

BMP Implementation Survey Study Plan

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INTRODUCTION

Background

The N.C. Forest Service (NCFS) recommends that forest operators implement best management practices (BMPs) for forestry to protect water quality. In the 2006 BMP manual, the NCFS lists nearly 400 individual practices that relate to different components of a timber harvest or other forestry operations. Since 2000, the NCFS has carried out three statewide assessments of BMP implementation. The number of sites and overall BMP implementation rate are summarized by each report in Table 1 below.

Table 1. Summary of previous BMP implementation surveys

Report publication*	Data collection period	# sites	BMP Implementation %
2005	2000-2003	565	82
2011	2006-2008	212	85
2018	2012-2016	210	84

*The first two survey cycles presented in the table above assessed BMPs found in the 1989 edition of the NC Forestry BMP Manual. The third and pending fourth survey assess the current 2006 edition.

In the most recent cycle of surveys, we changed several important survey methods to improve data consistency, applicability and organization. Data was collected by a single staff member (forest water Quality senior specialist) rather than by regional field staff throughout the state. The survey was separated by EPA ecoregion boundaries (Omernik 1987) rather than by regional NCFS office boundaries. The use of ecoregions, which capture landscape scale differences, allows us to better understand how those differences can affect harvest success. We used the four different Level III ecoregions within the state from west to east: Blue Ridge (level III ecoregion code 66), Piedmont (45), Southeastern Plains (65), and Mid-Atlantic Coastal Plain (63). Finally, we assessed each component of a harvest separately instead of grouping them and assessing them as a single feature for the entire tract. For example, we assessed every skid trail segment separately, rather than assessing all skid trails as a single group. We found that these changes improved the quality of our data, and have decided to keep them for the next sequence of surveys.

This study plan will establish our objectives and methods for the fourth cycle of BMP surveys.

Survey objectives and questions

The primary objectives are to develop estimates based on a sampling of active or recently completed logging operations such as:

- The frequency of implementation of forestry BMPs for water quality;
- The frequency of risks to water quality when BMPs are not implemented or are implemented incorrectly; and
- Whether the rate of BMP implementation and relative risks to water quality have changed as compared to past surveys.

These estimates will be summarized at a statewide, ecoregional, and by organizational boundaries (NCFS regions and districts) scale. Additional analyses will be performed to determine if lower levels of implementation or higher risks to water quality are associated with additional factors such as land ownership type, the extent of preharvest planning and assistance from forestry management professionals and North Carolina ProLogger training. Due to the major changes to the number of survey questions and methodology between the second and the third survey cycles, we will be able to

compare these subsequent results to the previous assessment (2012-2016), but not earlier assessments.

Depending on the findings, outcomes of this project may include:

- Identification of additional training or educational needs for landowners, timber buyers, foresters and loggers;
- Help with determination of NCFS water quality forester staffing needs;
- Modifications to the current BMP recommendations to enhance successful implementation of forestry BMPs, and therefore increasing compliance with state and/or federal water quality protection rules, especially the N.C. Forest Practices Guidelines Related to Water Quality (FPGs) and the N.C. General Statutes (GSs) related to stream or ditch obstructions.
- Support regional characterization of BMP implementation in the southeastern U.S. by the Southern Group of State Foresters (SGSF) Water Resources Committee and affiliates.

Differences from previous surveys

Unlike the round of surveys conducted between 2012 and 2016, we do not expect this survey to differ greatly from its predecessor. Most importantly, we do not expect to alter the way we select sites, the questions that we ask or the individualized examination of certain harvest features. This consistency will allow us to compare results across reports.

This round of surveys will use the ESRI® smartphone applications Collector and Survey123 to collect and store data. The previous round of surveys used a Microsoft Access tool on Panasonic tablets. Collecting field data using the mobile device applications should allow for streamlined data collection and more practical outdoor use when compared to the older and heavier tablet computers. The data collection of this BMP survey will serve as a robust pilot study to understand how mobile apps could be used for other intensive field data collection that is conducted by the NCFS across its water quality, forest management and fire control program areas. In addition, the mobile app is integrated into a GIS platform that will make mapping of the survey sites more efficient.

