

Indiana DNR Division of Forestry

State Forest Properties

1996 through 2014

Forestry Best Management Practices Monitoring Results

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**1996 through 2014
State Forest BMP Report**

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I. Executive Summary

Forestry BMP monitoring, as an internal audit by Division of Forestry personnel of all timber harvests on State Forest Properties, began on Nov. 1, 2000. Timber harvests being sold starting July 1, 1999 were monitored when Forestry BMPs were included on the timber sale contract and enforced, even though they commonly were practiced since the 1980's. The Statewide Forestry BMP program conducted 4 rounds of monitoring before this time in which state properties were monitored by monitoring teams that included DoF personnel as well as private and industry individuals interested in forestry in the state. This report includes 495 timber harvests monitored for Forestry BMPs between Nov. 1, 1996 and Dec. 31, 2014, and ranging in size from 1 to 821 acres.

The overall rates for forestry BMPs on state forests since 1996 are 86.19% application and 92.49% effectiveness in protecting the soil and water quality of the 495 sites monitored. In other words, 86.19% of the practices were applied as directed in the BMP guidelines, and another 13.16% were classified as minor departures as defined in the monitoring sheet (Appendix B). Major departures (141) represent only 0.64% of all practices monitored. Of the total 495 sites monitored on State properties, only one application question (0.00%) has scored a "Total Negligence." Of the 7.51% of BMPs that were ineffective at protecting the resources of the site, 2.94% were indirect and temporary, 0.99% were indirect and prolonged, 2.41 % were direct and temporary and 1.18% were direct and prolonged in their impacts.

Figure 1: Overall state forest BMP application percentages.

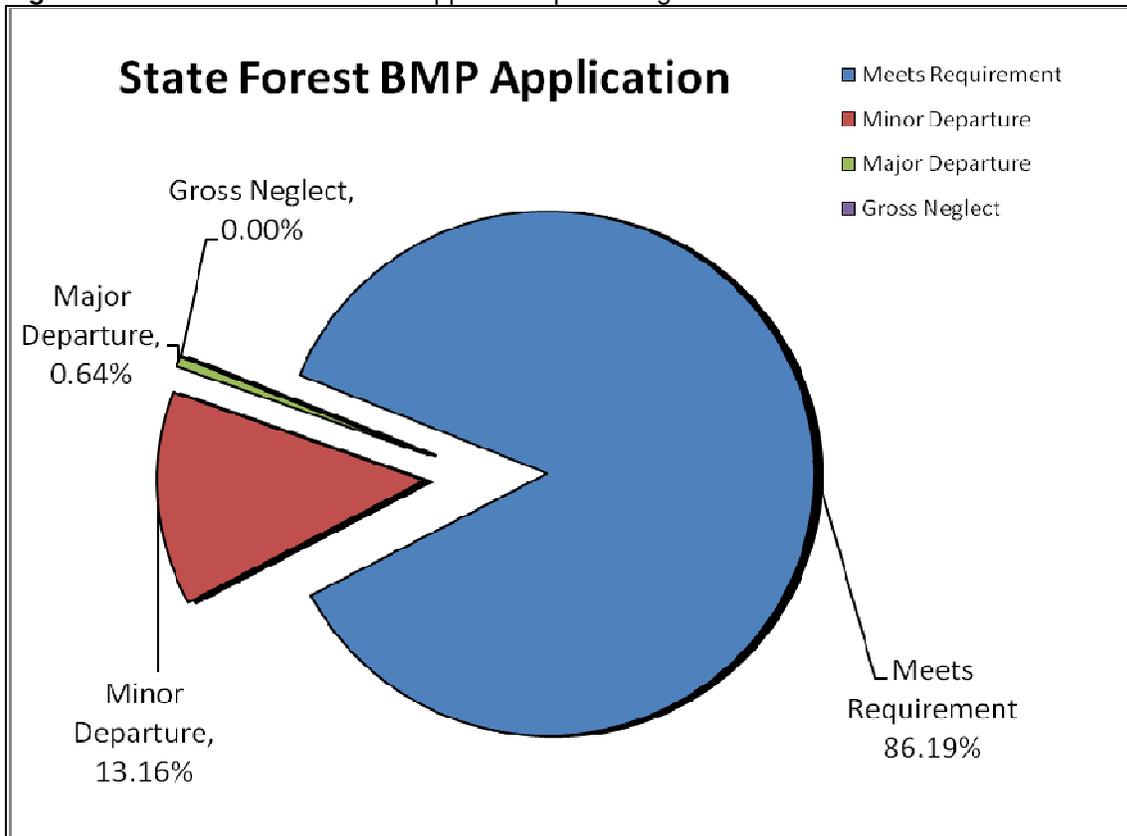
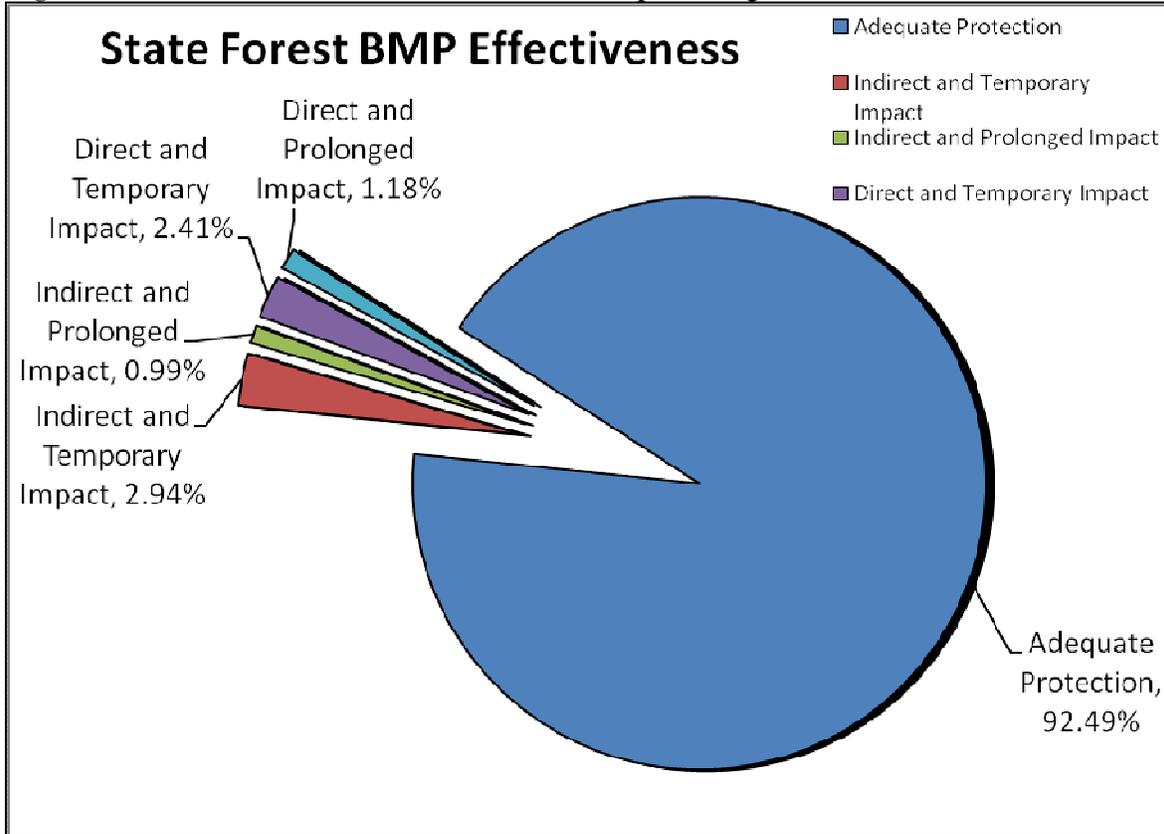


Figure 2: Overall state forest BMP effectiveness percentages.



