APPENDIX A

Maps

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Appendix B

Table B-1. Summary of Fieldwork Data on Soils and Down Woody Debris

Unit Name & Site Number	Location	Classification	Habitat Type	Estimated Amounts of DWD>3" (tons/acre) and Recommended Amounts from Graham et al (1994) and Lewis and Clark NF Forest Plan (USDA 1986)
Ford Ck #1, 6/27/06-1 (193 ac)	SWSE Sec 1, T19N, R9W	Typic Haploborolls, lsk, mixed	Fesdia/Agrcan	Estimated: 0 Recommended: 0
Ford Ck #1, 6/27/06-2	NWNE Sec 12, T19N, R9W	Argic Haploborolls, fine-loamy, mixed	Psemen/Symalb	Estimated: <5 Recommended: 10
Ford Ck #1, 6/27/06-3	SWNE Sec 12, T19N, R9W	Typic Argiborolls, fi-ly, mixed	Fessca/Fesida	Estimated: 0 Recommended: 0
Ford Ck #1, 6/27/06-4	SESE Sec 1, T19N, R9W	Oxyaquic Haplustepts, fi-ly, mixed	Poptre CT, Abilas/Calrub?	Estimated: <5 Recommended: 10+
Ford Ck #2, 6/28/06-1 (84 ac)	NENE Sec 13, T19N, R9W	Typic Haploborolls, fi-ly, mixed	Fesida/Argcan	Estimated: 0 Recommended: 0
Ford Ck #2, 6/28/06-2	SESE Sec 12, T19N, R9W	Typic Haploborolls, fi-ly, mixed	Potfru/Fessca	Estimated: 0 Recommended: 0
Ford Ck #2, 6/28/06-3	NESE Sec 12, T19N, R9W	Typic Argiustolls, fi-ly, mixed	Abilas/Linbor	Estimated: 20 Recommended: 12-25
Double Falls #1, 9/12/05-1 (1 ac)	NWNE Sec 15, T19N, R9W	Typic Haplustepts, fi-ly, mixed	Picea/Linbor	Estimated: 5-10 Recommended: 10+
Double Falls #2, 9/13/05-1 (42 ac)	SENW Sec 15, T19N, R9W	Typic Cryoboralfs, lsk, mixed	Psemen/Linbor	Estimated: 10 Recommended: 12+
Double Falls #2, 9/13/05-2	SWNE Sec 15, T19N, R9W	Typic Cryoboralfs, lsk, mixed	Psemen/Symalb	Estimated: 5 Recommended: 10+
Double Falls #2, 9/13/05-3	NENE Sec 15, T19N, R9W	Typic Cryoboralfs, lsk, mixed	Psemen/Linbor	Estimated: 10-15 Recommended: 12+
Double Falls #2, 9/13/05-4	NWNW Sec 14, T19N, R9W	Mollic Cryoboralfs, fi-ly, mixed	Psemen/Linbor	Estimated: <5 Recommended: 12+
Aspen #1, 9/12/05-2, 5/31/07-2 (44 ac)	SESW Sec10, T19N, R9W	Typic Cryoboralfs, fi-ly, mixed Udic Haplustepts, co-ly, mixed	Psemen/Symalb	Estimated: 5-10 Recommended: 10
Aspen #2,	NENW Sec	Fluvents, fi-ly,	Psemen/Symalb	Estimated: <5

