A Regional Protocol for Monitoring BMP Implementation and Effectiveness on Timber Harvest Operations

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The US Environmental Protection Agency (EPA) has cited a need for baseline monitoring information on forest harvesting to demonstrate compliance with the Clean Water Act and to respond to criticism of the silvicultural exemption. Historically, monitoring by state forestry agencies has been sporadic and anecdotal with little measurable evidence recorded. The Northeastern Area Association of State Foresters, Water Resources Committee initiated a project to develop and to test a standardized Best Management Practices (BMPs) protocol which provides the needed data for the 20-state Northeastern Area. A Phase 1 version of the protocol was developed in the fall and winter of 2001. Training and data collection occurred in nine states during the summers of 2001 and 2002, producing 97 samples and 21 quality control samples. Examples are provided to show the types of information that could be produced. However, they are not statistically sound because of the limited amount of data collected in each state. Beta testing is continuing through 2004 and 2005.

Keywords: *BMPs, Best Management Practices monitoring protocol, Northeastern Area*

The Need for a Monitoring Protocol

The term Best Management Practice (BMP) was originally defined in the 1987 Clean Water Act (CWA) to refer to precautionary activities designed to protect water resources during timber harvests. Currently, timber harvesting activities are exempt from the permitting requirements of the CWA when BMPs are used to protect water resources. In response to litigation, the US Environmental Protection Agency (EPA) is required to show evidence that the requirements of the exemption are being implemented. As a result, the EPA has long sought a standard BMP monitoring protocol that would provide measurable data that are reliable and comparable among states.

In its Technical Bulletin #820 published in January 2001, the National Council for Air and Stream Improvement, Inc., stated: "Most States recognize the potential for water quality impairment from timber harvesting, especially soil erosion and sedimentation caused by roads and stream crossings. The States repeatedly report a serious lack of monitoring information, and generally fall back on widely accepted generalizations about the impact of timber harvesting on water quality (NCASI 2001)."

Beard et al. (1999) stated that there is a serious problem in environmental monitoring because of measurement inconsistency. Results are often criticized and open to various interpretations. The only way to assure reliable information is to gather it in a consistent and well-documented manner. Sources that influence data collection errors and the consistency of monitoring results include timing of the measurements, location, external environmental factors, and most notably, change in personnel. All of these factors must be considered in any BMP monitoring protocol to ensure consistency of data and compatibility for analysis.

M Furniss, C Clifton, and K Ronnenberg, eds., 2007. *Advancing the Fundamental Sciences: Proceedings of the Forest Service National Earth Sciences Conference, San Diego, CA, 18-22 October 2004*, PNW-GTR-689, Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station.

Generally, state forestry agencies are in agreement that BMP monitoring should be implemented; however, barriers exist that hinder the states from having an effective monitoring program. Major hurdles have included costs, staff, time, variability of BMP practices among states, selection of practices to be monitored, activities monitored, and the method to be used to analyze the data.

How This Protocol Differs

This monitoring protocol is designed to assess the effectiveness of BMP use with respect to water quality goals and further identify easily discernible benchmarks at which BMPs are considered acceptable for protecting water quality. It evaluates the use of BMP principles, not individual practices. The premise is that it does not matter ***which*** practice is used to slow and disperse waterflow, but that practices ***were*** used and were successful in meeting the desired goals, such as preventing erosion and sedimentation. The impact of sediment on water quality has been adequately researched elsewhere and is beyond the scope of this protocol. This monitoring protocol is not intended to replace instream or biological assessments, but to produce a consistent site evaluation of BMP use and effectiveness.

The BMP principle approach permits the evaluation of data from a variety of practices or a combination of practices across a region. BMP principle categories used in this protocol include planning the operation, controlling waterflow, stabilizing disturbed soil, controlling and disposing of chemical pollutants from machinery, and minimizing undesirable impacts on a water body, such as heat and slash. By usng BMP principles, individual states maintain control of their BMP practice specifications, thus meeting their needs while allowing for regional analysis of monitoring results.

Under this protocol, all data are collected based on standard measures of physical evidence. States determine the acceptability of the degree of water quality protection provided by BMPs based on their unique resource situations. The protocol monitors and measures what happens during and after a harvest, but the acceptability of the level of protection is determined by the individual States. For example, sediment levels acceptable in the Mississippi River may not be acceptable in Appalachian trout streams.