We plan to incorporate soil erosion estimates into this project to quantify the erosion prevented by BMP implementation. Researchers at Virginia Tech University are leading an investigation into soil erosion and sediment delivery rates from harvesting operations across the physiographic regions of Virginia and North Carolina. The data generated from their study will produce a model that can estimate sediment delivery from different combinations of site characteristics and operational harvest components (haul roads, skid trails, decks, and general harvest areas) implemented with various levels of BMPs. Modeled soil erosion data collected by NCFS will utilize Virginia Tech's model to estimate sediment delivery stemming from the sites assessed in this project.

METHODS

Total sample size and stratification

The SGSF Water Resources Committee recommends using this equation to determine the appropriate sample size:

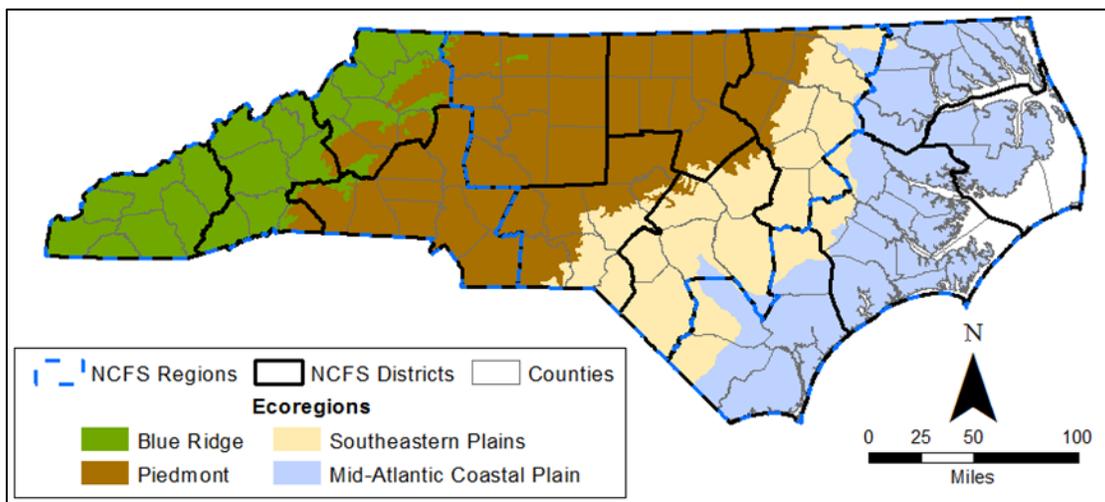
$$n = \frac{4p(100 - p)}{m^2}$$

where n = sample size; p = estimated percent implementation of BMPs statewide (84% or 0.84, based on the last survey); and m = margin of error (SGSF guidance suggests using 5% or 0.05, which corresponds to a 95% confidence level). This method results in a total statewide sample size of 215.04, rounded up to 216.

We will stratify our sample by ecoregion area as a proportion of total state land area. We also hope to conduct surveys in as many different counties as possible to further avoid bias and encounter a wider variety of operators, landowners, timber types and harvest techniques. However, we may not be able to find a suitable timber harvest during our data collection period in some of the more urban counties. The targeted number of survey sites for each ecoregion are listed in Table 2.

Table 2. Number of survey sites by ecoregion

Ecoregion	% of total NC area	Target number of survey sites
Blue Ridge	17%	37
Piedmont	37%	80
SE Plains	20%	43
Mid-Atlantic Coastal Plain	26%	56
TOTAL	100%	216



Site Identification

Potential survey sites will be identified using Landsat satellite imagery and processed using the SouthFACT online tool (www.southfact.com) and ArcGIS software. SouthFACT examines the changes in infrared radiation reflectance between images over time. In a timber harvest, practically all the live, green vegetation that strongly reflects infrared radiation is being replaced with bare soil or debris that does not reflect infrared radiation. Therefore, we can detect harvests by searching for drastic changes in reflectance. Data will be compiled and processed using the following workflow:

- First, we must download the satellite imagery for the desired area. Every eight days, new imagery may become available for a given area from either the Landsat 7 or Landsat 8 satellites. However, the state of North Carolina is broken up into six “scenes”, each available on a different day during the 8-day period.
- We may not always be able to use Landsat imagery. Significant cloud cover may obscure the image, and seasonal changes in foliage may produce false positive reflectance changes, causing delays in site identification. When we identify sites for this survey, we will use the most recent valid imagery available.
- After we submit a request, we receive a .zip folder with NDMI (normalized difference moisture index), NDVI (normalized difference vegetation index) and SWIR (short-wave infrared differencing) images, masks to remove clouds and Landsat 7 gaps from the images, and .lyr files to simplify symbology. For this project, we will only be examining the SWIR imagery since that product was found to be the most reliable in the previous survey.
- Using ArcGIS software, we will apply a series of masks to the images to remove clouds, Landsat 7 gaps and non-forest cover that could mistakenly be identified as timber harvests (a recently harvested crop field or pasture). We will also convert the data from raster imagery to vector polygons, dissolve and merge adjacent polygons and apply the given symbology to produce individual polygons that indicate significant changes in land cover.
- We will need to run several quality control checks on the produced polygons to improve reliability for when these results are used in the field. These steps include:
 - Removing polygons less than five acres in total size.
 - Checking the results against current satellite imagery to ensure our masks did not let any non-forestry related land cover changes pass through. This step may also remove sites that appear to be converting forestland to another land use, and therefore would not be surveyed.
 - Removing polygon outside of the state borders, or within areas that already have enough completed surveys.
- When we have a set of polygons we believe represents timber harvests that can be surveyed, we will save them into a centralized feature service hosted on NCDA’s ArcGIS online account.

This approach allows us to identify sites with little prior knowledge of the site’s history, reducing possible bias. However, SouthFACT may not always deliver valid imagery right when we need it since cloud cover, shadows or seasonal foliar changes can produce false positives. If we are unable to find sites using SouthFACT, we may rely on sites found during our travel throughout the state, or we may randomly select sites from NCFS records.

To appropriately assess risks to water quality, we will require streams to have an intermittent or perennial stream and/or waterbodies located within or adjacent to the harvest boundary. This stipulation could also include ditches, ephemeral streams or wetlands.

Preliminary field work

When potential survey sites have been identified, they should be added to the centralized feature service hosted on ArcGIS Online. This service will be included in the web map used to collect data, so whenever the service is updated, new potential site features will appear in the Collector smartphone app.

We will also do our best to notify local NCFS staff that we will be visiting the area. This may include the county ranger, assistant district forester, and/or water quality forester. In some situations, local staff may provide information on access or landowner/operator relationships.

Field assessments

Travel

Our decision to conduct surveys in an area at a certain time will depend on data needs and time and staff availability. We will travel to each site using NCFS agency owned vehicles. Based upon experience, we anticipate between two to four surveys getting completed each day. At times, overnight travel will be necessary to complete surveys in counties far from the Central Office. It's preferable to group these areas together, so all counties in said area can be completed during one trip.

We will randomly select sites to visit from those available in the hosted feature service. We may also choose to survey sites that we encounter during travel.

Arriving at the site

If an operator or landowner is present, we will attempt to speak with them before we begin our survey to gain a better understanding of the operation, site history and any possible safety hazards. If a landowner or operator at the site rejects our request to conduct a survey we will leave the site and abandon that survey.

The tract will be considered invalid if it holds any of the following characteristics:

- The site is less than five acres in total size. These small-scale operations happen frequently, tend to contain only a small suite of forestry BMPs and may be carried out by individual landowners rather than professional operators.
- The site is known to be a conversion from forestland to another land use. These operations carry different regulations that are enforced by agencies other than the NCFS. Operators in these situations may implement practices differently.
- Harvesting equipment or site conditions pose a safety risk to evaluators. When possible, these sites may be revisited later and surveyed when conditions improve.
- The operation appears to have been completed outside of the last six months. The regrowth of vegetation and/or presence of non-forestry land uses could obscure implemented BMPs or impacts from the logging operation.

FPG Compliance Determination

One notable addition in the fourth cycle of BMP surveys will be to assess the overall forestry-related, land disturbing activity for compliance with the North Carolina FPG standards. The FPG compliance determination will be made after completing the entire BMP site survey and data entry.

If the site/activity is suspected of being out of compliance with the FPGs, then the BMP evaluator will:

- 1 - Record the site as put of compliance in the BMP survey database.
- 2 - Take photograph(s) of the out of compliance problem.
- 3 - Notify the county ranger's office about the suspected out of compliance problem, share the photos and advise them to inspect the site so they can make the binding compliance determination so they can complete the appropriate NCFS water quality inspection form.