9/12/05-3 (39 ac)	15, T19N, R9W	mixed		Recommended: 10
Green Timber #1, 9/13/05-5 (9 ac)	SWSW Sec 31, T20N, R9W	Typic Cryochrepts, lsk, mixed	Abilas/Vacsco	Estimated: 2-5 Recommended: 7-15
Lick Creek #1, 9/13/05-6 (3 ac)	NENW Sec 36, T20N, R10W	Typic Cryochrepts, lsk, mixed	Abilas/Vaccae	Estimated: 25+ Recommended: 10+
Lick Creek #2, 6/27/06-5 (4 ac)	SWNE Sec 36, T20N, R10W	Typic Cryoboralfs, fi-ly, mixed	Abilas/Calrub	Estimated: 5-10 Recommended: 12+
Mule Ck #1, 9/14/05-2 (13 ac)	SWNE Sec 26, T20N, R10W	Typic Cryochrepts, lsk, mixed	Abilas/Vacsco	Estimated: 15-20 Recommended: 7-15
Mule Ck #2, 9/14/05-3 (17 ac)	NENW Sec 26, T20N, R10W	Typic Cryoboralfs, fine, mixed	Abilas/Linbor	Estimated: 15 Recommended: 12-25
Glade Ck #1, 9/14/05-5 (9 ac)	SWNWNE Sec 16, T20N, R10W	Typic Haplustalfs, lsk, mixed	Abilas/Vaccae	Estimated: 2 Recommended: 10+
Glade Ck #2, 9/14/05-4 (7 ac)	NENE Sec 16, T20N, R10W	Typic Cryoboralfs, lsk, mixed	Abilas/Linbor	Estimated: <2 Recommended: 12-25
Fairmule #2, 6/29/06-1 (22 ac)	SENE Sec 22, T20N, R10W	Fluvent, co-ly, mixed	Picea/Linbor	Estimated: 5-10 Recommended: 10+
Fairmule #2, 6/29/06-2	NESE Sec 22, T20N, R10W	Fluvent, lsk, mixed	Abilas/Vaccae	Estimated: <5 Recommended: 10+
Fairmule #3, 6/28/06-4 (19 ac)	NWSW Sec 23, T20N, R10W	Typic Cryochrepts, lsk, mixed	Abilas/Vaccae	Estimated: 15-20 Recommended: 10+
Fairmule #3, 6/28/06-5	NWSW Sec 23, T20N, R10W	Typic Cryochrepts, lsk, mixed	Abilas/Vaccae	Estimated: 5-10 Recommended: 10+
Fairmule #4 (1)	SWNE Sec 22, T20N, RR10W		Abilas/Vaccae	Recommended: 10+
Benchmark #1 7/18/06-3 (236 ac)	SESE Sec 9, T20N, R10W	Typic Haplustepts, lsk, mixed	Psemen/Calrub	Estimated: <5 Recommended: 10
Benchmark #2, 9/20/05-3 (8 ac)	SESW Sec 9, T20N, R10W	Typic Haplustepts, lsk, mixed	Abilas/Vaccae	Estimated: 5 Recommended: 10+
Benchmark	NESWSE	Typic Haplusalfs,	Abilas/Vaccae	Estimated: 2-5

#3, 9/20/05-2 (10 ac)	Sec 16, T20N, R10W	lsk, mixed, moderately deep		Recommended: 10+
Benchmark #4, 7/17/06-1 (6 ac)	NW Sec 9, T20N, R10W	Typic Haplustepts, fi-ly, mixed	Abilas/Linbor	Estimated: 5-10 Recommended: 12-25

Appendix C

Table C-1. Benchmark Fuels Anticipated Proposed and Existing Detrimental Soil Impacts

