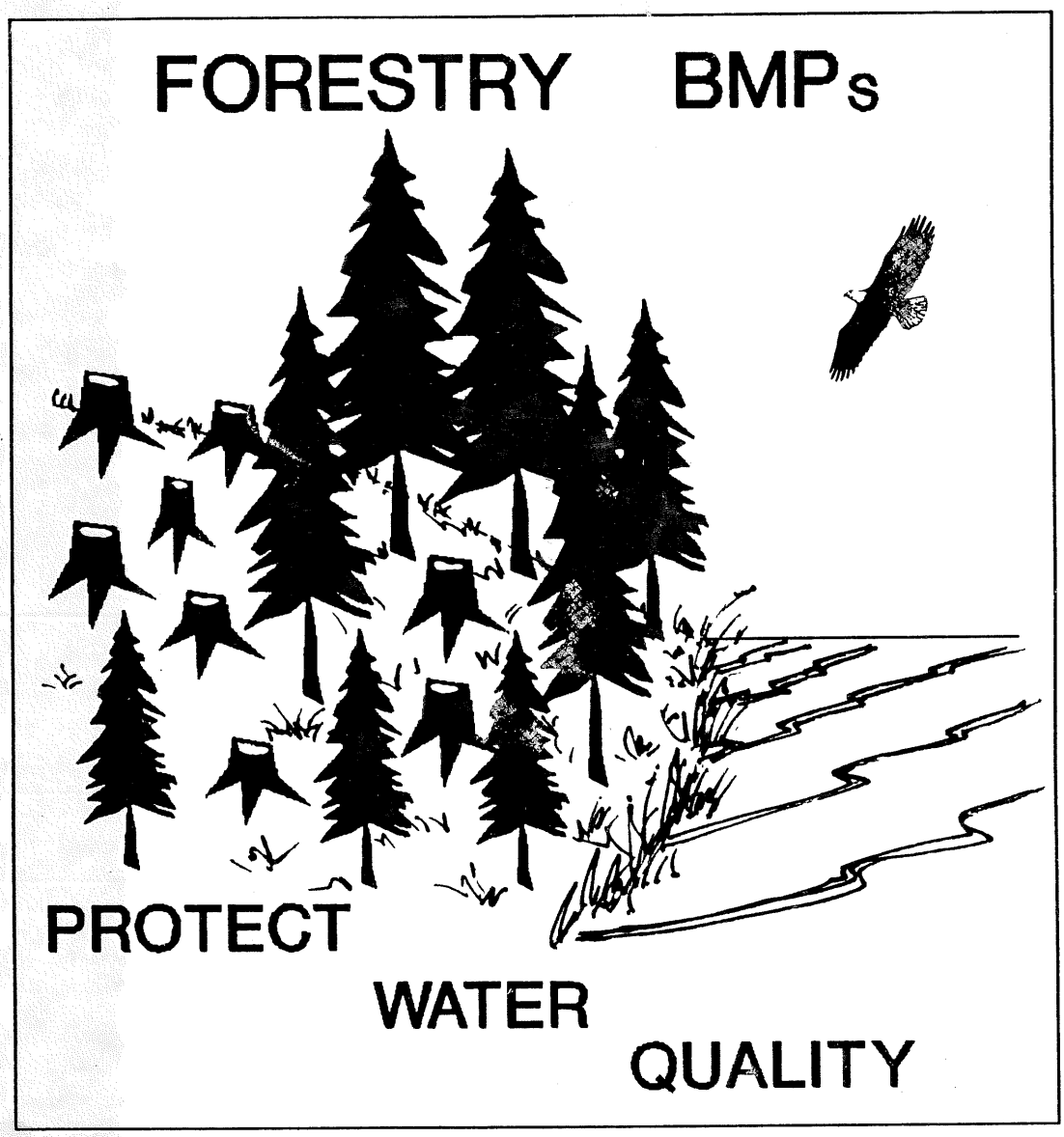
MINNESOTA

FORESTRY BEST MANAGEMENT PRACTICES IMPLEMENTATION MONITORING

1991 FORESTRY FIELD AUDIT



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The Division of Forestry is deeply appreciative to all of the audit team members, alternates, and organizations who supported and participated in this effort. Long hours, effective dialogue and professional judgements ensured that the field audit process remained credible.

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REPORT TO THE MINNESOTA POLLUTION CONTROL AGENCY

SEPTEMBER 1992

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EXECUTIVE SUMMARY

The use of forestry Best Management Practices (BMPs) to protect and maintain water quality has been actively promoted in Minnesota since 1988. As part of the implementation program, a pilot field audit process was initiated in 1991 to evaluate forest practices for BMP compliance on state, federal, and county lands; industrial private forest lands; and nonindustrial private forest lands. The pilot field audit process was funded through section 319 of the Clean Water Act and by the Minnesota Department of Natural Resources, Division of Forestry. The section 319 funding was provided by the Environmental Protection Agency through the Minnesota Pollution Control Agency.

The field audits were conducted by two interdisciplinary teams, one each in northeastern and southeastern Minnesota. The teams were composed of representatives from state and federal agencies, county land departments, industry, and conservation organizations. Efforts were made to ensure that each team incorporated expertise in road engineering, soil science, hydrology, fisheries and forest management.

The audits were based on the BMPs identified in the forestry guidebook titled Water Quality in Forest Management: Best Management Practices in Minnesota. The audit forms used to rate individual sites contained 96 specific practices. Each site was rated for the applicability of the specific BMPs (yes or no), whether the applicable BMPs were applied correctly (5-point scale), and the effectiveness of the BMP application (6-point scale). The teams rated a total of 1160 BMPs on 48 sites.

The major findings for the first year audit process are summarized below:

- The forestry community had a compliance rate with BMPs that averaged 79% across all forest land ownerships. The level of compliance was highest on county lands (90%) and lowest on nonindustrial private forest lands (71%). State, federal, and private industrial forest lands had compliance rates of 80%, 87% and 88%, respectively.

- Where departures from BMP requirements were found, 84% were minor in nature, producing little observable impact to water quality.

- Departures from BMP requirements were more common in southeastern Minnesota compared to northeastern Minnesota.

- Filter strip BMPs had the highest rate of compliance of any grouping of BMPs. Landowners, managers and operators appeared to be generally cautious when conducting management activities adjacent to lakes and streams.

- The majority of departures were associated with practices that influence the volume, velocity and direction of surface flow on roads and skid trails; i.e. the installation of water diversion devices and drainage structures.

- ☐ This information will provide the forestry community with an opportunity to target education and technical assistance efforts to problem areas with the limited resources available.

- ☐ Where BMPs were properly applied, adequate protection to the water resource was found 99% of the time. The magnitude of the impact to water quality increased with the extent to which the BMP requirements were ignored or not followed.

- ☐ Minnesota results are consistent with results reported nationally.

From these findings, the following recommendations are made:

- ☐ Continue the audit process and expand the audit teams to four.

- ☐ Continue the interdisciplinary makeup of the audit teams.

- ☐ Revisit 10 percent of sites evaluated the previous year.

- ☐ Refine and improve the site selection process for nonindustrial private forest landowners to ensure randomness of site selection.

- ☐ Base the number of audit sites per ownership group on the proportion of timber harvested by that ownership group the previous year.

- ☐ Continue education of loggers, landowners, and resource managers based on problem areas documented in the BMP field audits.

- ☐ Expand field audits into Native American tribal ownership.

- ☐ Ensure that future audit procedures are consistent with previous audits to provide a means for comparison.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

I. INTRODUCTION

Minnesota is blessed with vast acreages of forest land that supports the second largest manufacturing industry in the state, varied recreational opportunities, wildlife habitat, and highly prized watershed values. Clean water is an important natural resource in Minnesota, much of which is derived from these forest lands. Because forest management operations often take place in close proximity or adjacent to the water resource, forest managers, landowners and operators must ensure that activities undertaken are accomplished in a manner that minimizes impacts to the environment and water quality. Wise forest management is only possible where consideration for protecting water quality is as important as the efficient harvest of timber.

Water quality has been a national priority since passage of the Federal Water Pollution Control Act (FWPCA) of 1972 (PL 92-500). This Act was an ambitious piece of legislation with a declared objective to "restore and maintain the chemical, physical and biological integrity of the nations waters". Silvicultural activities were specifically identified by this legislation as an area of concern.

Since the passage of the FWPCA of 1972, tens of billions of dollars have been spent on technology and regulation to control traditional point sources of pollution. Successful efforts in the cleanup of point sources have resulted in a shift in the focus for water quality protection. According to state water quality assessments, nonpoint source (NPS) pollution is now identified as the primary single factor preventing the attainment of water quality standards nationwide (Copeland 1992).

The passage of the 1987 Amendments to the Clean Water Act (CWA) (PL 100-4) was a recognition by Congress that NPS pollution was not being adequately controlled. Enactment of Section 319 of the CWA established a comprehensive national program to control NPS pollution and, for the first time, made federal funding available to the states to control nonpoint sources. To be eligible for funding, states were required to develop:

1) an assessment report detailing the extent of NPS pollution problems, and

2) a management program specifying NPS pollution controls to address those problems.

This requirement included the development of preventative practices known as Best Management Practices (BMPs) and programs to achieve implementation of BMPs.

The Environmental Protection Agency (EPA) has indicated that state approved BMPs are the primary mechanisms for maintaining water quality (Jensen 1987). Proper installation, operation and maintenance of state approved BMPs are presumed to meet a landowner's obligation for compliance with applicable water quality standards. EPA intends that the states aggressively implement approved BMPs. Many state forestry agencies, including Minnesota's, have been delegated the principal responsibility for controlling silvicultural NPS

pollution. Best Management Practices serve as the cornerstone for the water quality protection programs developed by the states.