II. Introduction

Indiana has 5.1 million acres of forestland, 22% of the state's land base, providing many benefits to Indiana residents and wildlife. The State Forest system owns only 3.07% (156,600 acres) of Indiana's forestland. However, state forestland is important to all Hoosiers who frequently use state forest properties for various forms of recreation, including hiking, biking, hunting, fishing and wildlife watching. Since state forestland is also important to the public as a model for forest management, it is imperative that timber harvesting at state forests is done in a way that minimizes environmental impacts as much as possible. Although forests are known to be the best way to reduce nonpoint source pollution (NPS) to waterways, they also can be a source of these pollutants. When forest soils are exposed, there is opportunity for NPS pollution to occur. Forestry Best Management Practices (BMPs) are employed to protect forest soils and water quality during and after a harvest.

Forestry BMPs are a foundation for water quality protection and provide guidelines for protecting water quality during forest operations. The purpose of BMPs is to minimize the impact of forest activities that may affect soil and water quality. This report is a summary of the application and effectiveness of BMPs for timber harvests conducted on state forest properties from the time they officially were placed in the contracts of all state forest timber sales in July 1999 through the present. Data covers all BMP monitoring on State Forest Properties, looking at time trends and making comparisons.

From July 1999 to winter 2003, BMP monitoring on state forests was conducted with the Watershed Conservation (WC) Forester and/or the License Timber Buyer (LTB) Forester from the Special Programs Section of the Division of Forestry, the Administering Forester of the timber harvest being monitored, an Administering Forester from another property, and the Property Specialist who administered the timber harvest program. The Property Specialist stopped coordinating and participating in the monitoring of sites late in 2003. In October 2004, the Division of Forestry started to change the monitoring system to a sampling method. The transition was halted during a change in Division leadership and subsequently returned to a 100% monitoring. At present, 100% of timber harvests are monitored after completion, but the present monitoring team consists of a person from the State Forest BMP monitoring staff, the Administering Forester of the timber harvest being monitored, and any qualified help they can get from the property staff or BMP monitoring staff.

BMP Monitoring is a site evaluation based on the Indiana Logging and Forestry Best Management Practices: BMP Field Guide (BMP Field Guide) and Indiana's Forestry BMP Monitoring Worksheet. Fifty-eight BMP specifications are evaluated under five forestry operation categories: 1) forest access roads, 2) log landings, 3) skid trails, 4) stream crossings, and 5) riparian management zones. Each BMP specification is rated for application of the BMP and the effectiveness in protecting water quality. Seven general questions are posed on the evaluation dealing with the root of the noted failures and successes, and records other land uses on the site that could affect water quality.

III. Methods

A. BMP Monitoring Objectives

The objectives of BMP monitoring are: 1) to assess the effectiveness of BMP guidelines in minimizing soil erosion and stream sedimentation; 2) to provide information on the extent of BMP implementation, past and current; 3) to identify areas to focus future program training and educational efforts to improve BMP implementation and effectiveness; 4) to identify BMP specifications that may need technical modification; and 5) to identify improvements needed in future monitoring efforts; 6) to maintain certification of Indiana State Forests through the Forest Stewardship Council© (FSC-CO12858) and the Sustainable Forestry Initiative© (SFI©)program

B. Monitoring Team Selection

For State Forest Properties, we first tried to have the WC and LTB foresters come to every BMP monitoring. However, there were many sites at which one or the other was absent for personal or professional reasons, but the monitoring continued, which kept a good balance for consistency in the monitoring and results without the monitoring falling behind. There is now a BMP Monitoring staff that includes the LTB Forester and one or two intermittent positions whose focus is BMP monitoring.

The other participants are the Administering Forester and possibly another forester from that property, which balances the team for input in the site evaluation of monitoring process and provides good training and discussion.

From July 1999 until 2003, the coordination of monitoring dates and people was carried out by the Property Specialist who also attended the monitoring of every timber harvest. This practice was discontinued when administrative duties increased for that position and coordination of monitoring was passed to the LTB forester.

C. Site Selection

Every timber harvest conducted on state forest property is monitored if the timber was sold after July 1999, unless the harvest occurred in order to change the land use. For example, Ferdinand State Forest had a site where timber was harvested before the area was cleared for a pipeline right-of-way. This kind of land-use change makes it impossible to monitor for forestry BMPs.

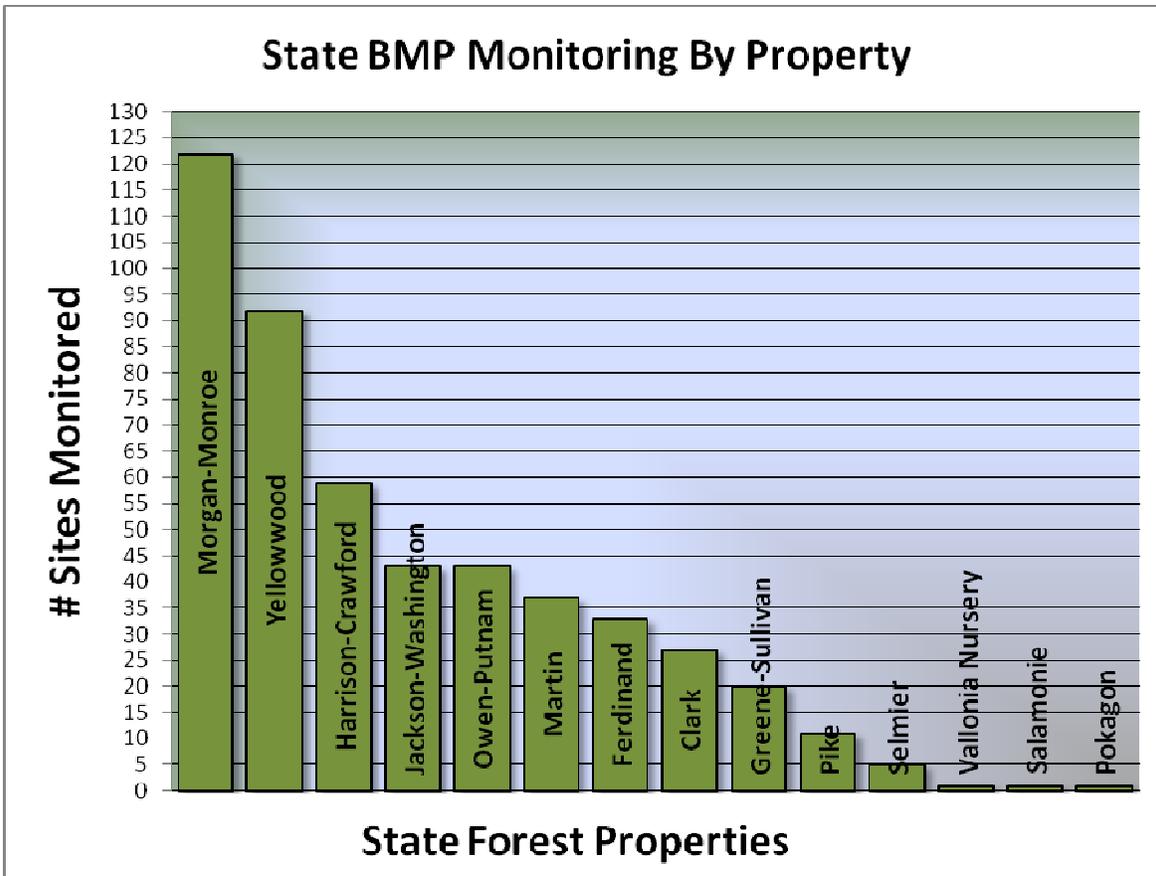


Figure 3: The number of harvests monitored at each property, for a total of 495 sites.