Unit	Acres in Unit	Harvest Impacts (ac)	Burning Impacts (ac)	Temp Road Impacts (ac)	Impacts from Landings (ac)	Existing Detrimental Soil Impacts (ac)	Total Impacts Anticipated (ac)
Ford Ck #1	193	0	193 X (0-7.5%) = 0-14.5	0	0	0.5	0.5-15.0
Ford Ck #2	84	0	84 X (0-7.5%) = 0-5.7	0	0	0.5	0.5-6.2
Aspen #1	44	10 X (0-6%)= 0-0.6	44 X (0-7.5%) = 0-3.3	0	0.3	0.3	0.6-4.8
Aspen #2	39	39 X (0-6%) = 0-2.3	0	600 X 10/43560= 0.1	0.3	1	1.4-3.7
Double Falls #1	1	1 X (0-6%) = 0-.1	0	0	0.1	0.2	0.3-0.4
Double Falls #2	42	42 X (0-6%) = 0-2.5	0	0	0.25	1	1.3-3.8
Green Timber #1	9	9 X (0-6%) = 0-0.5	0	0	0.3	0.5	0.8-1.3
Lick Ck #1	3	3 X (0-6%) = 0-0.2	0	0	0.1	0.2	0.3-0.5
Lick Ck #2	4	4 X (0-6%) = 0-0.2	0	0	0.1	0.2	0.3-0.5
Mule Ck #1	13	0	13 X (0-7.5%) = 0-1.0	0	0	0	0-1
Mule Ck #2	17	17 X (0-6%) = 0-1	0	0	0.5	0.5	1-2
Fairmule #2	22	22 X (0-6%) = 0-1.3	0	700 X 10/43560 = 0.2	(on temp spur)	0.5	0.7-2.0
Fairmule #3	19	19 X (0-6%) = 0-1.1	0	500 X 10/43560 = 0.1	0.5	0.5	1.1-2.2
Fairmule #4	1	1 X (0-6%) = 0-.06	0	0	0.1	0.2	0.3-0.4
Glade Ck #1	9	9 X (0-6%) = 0-0.5	0	0	0.2	0.5	0.7-1.2
Glade Ck #2	7	7 X (0-6%) = 0-	0	0	0.1	0.2	0.3-0.7

		0.4					
Benchmark #1	236	0	236 X (0-7.5%)= 0-17.7	0	0	2.5	2.5-20.2
Benchmark #2	8	0	8 X (0-7.5%) = 0-0.6	0	0.1	0.5	0.6-1.2
Benchmark #3	10	10 X (0-6%) = 0-0.6	0	0	0.35	0.5	0.9-1.5
Benchmark #4	6	11 X (0-6%) = 0-0.4	0	0	0.25	0.5	0.8-1.2

Appendix D

Best Management Practices

Best Management Practices

Best Management Practices (BMPs) are the primary mechanism to enable the achievement of water quality standards (Environmental Protection Agency 1987). This Appendix describes the Forest Service's BMP process in detail, lists the key Soil and Water Conservation Practices (comparable to BMPs) that have been selected to be used on this project, and describes each BMP that will be refined for site-specific conditions in order to arrive at the project level BMPs that protect beneficial uses and meet water quality objectives.

BMPs include, but are not limited to, structural and nonstructural controls, operations, and maintenance procedures. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters (40 CFR 130.2, EPA Water Quality Standards Regulation). Usually BMPs are applied as a system of practices rather than a single practice. BMPs are selected on the basis of site specific conditions that reflect natural background conditions and political, social, economic, and technical feasibility.

The Lewis and Clark National Forest Plan (chapter II, page 50) states that the Forest will "utilize adequate soil and water conservation practices to protect soil productivity and to control nonpoint water pollution from project activities, using as a minimum, practices specified in any State developed Best Management Practices". A project which causes excessive water pollution, undesirable water yield, soil erosion, or site deterioration will be corrected where feasible, or the project will be re-evaluated or terminated. Montana State Water Quality Standards require the use of reasonable land, soil, and water conservation practices (analogous to BMPs and SWCPs) as the controlling mechanism for nonpoint pollution. Use of BMPs is also required in the MOU between the Forest Service and the State of Montana as part of our responsibility as the Designated Water Quality Management Agency on National Forest System (NFS) lands.

The practices described herein are tiered to the practices in FSH 2509.22. They were developed as part of the NEPA process, with interdisciplinary involvement, and meet Forest and State water quality objectives.