Minnesota has adopted a nonregulatory BMP program. The nonregulatory approach requires a sustained effort and long-term commitment by the state forestry agency and the forestry community to ensure implementation. Forestry BMPs, published in 1989, were developed through a broadly based cooperative effort as Minnesota's first step in the program. Following this, attention has focused on the major components of a BMP implementation program: education, technical assistance, monitoring and research.

Implementation monitoring is the glue that binds the BMP process together. The forestry profession in many states uses annual or biennial field audits or surveys to determine the degree of compliance with silvicultural BMPs and to help identify specific implementation and practice deficiencies (Conner *et al.* 1989; NASF 1991; Schultz 1990). The field audits provide a qualitative measure of the effectiveness or inadequacy of specific practices. They are a snapshot-in-time of practices employed and a measure of subsequent impact. The ability to demonstrate compliance with forestry BMPs on all land ownerships is essential if the BMP process is to be credible.

The Minnesota DNR/Division of Forestry developed a pilot BMP compliance monitoring program in 1991 in cooperation with the forestry community, water quality agencies, and the public. The pilot program was funded with a $20,000 319 grant from EPA through the Minnesota Pollution Control Agency (PCA) and with $8,000 from the Department of Natural Resources/Division of Forestry. The objectives of the pilot field audits were to:

1) evaluate the level of BMP compliance for all forestry ownerships, i.e. state, federal, county, industrial private, and nonindustrial private;

2) provide a qualitative assessment of BMP effectiveness;

3) identify necessary modifications of the BMPs; and

4) utilize the results to target future education efforts and technical assistance.

II. METHODS

A. Development of Audit Process

Representatives from the following programs within the Minnesota Department of Natural Resources/Division of Forestry formed the work group which developed the field audit process: soils, utilization and marketing, and roads. The audit process was based on the design used by the Montana Department of State Lands and developed by Shultz (1990).

The principal function of the work group was to:

- ☐ develop the field audit rating guide and forms
- ☐ approve criteria for site selection
- ☐ solicit and select audit team members and alternates
- ☐ organize a calibration (training) workshop for audit team members
- ☐ prepare an annual report on results from field the audits

B. Audit Team Selection

In designating the audit teams, it was essential that each team be comprised of individuals with a wide range of interests and expertise. A generic invitation to participate was sent to a broad range of individuals and organizations with an interest in forestry issues. From the respondents, two audit teams and alternates were selected by the work group. One team each was assigned to the southeastern and northeastern areas of the state. Individual teams consisted of six to eight members with expertise in the areas of forest management, fisheries, road engineering, soil science, hydrology and conservation. Team leaders were staff from the Division of Forestry (DOF). Field audit teams included representatives from forest industry; federal, state and county agencies; University of Minnesota; the public; and conservation organizations. For the conservation organizations, the Sierra Club, Audubon Society, Izaak Walton League, Soil and Water Conservation Society (Minnesota chapter) and Minnesota Conservation Federation were represented. See Appendix A for a complete list of team members and alternates.

The EPA 319 grant supporting the pilot program included funds to pay travel expenses for all audit team members, and provided $50 per day for those who participated on their own time rather than on their employer's payroll.

C. Site Selection

Forest landowners in Minnesota fall into one of five categories: state, county, federal, private industrial (PI) and nonindustrial private forest (NIPF) landowners. Not all forest lands are adjacent to water, and specific criteria were developed so that only sites in close proximity to open water or intermittent drainages would be audited. Site selection among land ownerships was accomplished by soliciting state, county, and federal agencies and private industry to submit all timber sales and site preparation projects that met the criteria given below. Audit sites were randomly selected from those submitted. For the pilot program, a minimum of 40 sites were to be audited with at least five sites in each landowner type.

For NIPF landowners, there is not a current method of identifying all potential audit sites. The reporting of timber sales to the state forestry agency is not required as it is for other states such as Montana (Bill Schultz, personal communication). Private forest management specialists within the DOF and private industry were contacted and requested to identify sales that they were involved with or had knowledge of in their respective work areas. This method incorporated a potential bias in the selection process for NIPF landowners. NIPF landowners who solicit professional assistance are likely to be better informed about appropriate forest practices and are likely to have more of a conservation ethic than those who do not use this assistance. Identifying means to improve the selection of NIPF landowners is a priority for the audit process.

D. Site Selection Criteria

The following criteria were used by the DOF to select audit sites:

- ☐ Areas harvested by clearcutting or site prepared using mechanical or mechanical and chemical means. Selective harvest was included in southeastern Minnesota.

- ☐ Ownerships audited in proportion to timber harvested. To the extent feasible, the number of audits per ownership group were to be proportional to the volume of timber harvested within each ownership group based on 1990 timber harvest data.

- ☐ Forest management activities that occurred in 1989, 1990, or 1991. Priority was given to the most recent sites.

- ☐ Portion of each site located within 200 feet of a lake, stream or protected wetland.

- ☐ Minimum size of 10 acres in northeastern Minnesota and 5 acres in southeastern Minnesota.

In developing the audit process, the workgroup agreed that there should be proportionality in the number of acres reviewed and the actual acres of harvest activity by landowner type. The assumption was that the potential for impacts to water quality was more closely related to the number of acres over which the operations occurred rather than such factors as volume of timber harvested. However, statewide timber harvest data is compiled by volume, not acres. It was assumed that volume harvested by landowner type was reasonably proportional to acres harvested.

E. Audit Forms

Audit forms were developed by the DOF. The forms list the specific BMPs identified in the guidebook Water Quality in Forest Management: Best Management Practices in Minnesota. Ninety-six practices were incorporated in the forms. The audit sites were rated for:

1) applicability of each BMP to the site (yes or no),

2) whether the applicable BMPs were applied correctly in the proper location (5-point scale), and

3) the effectiveness of BMP applications (6-point scale).

A lack of adequate application or misapplication was considered a departure from the BMP. Ratings for each BMP were determined by the consensus of the field audit team. A copy of the audit form is found in Appendix B.

The decision matrix for evaluating on-site BMP compliance is given in Figure 1. If the specific BMP was applicable to the site, then the rating guide to determine the level of application of BMPs was:

5: operation exceeds requirement of BMP
4: operation meets requirement of BMP
3: minor departure from BMP
2: major departure from BMP
1: gross neglect of BMP

Ratings 5 and 4 are self explanatory. Minor departures (rating 3) applied to those which were small in magnitude and localized. Major departures (rating 2) applied where departures were of significant magnitude or where the BMPs were consistently neglected. Gross neglect (rating 1) applied where the potential risk to water resources was significant and there was no evidence that any attempt had been made by the operator to apply the BMP.

The effectiveness ratings provided a qualitative evaluation of how well the applied BMP was preventing the movement of sediment to water bodies or intermittent drainages. Less emphasis was placed in evaluating other nonpoint source components (e.g. nutrients, pesticides, increases in water temperature).The effectiveness ratings guide was:

6: improved protection of soil and water resources over pre-project condition
5: adequate protection of soil and water resources
4: minor and temporary impacts on soil and water resources
3: major and temporary impacts on soil and water resources
2: minor and prolonged impacts on soil and water resources
1: major and prolonged impacts on soil and water resources

The terms for effectiveness are defined as follows:

Adequate:	small amount of material eroded; material does not reach drainages, streams, lakes or open water wetlands.
Minor:	erosion and delivery of material to intermittent drainages but not to streams, lakes or open water wetlands.
Major:	erosion and delivery of sediment directly to streams, lakes or open water wetlands. It should not be inferred that major necessarily indicates a serious impact to water quality. The delivery of sediment could vary from small amounts to large quantities.
Temporary:	impacts lasting one year or less; no more than one runoff season.
Prolonged:	impacts lasting more than one year.

The comments column was used to describe specifics related to departures and potential effects, and to further describe site characteristics.

F. Field Procedure for On-Site BMP Evaluation

Prior to initiating the field audits, a two-day calibration workshop was held to familiarize the team members and alternates with the objectives and procedures of the field audits and to instill continuity among teams in rating audit sites. The calibration workshop consisted of a half-day classroom session followed by a day and a half of field review and discussions.