D. Monitoring Process

BMP monitoring is based on the evaluation of each specific practice for application and effectiveness. Application is the installation of a practice and the condition of the practice at the time of monitoring. Effectiveness is the level of success a practice has in the prevention of pollutants entering a water body and the level of impact the pollutant is having on the water body at the time of monitoring. It is possible to apply all of the BMPs properly and get a good score in application, but still have soil entering a stream, which would call for a lower score in effectiveness. The opposite may be possible as well.

Monitoring on state forest properties follows the same format as all other forestry BMP monitoring in Indiana except that the team of monitors is made up of professionals with similar backgrounds. On any monitoring day, the team meets at the forest office and goes to the field to conduct the BMP monitoring on a harvest that is completed and closed. The team walks each part of the harvest area, covering all access roads, inspecting log landings, skid trails, riparian management zones, and stream crossings as suggested in the Indiana BMP Monitoring Protocol, and commenting on successes and departures from the BMP guidelines.

Once on the site, the state forest monitoring team walks the area and its adjacent and interior intermittent or larger streams carrying maps of the site, the BMP monitoring form

and the BMP Field Guide. This allows each team member to evaluate the BMPs on the site. Once team members have walked most of the area, they come together to discuss each question on the BMP monitoring form until they reach consensus on both scores for each question.

IV. Results

A. Overall application and effectiveness

The BMP monitoring form includes 58 specifications that are evaluated on each site. To date, 495 state forest sites have been monitored. Therefore, when scores of 0 (questions not applicable) are removed from the dataset there are 21,867 questions answered in regard to BMP application and effectiveness of BMPs on State Forests. Overall BMP application on State Forest land is 86.2% with a 92.5% effectiveness rate. In other words, BMPs that were needed were implemented correctly 86.2% of the time and were effective at protecting water quality from NPS 92.5% of the time.

When looking at application, 86.2% of the 21,867 questions were answered with a “1,” which means the practice met the BMP guideline when it was needed. If an answer had a “0” in application, it meant the practice was not needed on the site and was not included in counting the percentage of application. A score of “2” or higher indicated departures from the BMP guidelines to some degree and occurred on 13.2% of all application scores that were tallied.

When looking at effectiveness, 92.5% of the 21867 questions were answered with a “1,” which meant there was adequate protection of the water resource by the BMP guidelines. If an answer had a “0” in application, it meant the practice was not needed to protect water quality on the site and was not included in counting the percentage of effectiveness. A score of “2” or higher indicated a visible impact to water quality to some degree and occurred on 7.5 % of all effectiveness scores that were tallied.

More detailed definitions can be found on the Forestry BMP Monitoring Worksheet (Appendix B).

B. BMPs by Category; Application & Effectiveness

1. Access Roads

Access road BMPs were applied correctly 95% of the time. All access road BMP specifications employed had a 98.2% effectiveness rate.

Table 1: Application and effectiveness of BMP specifications for access roads.

Access Roads	% Application	% Effective
A1. Uses existing routes where appropriate	99.8	99.8
A2. Adequate buffer strip next to watercourses and sensitive areas	94.2	98.4
A3. Avoids unstable gullies, seeps, very poorly drained areas	95.3	99.1
A4. Road grades are within standards	98.0	100.0

A5. Amount of roads minimized	99.8	100.0
A6. Stream crossings minimized	100.0	100.0
A7. Road excavation minimized	98.2	99.8
A8. Excavated and fill materials placed properly	98.9	99.1
A9. Roads constructed to drain well	86.1	97.1
A10. Appropriate road stabilization, drainage and diversions installed	84.0	94.0
A11. Water diversions functioning properly	91.1	96.4
A12. Runoff diverted onto stable forest floor areas	88.8	92.5
A13. Public road drainage system maintained	98.8	99.3
A14. Public road's drainage maintained	99.8	99.8
A15. Traffic barriers installed	92.9	98.9
Overall Access Road	95.0	98.2

Access road drainage needs some further attention with the installation of drainage diversions and road stabilization. Although this area had an 84% application rate, there was a 94% effectiveness rate, indicating virtually no visible impact to water quality due to these departures. 86.1% of the time access roads were constructed to drain well (A9), this does leave some room for improvement. Effectiveness of this specification (A9) is 97.1%, therefore departures in application are causing minimal impact to the resources. Many of the access roads are permanent fire trails or other roads that are used and maintained to varying degrees. Thus some are more structurally stable while others have had the diversions worn down by use over long periods. An effectiveness problem seems to occur in old access roads where the main goal was to get water off of the road and put it into the streams in order to get the water away as soon as possible. The Division of Forestry has been working to correct these problems over the long term.

2. Log Landings

Log landing BMPs were applied correctly 89.9% of the time. All log landing BMP specifications employed were 97.5% effective at protecting the water resources of the site.

Table 2: Application and effectiveness of the BMP specifications for log landings.

Log Landings	% Application	% Effective
Y1. Suitable number and size of landings	93.8	99.6
Y2. Landings located outside RMZ	95.0	99.0
Y3. Landings located on stable areas	92.8	99.2
Y4. Excavation of site minimized	92.4	98.2
Y5. Landings avoid concentrating or collecting runoff	75.2	95.9
Y6. Landing's runoff enters stable area	80.9	93.2
Y7. Proper water diversions in working order	87.4	94.4
Y8. Landing smoothed and soil stabilized	88.5	96.9
Y9. Landings free of fuel and lubricant spills and litter	93.6	98.8
Y10. Landing location suitable for equipment fueling and maintenance	99.2	99.8
Overall Log Landings	89.9	97.5

Correct drainage of landings was not universally applied well in log yards, with an application rate of only 75.2% (Y5). However, the effectiveness rate was 95.9% (Y5). Diversion of runoff to stable areas (Y6) had an 80.9% application rate, but a 93.2% effectiveness rate. Therefore application shortfalls of landing drainage tended to have a minor impact upon the resources of the sites.

3. Skid Trails

Skid trail BMPs were correctly applied 76.7% of the time. All of the skid trail BMP specifications employed were 88.8% effective at protecting the water resources of the sites.

Table 3: Application and effectiveness of BMP specifications for skid trails.