ABBREVIATIONS:

TSC = Timber Sale Contract
SAM = Sale Area Map
TSA = Timber Sale Administrator
COR = Contracting Officer Representative
PWC = Public Works Contract
SWCP = Soil and Water Conservation Practices
BMP = Best Management Practice
SMZ = Streamside Management Zone
SPS = Special Project Specification
EPA = Environmental Protection Agency
CFR = Code of Federal Regulations

BMP IMPLEMENTATION PROCESS

In cooperation with the State, the USDA Forest Service's primary strategy for the control of nonpoint sources is based on the implementation of preventive practices (BMPs) determined necessary for the protection of the identified beneficial uses.

The Forest Service Nonpoint Source Management System consists of:

1. BMP selection and design based on site-specific conditions; technical, economic and institutional feasibility; and the designated beneficial uses of the streams.

2. BMP Application.

3. BMP monitoring to ensure that they are being implemented and are effective in protecting designated beneficial uses.

4. Evaluation of BMP monitoring results from "steps" 2 and 3.

5. Feeding back the results into current/future activities and BMP design.

The District Ranger is responsible for insuring that this BMP feedback loop is implemented on all projects.

1. BMP Selection and Design. Water quality goals are identified in Forest Plans. These goals meet or exceed applicable legal requirements, including State water quality regulations, the Clean Water Act, and the National Forest Management Act. Environmental assessments for projects are tiered to Forest Plans, using the NEPA process.

Appropriate BMPs are selected for each project by an interdisciplinary team. Each time BMPs are applied to a new location, there is flexibility to design different BMPs depending on the local conditions and values, and the downstream beneficial uses of water.

BMP selection and design are dictated by water quality objectives, soils, topography, geology, vegetation, and climate. Environmental impacts and water quality protection options are evaluated and alternative mixes of practices are considered. A final collection of practices are selected that not only protect water quality but meet other resource needs. These final selected practices constitute the BMPs.

2. BMP Application. The BMPs are translated into contract clauses, special use permit requirements, project plan specifications, and so forth. This ensures that the operator or person responsible for applying the BMP actually is required to apply it. The site-specific BMP prescriptions are taken from plan-to-ground by a combination of project layout and resource specialists (hydrology, fisheries, soil, geology, etc.). This is when final adjustments to fit the BMP prescriptions to the site are made before implementing the resource activity.

3. BMP Monitoring. When the resource activity (timber harvest or road construction) begins, timber sale administrators, engineering representatives, resource specialists, and others ensure that the BMPs are implemented according to plan. BMP implementation monitoring is done before, during, and after resource activity implementation.

This monitoring answers the question: Did we do what we said we were going to do? Once BMPs have been implemented, further monitoring is done to evaluate if BMPs are effective in meeting management objectives and protecting beneficial uses of water. This is accomplished through BMP reviews. Monitoring is also conducted on streams, management activities, and BMPs outside the analysis area. This Forest-wide monitoring will aid in determining the effectiveness of BMPs.

4. BMP Monitoring Evaluation. The technical evaluation/monitoring described above will determine how effectively BMPs protect and/or improve water quality. Water quality standards and conditions of the beneficial uses of water will serve as one evaluation criteria. If the evaluation indicates that water quality standards are not being met and/or beneficial uses are not being protected, corrective action will consider the following three components:

a. The BMP: Is it technically sound? Is it really best, or is there a better practice which is technically sound and feasible to implement?

b. The implementation program or processes: Was the BMP applied entirely as designed? Was it only partially implemented? Were personnel, equipment, funds, or training lacking with a result of inadequate or incomplete implementation?

c. The State water quality criteria: Do the parameters and criteria that constitute water quality standards adequately reflect human induced changes to water quality and beneficial uses?

5. Feedback. Feedback of the results of BMP evaluation is both short- and long-term in nature. Where corrective action is needed, immediate response will be undertaken. This action may include: modification of the BMP, modification of the activity, ceasing the activity or possibly modification of the State water quality standard. Cumulative effects over the long-term may also lead to the need for possible corrective actions.

FORMAT OF THE BMPs

Each Soil and Water Conservation Practice (SWCP) is described as follows:

Title: Includes the sequential number of the SWCP and a brief title

Objective: Describes the SWCP objective(s) and the desired results for protecting water quality.