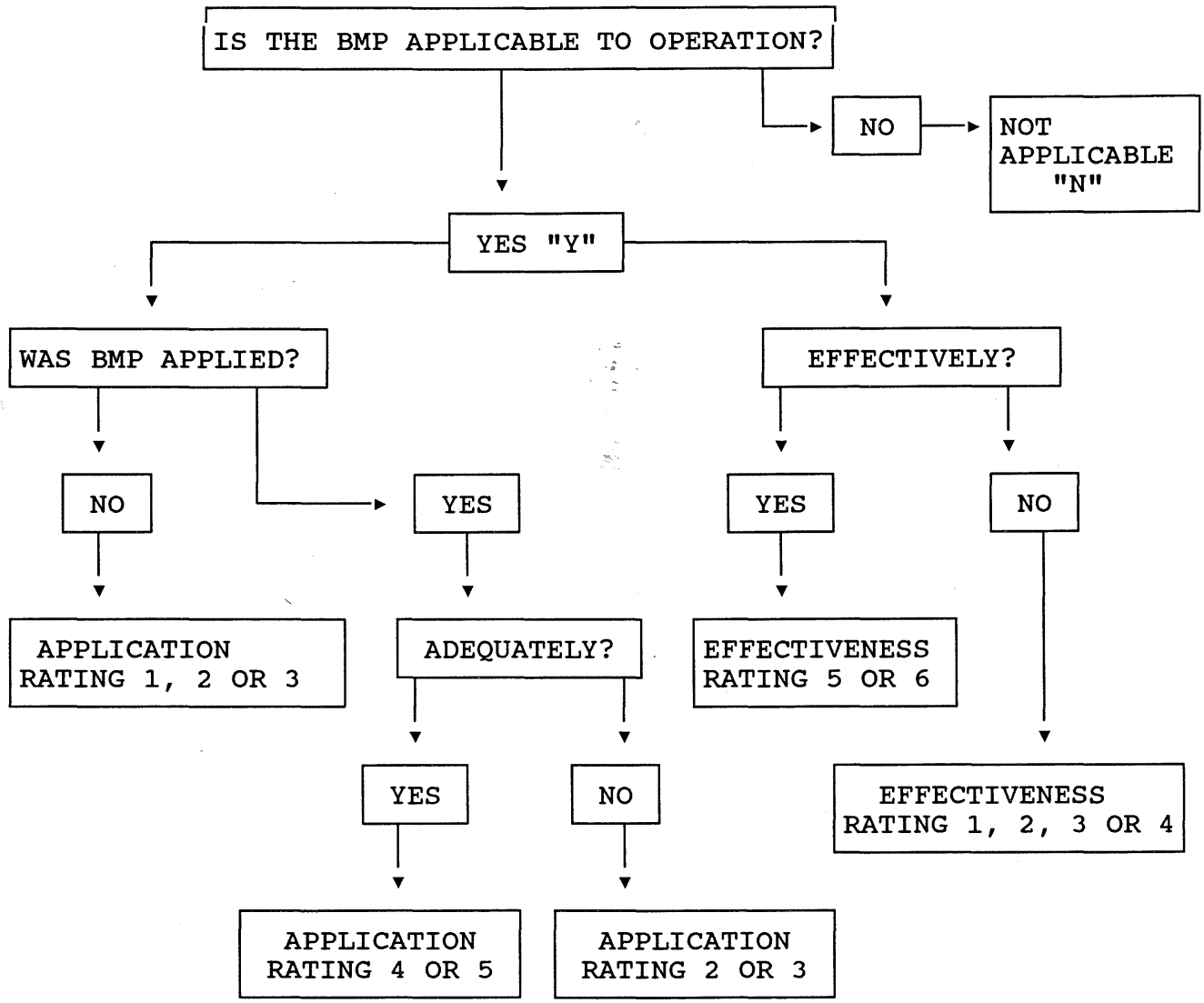
The on-site procedure followed by the field audit teams is given below.

1. Site characteristics and management activities were reviewed by the audit team leader. Team members were provided with maps and audit forms. Where possible, the landowner or site manager provided background information on the forest management activities.

2. After the introduction, the team traversed the site as a group or as individuals checking for BMP application and effectiveness for potential impact areas such as roads, skid trails, and along streams. At that time team members were encouraged to make notes on their individual evaluation forms.

3. After sufficient time to walk over and examine the site, generally one to three hours, the team reconvened at a central location to discuss the site evaluation. The team leader lead the discussion in rating the site and filled out the evaluation worksheet. When auditing state forest land, the opportunity was given for someone from an organization other that the DOF to lead the discussion to dispel any potential bias in rating the site. Each rating was determined by group consensus and a single rating form was produced for each site.

Figure 1. Decision matrix for on-site evaluation of BMP compliance.



G. Limitations to Field Audits

The limitations inherent in this type of process were articulated by Schultz (1990). The audits provide a point-in-time sampling which documents problems in the first or second year after a forest management operation when impacts are most likely to occur. However, the

audits may not identify problems that occurred during the operations themselves.

The audits provide a visual evaluation of BMP use and a qualitative evaluation of BMP effectiveness based on a one-time observation of erosion and sediment movement. The technique is inadequate to determine future impacts on the site.

On large sites, there may not be adequate time to review the entire site. In those cases, team members should concentrate their review on the critical areas where potential problems are likely to occur.

Where subjective evaluation is the principal method of analysis, it is probable that some differences between teams will occur in rating specific practices. However, the two day calibration workshop and continuous dialogue among team members and between team leaders should minimize differences and provide continuity between teams in how to rate specific practices.

III. RESULTS

A. Overview

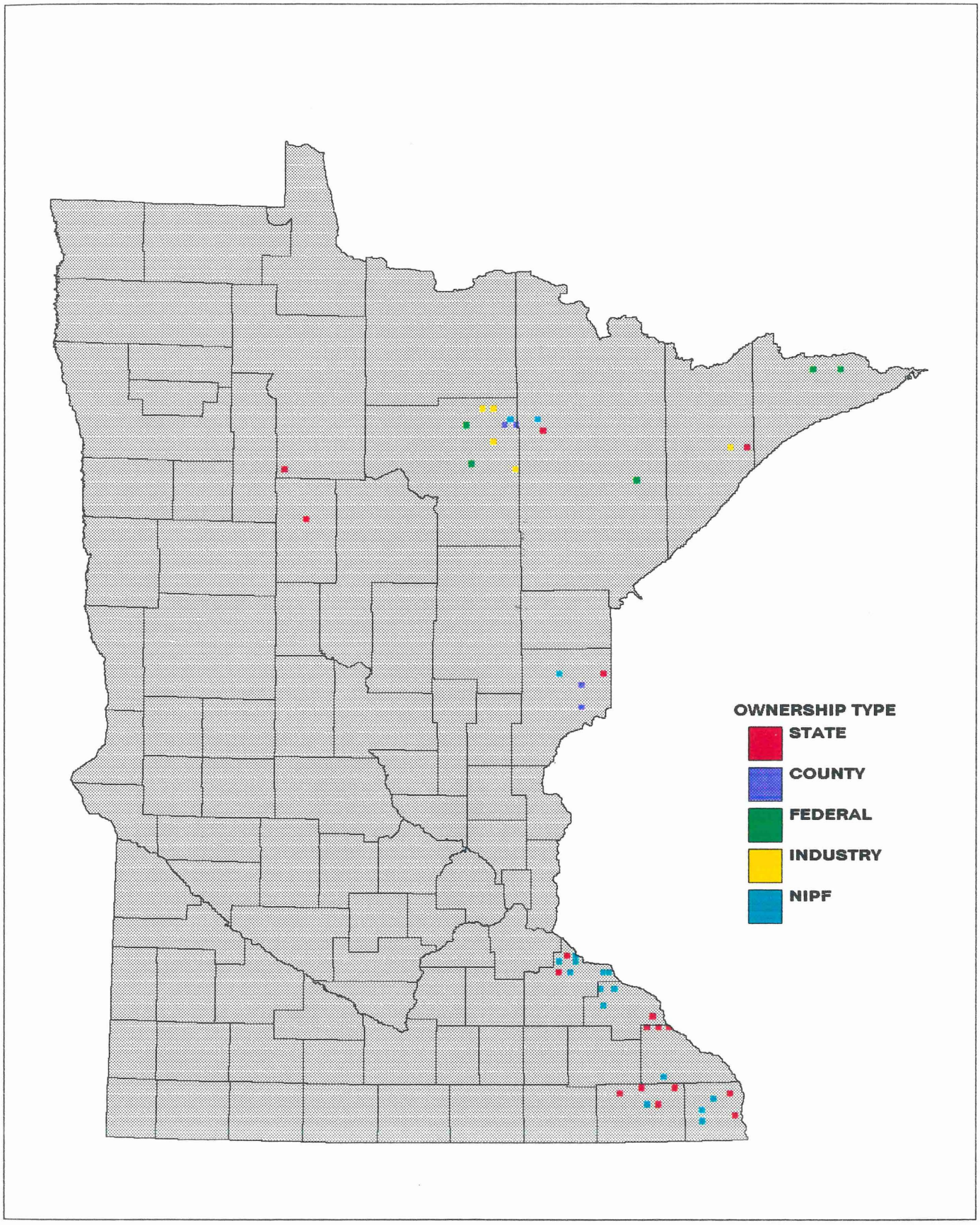
A total of 48 sites were audited in northeastern and southeastern Minnesota in August and September 1991 (Table 1). The locations of the audited sites are found in Figure 2. For the northeastern team, audit sites were, for the most part, evenly distributed among the five landowner classes. All audit sites for the southeastern team were on state and NIPF lands, which reflected forest landownership patterns in southeastern Minnesota. Total sites audited on county lands were less than the established goal of at least five for each landowner type. Inclement weather and time constraints precluded review of one of the selected county sites.

The percent of total harvest by landowner type, based on 1990 data, was compared to acres reviewed (Figure 3). Acreage reviewed was in proportion to volumes harvested from state, federal and NIPF lands. Private industry acres reviewed exceeded the proportion of timber harvested on this ownership type due to the small PI forest land base and the requirement that a minimum of five sites should be reviewed to assure an adequate representative sample. County acres reviewed were substantially below the level desired. More county sites need to be included in future audits.