Skid Trails	% Application	% Effective
S1. Uses existing routes were appropriate	97.7	99.0
S2. Adequate buffer strip next to water courses and sensitive areas	68.7	84.7
S3. Avoids steep and long straight grades (>20% for >200')	75.1	96.5
S4. Avoids unstable gullies, seeps, poorly drained areas	79.8	91.0
S5. Amount of skid trails minimized	81.2	93.7
S6. Trail excavation minimized	86.1	94.7
S7. Appropriate drainage and diversions installed	47.6	79.3
S8. Water diversions in working order	79.6	88.7
S9. Runoff diverted onto stable forest floor areas	69.1	76.3
S10. Streams not used as skid trails (except for crossings)	82.5	84.8
Overall Skid Trail	76.7	88.8

Skid trails often are in rough areas with limited options for diversion installation, and often there is debate as to whether or not diversions are necessary, thus the 47.6% application rate. Despite low application in this specification, the effectiveness rate is 79.3%. Runoff diverted onto the stable forest floor areas has a 69.1% application rate and a 76.3% effectiveness rate, with 80 out of 150 departures having indirect and temporary impacts, 22 having indirect and prolonged impacts, 12 having direct and temporary impacts, and 1 having a direct and prolonged impact. Of the 495 sites having diversions on skid trails, 388 had no negative effect on water quality. Of the 101 sites with diversions that had effectiveness departures, 68 were indirect and temporary, 23 were indirect and prolonged, 8 were direct and temporary, and 2 was determined to have direct and prolonged impact. Skid trail application could be improved by avoiding areas that have a higher probability of negative impact if they are utilized during a harvest. These areas include watercourses and sensitive areas, long and steep straight grades, gullies, seeps and poorly drained areas. BMP application for avoidance of these areas ranges from 68.7% to 79.8% (S2 – S4). However, the effectiveness from these 3 specifications was good, ranging from 84.7% to 96.5%. This indicates that when these areas were entered, that it was done in a manner that would protect the resources of most sites.

4. Stream Crossings

Stream crossing BMPs were applied correctly 77.8% of the time. All stream crossing BMP specifications employed were 80.1% effective at protecting the water resources of the sites.

Table 4: Application and effectiveness of BMP specifications for stream crossings.

Stream Crossing	% Application	% Effective
X1. Number of crossings minimized	88.9	91.1
X2. Crossings minimize disturbance to the natural bed and banks	71.9	74.2
X3. Streambank approaches properly designed and stabilized	64.0	67.4
X4. Water runoff diverted from road prior to crossing	60.8	64.8
X5. Crossing as close to 90 degrees as practicable	85.4	91.0
X6. Crossing does not unduly restrict water flow	83.1	84.3
X7. Soil has not been used as fill in the stream (except culverts)	80.7	81.8
X8. Ford constructed of non erosive materials	88.1	88.7
X9. Fords have stable banks and streambeds	64.2	64.2
X10. Culverts are properly sized and installed	62.5	66.7
X11. Culverts clear of significant flow obstructions	66.7	70.8
X12. Temporary structures properly anchored	95.5	95.5
X13. Temporary structures and resulting obstructions removed	83.3	83.3
Stream Crossing	77.8	80.1

Stream crossings always deal directly with water bodies, so whether there are departures or not, there can be some impact to the water quality. If there is an impact, it will almost always be direct. The likely impacts of stream crossings are why managers will often avoid using them if possible. The avoidance of stream crossings by sale administrators and loggers is reflected in the statistic for stream crossings – 329 sites (66.5%) had no crossings and only 166 sites (33.5%) out of 495 sites monitored had at least 1 stream crossing. 88 sites had only 1 crossing, 31 had 2 crossings, 19 had 3 crossings, 8 had 4 crossings, 4 had 5 crossings, 4 had 6 crossings, 3 had 7 crossings, 1 site had 8 crossings, 2 had 9 crossings, 1 had 10 crossings, 1 had 12 crossings, 2 sites had 13 crossings, 1 site had 15 crossings and 1 site had 60 crossings for a total of 453 crossings on state properties over a 15-year period. The site with 60 crossings was a large (821 acre) site at Clark State Forest that was a tornado salvage sale. There were 12 sites at which the number of crossings and corresponding widths were not recorded.

Unmapped intermittent stream crossings numbered at 171 (37.7% of crossings). Unmapped intermittent streams are those streams that meet the definition of Intermittent stream in the Glossary of the Indiana Logging and Forestry Best Management Practices; BMP Field Guide, but the USGS quadrangle maps did not map them as intermittent streams. There were 271 crossings on intermittent streams identified on the USGS maps. There were 11 crossings on perennial streams.

5. Riparian Management Zones

Riparian management zone (RMZ) BMPs were applied correctly 82.4% of the time. All of the RMZ BMP specifications employed were 88.6% effective at protecting the water resources of the sites.

Table 5: Application and effectiveness of BMP specifications for Riparian Management Zones.

Riparian Management Zones	% Application	% Effective
Z2. Perennial & large intermittent streams clear of obstructing debris	68.3	69.3
Z3. Tree tops and cutoffs placed back from water course to prevent movement into streams during floods	90.2	93.7
Z4. RMZ free of excavated material & debris (other than above)	94.2	96.7
Z5. Less than 10% bare mineral soil exposed within RMZ (not including crossings)	96.7	99.4
Z6. Adequate tree stocking in primary RMZ next to perennial streams	98.9	98.5
Z7. RMZ free of roads and landings (except crossing)	67.1	92.5
Z8. Water diverted from roads before entering RMZ	84.6	91.7
Z9. Water diverted onto stable areas of the forest floor	86.8	92.5
Z10. Road and trail surfaces stabilized as needed within RMZ	89.1	92.8
Z11. Ephemeral channels free of excavated material	64.0	69.2
Riparian Management Zones	82.4	88.6

Perennial & large intermittent streams clear of obstructing logging debris on state forest properties has had varied definitions since the beginning of Indiana State Forest BMP monitoring because of the “4-Foot Rule” adopted as an automatic “large intermittent” stream starting July 1, 1999 when BMPs officially were put in timber sale contracts. On other forest ownership types, the definition of a “large intermittent” was determined by the interpretation of the monitoring crew at the site. As of July 1, 2010, consistency across all landowner classifications was attained by defining “large intermittent” streams as those that were mapped as intermittent streams on the USGS 7.5 Minute Quadrangle maps. So, between July 1, 1999 and July 1, 2010, there may have been logging debris (Z2) departures counted on state forest properties that may not have been counted as departures on other landowner types in similar streams.

Out of 495 sites, 444 had a water body of some type that had a RMZ. In specification Z2, “streams clear of obstructing debris,” the application rate was 68.3% and the effectiveness rate was 69.3%. Of the 125 sites that had a departure in effectiveness for Z2, 6 were indirect and temporary, 9 were indirect and prolonged, 23 direct and temporary, and 87 direct and prolonged. The nature of the debris would be prolonged unless it could be removed or mitigated in some way. In a few rare cases there is debris in the stream that is to remain in the stream for additional aquatic habitat. Some debris found in streams will breakdown and move down stream within a year which explains the small number temporary effectiveness ratings. Mitigation by removing debris is the standard recommendation. Roads and landings in the RMZ scored lower in application with a 67.1% but had 92.5% effectiveness. This suggests that although there were some roads or landings in the RMZ water quality of the sites was protected. In Z11 (“ephemeral channels free of excavated material”), there were 158 departures in application, 147 of which were minor and 9 were major. There were 164 departures in effectiveness for the Z11 specification; 104 with an indirect and temporary impact on soil and water quality, 57 indirect and prolonged, and 3 direct and temporary impacts.