Effectiveness: Provides a qualitative assessment of expected effectiveness that the applied measure will have on preventing or reducing impacts on water quality. The SWCP effectiveness rating is based on literature & research, administrative studies, and professional experience. The SWCP is rated either High, Moderate, or Low based on the following criteria:

1. Literature/Research (must be applicable to area)
2. Administrative studies (local or within similar ecosystem)
3. Experience (judgment of an expert by education and/or experience)
4. Fact (obvious by reasoned [logical] response)

Please see the section below on BMP monitoring results that have been documented for the Lewis and Clark National Forest.
Implementation: This section identifies: 1) the range of site-specific water quality protection measures to be implemented; and 2) how the practices are expected to be applied.

BMP MONITORING

BMP monitoring is an important component of the implementation process. Past BMP monitoring from 1995 to 2005 is as follows:

An administrative review was conducted on the Deadhorse-Bluff Timber Sale on September 26-28, 1995. Part of this review evaluated BMP implementation and effectiveness. Specific management practices discussed included slash filter windrows, road surfacing adjacent to stream crossings, revegetation of disturbed areas and equipment operation in moist soil types (landtype 11). Observations indicate that BMPs were implemented as planned and were effective in reducing soil and water impacts. The only exception was one instance of improper discarding of waste oil. Recommendations include continue to use slash filter windrows, provide adequate cross drain spacing, and improve grass establishment by scarifying road surface and properly time seed applications. Additionally, moist soil conditions need to be adequately surveyed and documented through NFMA and NEPA analyses.

During the 1996 field season, 61 miles of road and 34 harvest units were monitored for soil and water impacts and BMP effectiveness. Portions of 10 road segments and 9 harvest units had potential for causing unacceptable soil and water impacts and were reviewed again with District personnel in 1997. Three of these road segments were addressed through the Dry Fork Vegetation Restoration EIS as road obliteration proposals. Except for two harvest units, all others appeared to provide adequate ground vegetation, slash and filter distance and do not contribute significant sediment or overland flows to stream systems. Of the two units of concern, one was harvested just prior to the review, so revegetation had not yet begun. The other unit was revegetated, but harvested prior to establishment of State SMZ guidelines and did not have adequate filtering capacity near two channels. This unit was incorporated into the Districts soil and water improvement program and addressed in 1998 by placing down woody debris on contour, upslope from the two channels.

During the 1998 field season, BMPs on six harvest units and adjacent road systems were evaluated by Forest personnel. Approximately 55 site-specific BMPs were evaluated in each unit. For the most part, BMPs were implemented as planned and effective in limiting soil and water impacts. The exceptions were as follows:

- Two temporary roads could have been built to a lower standard.

- Drainage from one road segment was not adequate and did not provide adequate filtration zones.

- One temporary road could have been better rehabilitated by providing more outsloping and slash scattered on the roadbase.

- The terminal point of one section of road reconstruction, including one reconstructed crossing, appeared to be unnecessary. Road drainage and sediment is routed to the stream, however streamflow subsurfaces and is blocked by a natural earthen dam downstream.
- Two landings were located on/near ephemeral draws.

- Minor deviations from required SMZ widths were noted in two units, although surface flows or sediment did not appear to be routed to streams.

These exceptions resulted in minor deviations from standard application procedures and/or minor and temporary impacts to soil and water resources.

During 1996, 1998 and 2000, BMPs were evaluated on the Forest as part of the State BMP Audit process. Approximately 55 site-specific BMPs were evaluated in each unit.

The 1996 audit was on unit 29 of the Deadhorse Bluff Timber Sale. Four BMPs had minor departures from standard applications, but still provided adequate protection for soil and water resources. Minor departures involved inadequate energy dissipaters at drainage structure outlets, equipment operation on steep slopes and inadequate streamside management zone (SMZ) width on slopes exceeding 35%. Two BMPs had minor departures from standard applications, and minor but temporary impacts to soil and water resources. One departure was on one road segment that intercepted subsurface flows which resulted in a soft roadbed requiring continual maintenance or improved drainage features. The other departure was that equipment operation during slash treatment and site preparation did not minimize soil compaction and displacement because activities were not limited to dry or frozen soil conditions.