- If the subsequent inspection by the NCFS county office personnel does not align with the BMP evaluator's out of compliance determination, then the BMP evaluator will request the water quality forester to assess the site/activity and make the final decision.
- If the water quality forester determines that the site is in compliance, then the BMP survey database record will be changed to reflect 'in compliance'.

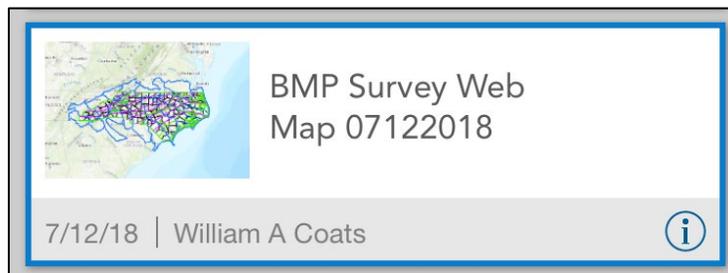
Data Entry – BMP Survey

Users should only use one form for the entire survey. If the user decides to split up the survey site into multiple units, they should use a separate survey form for each unit.

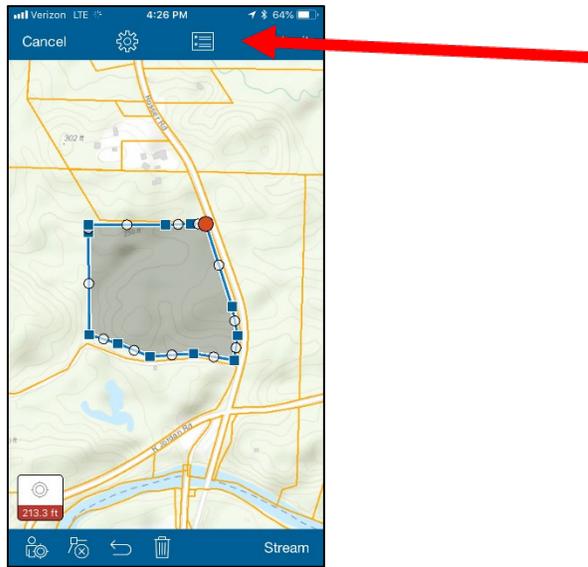
- From a smartphone, open the Collector app.



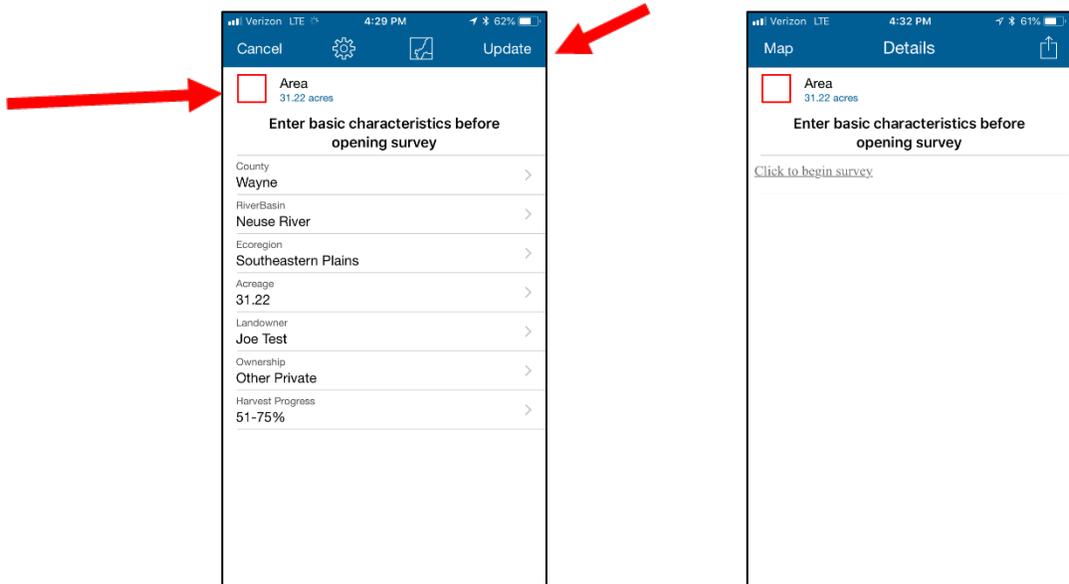
- Click on the web map named "BMP Survey Map". The map should zoom to and center on the users' current location.