C. Yearly BMP Monitoring Trends

All monitoring rounds on state forest properties from 1996 to present were broken down by year to determine the overall application and effectiveness rates. Arranging the data in this manner can be helpful in determining the presence of any possible trends. In Figure 4, it is apparent application and effectiveness rates are lower for all years following 1999. These lower numbers can be attributed to 1) the change in the “4-Foot Rule” at the beginning of the 2000 monitoring year, and 2) that internal BMP monitoring of state forest harvests was started that year.

All monitoring prior to 2000 was completed by monitoring teams formed of people within and outside the Division of Forestry who volunteered for BMP monitoring on different types of land ownerships. These rounds of monitoring are better explained in the reports Indiana Forestry Best Management Practices Report of Findings: 1996, 1997, 1999, 2000, 1996-2003, 1996-2004, 1996-2005 1999-2006, 1996-2007, 1996-2008, 1996-2009, 1996 - 2010, and 1996 -2011, 1996-2012 and 1996-2013.

Table 6: Overall application and effectiveness of all BMP monitoring rounds.

Year	% Application rate	% Effectiveness		# sites (n)
		rate	rate	
1996	93.0	96.2	12.0	
1997	93.5	95.8	7.0	
1999	96.2	99.2	3.0	
2000	87.1	94.6	15.0	
2001	87.9	89.2	19.0	
2002	89.6	94.6	25.0	
2003	83.6	91.7	15.0	
2004	83.5	92.2	21.0	
2005	89.8	95.6	22.0	
2006	92.6	96.0	25.0	
2007	89.3	95.7	26.0	
2008	84.0	92.9	47.0	
2009	82.9	90.6	48.0	
2010	84.2	91.4	24.0	
2011	84.8	91.3	52.0	
2012	87.4	92.9	48.0	
2013	83.5	89.5	49.0	
2014	85.0	89.7	37.0	
Overall	86.2	92.5	495	

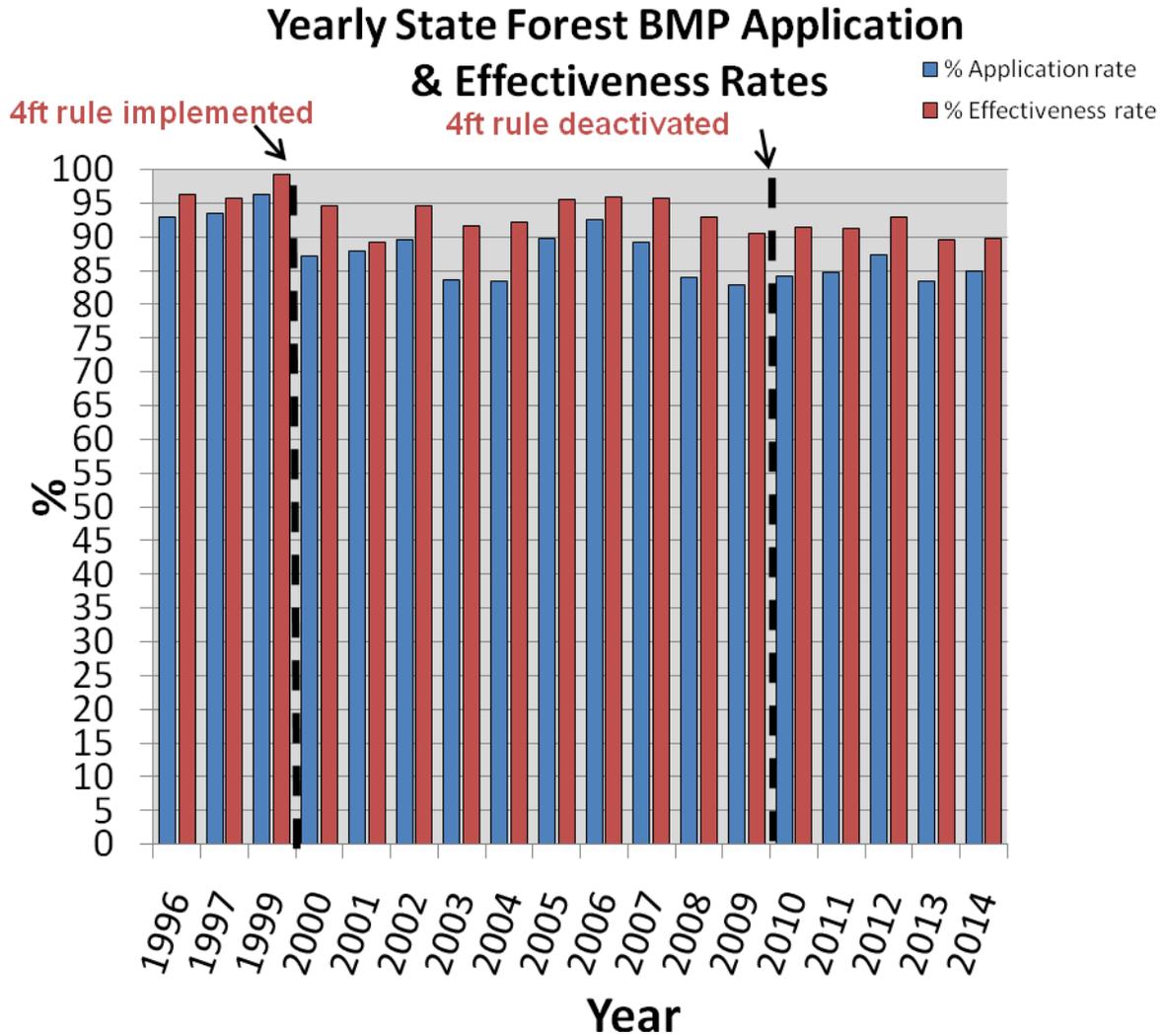


Figure 4: Overall application and effectiveness rates for each year of BMP monitoring.

D. Overall Site Ratings

On the final page of the monitoring form, there is an opportunity for each site monitor to rank his or her overall subjective impression of the site’s BMP application and effectiveness (Appendix B). Sites can be rated from 1 to 4.

The application rating scale is: 1=above average, 2=average, 3=poor, 4=total negligence. The effectiveness rating scale is: 1= no visible impact, 2=slight, 3=moderate, 4=severe. Table 6 shows the average ratings for all the sites monitored on the state forests. The overall site rating is an average of the application and effectiveness ratings. On average the monitors found BMPs on Indiana State Forests to be applied between average and above average. They also found effectiveness of sites, on average, to have between no visible impact and slight impact.

Table 7. The average site ratings for application, effectiveness and the overall site rating.

Overall Application	Overall Effectiveness	Overall Site Rating
1.55	1.61	1.57

V. Discussion

The overall BMP application rate was 86.3% at the time of this report. BMPs on state forest properties were also found to be 92.7% effective at protecting water quality. Time trends show that as BMP monitoring became internal to the Division of Forestry, the application rate declined, not because application of BMPs on state properties dropped but because the standard of BMPs on state forest properties was being raised. The effectiveness scores have remained consistent over the years; evidence that BMPs always were practiced.

Also, the implementation of the “4-Foot Rule” tightened the restriction of tops in the stream on state properties, which is always a 4 or 5 in effectiveness, but is often mitigated by being cleaned out soon after the monitoring, unless there is another reason the Administrating Forester has for keeping the top in the stream, such as stream restoration or wildlife habitat.

In looking at the application rate, the 1s (meets requirement) were at 86.2%; the 2s (minor departure) accounted for 13.2%; the 3s (major departures) accounted for 0.6%. The 1 application score out of 21867 with a score of 4 (total negligence).