The 1998 audit was on unit 2 of the Moose Park Timber Sale. One BMP had a minor departure from standard applications, but still provided adequate protection for soil and water resources. This departure involved excess road surface material being placed in a ditch before a stream crossing and likely occurred as a result of snow plowing.

The 1998 State Audit also included a reaudit site on the Mill-Lion Timber Sale which was first audited in 1994. BMP departures noted in 1994 included minor sediment delivery to ephemeral streams from road surfaces and ditches and erosion resulting from poor stream crossing design and installation at one culvert. The 1998 reaudit identified that the road drainage problems had been fixed by maintenance actions, but the stream crossing problems were still evident. These problems could have been avoided by removing a large adjacent spruce tree during the initial construction activities. It was also noted that all six SMZ functions were preserved and no windthrow had occurred in the SMZ.

The 2000 audit was on unit 36 of the Spring Basin Timber Sale and unit 3 of the Tenderfoot Creek Experimental Forest Timber Sale. In unit 36, four BMPs had minor departures from standard applications, but still provided effective protection for soil and water resources. Minor departures involved inadequate direction of road drainage away from stream crossing site, inadequate streamside management zone (SMZ) width on slopes exceeding 35%, inadequate retention tree requirements met and inadequate exclusion of equipment operation in SMZ.

Two BMPs had minor departures from standard applications, and minor but prolonged effects to soil and water resources. This involved one existing road segment built prior to the sale that did not provide adequate road surface drainage. The other departure was also related to road drainage by inadequate maintenance (grading).

In unit 3, one BMP had a major departure from standard applications, but still provided effective protection for soil and water resources. This departures involved inadequate streamside management zone (SMZ). Two BMPs had minor departures from standard applications, and minor and temporary effects to soil and water resources. This involved inadequate direction of road drainage away from stream crossing site, and inadequate protection, stabilization or skewing of ditch and relief culverts.

According to The Montana 2000 Forestry BMP Audit Report (MT-DNRC, 2000), 97% of the BMP practices rated on Federal lands were effective in protecting soil and water resources, while 91% of the "high risk" BMP practices rated on Federal lands were effective. In comparison to past audit results, a steady and continual increase in BMP application and effectiveness has occurred for all practices and high risk practices (total of all ownerships).

On October 31, 2001, field review was completed on two timber sales authorized under the salvage sale rider of the 1995 Recission Bill. These two sales were the Foothills Salvage T.S. and Dead Clyde Salvage T.S.

The Foothills Salvage was comprised of 7 small units totaling 73 acres. Portions of four units were reviewed where Streamside Management Zones (SMZ's) were identified. Two of the five SMZ's were actually dry, vegetated swales and therefore posed no risk to water quality. Harvest activities along three other SMZ's were determined to be in compliance with the Montana SMZ law. Although some harvest did occur within the SMZ's, more than adequate leave tree requirements were met and there appeared to be no equipment operation within this zone. Due to heads up sale administration, timber within the SMZ in one unit was dropped because yarding difficulties in terms of crossing the streambed were identified prior to cutting. Because of the relatively low volume harvested, soil disturbance from skid trails posed little risk of down slope impacts to water quality.

The Dead Clyde Salvage was comprised of 8 units between 2 and 26 acres. Three units were reviewed, two of which were on flat ground where standing water and saturated soils were likely to occur during most years. Soils in both units were either dry or frozen as no rutting or other major soil displacement was observed. There were no intermittent or perennial streams in or adjacent to these units, so the risk of impacting water quality was basically non-existent.