B. Application of BMPs Statewide

The level of compliance with silvicultural BMPs by landowner type statewide is given in Table 2. In all, 1160 practices were rated on the 48 sites. This represented 24% of the specific practices (4608) that could have been rated if all practices were needed for all sites. Most of the practices rated were on state and NIPF land, as 70% of the audit sites were on

Figure 2. Approximate locations of 1991 BMP audit sites.



these ownerships. On average, the forestry community met or exceeded the BMP requirements 79% of the time. The level of compliance by landowner types decreased in the order:

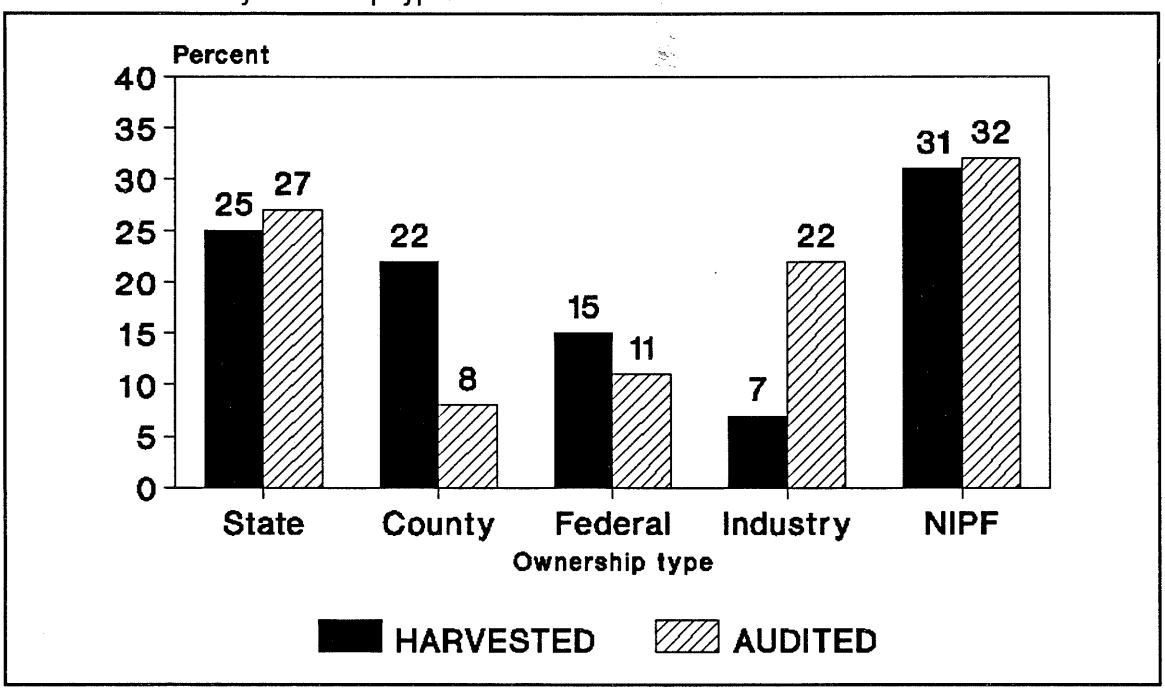
county > PI > federal > state > NIPF.

The majority of departures (198 of 237) from BMP requirements were minor in nature. Major departures or gross neglect were found for less than 4% of the practices rated, and most occurred on NIPF lands.

Table 1. Field audits completed by ownership type.

OWNERSHIP TYPE	NUMBER OF SITES AUDITED		
	NORTHEAST	SOUTHEAST	TOTAL SITES
STATE (DNR)	5	12	17
COUNTY	4	0	4
FEDERAL (USFS)	5	0	5
PRIVATE INDUSTRIAL (PI)	5	0	5
NON-INDUSTRIAL PRIVATE (NIPF)	3	14	17
TOTAL SITES	22	26	48

Figure 3. Comparison of the percentage of sites audited to the percentage of total state harvest volume by ownership type.



* Percent of timber harvested in 1990 for federal lands includes more than USFS lands. Audit were conducted on only USFS lands. Source: Minnesota Department of Natural Resources/Division of Forestry. May 1992. Minnesota Forest Resources. St. Paul. 50p.

Table 2. Application of BMPs by rating category for all practices evaluated by ownership type statewide.

OWNERSHIP TYPE	NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
STATE	373	80%	17%	2%	0.5%
COUNTY	80	90%	10%	-	-
FEDERAL	161	87%	11%	2%	-
PI	146	88%	12%	-	-
NIPF	400	71%	21%	8%	-
ALL SITES	1160	79%	17%	<4%	<0.5%

The BMP audit results by geographic region are presented in Table 3. The level of compliance for southeastern Minnesota was lower than in northeastern Minnesota. The lower level of compliance likely reflected the more difficult operating terrain in the southeast region where slopes are generally steeper. In addition, more of the sites in southeastern Minnesota were on NIPF lands which consistently had a lower compliance rate compared to other landowner types. The only gross neglect recorded in the audits occurred on state land in southeastern Minnesota. This resulted from a failure to close a road after a timber sale was completed, which allowed recreational vehicles (RV) to access the site. It was the RV activity that caused the water quality impacts.

Most of the forest management activities reviewed in the audits were associated with timber harvesting and forest roads (Table 4). There were few practices rated for activities associated with pesticide use and prescribed burning, and compliance levels for these activities must be viewed with caution. The few practices rated were insufficient to provide definitive conclusions relative to those forest management activities.

Another approach in evaluating the results is to determine the percentage of sites that departed from BMP requirements and the average number of departures per site (Table 5). Only on state land were any of the sites found with no departures (3 of 17). Nearly all sites reviewed (41 of 48) had at least one minor departure. Approximately half of the NIPF sites (8 of 17) had at least one major departure. For all ownerships, 23% of the sites (11 of 48) had at least one major departure from the BMP requirements. None of the major departures were found on county or private industrial lands. The average number of departures per site was lowest for county lands and highest for NIPF lands.

Table 3. Application of BMPs by rating category for all practices evaluated by ownership type for the northeast and southeast audit areas.

OWNERSHIP TYPE		NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
			MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
NE	STATE	151	83%	17%	<1%	-
	COUNTY	80	90%	10%	-	-
	FEDERAL	161	87%	11%	2%	-
	PI	146	88%	12%	-	-
	NIPF	91	71%	22%	7%	-
	ALL SITES	629	84%	14%	2%	-
SE	STATE	222	78%	18%	3%	1%
	NIPF	309	71%	21%	8%	-
	ALL SITES	531	74%	20%	6%	<0.5%
ALL SITES STATEWIDE		1160	79%	17%	<4%	<0.5%

Table 4. Application of BMPs by rating category for forest management activities on all ownership types statewide.

FOREST MANAGEMENT ACTIVITIES	NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
GENERAL *	38	79%	21%	-	-
FOREST ROADS	518	76%	19%	5%	<1%
TIMBER HARVEST	552	82%	15%	3%	-
SITE PREP	31	94%	7%	-	-
PESTICIDES USED	7	100%	-	-	-
PRESCRIBED BURNING	14	71%	29%	-	-

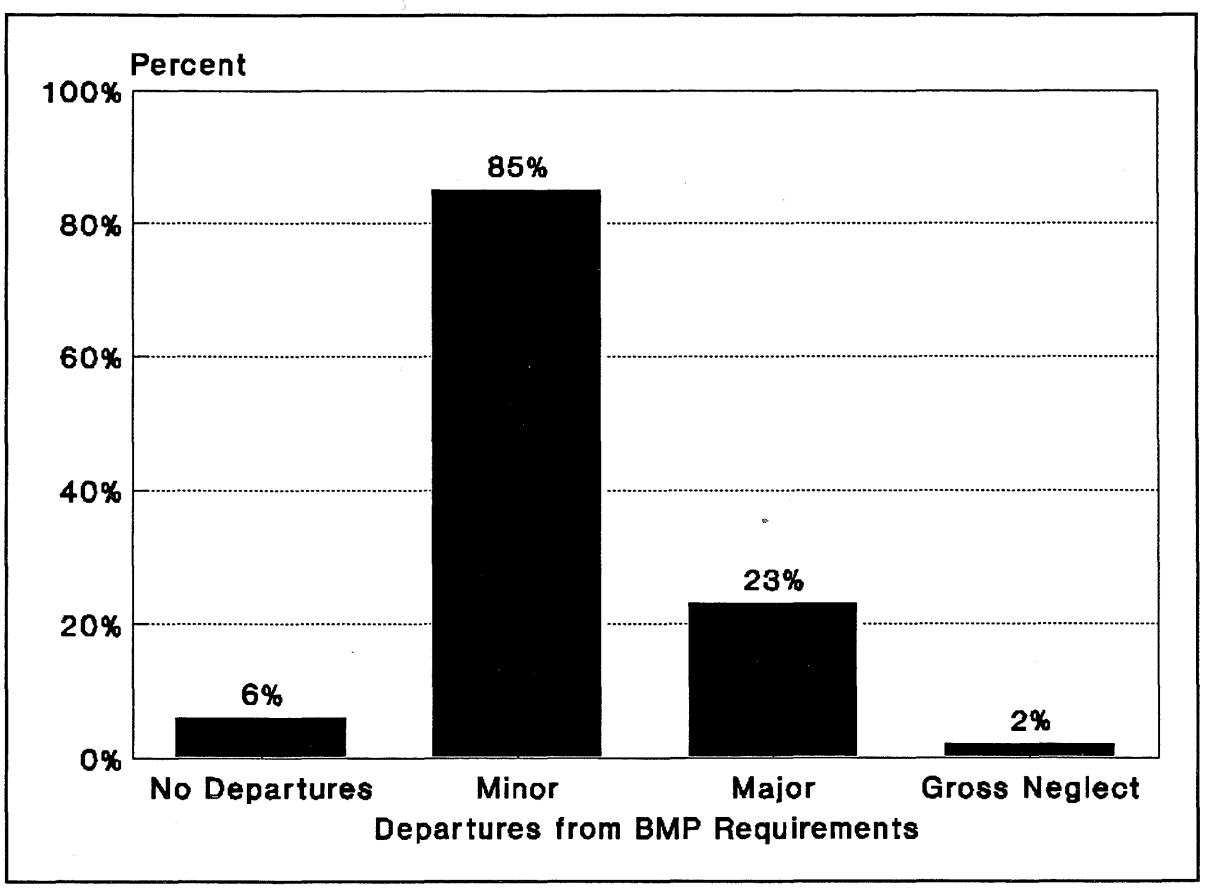
* Refers to general management categories on audit worksheet. See Appendix B.