This method also fosters continuous improvement by allowing state forestry agencies and other educators to focus training efforts on identified problems or weaknesses in BMP implementation. Taken together, these characteristics add considerably to the credibility of BMP monitoring results.

Protocol Components

Data Dictionary. The BMP monitoring protocol consists of a series of questions with an array of answer choices, which functions much like a dichotomous key. The questions and related answer choices were programmed into a Trimble GEO 3 GPS unit[1], but have since been programmed into other data collecting units using Windows-based pocket PC software.

Participants. During the pilot phase of this project, nine states and one industrial landowner were trained in the use of the protocol and the GPS data collection equipment. The participants included: New York City, Watershed Agricultural Council; state of New York, Department of Environmental Conservation; state of New Hampshire, Department of Resources and Economic Development, Division of Forests and Lands; state of Maine, Department of Conservation, Maine Forest Service; state of Maryland, Department of Natural Resources, Forest Service; state of West Virginia, Department of Commerce, Division of Forestry; Commonwealth of Pennsylvania, Department of Conservation and Natural Resources, Bureau of Forestry; state of Ohio, Department of Natural Resources, Division of Forestry; state of Indiana, Department of Natural Resources, Division of Forestry; and MeadeWestVaco, Maine.

What is Monitored and Where?

The protocol focuses monitoring on the following logging, road construction, and road maintenance activities: At haul road water crossings; at skidder water crossings; at haul roads or landings within filter/buffer zones; within state-specified filter/buffer zones; and the slope distance outside the filter/buffer zone.

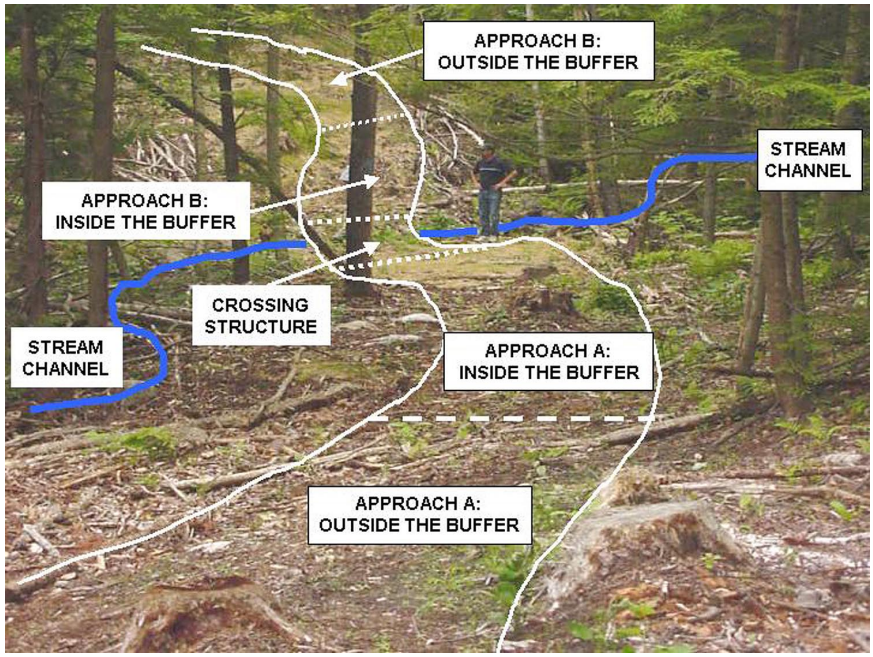
Monitoring activities within these focus areas will improve efficiency by focusing efforts in locations that typically have the highest potential to affect water quality.

Focus Areas. The protocol is made up of a series of question sets relating to each of these focus areas (Figure 1). The outline of the protocol includes:

1. **General focus area.** This focus area gathers information on landowners, the timber sale contract, location and year logged, acres harvested, and other site information.
2. **Haul road water body crossing and attribute focus area**

[1]The use of trade or firm names in this publication is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

Figure 1. Protocol focus areas.



Approaches "A" and "B", on either side of the stream
Inside and outside the buffer evaluation
Crossing structure evaluation (fords, bridges, and culverts)

3. **Skidder water body crossing and attribute focus area**
   Approaches "A" and "B", on either side of the stream
   Inside and outside the filter/buffer evaluation
   Crossing structure evaluation
4. **Filter/buffer focus area**
   Filter/buffer attributes
   Shade evaluation
   Woody debris recruitment potential
   Slash additions to water body evaluation
   Inside and outside the filter/buffer evaluation
5. **Chemical pollutants focus area.** Determines whether oil, gas, anti-freeze, brake fluid, battery lead, and other materials and containers were left at the site and if the products have the potential to reach surface water or groundwater.

