
Cont. Corn	Reduced Manure P (Nutrient Management	1,759	176	176	176	176	176	880	50%	150	$19	$50,132
Corn/Hay	(Nutrient Management and CAP)	8,835	884	884	884	884	884	4,418	50%	442	$19	$251,798
Cont. Corn	Ditch Buffer	4	0	0	0	1	1	3	70%	18	$550	$0
Corn/Hay	Ditch Buffer	86	9	9	9	17	17	60	70%	253	$550	$0
Hay	Reduced P inputs and Injection	2,151	215	215	215	215	215	1,076	50%	108	$70	$225,855
Pasture	Livestock Exclusion	2,071	0	25	50	50	50	175	8%	403	$50,000 ea.	$87,500
Pasture	Livestock Exclusion and Riparian Buffer (CREP)	2,071	207	207	207	207	207	1,036	50%	3210	N/A	$0
Farmstead	Waste Management Improvements	47 HQ's	1	2	2	2	1	8	11%	80	$200,000	$1,600,000
			4251	4917	5072	4981	3904	23,126				
Total Reduction										13,000	50% of Target Load = 13,000	
TMDL Target										26,000	60% of Total Load	
Total Watershed Load										43,276		
Total Cost												$7,194,481

Scenario Components	Selected BMP	Cost by Year: 2016	2017	2018	2019	2020	Total
Cont. Corn	Cover Crop-Conservation Tillage-	86,592	86,543	86,543	86,543	86,543	432,763
Corn/Hay	Conservation Tillage-Manure Injection	221,892	260,809	260,809	260,809	260,809	1,265,129
Cont. corn	Cover Crop	69,481	79,000	118,500	79,000	79,000	424,981
Corn/Hay	Cover Crop	316,000	523,474	523,474	523,474	207,375	2,093,796
Cont. Corn	Crop Rotation	12,665	12,665	12,665	12,665	0	50,659
Corn/Hay	Crop Rotation	42,408	42,408	42,408	42,408	42,408	212,040
Cont. Corn	Filter Strip	232	581	581	581	0	1,975
Corn/Hay	Filter Strip	4,997	11,620	11,620	11,620	4,997	44,853
Cropland	Grassed Waterays	0	0	151,000	151,000	151,000	453,000
Cont. Corn	Reduced Manure P (Nutrient Management	$10,026.30	$10,026.30	$10,026.30	$10,026.30	$10,026.30	50,132
Corn/Hay	(Nutrient Management and CAP)	$50,359.50	$50,359.50	$50,359.50	$50,359.50	$50,359.50	251,798
Cont. Corn	Ditch Buffer	0	$0	$0	$0	$0	0
Corn/Hay	Ditch Buffer	0	$0	$0	$0	$0	0
Hay	Reduced P inputs and Injection	$45,171.00	$45,171.00	$45,171.00	$45,171.00	$45,171.00	225,855
Pasture	Livestock Exclusion	0	12500	25000	25000	25000	87,500
Pasture	Livestock Exclusion and Riparian Buffer (CREP)	0	$0	$0	$0	$0	0
Farmstead	Waste Management Improvements	200,000	400,000	400,000	400,000	200,000	1,600,000
		1,059,823	1,535,156	1,738,156	1,698,656	1,162,688	7,194,481