Table 5. Departures from BMP requirements on audit sites.

		PERCENT OF SITES WITH DEPARTURES				DEPARTURES / SITE (MEAN)*		
OWNERSHIP TYPE	NUMBER OF SITES	NO DEPART.	MINOR	MAJOR	GROSS NEGLECT	MINOR	MAJOR	GROSS NEGLECT
STATE	17	18%	77%	12%	6%	3.8	0.4	0.1
COUNTY	4	-	100%	-	-	2.0	-	-
FEDERAL	5	-	80%	20%	-	3.6	0.6	-
PI	5	-	100%	-	-	3.6	-	-
NIPF	17	-	88%	47%	-	5.0	1.9	-

* Includes all sites, not just sites with departures

Figure 4. Percentage of audit sites in each departure category.



C. Application of Specific BMPs

The previous section is a summary of the level of compliance with all appropriate BMPs. Each of these BMPs provides a degree of protection to water quality from the impacts of NPS pollution. Arguably, not all BMPs provide the same degree of protection. For example, "obtaining proper permits" has less of a direct effect on water quality than does "draining surface water into the filter strip or vegetative draw".

The authors felt that it would be instructive to identify and analyze those BMPs which provided the greatest degree of direct protection to water quality. Selection of the BMPs evaluated in this analysis was the decision of the authors. The focus was on two components of that protection: 1) the use of filter strips, and 2) those BMPs critical to reducing the direct addition or delivery of sediment and other NPS pollutants to water courses. The relative importance of each of the specific critical (for lack of a better term) BMPs compared to the other BMPs is debateable. Others reviewing the audit forms and data may consider other BMPs to be of equal or greater importance.

1. Filter Strip BMPs

Nine specific BMPs were identified for filter strip use associated with forest management activities. The level of compliance was high for individual practices (Table 6) and for each of the landowner types (Table 7). Regional differences in the level of filter strip compliance were evident (Table 8). In northeastern Minnesota, the compliance rate was above 90% for all landowner types, and few minor and no major departures were identified. The level of compliance was much lower for state and NIPF lands in southeastern Minnesota. However, the majority of the departures (21 of 26) from BMP requirements were minor. The steep terrain in southeastern Minnesota required wider filter strips than were generally needed for northeastern sites. This increased the probability of an infraction occurring since filter strips occupied a greater portion of a site.

2. Critical BMPs

Twenty-one of the individual BMPs were considered critical (Table 9). These included BMPs that directly influenced activities adjacent to water and that influenced the volume, velocity and direction of surface flow. Although the overall compliance rate for the critical BMPs was 73%, there were notable problem areas. Minor departures were common where water diversion devices and drainage structures were required.

The application of critical BMPs by landowner type statewide is shown in Table 10. Lowest levels of application again were found for NIPF landowners. The percentage of minor departures were similar among landowner types while most of the major departures occurred on NIPF lands.

Table 6. Application of filter strip BMPs statewide.

FILTER STRIP PRACTICES		NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
LINE NO.	SPECIFIC BMPs		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
	*ROADS					
2E1 **	Filter strip width	27	89%	7%	4%	-
2E2	Filter strip disturbance	27	93%	7%	-	-
2E3	Filter strip slash disposal	26	85%	11%	4%	-
	TIMBER HARVEST					
11C	Minimize mineral soil exposure in filter strip	39	95%	5%	-	-
13B	Locate skid trails outside of filter strips	44	82%	14%	6%	-
14B	Locate landings outside of filter strip	38	92%	8%	-	-
	SITE PREPARATION					
15B	Provide adequate filter strips for site preparation	7	100%	-	-	-
	PRESCRIBED BURNING					
18C	Establish filter strips for fire lines	1	100%	-	-	-
18D	Avoid placement of debris piles for burning in filter strips or sensitive areas	4	25%	75%	-	-
ALL PRACTICES		213	88%	10%	2%	-

* Refers to general categories on the audit worksheet. See Appendix B.
** Refers to line numbers on the audit worksheet. See Appendix B.

There were few apparent regional differences in the application of critical BMPs between northeastern and southeastern Minnesota (Table 11). Perhaps the most striking difference was for NIPF lands in the northeast where only 59% of the critical practices met or exceeded the BMP requirements. The low level of compliance could have been an artifact of the low number of critical practices that were rated for NIPF landowners in the northeastern area. But if this compliance level is confirmed in future audits, it would indicate that additional efforts are needed to sensitize landowners, managers and equipment operators on the proper installation and use of water diversion and drainage structures.

When the critical and filter strip BMPs are summed together (Tables 12 and 13), the results are comparable to those found for statewide and regional totals for all BMPs (Tables 2 and 3). In total, critical and filter strip BMPs together account for approximately 40% of all practices rated.

Table 7. Application of filter strip BMPs by ownership type statewide.

OWNERSHIP TYPE	NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
STATE	73	83%	14%	3%	-
COUNTY	18	100%	-	-	-
FEDERAL	28	100%	-	-	-
PI	31	97%	3%	-	-
NIPF	63	81%	16%	3%	-
ALL SITES	213	88%	10%	2%	-

Table 8. Application of filter strip BMPs by ownership type for the northeast and southeast audit areas.

OWNERSHIP TYPE		NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
			MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
NE	STATE	33	91%	9%	-	-
	COUNTY	18	100%	-	-	-
	FEDERAL	28	100%	-	-	-
	PI	31	97%	3%	-	-
	NIPF	19	95%	5%	-	-
	ALL SITES	129	96%	4%	-	-
SE	STATE	40	78%	18%	5%	-
	NIPF	44	75%	20%	5%	-
	ALL SITES	84	76%	19%	5%	-
ALL SITES STATEWIDE		213	88%	10%	2%	-

Table 9. Application of critical BMPs statewide.

CRITICAL PRACTICES		NUMBER OF TIMES PRACTICE RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
LINE NO.	SPECIFIC BMPs		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
1a	Adequate storage and disposal for fuel, debris, lubricants.....	38	79%	21%	-	-
2b	Minimize number of water crossings	18	94%	6%	-	-
2d	Avoid activity below OHW	18	94%	6%	-	-
4c	Temporary/winter crossings removed prior to breakup	4	100%	-	-	-
5a	Culverts properly sized and installed	6	50%	17%	33%	-
5c1 5c2 5c3	Install water diversion devices on road surfaces: broad base dips; open culverts; water bars	16	19%	75%	6%	-
5d	Drain surface water into filter strip or vegetative draw	23	61%	22%	17%	-
5e1 5e2 5e3	Design ditches to avoid carrying water long distances: lead-offs; cross culverts; cross drains	19	63%	26%	11%	-
9a 10a	Properly close occasional use and abandoned roads when not in use	21	52%	38%	5%	5%
9c 10c	Proper water diversion devices on occasional use and abandoned roads	9	44%	56%	-	-
13c	Design skid trails to avoid concentrating runoff	38	84%	13%	3%	-
13e 14g	Drain surface water from skid trails and landings into vegetative draw	24	88%	12%	-	-
13i	Minimize number of skid trail water crossings	12	100%	-	-	-
13L	Temporary/winter skid trail crossings removed prior to spring breakup	2	100%	-	-	-
ALL PRACTICES		248	73%	22%	4%	<1%

Table 10. Application of critical BMPs by ownership type statewide.

OWNERSHIP TYPE	NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
STATE	75	73%	23%	3%	1%
COUNTY	17	82%	18%	-	-
FEDERAL	36	75%	22%	3%	-
PI	32	84%	16%	-	-
NIPF	88	67%	24%	9%	-
STATEWIDE	248	73%	22%	4%	<1%

Table 11. Application of critical BMPs by ownership type for the northeast and southeast audit areas.

OWNERSHIP TYPE		NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
			MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
NE	STATE	28	71%	29%	-	-
	COUNTY	17	82%	18%	-	-
	FEDERAL	36	75%	22%	3%	-
	PI	32	84%	16%	-	-
	NIPF	22	59%	32%	9%	-
	ALL SITES	135	75%	23%	2%	-
SE	STATE	47	75%	19%	4%	2%
	NIPF	66	70%	21%	9%	-
	ALL SITES	113	72%	20%	7%	1%
ALL SITES STATEWIDE		248	73%	22%	4%	<1%

D. Departures from BMPs

To have an effective BMP implementation program requires an understanding of the extent that the appropriate BMPs are utilized. Identifying which BMPs are not consistently used where needed or properly installed allows the forestry community to target problem areas with the limited resources that are available. Table 14 lists the specific BMPs which were rated with departures at least 33% of the time. Most of these departures were for

Table 12. Application of critical BMPs and filter strip BMPs by ownership type statewide.

OWNERSHIP TYPE	NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
STATE	148	78%	18%	3%	<1%
COUNTY	35	91%	9%	-	-
FEDERAL	64	86%	13%	1%	-
PI	63	90%	10%	-	-
NIPF	151	73%	21%	7%	-
ALL SITES	461	80%	16%	3%	<1%

Table 13. Application of critical BMPs and filter strip BMPs by ownership type for the northeast and southeast audit areas.