Sample Unit. A "sample unit" was defined to eliminate averaging the evaluations of multiple water crossings on large harvest sites.

A sample unit is a contiguous harvest unit that includes either a riparian zone or a water body crossing, or both (see Figure 2). It is bounded by any combination of water bodies and the boundary of the harvest area or a land ownership boundary. The sample unit starts when a water body is crossed or a riparian area entered. A new sample unit begins each time a water body is crossed and ends at the next water body, the edge of the harvest area, or the land ownership boundary, whichever is encountered first.

Sampling. The first phase of the project was not intended to gather reliable data, but to test the protocol under a variety of site conditions throughout the Northeastern Area. Sampling was neither random nor unbiased. Each participating state chose ten sites to sample with the intent of testing the protocol on as many diverse sites and conditions as possible. The diversity of sample units was based on soils, topography, geography, or other characteristics that were identified as important to the individual state or company.

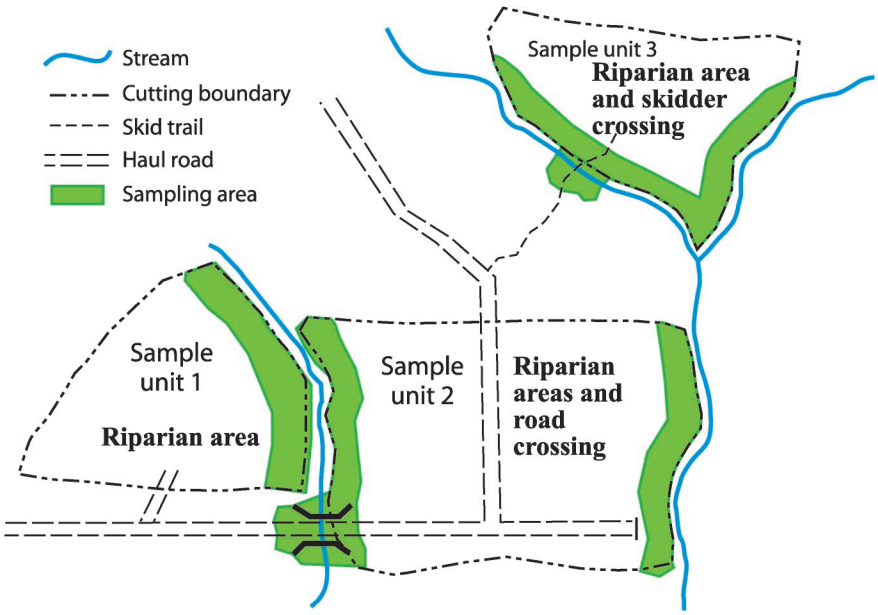
Different monitoring teams revisited three of the ten sites in each state to conduct a blind quality control sample. The returning monitoring team had access to only the general information section of the initial sample data in order to locate the sample unit. The quality control sample was used to determine which questions were producing consistent results and which questions needed to be clarified. The goal was to strive for a repeatable process, which returns consistent evaluations by different individuals.

ELECTRONICALLY MANAGING DATA

Purpose. The protocol is intended to be used to collect field data across a wide geographic area and simplify data entry.

Equipment. The question sets were programmed into Trimble GEO 3 GPS units using Pathfinder Office Software version 2.90. Revised question sets have since been programmed to run on several types of data collecting

Figure 2. Sample Units.



equipment using Microsoft WindowsTM pocket PC software.

Collecting Data. Data were collected during the 2001 and 2002 field seasons. All GPS locations were collected based on the World Geodetic System (WGS) 84 datum and sent to the Maine Forest Service for analysis.

Processing Data. The participants sent data files to the Maine Forest Service by e-mail or CD-ROM. Data processing was a little more time consuming than anticipated because of entry errors. However, this resulted in greater use of drop-down lists in subsequent versions of the protocol, streamlining the process and eliminating most recording errors.

Data from individual states were combined in ESRI ArcInfo and exported to Microsoft Excel for data comparison.