- Click the "plus sign" at the top of the screen (in Android, this is a plus sign with a small box), then select the "BMP Surveys" feature. Before entering site characteristics, click the small map button at the top right of the screen. Draw a polygon outlining the area where the forestry operation is located.



- When you have finished drawing, click the list button at the top of the screen and enter the basic site characteristics. Click “Submit” when you are finished. If you need to go back and make changes to the attributes you have entered, click on the polygon, and then click the button with a square and an arrow in the bottom right corner (in Android, this will appear as a curved arrow). Then, press “Edit”. Make your changes, then press “Update”, in the top right corner.



- Click on the polygon and open the pop-up so that it fills the screen. Click the “Click to begin survey” link.

- Fill out survey.
 - Page 1 – Site Characteristics
 - This page includes basic information about the site that is currently being surveyed. Many of these attributes will be populated from the input in the Collector app. The user can also enter any other comments and add general pictures.

BMP Implementation Survey

Site Characteristics

Survey Date & Time
 Thursday, July 12, 2018 9:04 AM

Acreage
 31.2

River Basin
 Neuse

County
 Wayne

Ecoregion
 Southeastern Plains

Tract Ownership
 Private

Harvest Progress
 51-75%

- Page 2 – BMP Survey
 - This page allows the user to enter information about BMP implementation on the site, within drop-down sections for each BMP category. At the bottom of the page is a section outlining what is considered a “risk to water quality”.
 - For every BMP, the user will be answering two questions:
 - *Has the BMP been properly implemented?*
 - *Is there a risk to water quality?*
 - When the two questions are combined, each BMP can be answered in one of four ways. These options are given for every BMP listed in our survey.
 - The survey is designed to handle individually assessed BMPs. Generally, users will do this by selecting the BMP they wish to assess, then entering a number below each of the four answer options. They will then press the “plus” sign below the answer options to move on to the next BMP in that category and enter numbers for that BMP. If they would like to update an answer, users can navigate from different BMPs by pressing the left and right arrows.

BMP Implementation Survey

▼ Brush Barriers

▼ Brush Barriers -- Multiple Assessment

Select BMP:

Prop. Imp. / No Risk

Prop. Imp. / Risk

Improp. Imp. / No Risk

Improp. Imp. / Risk


◀ 2 of 2
+

- In some categories, users will be prompted to enter details about the feature being assessed such as the type of path at a stream crossing, or the type of stream being protected at an SMZ.
- Page 3 – FPG Inspection
 - This page allows a user to carry out an FPG inspection and enter the details in the form. The main section allows the user to select the noncompliant FPG, pinpoint the location, take pictures and provide any comments. By clicking the “plus” sign at the bottom right of this section, the inspector can add information about other areas of noncompliance. The bottom of the page contains a section defining each of the FPGs.

BMP Implementation Survey

FPG Assessment

▼ Non-compliant FPGs (repeat as needed)

Select Non-compliant FPG

Location of non-compliance

No Location
Position source access error


Press to capture location using a map

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Take a picture:

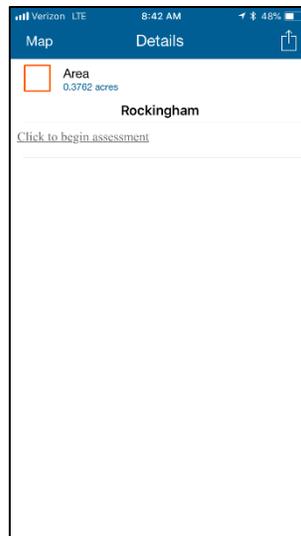
Comments:


1 of 1
+

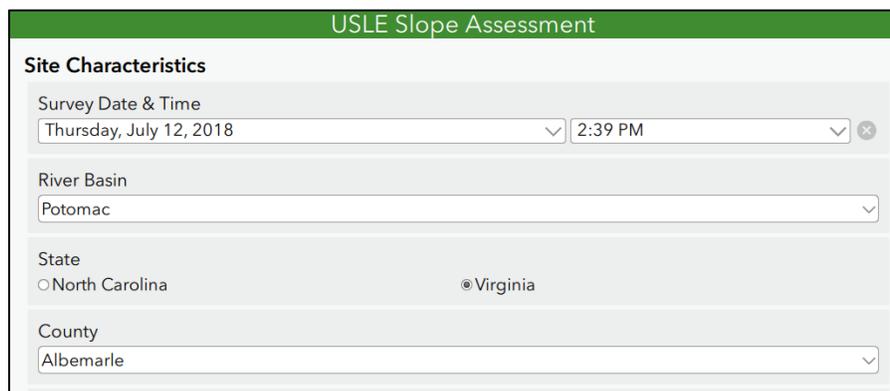
Data Entry – USLE Assessment

This form should be used once for each area of erosion associated with a harvest feature.

- From a smartphone, open the Collector app. Click on the web map named “BMP Survey Web Map”. The map should zoom to and center on your location.
- Click the “plus sign” at the top of the screen, then select the “USLE Assessments” feature. Before entering site characteristics, click the small map button at the top right of the screen. Draw a polygon outlining the area where erosion has occurred.
- When you have finished drawing, click the list button at the top of the screen, and enter the basic site characteristics. Click “Submit” when you are finished. If you need to go back and make changes to the attributes you have entered, click on the polygon and click the button with a square and an arrow in the bottom right corner. Then, press “Edit”. Make your changes, then press “Update” in the top right corner.
- Click on the polygon and open the pop-up so that it fills the screen. Click the “Begin Assessment” link.



- Fill out survey
 - Page 1 – Site Characteristics
 - This page includes basic information about the site that is currently being surveyed. Many of these attributes will be populated from the input in the Collector app. The user can also add any other comments and general pictures.

A screenshot of a web form titled 'USLE Slope Assessment'. The form is titled 'Site Characteristics' and contains several input fields. The first field is 'Survey Date & Time', with a date dropdown set to 'Thursday, July 12, 2018' and a time dropdown set to '2:39 PM'. The second field is 'River Basin', with a dropdown menu set to 'Potomac'. The third field is 'State', with radio buttons for 'North Carolina' and 'Virginia', where 'Virginia' is selected. The fourth field is 'County', with a dropdown menu set to 'Albemarle'.

- Page 2 – USLE Assessment
 - This page uses the USLE to calculate the predicted soil loss in tons per-acre annually from the user’s inputs. The first small section allows the user to enter their name, pinpoint the location of the slope and identify the feature associated with the assessment.
 - R Factor: This value can be passed over from the Collector entry. However, if not, the user will need to refer to an [R-factor map](#).
 - K Factor: The user can pass over the “SSURGO Key” and “Component Name” values from Collector. Once in Survey123, they will click on a link to a spreadsheet showing K Factor values for practically all soils in Virginia and North Carolina. They will then use the SSURGO key, component name and horizon to determine the exact K Factor value. They will need to switch back to the Survey123 app and enter the value there.
 - LS Factor: The user will need to measure the slope length (in feet) and steepness (percentage) on the ground. After entering those values, the form will calculate and display the combined LS factor value.

▼ **LS Factor Choices**

Slope Length
Feet:

Slope Steepness
Percent:

LS: Topography

- CP Factor: The user will be directed to answer a series of questions regarding crops, cover management and conservation on the slope. After answering some questions, the user will be directed to enter values from tables that appear as images. At the end of the section, the tool will calculate and display the combined CP Factor value.

Are there steps?
 Yes
 No

Steps (enter value from table)

Percent slope	Percent of total slope in steps										
	0	10	20	30	40	50	60	70	80	90	100
5	1.00	.99	.99	.98	.97	.96	.95	.94	.94	.93	.92
6	1.00	.97	.94	.92	.89	.86	.84	.81	.78	.76	.73
7	1.00	.96	.92	.88	.84	.80	.75	.71	.67	.63	.59
8	1.00	.95	.90	.85	.80	.75	.69	.64	.59	.54	.49
9	1.00	.94	.89	.83	.77	.71	.65	.60	.54	.48	.42
10	1.00	.94	.87	.81	.75	.68	.62	.56	.49	.43	.36
12	1.00	.93	.85	.78	.71	.63	.56	.49	.42	.34	.27
15	1.00	.92	.84	.75	.67	.59	.51	.43	.34	.26	.18
20	1.00	.91	.82	.74	.65	.56	.47	.38	.29	.20	.11
30+	1.00	.91	.81	.72	.63	.53	.44	.35	.25	.15	.06

.94

- Predicted soil loss: At the end of this section, if all the previous values have been entered, the tool will calculate an A-value, or a predicted loss of soil, in tons per-acre annually.