In effectiveness, 1s (adequate protection) accounted for 92.5% of a total of 21,866 scores; 2.9% were 2s (indirect and temporary impacts), 1% were 3s (indirect and prolonged), 2.4% were 4s (direct and temporary), and 1.2% were 5s (direct and prolonged).

The high application and effectiveness scores show there are many sound practices taking place on state forest timber harvest sites to maintain the integrity of the soil and water resources. When there are problems in either application or effectiveness, they are mostly minor and short term.

Forest harvest activities on access roads and log landings had little to no effect on water quality. Roads and landings are established with the knowledge these are areas where the concentration and amount of repeated traffic will be highest. During site planning and layout, managers will put roads and landings on the most stable areas outside RMZs (94.2% and 95% application, respectively). Sometimes site landform and characteristics force the roads to cross streams or be in a RMZ or force landings to be within a RMZ, in which case, managers are more thoughtful and careful about how the harvest and closeout are carried out (98.4% and 99% effectiveness, respectively). The results of the monitoring show the above inferences to be true by having all effectiveness scores in both categories above 98%.

For skid trails, 76.7% of the application scores were 1, but effectiveness scores of 1 account for 88.8%, showing a difficulty in implementing some practices within the guidelines, but affecting water quality to some degree only 11.2% of the time. Skid trails can have a spectrum of disturbance levels depending on how often equipment drives over a particular point on the ground. For instance, the main trail just off the landing would have a higher disturbance level because all harvested logs have to be moved to the landing, while an area traveled over only twice – once to access trees and the other pulling the logs out – has a much lower level of disturbance. Also, skid trails go to areas that other equipment cannot access, so it may cross drainages, travel down or across hill slopes, or go into areas that are wet most of the time. Therefore, most of the application and effectiveness issues of a site are from skid trails. Also, most closeout practices are put in place with limited space as landforms, and adjacent vegetation will often limit the equipment's ability to place structures where they would be most effective. This causes minor departures in application (22.6% of skid trail application scores are minor departures) with little to no effect on water quality.

Stream crossings are difficult to use without having some impact to water quality. The stream crossings cross some sort of water body, so any impact would be direct in effectiveness causing a 4 or 5 as an effectiveness score if anything goes wrong. Consequently, the Division of Forestry tries to avoid crossing streams if possible and still be able to access the site. Of 495 sites, only 33.5% (166 sites) had stream crossings. At those 166 sites, there were 453 crossings; 271 on mapped intermittent streams, 171 on unmapped intermittent streams, and 11 on perennial streams. In stream crossing applications, 77.8% of the practices were implemented within guidelines and had a 80.1% effectiveness score. As mentioned, stream crossings have a direct effect according to the definitions in effectiveness scoring. There are only 5 scores (0.27 %) of 2 and 3 scores of 3 in effectiveness (0.16%), but 13.17% of the effectiveness scores had a 4 (direct and temporary impacts) and 6.31% had a score of 5 (direct and prolonged impacts). There was an average of 2.72 crossings for the 166 sites that had a crossing.

RMZs are much like stream crossings in that they are in close proximity to water bodies. If there is a problem, it often leads to direct impacts to water quality, so managers often try to avoid placing high impact infrastructure like access roads or landings in RMZs unless they already exist. There were 444 sites with at least one RMZ; 292 (67.1%) had no roads or landings. 13 sites had no information on roads or landings in the RMZ. There were 143 sites with skid trails and/or landings in the RMZ; 88 had no impact to water quality, 19 had an indirect and temporary effect, 3 had an indirect and prolonged effect, 29 had a direct but temporary effect, and 4 had a direct and prolonged effect.

VI. Recommendations

- Concentrate on areas where problems are more common, such as skid trails, RMZs, and stream crossings.

- Continue to emphasize importance of diverting water before it concentrates on roads, landings, skid trails and enters streams and RMZs.

- Continue providing BMP educational information and programs for loggers and resource professionals that work on state properties. If there is an area of concern on state properties, focus training on that area.

VII. Conclusions

The Indiana Forestry BMP Guidelines are scrutinized and enforced on state forest properties more than any other general landowner category in the state of Indiana. When the internal inspections began, the application scores actually dropped due to the standards on the state forest properties being raised by factors such as the “4-Foot Rule.” However, effectiveness in protecting water quality, which is the main goal of Indiana’s Forestry BMPs, has always been high and continues at the time of this report.

Our state forest system has diverse uses. It is the responsibility of the Division of Forestry to ensure forest resources are protected. Forestry BMPs are the means used to safeguard harvest sites by eliminating or reducing soil erosion on disturbed ground. Minimal soil erosion allows for quick recovery of the site because the topsoil is still in place to allow for natural succession to take place. Limited sedimentation to the surface waters of the forest protects or restores water quality.

Appendix A

BMP Definition Clarification – 4-Foot Rule

Background

The BMP Field Guide states, “Remove felled tops and logging debris from the channels of perennial and large intermittent streams.” On the BMP Monitor Sheet (expanded) the definition of the streams was further defined as “...wider than 6’...” The purpose was to identify a specified width **for monitoring purposes** rather than leaving a vague descriptive term (e.g. large intermittent). It should be realized that BMPs are guidelines. In some instances even a 6-foot width may not be “large” while in other situations more narrow streams may be large from a hydrological standpoint. Foresters therefore are expected to interpret the local hydrology and make on-site determinations when applying BMPs. This is clearly true for this BMP standard.

At the start of BMP monitoring on State Forests, it was decided to try to adhere to a tighter standard for streams on State Forests; hence the 4-foot standard for large intermittent streams. This would serve both as a demonstration of commitment to water quality and as a demonstration and test of a tighter standard.

Variable stream width cropped up as a problem early in this process, requiring clarification of stream width. Streams would widen out over four feet then narrow to less than four feet. This created a burden of trying to find the last point upstream that a stream was four feet wide. To solve this, it was decided that to meet the 4-Foot Rule, a stream had to be consistently four-feet wide or wider. This solved some concerns, but there are other concerns, such as what debris needs to be removed and where a stream is consistently four-feet wide or wider.

Below is the latest attempt to clarify the 4-Four-Rule. This covers the definition of the stream and what debris is to be removed.

Removing Logging Debris from Streams – 4-Foot Rule

To meet the BMP Field Guide guidelines for riparian zones that states “Remove felled tops and logging debris from the channels of perennial and large intermittent streams,” the BMP Monitor Sheet has Item Z2 “Perennial & large intermittent streams clear of obstructing debris.” On state forests, all streams that are to meet this standard will have a clearly defined bed with a width that equals or exceeds four feet.

The bed is that portion of the stream that is the lowest level where water commonly flows at typical (not storm) levels. This generally will be at the base of the banks and will usually consist of aggregate or exposed alluvium. The bed generally will be free of any significant vegetation because of the regular scouring and water flows. An area with a strong, well-rooted vegetative component with a relatively stable soil surface will not be considered

streambed. In streams where the channel is strewn with large rocks, the bed will be the area of smaller gravel at the base of the large rocks.

The stream will be considered four feet or wider until the bed, moving upstream, reaches the first point where the stream bed width drops below four feet for a lineal distance of 10 feet or more. Any portion of the drainage system up stream of this point will not be subject to the debris removal guidelines for large intermittent streams, and debris left in these portions of the drainage will not be considered a departure during monitoring.