The last unit reviewed in the Dead Clyde Salvage was the closest unit in the sale area to any streams. It was located about 400 feet from an intermittent channel to the south and about 150 feet from a perennial stream to the north. A temporary road skirted the perimeter of the unit between these two drainages. Except for a few low gradient segments, the road basically followed the contour around the unit. The road base was about 70% vegetated with forbs and grass and an occasional conifer seedling. The geology of the area produced very sandy soils that could be highly mobile.

However, due to the high infiltration capacity of the soil, the vegetated road base and the low gradient of the road, only very minimal and spotty surface erosion was observed on the road surface. Skid trails within the unit were basically no longer visible. There was no indication of water movement down slope to the temporary road.

A perennial stream on the north end was investigated. Except for the fine textured soil banks, it is a relatively stable channel controlled by woody debris and adjacent tree roots. The harvest unit boundary was about 150 feet from the channel at the closest point. There were no affects from the timber harvest or temporary road observed. The main impact to the channel was from livestock accessing the channel from the harvest unit. The remainder of the stream adjacent to this unit is also not affected by the harvest due to a 200 to 400 foot buffer zone.

On September 29, 2003 the Blank Ant Salvage Sale was inspected. The sale comprised 133 acres and harvested 0.448 million board feet of timber. Logging method included tractor and rubber tired skidder with tree length yarding. Approximately 0.5 to 0.75 miles of temporary roads were constructed. Slash pile disposal was not completed at time of inspection. A small unnamed tributary to the North Fork of the Musselshell was located within 200 feet of the project area. Harvest was not completed within the SMZ. Soil erodibility was determined to be high.

Two minor departures for inadequate road drainage were documented during the inspection. The bottom of a temporary road routed flow across a meadow to a draw below the main road.

The Dry Wolf Stewardship Project was inspected on July 15, 2004. The unit included 145 acres with 0.8 million board feet harvested. Method of harvest was tree length mechanized to landings. Approximately 1.57 miles of specified and temporary roads were constructed. Slash piles disposal was completed by pile landing and burning. Lyon Gulch, a tributary to Dry Wolf Creek, is was within 200 feet of the harvest unit. Harvest was not completed within the SMZ. Soils erodibility was determined to be medium.

Five minor BMP departures and one major departure were documented during the inspection. Minor departures involved not having adequate length, cleaning and size of culverts. Two minor departures were noted for skid trail construction and maintenance. One minor departure was given for non-compliance with the 124 permit. The permit called for 2-36 inch arched culvers. Two 18 inch culverts were used.

One BMP had a major departure given for directing road drainage away from stream crossing site. A 50 foot section of road was directing sediment to Lyons Gulch.

The Allan Park Salvage and the Highway 89 Fuels reduction were inspected on September 29, 2005. Both operations were inprogress to be completed later that fall. The 24 acre Allan Park Salvage was a ground based operation with whole tree yarding. Jackpot and landing pile burns were planned. Primary drainages in the area of the unit were Allen Creek and Indian Creek. The 8.7 acre Highway 89 Fuels Reduction project was a ground based forwarder operation with construction of approximately half mile of road. Treatment within riparian areas was not planned for either project.

The inspection of Allan Park Salvage reveled operations on 20 percent slope. Five minor departures were discovered. Two departures were assessed for road surface drainage and the design of a culvert was inadequate. Two departures were assessed for road maintenance and one for skidding operations not minimizing soil compaction and displacement.

Highway 89 Fuels Reduction was assessed only one minor departure for miss handling and storage of hazardous substances. Small spills of oils and lubricants were noted at camp and on the forwarding routes.

In conclusion, given the high number of timber management activities, only a small percentage of BMPs are not implemented correctly and an even smaller percentage are occasionally not effective in protecting soil and water resources.