OWNERSHIP TYPE		NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
			MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
NE	STATE	61	82%	18%	-	-
	COUNTY	35	91%	9%	-	-
	FEDERAL	64	86%	13%	1%	-
	PI	63	90%	10%	-	-
	NIPF	41	76%	19%	5%	-
	ALL SITES	264	85%	14%	1%	-
SE	STATE	87	76%	18%	5%	1%
	NIPF	110	72%	21%	7%	-
	ALL SITES	197	74%	20%	6%	<1%
ALL SITES STATEWIDE		461	80%	16%	3%	<1%

practices that influence the volume, velocity and direction of surface flow. They were often the types of practices that required the additional investment of operator time (e.g.grade roads, shape inslopes and backslopes) or money (e.g. culvert installation). However, the majority of departures were minor which suggests that the problems are correctable.

Table 14. Application of BMPs where departures were found to equal or exceed 33%

LINE NO.	SPECIFIC BMPs	NUMBER OF TIMES RATED	DEPARTURES (percent)	NUMBER OF DEPARTURES		
				MINOR	MAJOR	GROSS
3C	Crossings vs. fish migration	6	33%	2	-	-
3D	Low water crossings	7	43%	-	3	-
5A	Culverts	6	50%	1	2	-
5C2 5C3	Water diversion on road surface; open culverts, water bars	10	100%	9	1	-
5D	Drain water into vegetative draw	23	39%	5	4	-
5E1	Lead-offs	11	63%	5	2	-
5G	Remove berms	18	33%	5	1	-
6B	Shape inslopes and backslopes	13	54%	7	-	-
6G	Properly surface road	16	37%	6	-	-
7B	Road erosion control features functional	14	36%	5	-	-
7C	Stabilize erodible soils by seeding	16	44%	6	1	-
8A	Grade roads	11	54%	6	-	-
9A	Properly close occasional use roads	11	64%	5	1	1
9C 10c	Water diversion devices on occasional or closed roads	9	55%	5	-	-
11D	Streams, lakes, wetlands free of debris	36	44%	12	4	-
11F	Restore water course	7	43%	3	-	-
11G	Erosion barriers properly maintained	7	85%	5	1	-
13D1 13D2	Water diversion devices on skid trails	8	87%	6	1	-
13G	Shape inslopes and backslopes of skid trails	5	80%	4	-	-
13H	Remove berms from skid trails	5	40%	2	-	-
13N	Rehabilitate skid trails	31	35%	10	1	-
18D	Avoid placement of burning piles in f-strips or sensitive areas	4	75%	3	-	-

E. Professional Assistance for NIPF landowners

In discussions on BMP implementation, it has been assumed that NIPF landowners who obtain professional management assistance would be better informed or have more of a conservation ethic and, thus, would be more likely to employ BMPs in managing their lands. Eight of the 17 audited NIPF sites received some form of forestry assistance. There was little apparent difference in the level of BMP compliance for those sites which received professional assistance compared to those who did not (Table 15). The biggest discrepancy

was the higher percentage of major departures for NIPF lands which did not employ professional assistance in management.

The significance of this comparison for NIPF lands is questionable. It could not be determined if BMP recommendations were actually made as part of any of the management prescriptions, whether the landowner included all or a portion of the BMP recommendations in the management prescription, or, if the recommendations were made, whether they were followed by the operator.

Table 15. Level of BMP compliance for NIPF landowners who received professional assistance compared to those who did not.

	NUMBER OF PRACTICES RATED	LEVEL OF BMP APPLICATION BY RATING CATEGORY (PERCENT)			
		MEETS OR EXCEEDS	MINOR DEPARTURE	MAJOR DEPARTURE	GROSS NEGLECT
FORESTER ASSISTED	188	74%	25%	1%	-
NO FORESTER ASSISTANCE	212	68%	18%	14%	-
ALL SITES	400	71%	21%	8%	-

F. Effectiveness of BMPs

The effectiveness rating provides a qualitative measure of the degree of protection to water resources. What is being evaluated is the erosion and sediment movement to intermittent drainages and perennial water courses (see Methods, Section E). For the pilot audits, a total of 1160 practices were rated. Table 16 provides a summary of the effectiveness for all practices rated by land ownership type. On average, 89% of the practices rated statewide provided adequate protection. This level of protection exceeded the percentage of practices which met or exceeded the BMP requirement (Table 3). What this indicated was that adequate protection was provided even where departures occurred in many cases. This effect is shown graphically in Figure 5 and in Table 17. Where application met or exceeded the BMP requirement, adequate protection was provided in 99% of the cases. Even where minor departures were found, adequate protection was provided almost 60% of the time. However, where major departures were noted, a substantial increase in major long term impacts were found. What this showed was that where the BMPs were followed, they appeared to work, and the magnitude of the impact to water quality increased with the extent to which the BMP requirements were ignored or not followed.

One point needs to be reemphasized. When a particular BMP departure was rated as major, it did not necessarily imply a significant or large scale impact to the water resource. It only indicated that the effect of the departure occurred directly to a perennial system. The extent of the impact may have been negligible to substantial. Future audits will attempt to quantify the extent of the impact.

Table 16. Effectiveness of BMPs in preventing sediment movement for each land ownership type statewide.

OWNERSHIP TYPE	NUMBER OF PRACTICES RATED	EFFECTIVENESS RATING (PERCENT)				
		ADEQUATE PROTECTION	MINOR TEMPORARY	MAJOR TEMPORARY	MINOR PROLONGED	MAJOR PROLONGED
STATE	373	90%	5%	-	3%	2%
COUNTY	79	100%	-	-	-	-
FEDERAL	161	96%	-	-	3%	1%
PI	146	95%	1%	-	1%	3%
NIPF	400	82%	7%	1%	7%	3%
ALL SITES	1160	89%	4%	<1%	4%	2%

Figure 5. Effectiveness of BMPs compared to the level of application for all sites statewide.

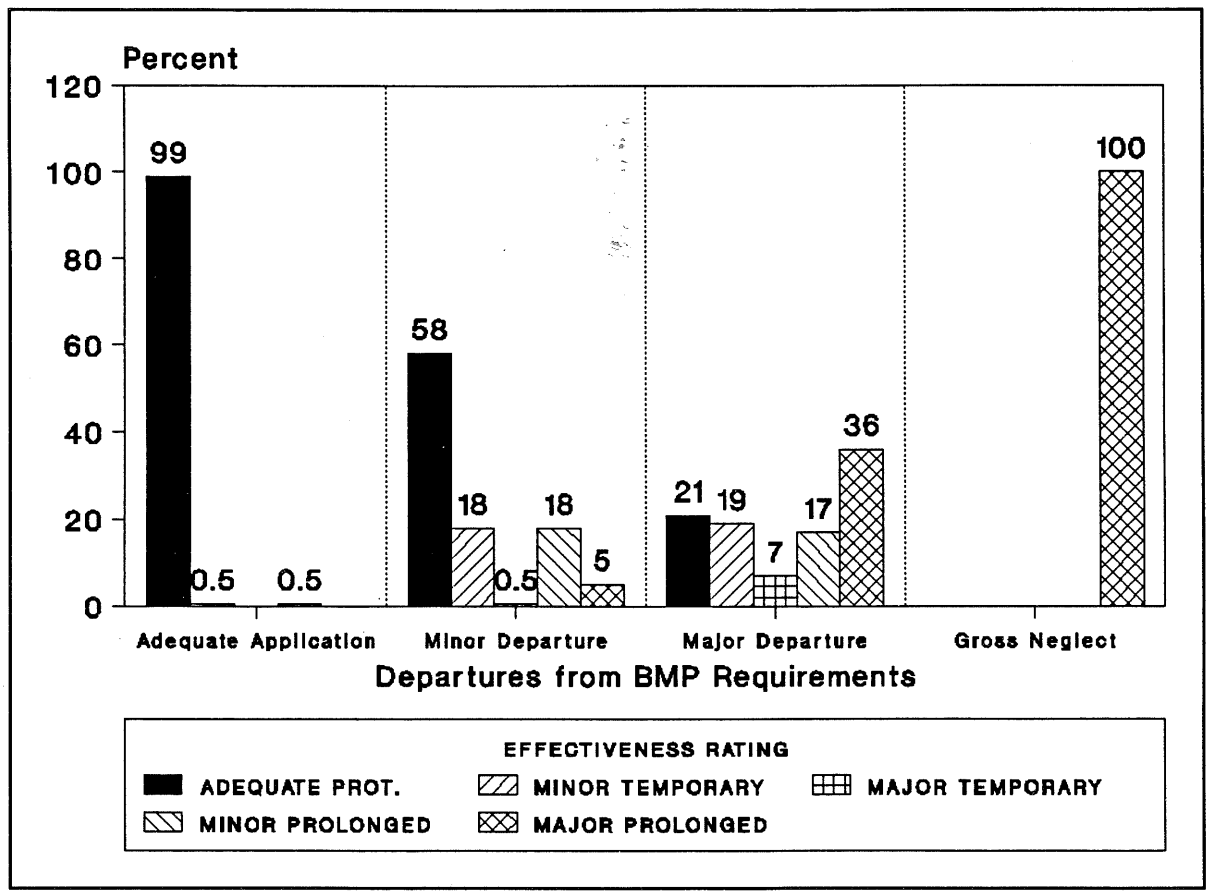


Table 17. Effectiveness of BMPs in preventing sediment movement compared to the level of application for all sites statewide.