Downstream of the identified four-foot-wide point, all logging debris, except as noted below, that will come in contact with the water when the stream is “bank full” and impede or divert stream flow must be removed from the stream channel. Unattached, individual pieces of debris less than two inches in diameter or less than four feet in length ordinarily will not impede flow and does not need to be removed. Debris that bridges the stream channel from top of bank to top of bank, does not impede flow, and is unlikely to fall into the stream channel within one year is not required to be removed. Debris less than two inches in diameter obstructing less than 20 % of the stream channel does not need to be removed.

Debris removal is to be accomplished in a manner that minimizes disturbance to the stream banks. The recommended method of removal is to pull the material free of the channel using a cable skidder or other equipment that is kept back from the stream edges. Another option is to cut debris into smaller pieces that can be removed from the channel or would no longer impede flow. Equipment should not be used in the stream channel to push the material out of the channel. Careful marking of the trees to be harvested, use of directional felling, and clearly explaining the BMP requirements during the pre-harvest conference will minimize the amount of debris that must be removed from stream channels.

The point where the stream channel reaches the four-foot width threshold should be clearly delineated in harvest areas. While upstream of this point will not be considered subject to debris removal from streams, care should be taken to avoid excessive, intentional deposition of debris in all naturally occurring drainage features regardless of size. Excessive piling (beyond felling) of debris in any drainage that severely impedes flow may be considered a departure.

Appendix B

FORESTRY BMP MONITORING WORKSHEET
(2000)

DATE INSPECTED: _____	TEAM: _____
OWNER: _____	PHONE: _____
_____	_____
_____	_____
COUNTY: _____ Site #: _____	ACRES HARVESTED: _____
CIVIL TWP: _____	USGS QUAD: _____
SEC: _____ TWP: _____	RANGE: _____
MAJOR WATERSHED: _____	
DATE OF ACTIVITY: _____	
HARVEST EQUIPMENT USED: Dozer:___ Skidder:___ Horses:___ Other:___	
TYPE OF HARVEST: Diameter limit:___ Single Tree:___ Group Selection:___ Clear Cut:___ Other:___	

SITE CONDITIONS	
TERRAIN: BOTTOMLAND _____ % RIDGES _____ %	SIDE SLOPES _____ %
SLOPE STEEPNESS: (2-6%) _____ (6-12%) _____ (12-20%) _____ (20+%) _____	
LAKES PRESENT: name: _____	shore length: _____
PERENNIAL STREAMS PRESENT: name: _____	width: _____ length: _____
SINKHOLES PRESENT: Yes _____ No _____	FLOWING SPRINGS PRESENT: Yes _____ No _____
OPEN WATER WETLANDS PRESENT: Yes _____ No _____ .	

FOR OFFICE USE – DO NOT COMPLETE	
OPERATOR/FORESTER: (leave blank) _____	
TYPE OF OWNERSHIP: nipf:___ clf:___ industry:___ state:___ fed:___ county:___ other:___	

APPLICATION

- 0--The Practice Not Needed or Applied on Site
- 1--Operation Meets Requirement of Bmp
- 2--Minor Departure from Bmp
- 3--Major Departure from Bmp
- 4--Gross Neglect of Bmp

EFFECTIVENESS

- 1--Adequate Protection of Water Resources.
- 2--Indirect and Temporary Impacts on Water Resources.
- 3--Indirect and Prolonged Impacts on Water Resources.
- 4--Direct and Temporary Impacts on Water Resources.
- 5--Direct and Prolonged Impacts on Water Resources.

APPLICATION DEFINITIONS (BY EXAMPLE)

MINOR DEPARTURE: Practice not clearly needed; attempted practice but poorly applied; small potential for soil to reach streams.
MAJOR DEPARTURE: Practice clearly needed; common departures from practice; large potential for soil to reach streams.
GROSS NEGLECT: No attempt at application; total disregard for water quality; large and direct impacts.

EFFECTIVENESS DEFINITIONS (BY EXAMPLE)

ADEQUATE: Small amount of material eroded; material does not reach drainages, streams, lakes or sinkhole openings.
INDIRECT IMPACT: Erosion and delivery of material to drainages (including ephemerals) but not to intermittent or perennial streams, lakes or sinkhole openings.
DIRECT IMPACT: Erosion and subsequent delivery of sediment to intermittent or perennial streams, lakes or sinkhole openings.
TEMPORARY IMPACT: Impacts lasting one year or less; no more than one runoff season; small amount of material involved.
PROLONGED IMPACT: Impacts lasting more than one year; large amount of material involved.

*It is possible to have a departure from BMPs and still have adequate protection.

ACCESS ROADS

ACCESS ROADS				APPLICATION (0-4)			
							EFFECTIVENESS (1-5)
							COMMENTS
There is no access road present ____ (If true, do not answer questions below)							
A1. Uses existing routes where appropriate							
A2. Adequate buffer strip next to watercourses and sensitive areas							
A3. Avoids unstable gullies, seeps, very poorly drained areas							
A4. Road grades are within standards							
A5. Amount of roads minimized							
A6. Stream crossings minimized							
A7. Road excavation minimized							
A8. Excavated and fill materials placed appropriately							
A9. Roads constructed to drain well							
A10. Appropriate road stabilization, drainage & diversions installed							
X=applied	water bars ____ dips/rolls ____ out slopes ____ berms cut ____ culverts ____ geotextile ____ rock ____ seed ____ mulch ____						
A11. Water diversions are in working order (____ % working)							
Failure due to: installation, damage, location, timing, weather, other							
A12. Runoff diverted onto stable forest floor areas							
A13. Mud kept off public roadways							
A14. Public road drainage system maintained							
A15. Appropriate traffic barriers installed							

APPLICATION

- 0--The Practice Not Applicable
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EFFECTIVENESS

- 1--Adequate Protection of Water Resources.
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- 3--Indirect and Prolonged Impacts on Water Resources.
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LOG LANDINGS									
							APPLICATION (0-4)		
							EFFECTIVENESS (1-5)		
							COMMENTS		
Y1. Suitable number and size of landings									
Y2. Landings located outside RMZ									
Y3. Landings located on stable areas									
Y4. Excavation of site minimized									
Y5. Landings avoid concentrating or collecting runoff									
Y6. Landing's runoff enters stable area									
Y7. Proper water diversions in working order									
Y8. Landing smoothed and soil stabilized									
Y9. Landings free of fuel and lubricant spills and litter									
Y10. Landing location suitable for equipment fueling and maintenance									
Number of log landings _____							Size: (acres) _____.		

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SKID TRAILS							
				APPLICATION (0-4)			
				EFFECTIVENESS (1-5)			
				COMMENTS			
S1. Uses existing routes where appropriate							
S2. Adequate buffer strip next to watercourses & sensitive areas							
S3. Avoids steep and long straight grades (>20% for >200')							
S4. Avoids unstable gullies, seeps, poorly drained areas							
S5. Amount of skid trails minimized							
S6. Trail excavation minimized							
S7. Appropriate drainage and diversions installed							
X= applied	water bars ___ outslopes ___ dips/rolls ___ berms cut ___ culverts ___ seed ___ mulch ___ rock ___ other ___						
S8. Water diversions in working order (___ % working)							
Failure due to: installation, damage, location, timing, weather, other							
S9. Runoff diverted onto stable forest floor areas							
S10. Streams not used as skid trails (except crossings)							
Types of streams involved and length of disturbance: perennial _____, mapped intermittent _____.							
Unmapped intermittent _____, ephemeral _____.							