Reporting Results Using the Pilot Project Data

Note: *The data were collected in 2001 and 2002 to test the monitoring protocol and analyzed to demonstrate how the results could be illustrated. Therefore, these data are not a statistically meaningful representation of conditions on the ground, but simply a test of the procedure and examples of possible data outputs.*

Ninety-one sample units were observed. Of these, 79 were water crossings involving a culvert, bridge, or ford; 37 were haul road crossings; and 46 skidder crossings. Results of the data collecting can be grouped into six BMP categories (Figure 3).

In summary, the results show that:

- Sediment was not discharged on 25 of the 91 sample units.
- Fish passage was not blocked at 66 of the 79 water crossings.
- Stream channels were unaltered at 73 of the 79 water crossings.
- Plastic containers or chemical spills (Hazmat) were not found on 84 of the 91 sample units.
- Slash from the current harvest operation was not added into stream channels on 22 of the 41 riparian areas observed.
- There was less than 40 percent shade reduction on 7,356 m (24,135 ft) of the 9,808 m (32,180 ft) of surveyed filter/buffer strips.

The BMP implementation and effectiveness monitoring results (Figure 4) are based on 395 total observations in 91 sample units during the initial protocol testing in 2001. An "observation" should not be confused with a "sample unit." While conducting monitoring within a sample unit, many observations are made in Approaches A and B, inside and outside the filter/buffer, and at the crossing itself. Specific examples of results include:

- Soil was stabilized and waterflow was effectively controlled 80 percent of the time when BMPs were adequately implemented.
- The first three bars represent 198 observations that recorded no soil movement, i.e., those observations were stable. However, the remaining 197 observations indicate that there was either soil movement or a sediment discharge into a water body. For example, there was soil movement 26 percent of the time and discharge 40 percent of the time when BMPs were not applied (4th bar set).
- Although BMPs were applied, they failed to prevent soil movement 19 percent of the time.

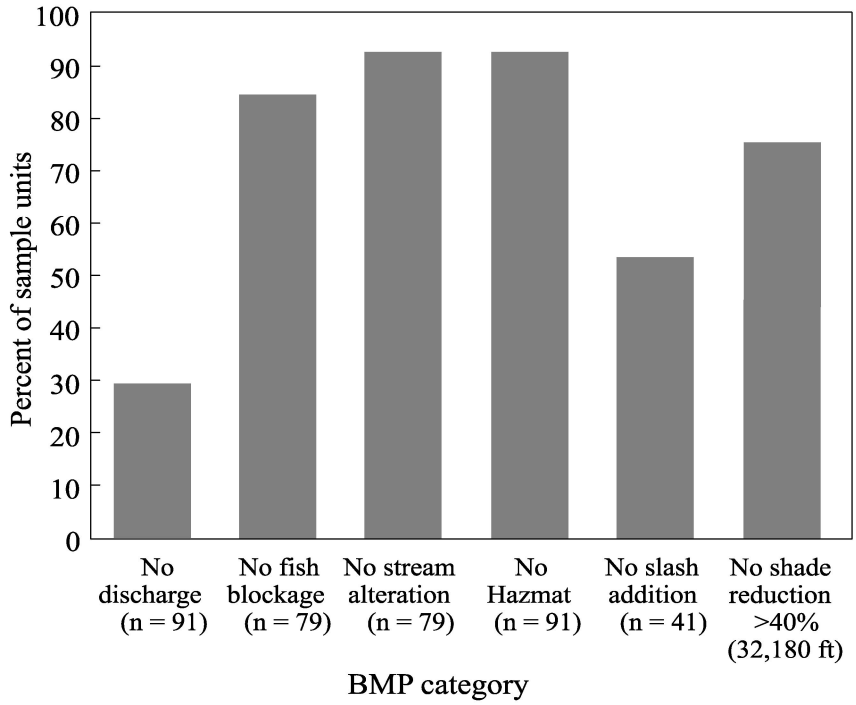


Figure 3. Overview of BMP categories by "sample unit".