A: Predicted Soil Loss (tons per acre per year)

10.024359228

Offline Data Entry

If an assessor is unable to use a smartphone during a survey, they will be able to record results on a backup paper survey form. If the assessor can record the coordinates of the survey, they can determine most site characteristics later, using freely available resources. The forms do not require any of the fields to be entered before they are submitted, so the assessor can omit certain information if necessary. However, to maximize data accuracy, they will need to record certain site characteristics, BMP survey responses and USLE L, S, C and P factors while on the site. They will need to add any results from these surveys into the central database when they return to the office.

If smartphones are functional, but cellular data service or wireless internet is unavailable, assessors may still be able to use the digital survey forms.

Collector:

When looking at all available maps in the main menu, click on the cloud with an arrow next to the BMP Survey Web Map. You will then need to zoom in or out to select your work area of interest. You can then zoom in to select your map detail. Larger work areas and finer map details will lead to larger files and longer download times. Click download when you are satisfied with the work area and map detail.



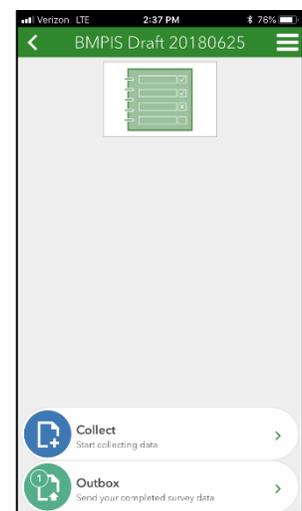
You can now make edits to this map while offline. When you have returned to an area with cellular data coverage or wireless internet, you can sync your edits with the central database by clicking the cloud with two arrows next to the BMP Survey Web Map on the main menu.

Survey123:

The Survey123 smartphone is designed to work offline by default if the survey has been previously downloaded when cellular data was available. Once a survey form has been completed, the survey will save in the app's outbox. Multiple survey forms can be completed and saved in the outbox while offline.

When the assessor has returned to an area with cellular data coverage or wireless internet, they will need to click on the survey form. To do this, click the "Outbox" button at the bottom of the screen, and then click the "Send" button in the bottom right corner.

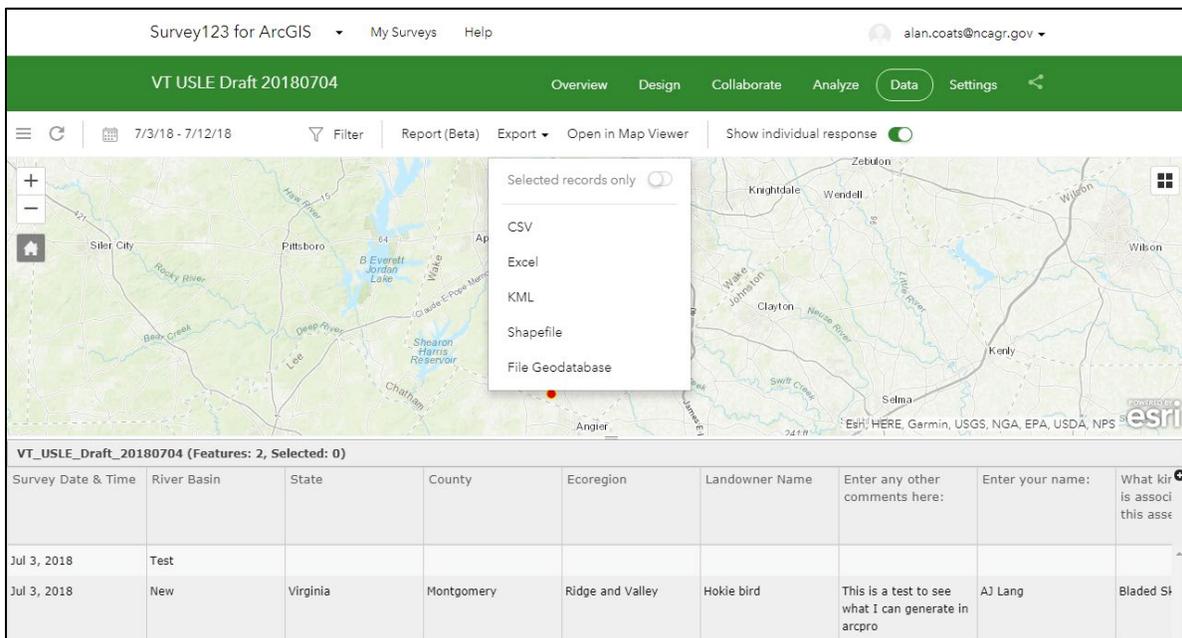
To access the K Factor table while offline, the user will need to install the Google Sheets app. When viewing the table within the app, click the three dots in the top right corner, then find the "Available offline" button on the toolbar that appears. Click the slider, which will turn green, indicating that the table is now available offline. This process will need to be done while the user is still within cellular data coverage or wireless internet.