BMP APPLICATION RATING	TOTAL NUMBER OF PRACTICES RATED	EFFECTIVENESS RATING (PERCENT)				
		ADEQUATE PROTECTION	MINOR TEMPORARY	MAJOR TEMPORARY	MINOR PROLONGED	MAJOR PROLONGED
MEETS OR EXCEEDS	923	99%	0.5%	-	.5%	-
MINOR DEPARTURE	193	58%	18%	<0.5%	18%	5%
MAJOR DEPARTURE	42	21%	19%	7%	17%	36%
GROSS NEGLECT	2	-	-	-	-	100%

IV. DISCUSSION

The use of BMP audits is becoming a standard practice in forestry. As of 1991, 25 states had either implemented compliance monitoring programs or were in the process of developing programs (NASF 1991). Published results from monitoring have indicated that compliance with BMP requirements generally ranges from 70% to 100% (Conner *et al.* 1989, NASF 1991, Schultz 1990). Minnesota's audit results are consistent with these findings.

The EPA has recognized the utility of BMPs as a preventative system to control NPS pollution (Jensen 1987). However, the success of any NPS control program will depend on the degree to which compliance is achieved and on the willingness of the forestry community to identify and target remedial actions to address specific implementation and compliance problems. The detailed nature of the field audits provides the means for forestry to focus on specific areas in need of attention.

For example, the field audits found a high level of compliance with filter strip BMP requirements for all landowner types in northeastern Minnesota (Table 8). What this indicates is that landowners, managers and operators are generally cautious in conducting management activities adjacent to or near surface water. In contrast, lower levels of compliance with filter strip BMP requirements were noted for southeastern Minnesota (Table 8). These results suggest that more effort is required to ensure proper application of filter strips in the southeastern compared to the northeastern region of the state.

Forest roads and skid trails provide another example of identifying specific problem areas. Statewide, the audits consistently found that the majority of all departures from BMP requirements were associated with forest roads and skid trails (Table 14). BMPs related to forest roads and skid trails clearly need increased attention.

The ability to identify specific problem areas is critical. By focusing on these problem areas, the forestry community will be able to effectively target limited resources to correct

deficiencies in the NPS control program. Education efforts and technical assistance can be more effectively targeted to need. Future audits will confirm these preliminary results or identify additional concerns and needs.

V. CONCLUSIONS

The audit process is a positive and productive approach to dealing with a complex natural resource issue. Recent BMP implementation efforts in Minnesota have earned the forestry profession greater credibility and have given it the opportunity to direct and strongly influence its own destiny. Information from the audits can demonstrate to the public and the regulatory agencies that the forestry community is committed to ensuring effective water quality protection.

The results from the pilot audits indicate that compliance with forestry BMPs is relatively high. However, the audits have also identified specific problem areas that must be addressed if forestry is to demonstrate progressive improvement in the adoption and use of BMPs. Maintaining a reasonable regulatory climate for forestry in Minnesota will require continued documentation of BMP effectiveness and successful implementation. Future BMP monitoring will continue to play a major role in providing that documentation.

An additional benefit that resulted during the audits was the positive interaction between the professional foresters and the environmental community. This is not a small accomplishment. Often we talk past each other when presenting our viewpoints on natural resource issues and pose these issues as win-lose propositions. The audit teams spent several weeks together in the field and used goodwill, positive dialogue and communication to evaluate a natural resource issue. It would be desirable to carry that type of positive momentum into the future in dealing with other natural resource issues.

VI. RECOMMENDATIONS

- ☐ When rating roads, only rate the portion of the road within a practical impact distance to the water body.
  * *Change made for 1992 audits*

- ☐ Provide copy of the audit worksheet to the landowner as soon as possible with comments and recommendations.
  * *To be done for 1992 audits*

- ☐ Continue the audit process and expand teams to 4.
  * *To be done for 1992 audits*

- ☐ Continue interdisciplinary makeup of the teams.
  * *Interdisciplinary teams already formed for 1992*

- ☐ Revisit 10% of the sites from the previous year.
  * *To be done for 1992 audits*

- ☐ Refine and improve the audit site selection process to insure random sampling of all ownerships and management activities, especially for NIPF lands.
  * *Under active consideration*

- ☐ Add a column that identifies the extent of the impact such as acres impacted or percentage of site that effects a particular BMP to quantify the departures and impacts.
  * *To be included on the 1992 audit forms in the comments column*

- ☐ Change terminology for effectiveness rating from major or minor to direct or indirect
  * *Change incorporated on the 1992 audit forms*

- ☐ Edits and clarifications added to the audit forms:
  * *Delete Line 7A, it is covered by 6g*
  * *Change definitions/terminology for major and minor impacts to direct and indirect on the cover sheet of the worksheet*
  * *Add "Degree of Forester Assistance" to the cover sheet*
  * *Be more precise on the type of water present on the cover sheet. Individual line for wetlands, streams and lakes*
  * *Change "roads" in 13d to "skid trails"*
  * *Add to 7d "if use could impact water quality"*

- ☐ Separate audit sites by slope or landscape position rather than just be region.
  * *Not practical for the 1991 report but will be considered for the 1992 or later report*

- ☐ Continue education of loggers, landowners and resource managers based on problem areas identified in the audit process.
  * *Planned for future workshops and training sessions*

- ☐ Expand field audits into Native American tribal ownerships.
  * *To be done for 1992 audits*

- ☐ Obtain air photos for review on sites to be audited.
  * *To be done for 1992 audits*

- ☐ Regionalize BMPs for southeastern Minnesota compared to the northern portion of the state (ie. skid trails in the SE are constructed and used more like roads than in the northern part of Minnesota).
  * *To be considered when BMP guidebook is reevaluated*

- ☐ Clarify criteria for site selection.
  * *To be done for 1992 audits*

- ☐ Include all open-water wetland types in the audits, including those created by beaver dams.
  * *To be done for 1992 audits*

- ☐ Randomly select a representative sample of counties and state forest districts from which to select sites each year.
  * *No action to date*

- ☐ Increase proportion of county sites audited.
  * *To be done for 1992 audits*

VII. REFERENCES CITED

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VII. APPENDICES

Appendix A. 1991 Forestry BMP Field Audit Team Members

1. *Northeast Audit Team*

Team Leaders:
Dick Rossman, DNR-Division of Forestry
Mike Phillips, DNR-Division of Forestry

Soils:
Barb Luelling, USFS, Superior National Forest
(Dick Rossman, Mike Phillips)

Hydrology:
Jim Lemmerman, Board of Water and Soil Resources (BOWSR)
Bob Berrisford, USFS, Superior National Forest
(Barb Luelling)

Roads/engineering:
John Cedergren, Retired Forester

Fish & Wildlife:
Charles Gernes, Izaak Walton League
Leon Johnson, Audubon Society

Forest Management:
Bob Morrow, Blandin Paper Company
Dave Anderson, Potlatch Corporation
Harry Kobs, Minnesota Association of County Land Commissioners

Miscellaneous:
George-Ann Maxson, Audubon Society

Alternates:
Dan Hanson, DNR-Division of Forestry
Dirk Peterson, DNR-Division of Fish and Wildlife
Ken Hiemenz, Minnesota Conservation Federation

2. *Southeast Audit Team*

Team Leaders:
Eric Geisler, DNR-Division of Forestry
Mike Phillips, DNR-Division of Forestry

Soils:
Tim Wagar, University of Minnesota (Soil and Water Conservation Society)
(Mike Phillips)

Hydrology:
(Tim Wagar)

Roads/engineering:
(Eric Geisler)

Fish & Wildlife:
Mark Ebbers, DNR-Fisheries
Dirk Peterson, DNR-Fisheries

Forest Management:
Rick Dahlman, DNR-Division of Forestry
Jim Edgar, DNR-Division of Forestry
Jerry Jensen, DNR-Division of Forestry
Larry Westerberg, DNR-Division of Forestry
Craig Locey, USFS State and Private Forestry

Miscellaneous:
Jock Bishop, Sierra Club
Lyle Bradley, Minnesota Science Teachers Association

Alternates:
Ken Brooks, University of Minnesota
Doug Rau, DNR-Forestry
Jessi Goodman, Sierra Club
Eric Streed, Sierra Club

Appendix B. Forestry Best Management Practices Field Audit Worksheet.

SITE NUMBER:_____ DATE:_____
OWNERSHIP:_____ OPERATOR:_____
LEGAL DESCRIPTION:_____ SALE OR PROJECT NUMBER:_____
PROJECT ACRES REVIEWED:_____ TEAM INITIALS:_____

SITE CONDITIONS	PRACTICES
LANDFORM:_____ GENERAL SOILS:_____ DRAINAGE:_____ SLOPE RANGE:_____ WATER BODIES PRESENT (type):_____ _____ _____ DEPTH/WIDTH OF STREAMS(type):_____ _____ _____ OTHER:_____ _____	STAGE ("x" if completed) PREHARVEST ( ) ROAD CONSTRUCTION ( ) HARVEST ( ) SLASH DISPOSAL ( ) SITE PREP ( ) DATE OF ACTIVITY_____ ROADS: NEW CONSTRUCTION (length):_____ RECONSTRUCTION (length):_____ HARVEST ACRES:_____ HARVEST METHOD:_____ SITE PREP ACRES:_____ SITE PREP METHOD:_____ SLASH DISPOSAL:_____ PESTICIDES USED:_____ OTHER:_____ _____

RATING GUIDE

APPLICATION
5--OPERATION EXCEEDS REQUIREMENT OF BMP 4--OPERATION MEETS REQUIREMENT OF BMP 3--MINOR DEPARTURE FROM BMP 2--MAJOR DEPARTURE FROM BMP 1--GROSS NEGLECT OF BMP
EFFECTIVENESS
6--IMPROVED PROTECTION OF SOIL AND WATER RESOURCES OVER PRE-PROJECT CONDITION. 5--ADEQUATE PROTECTION OF SOIL AND WATER RESOURCES. 4--MINOR AND TEMPORARY IMPACTS ON SOIL AND WATER RESOURCES. 3--MAJOR AND TEMPORARY IMPACTS ON SOIL AND WATER RESOURCES. 2--MINOR AND PROLONGED IMPACTS ON SOIL AND WATER RESOURCES. 1--MAJOR AND PROLONGED IMPACTS ON SOIL AND WATER RESOURCES.
DEFINITIONS (BY EXAMPLE)
ADEQUATE: Small amount of material eroded; material does not reach drainages, streams, lakes or wetlands MINOR: Erosion and delivery of material to drainages but not to streams, lakes or open-water wetlands. MAJOR: Erosion and subsequent delivery of sediment to streams, lakes or open water wetlands. TEMPORARY: Impacts lasting one year or less; no more than one runoff season. PROLONGED: Impacts lasting more than one year. * It is possible to have a departure from BMPs and still adequate protection.