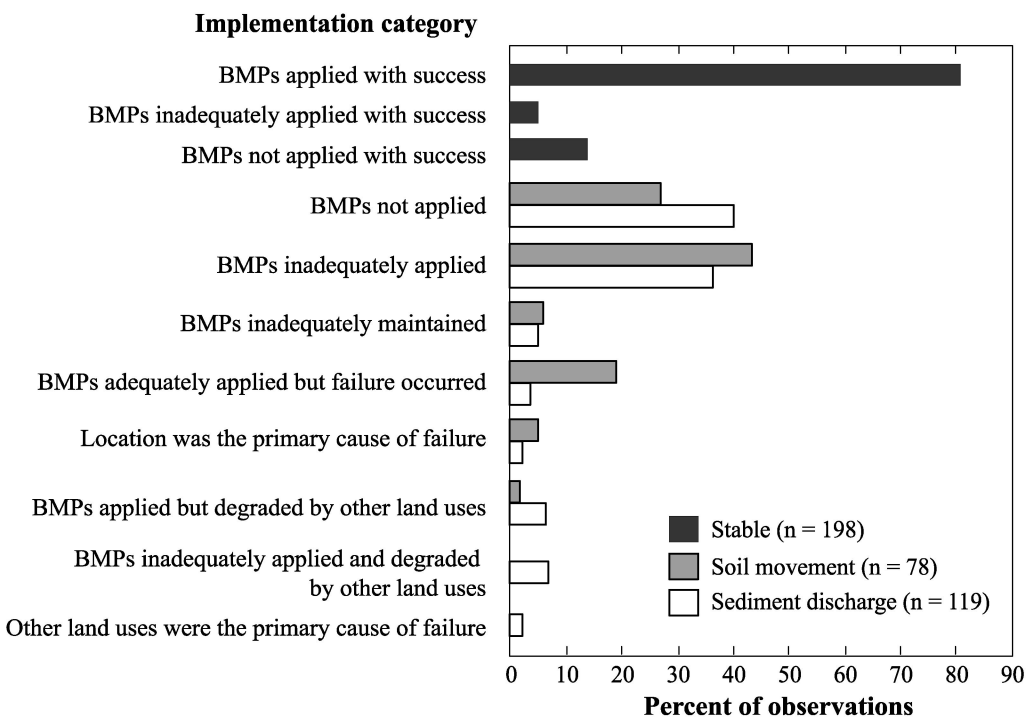


Figure 4. BMP implementation and effectiveness for soil stabilization and waterflow control based on BMP practice functionality.

- BMPs rarely failed due to impacts of other land uses (OLU).

Haul road crossings. Data can be assessed by sediment delivery mechanism and primary cause of sediment discharge at haul road crossings. There were 37 sample units with haul road crossings. Sediment discharges resulted from sheet flow, soil slumping, and soil dropping into the water body at 20 locations (Figure 5). The second highest discharge category was direct ditches at seven of the locations.

For haul road crossings (Figure 6), the road structure or design was the primary cause of soil discharges (38 percent of discharges). Instability of the crossing structure (22 percent) and maintenance of the crossing structure (16 percent) were also noticeable contributors to soil discharges from haul road crossings.

Data input is done in the field using a variety of recording devices that use Windows software for portable PCs. Once

Figure 5. Haul road discharges by discharge category.

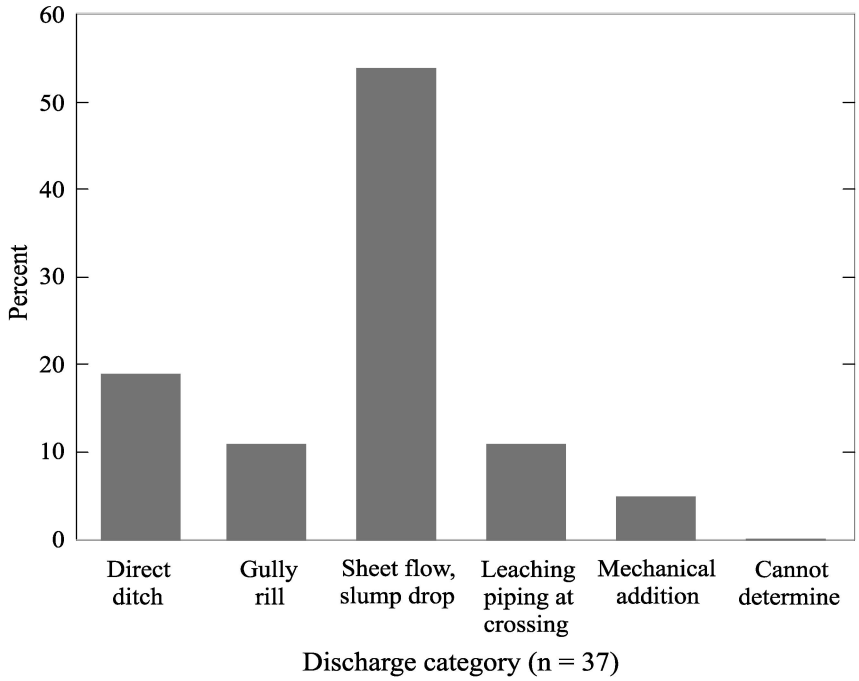
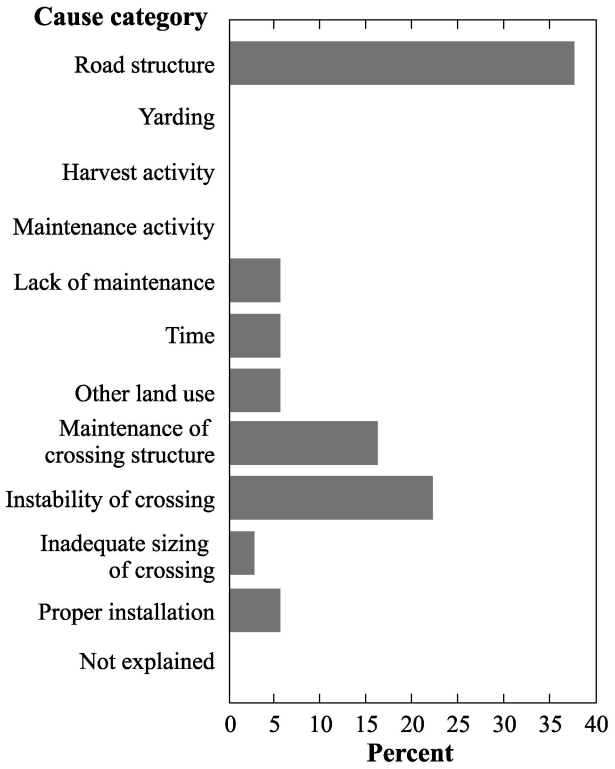