Post field work

Once they have returned to the office after conducting a set of surveys, staff should carry out the following steps as quickly as possible.

- Notify appropriate county and/or district staff of sites that were visited, whether they were surveyed or not, and any potential FPG compliance issues that were seen.
- Validate or retrieve information about the site or activity that was not available during the survey such as logger name, landowner name, etc.
- Download photos and save to a folder created for that site.
- Download and backup survey responses.
 - The easiest way to do this will be to navigate to the [Survey123 website](#), find the appropriate survey form, click on the “Data” tab, then click “Export” and select a file format.
 - The user can also view the survey’s feature service in ArcGIS Pro, ArcMap or an online map, and then export the attribute table.



The screenshot displays the Survey123 for ArcGIS web interface. At the top, the title is "VT USLE Draft 20180704" with navigation tabs for Overview, Design, Collaborate, Analyze, Data (selected), and Settings. Below the navigation bar, there are controls for filters, reports, and map viewing options. A map of the region around Pittsboro, VT, is shown with a red dot indicating a survey location. An export menu is open, listing options: CSV, Excel, KML, Shapefile, and File Geodatabase. Below the map, a table displays the survey data.

Survey Date & Time	River Basin	State	County	Ecoregion	Landowner Name	Enter any other comments here:	Enter your name:	What kir is associ this asse
Jul 3, 2018	Test							
Jul 3, 2018	New	Virginia	Montgomery	Ridge and Valley	Hokie bird	This is a test to see what I can generate in arcpro	AJ Lang	Bladed St

Data analysis and reporting

Data analysis will examine BMP implementation, threats to water quality, and soil erosion potential. We will search for patterns between each of these results and site specific characteristics such as ecoregion, harvesting method and progress/phase of the harvest operation. Data analysis will be completed using R statistical programming software and Microsoft Excel. As in previous rounds of surveys, detailed results will be published in a nontechnical report. We may also create story maps, summary leaflets or other means of communicating to a range of audiences. The products will be disseminated via NCFs website and distribution of printed copies. Oral presentations will be given to external and internal audiences, and the results will be shared with the other members of the SGSF.

Project schedule

Ecoregion	Targeted sample size	Completed surveys	Remaining surveys	Estimated field time required to complete (work days)
Blue Ridge	37	0	37	15-20 days
Piedmont	80	0	80	25-35 days
SE Plains	43	0	43	15-20 days
Mid-Atlantic Coastal Plain	56	0	56	20-30 days
Total Field	218	0	218	75-105 days
Total Office	--	--	--	40 days
Estimated Total Field + Office Time	--	--	--	115-145 days

	2018		2019				2020			
	Jul-Sept	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec	Jan-Mar	Apr-Jun	Jul-Sept	Oct-Dec
Blue Ridge field work	■	■								
MACP field work			■	■						
SE Plains field work			■	■	■					
Piedmont field work				■	■	■				
Data compilation/analysis						■	■	■		
Draft report completed							■	■	■	
Internal review									■	■
Revisions										■
Final report completed										■

Expected Milestones

Field work started: Aug. 1, 2018

Field work completed: Sept. 30, 2019

Data compilation/analysis completed: Jan. 31, 2020

Draft report completed: April 30, 2020

Final report completed and ready for management review: Dec. 31, 2020

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