RECOMMENDED BEST MANAGEMENT PRACTICES	APPLICABLE TO SITE (Y/N) APPLICATION EFFECTIVENESS			COMMENTS / IMPACT (quantity & duration) (distance to water)
GENERAL PRACTICES				
1 Fuel, Lubricant and Equipment Management (p11 & 12)				
1a Adequate storage and disposal for fuel, debris, lubricants, fluids and rinsate from equipment cleanup				
FOREST ROADS				
2 Alignment (p17-20)				
2a Minimize the total road mileage required to meet the landowner's objectives				
2b Minimize the number of water crossings				
2c Minimize cut and fill				
2d Avoid activity below the ordinary high water mark				
2e Provide adequate filter strips (p14) between roads and lakes, streams, and intermittent waterways				
- width				
- Disturbance				
- slash disposal				
3 Water Crossings (p20-23)				
3a Cross streams at right angles				
3b1 Minimize amount of natural stream channel disturbance				
3b2 Streambank approaches properly designed				
3c Crossings do not impede fish migration				
3d Low water crossings constructed of non-erosive and stable material				
3e Proper permits obtained				
4 Winter Roads or Temporary Crossings (p23 & 24)				
4a Temporary crossings properly located and installed				
4b Avoid use of mineral soil as fill on winter crossings				
4c Temporary / winter crossings removed prior to breakup				

RECOMMENDED BEST MANAGEMENT PRACTICES	APPLICABLE TO SITE (Y/N)	APPLICATION	EFFECTIVENESS	COMMENTS / IMPACT (quantity & duration) (distance to water)
5 Drainage (p24-29)				
5a Culverts properly sized and installed				
5b Culverts properly armored if needed				
5c Install water diversion devises on road surfaces:				
- Broad base dips / grade rolls				
- Open culverts				
- water bars				
5d Drain surface water into filter strip or vegetative draw				
5e Design ditches to avoid carrying water long distances. Use proper size and number of:				
- lead-offs				
- cross culverts under road				
- cross drains under road				
5f install silt fences were needed				
5g Remove all berms				
6 Construction, Clearing & Excavation (p28-31)				
6a Proper placement of clearing debris				
6b Shape inslopes and backslopes to 1 1/2:1 or flatter to stabilize soils				
6c Properly compact fill material				
6d Install proper subgrade support				
6e Shape and stabilize borrow pits				
6f Stabilize erodible soils by seeding				
6g Properly surface road to minimize water quality impacts				
Maintenance				
7 All Roads (p36)				
7a Properly surface road to minimize water quality impacts				
7b Erosion control features functional				
7c Stabilize erodible soils by seeding				
7d Restrict use of roads during wet periods and spring breakup				

RECOMMENDED BEST MANAGEMENT PRACTICES	APPLICABLE TO SITE (Y/N)	APPLICATION	EFFECTIVENESS	COMMENTS / IMPACT (quantity & duration) (distance to water)
8 Active roads (p37)				
8a Grade roads to maintain drainage and prevent erosion				
8b Proper use of dust control agents				
9. Occasional use roads				
9a Properly close when not in use				
9b Stabilize road surface				
9c Proper water diversion devices in working order				
10 Temporary/Abandoned roads				
10a Properly close abandoned roads				
10b Stabilize road surface				
10c Proper water diversion devices in working order				
TIMBER HARVEST				
11 GENERAL				
11a Employ a suitable harvest system for the site				
11b Time harvest compatible with soil and topography				
11c Minimize mineral soil exposure in filter strip (less than 5%)				
11d Streams, lakes, wetlands free of logging debris				
11e Avoid felling timber into nonforested wetlands				
11f Restore water courses to approximate natural condition				
11g Erosion barriers properly maintained				
12 Shade Strips (p47)				
12a Maintain vegetation adjacent to designated trout streams or lakes				

13 Skid Trails				
13a Minimize the total skid trail mileage required to meet the landowner's objectives				
13b Locate skid trails outside of filter strips				
13c Design skid trails to avoid concentrating runoff				
13d Install water diversion devises on skid trails:				
- Broad base dips / grade rolls				
- Open culverts				
- water bars				
13e Drain surface water into filter strip or vegetative draw				
13f Proper placement of clearing debris				
13g Shape inslopes and backslopes to 1 1/2:1 or flatter to stabilize soils				
13h Remove all berms				
13i Minimize the number of water crossings				
13j Minimize amount of natural stream channel disturbance				
13k Low water crossings constructed of non-erosive and stable material				
13L Temporary / winter crossings removed prior to breakup				
13m Temporary crossings properly located and installed				
13n Rehabilitate skid trails				
14 Landings				
14a Design suitable size and number of landings				
14b Locate landings outside of filter strips				
14c Location suitable for maintenance and fueling				
14d Proper placement of clearing debris				
14e Provide for maximum cross-drainage and minimum down slope flow				
14f Proper water diversion devices in working order				
14g Drain surface water into filter strip or vegetative draw				
14h Erosion control features functional				
14i Stabilize erodible soils by seeding				
14j Rehabilitate landings				

RECOMMENDED BEST MANAGEMENT PRACTICES	APPLICABLE TO SITE (Y/N)	APPLICATION	EFFECTIVENESS	COMMENTS
MECHANICAL SITE PREP				
15 General Recommendations (p50)				
15a Site prep technique appropriate to the site				
15b Provide adequate filter strips				
15c Avoid operating during periods of saturated soil				
15d Maintain adequate vegetation adjacent to designated trout streams				
15e Site prep technique properly employed (p50-52)				
- Shearing and raking				
- Disking				
- Patch or row scarification				
- Other				
PESTICIDE USE				
16 Prevent entry of pesticide residues into surface and ground waters (p57-75)				
PRESCRIBED BURNING				
17 Planning (p78)				
17a Obtain proper permits				
18 Prescriptions (p79-81)				
18a Locate fire lines on the contour				
18b Use natural or in-place fire barriers				
18c Establish filter strips for fire lines				
18d Avoid placement of debris piles for burning in filter strips or sensitive areas				
18e Limit water quality impacts from fire line construction by using mowing, herbicides, retardant etc.				
19 Maintenance (p81)				
19a Maintain erosion control measures on firelines				

Appendix C. Location of 1991 Audit Sites by Legal Description and County.

Site number	Ownership type	Legal Description sec.twp.range	County
1	State	16-146N-35W	BELTRAMI
2	State	31-143N-33W	HUBBARD
3	PI	28-058N-22W	ITASCA
4	NIPF	20-061N-22W	ITASCA
5	NIPF	23-061N-20W	ST.LOUIS
6	State	04-060N-20W	ST.LOUIS
7	PI	28-060N-23W	ITASCA
8	PI	21-062N-23W	ITASCA
9	County	27-061N-22W	ITASCA
10	PI	30-062N-23W	ITASCA
11	County	21-061N-22W	ITASCA
12	Federal	34-059N-26W	ITASCA
13	Federal	25-058N-25W	ITASCA
14	State	33-044N-16W	PINE
15	NIPF	28-044N-19W	PINE
16	County	18-042N-17W	PINE
17	County	19-043N-17W	PINE
18	Federal	30-057N-13W	ST.LOUIS
19	State	22-059N-06W	LAKE
20	PI	21-059N-07W	LAKE
21	Federal	19-064N-02E	COOK
22	Federal	25-064N-01E	COOK
23	State	06-102N-11W	FILLMORE
24	NIPF	15-103N-10W	FILLMORE
25	State	22-102N-12W	FILLMORE
26	State	21-103N-09W	FILLMORE
27	State	18-104N-08W	FILLMORE
28	NIPF	22-105N-09W	WINONA
29	State	08-108N-09W	WINONA
30	State	04-108N-09W	WINONA
31	State	11-108N-10W	WINONA
32	State	14-109N-10W	WABASHA
33	NIPF	17-112N-13W	GOODHUE
34	NIPF	18-112N-15W	GOODHUE
35	State	21-112N-16W	GOODHUE
36	NIPF	29-113N-16W	GOODHUE
37	NIPF	18-111N-12W	WABASHA
38	NIPF	07-102N-06W	HOUSTON
39	NIPF	06-103N-05W	HOUSTON
40	State	29-104N-04W	HOUSTON
41	State	15-102N-04W	HOUSTON
42	NIPF	25-110N-13W	WABASHA
43	NIPF	06-111N-13W	WABASHA
44	NIPF	22-112N-13W	GOODHUE
45	NIPF	19-102N-06W	HOUSTON
46	NIPF	10-113N-15W	GOODHUE
47	State	09-113N-15W	GOODHUE
48	NIPF	22-113N-15N	GOODHUE