Figure 6. Haul road discharges by cause.



data are collected, the files are uploaded to a desktop computer and automatically combined with previous files in a Microsoft Excel spreadsheet. No additional office work is needed, which reduces error and saves time.

A standard data summary generator creates the types of data, which has been discussed above. Further refinement of the data will be possible with additional queries.

The results of the data can be used to focus training on improving BMP design specifications or installation and implementation errors. Specific examples include: Adjusting riparian buffer widths; using crossing structures with larger openings and open bottoms; and improving maintenance of roads and crossing structures.

Conclusions and Recommendations

The approach to BMP monitoring using this BMP protocol appears to account for most of the topographic, soil, and geographic differences in the test area. Evaluation of BMPs based on their principles and desired function is a key component that allows the development of a standard BMP monitoring protocol which is workable across broad geographic and political variables.

An analysis was done comparing sample units with their quality control samples to determine how well different individuals independently evaluated the same site. We found that, for any given question, the participants usually came up with the same answer for the quality control sample as in the original sample. The goal was to attain a 90 percent match on most questions. The data show we fell short of our goal; however, based on comments during the training and suggestions after data collection, it appears that most of the improvements needed to obtain a 90 percent match can be accomplished by editing the text of some of the questions and answers. The other improvements regarding consistency among observers will come from training and added experience as the protocol is used.

There was a need to edit the protocol questions as well as to reduce and combine specific questions and answers. Improvements to user friendliness were accomplished by automating the movement to subsequent questions based on the selected answer.

Since the data were collected electronically in a compatible database format, there was no data entry other than the initial electronic entry in the field. This greatly reduces costs of data entry, reduces errors, and allows the data to be transferred easily by e-mail and entered directly into the main database.

Data collection with the Trimble GPS unit was successful overall during the 2001 and 2002 field seasons. It is our goal to reduce costs, increase user friendliness, and keep the amount of data entry required at the office to a minimum. At the suggestion of participants, the protocol has been adapted to more economical and user-friendly Pocket PCs, Palm Pilots, and other hand-held equipment.

Based on the data and participant comments, this project has moved to the next phase, which expanded the use of an edited version of the current protocol. Beta testing with new equipment and an updated version of the protocol was conducted during the 2004 and 2005 field seasons.

Once the data are analyzed, it is our hope that the participants and additional states will accept the standardized protocol to facilitate the gathering and assessment of data over the Northeastern Area. We will continue to assist states in the development of an effective BMP monitoring program and encourage states to conduct their monitoring using the protocol. States will be able to develop their own sampling design, generate automated reports, and maintain a database. The data should be of immeasurable value in improving BMP effectiveness and verifying enforcement of the CWA.

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