APPLICATION

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STREAM CROSSINGS

STREAM CROSSINGS		APPLICATION (0-4)	
		EFFECTIVENESS (1-5)	
		COMMENTS	
X1. Number of crossings minimized			
X2. Crossings minimize disturbance to the natural bed & banks			
X3. Streambank approaches properly designed and stabilized			
X4. Water runoff diverted from road prior to crossing			
X5. Crossing as close to 90 degree angle as practicable			
X6. Crossing does not unduly restrict water flow			
X7. Soil has not been used as fill in the stream (except culverts)			
X8. Ford constructed of non erosive materials that will not degrade water quality			
X9. Fords have stable banks and streambed			
X10. Culverts are properly sized and installed			
X11. Culverts clear of significant flow obstructions			
X12. Temporary structures properly anchored			
X13. Temporary structures and resulting obstructions removed			
<p>Number of perennial crossings _____ widths _____.</p> <p>Number of intermittent crossings _____ widths _____ Number of unmapped intermittents widths _____.</p>			

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RIPARIAN MANAGEMENT ZONES

RIPARIAN MANAGEMENT ZONES			
	APPLICATION (0-4)		
		EFFECTIVENESS (1-5)	
			COMMENTS
Z1. RMZ present on this site include: _____ lakes, _____ rivers, _____ perennial streams, _____ intermittent streams, _____ sinkhole openings (specify), _____ open water wetlands, _____ unmapped intermittent streams			
Z2. Perennial & large intermittent streams clear of obstructing logging debris			
Z3. Logging debris placed back from watercourse to prevent movement into streams during floods			
Z4. RMZ free of piled slash, debris and fill			
Z5. Less than 10% bare mineral soil scattered within RMZ - not including crossing			
Z6. Adequate tree stocking in primary RMZ next to perennial streams			
Z7. RMZ free of roads and landings (except crossings) Were roads pre-existing? _____			
Z8. Water diverted from roads before entering RMZ			
Z9. Water diverted onto stable areas of the forest floor			
Z10. Road and trail surfaces stabilized as needed within RMZ			
Z11. Ephemeral channels free of excavated material			

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SUPPLEMENTAL QUESTIONS AND SUMMARY

1) WHAT WENT RIGHT ON THIS SITE? (SUMMARIZE HIGHLIGHTS)

2) WHAT WENT WRONG ON THIS SITE? (SUMMARIZE PROBLEMS)

3) HAVE OTHER ACTIVITIES OCCURRED ON THIS SITE THAT POTENTIALLY IMPACT WATER QUALITY? (E.G. ATV use, vehicle traffic, grazing, etc.)
If so, please explain.

4) WERE TRAFFIC BARRIERS IN PLACE TO PREVENT TRESPASS DAMAGE? _____.
WHAT KIND OF TRESPASS DAMAGE WAS OBSERVED?

5) ARE THERE MITIGATING ACTIVITIES THAT SHOULD TAKE PLACE ON THIS SITE OR IS CORRECTIVE ACTION ALREADY BEING TAKEN.

6) -HAS THE SALE ADMINISTRATOR RECEIVED BMP TRAINING?	Yes _____	No _____	Unknown _____.
- HAS THE OPERATOR (LOGGER) RECEIVED ANY BMP TRAINING?	Yes _____	No _____	Unknown _____.
- WAS THE SALE ADMINISTERED BY A FORESTER?	Yes _____	No _____	Unknown _____.
- IS THE LANDOWNER AWARE OF BMPs?	Yes _____	No _____	Unknown _____.

7) GIVE THIS SITE AN OVERALL RATING OF 1-8 COMBINING APPLICATION OF BMPs WITH IMPACT TO WATER QUALITY.

RATE THIS SITE FROM 1-4 FOR THE OVERALL APPLICATION OF BMPs _____
1=above average 2=average 3=poor 4=total negligence

RATE THIS SITE FROM 1-4 FOR ITS OVERALL IMPACT TO WATER QUALITY _____
1= no visible impact 2=slight 3=moderate 4=severe

SITE RATING _____/2=_____

Note: These numbers do not necessarily need to directly reflect the worksheet ratings for application or effectiveness

Field Guide Cross Reference

On this page is each question in the monitoring sheet and the corresponding pages on the subject in the BMP Field Guide.

ACCESS ROADS == Section II, pages 8-16

A1 == pages 4, 8, 10

A2 == pages 8, 9, 12, Section V page 32, 33, Table 4 page 34, 35

A3 == page 8

A4 == page 8

A5 == page 10

A6 == page 8 and Section IV page 24 – 30

A7 == pages 8, 10

A8 == pages 10, 12, 24, 29

A9 == pages 8, 10, Table 1 page 11, 12

A10 = pages 8, 10 Table 1 page 11, 12, 14, 15, Table 2 page 21, 22

X=Applied == (waterbars, pages 21-22), (dips/rolls, pages 21-22), (outslopes, Glossary), (berms cut, Glossary), (culverts, pages 27-28), (geotextile, Glossary), (rock, page 10), (seed, Appendix A), (mulch, Appendix A).

A11 = pages 14, 15, Table 1 page 11, 18, Table 2 page 21

A12 = page 10

A13 = pages 13, 14

A14 = page 14

LOG LANDINGS == Section IV, pages 36-40

Y1 == pages 36, 39

Y2 == Table 4 page 34, 36

Y3 == page 36

Y4 == page 38

Y5 == pages 36, 38-40

Y6 == pages 38-40

Y7 == pages 38-40

Y8 == pages 38-40

Y9 == pages 39, 40

Y10 = page 39

SKID TRAILS == Section III, pages 18-22

S1 == pages 4, 18

S2 == pages 18, 20, Section V pages 32-35

S3 == page 18

S4 == page 18

S5 == page 18

S6 == page 18

S7 == Table 1 page 11, pages 18-20, Table 2 page 21, 22, 27, 28

X=Applied == (waterbars, pages 21-22), (dips/rolls, pages 21-22), (outslopes, Glossary), (berms cut, Glossary), (culverts, pages 27-28), (geotextile, Glossary), (rock, page 10), (seed, Appendix A), (mulch, Appendix A).

S8 == Table 1 page 11, pages 14, 15, 20 Table 2 page 21

S9 == page 20

S10 = pages 18-20, Section IV pages 24-30

Types of Streams == page 24, Glossary, and Section V pages 32-35

STREAM CROSSINGS == Section IV, pages 24-30

X1 == page 24

X2 == page 24

X3 == pages 24, 25

X4 == pages 24, 25

X5 == page 24

X6 == pages 24-26, 28

X7 == pages 24, 29

X8 == pages 24, 29

X9 == pages 24, 25, 29

X10 = pages 25, 27, Table 3 page 28

X11 = pages 24, 27, 28

X12 = pages 25, 26

X13 = pages 25-29

RIPARIAN MANAGEMENT ZONES == Section V, pages 32-35

Z1 == pages 32, 34, Glossary

Z2 == page 33

Z3 == pages 32-34

Z4 == pages 32-34

Z5 == pages 32-34

Z6 == pages 32-34

Z7 == pages 32, 34

Z8 == pages 33, 34

Z9 == pages 32-34

Z10 = pages 33, 34

Z11 = page 35