KEY SOIL AND WATER CONSERVATION PRACTICE LIST

The following table displays the Soil and Water Conservation Practices (comparable to BMPs) required in Forest Service Handbook 2509.22, along with units or roads that would be affected by the SWCP. The chart also references the timber sale contract provision that would respond to the required SWCP. Note that not all the SWCPs are listed here--only those that require further specificity in the EA are listed. The Forest Service requires adherence to all practices outlined in the handbook. There are standard provisions for compliance in every timber sale contract for BMPs pertaining to timber harvesting (refer to FSM 2509.22 and Timber Sale Contract Provisions available in the Ranger District Office).

Table D-1. Soil and Water Conservation Practices

ID #	SWCP Title	Contract Provision
11 - WATERSHED MANAGEMENT		
11.05	Wetlands Analysis and Evaluation	none
11.07	Oil and Hazardous Substance Spill Contingency Planning	C6.341, C6.53
11.09	Management By Closure to Use	
13 - VEGETATION MANIPULATION		
13.02	Slope Limitations For Tractor Operations	B6.6
13.04	Revegetation of Surface Disturbed Areas	C6.601, C6.623
13.06	Soil Moisture Limitations for Tractor Operation	none
14 - TIMBER		
14.02	Timber Harvest Unit Design	none
14.03	Use of Sale Area Maps for Designating Soil and Water Protection Needs	B1.1, B6.5, C6.51
14.04	Limiting the Operating Period of Timber Sale Activities	SPS 204, B6.6
14.06	Riparian Area Designation	C6.5, C5.421
14.07	Determining Tractor Loggable Ground	C6.4
14.08	Tractor Skidding Design	B6.422
14.10	Log Landing Location and Design	B6.422
14.11	Log Landing Erosion Prevention and Control	B6.422, B6.64
14.12	Erosion Prevention and Control Measures During Timber Sale Operations	B6.6
14.14	Revegetation of Areas Disturbed by Harvest Activities	B6.6, C6.6, 6.601
14.15	Erosion Control on Skid Trails	B6.422, B6.6, B6.66,C6.601

ID #	SWCP Title	Contract Provision
14.16	Meadow Protection During Timber Harvesting	C6.61
14.17	Stream Channel Protection	B6.5, B6.6, C6.5, C6.6, C6.53
14.18	Erosion Control Structure Maintenance	B6.6, B6.66, 4.225
14.19	Acceptance of Timber Sale Erosion Control Measures Before Sale Closure	B6.6,B6.63,B6.64, B6.65, C6.6
14.20	Slash Treatment in Sensitive Areas	C6.7
14.22	Modification of Timber Sale Contract	B8.3, B8.33
14.23	Reforestation Requirement	none
15 – ROADS AND TRAILS		
15.02	General Guidelines for Road Location/Design	none
15.03	Road and Trail Erosion Control Plan	none
15.04	Timing of Construction Activities	C6.3, C6.36, B6.31
15.06	Mitigation of Surface Erosion and Stabilization of Slopes	B6.31,B6.6,B6.62,C5.2, C5.4,C6.36
15.07	Control of Permanent Road Drainage	B6.6,B6.66,C6.3, C6.6, C6.601
15.09	Timely Erosion Control Measures on Incomplete Road and Streamcrossing Projects	SPS 204, B6.31, B6.6,C6.6
15.10	Control of Road Construction Excavation & Sidecast Material	C6.221, C5.4
15.11	Servicing and Refueling of Equipment	C6.34,C6.341,C6.34
15.12	Control of Construction in Riparian Areas	B6.5, B6.61, C6.51, C6.52
15.13	Controlling In-Channel Excavation	B6.5,B6.422, C6.6,Std. Spec. 204.04
15.15	Streamcrossings on temporary Roads	B6.5,B6.62, B6.65,C6.3, C6.51,C6.52, C6.6,C6.753
15.18	Disposal of Right-of-Way and Roadside Debris	
15.21	Maintenance of Roads	C5.4 4 d
15.22	Road Surface Treatment to Prevent Loss of Materials	FSH 2409.15
15.23	Traffic Control During Wet Periods	B5.12, B6.22, C.5.12
15.24	Snow Removal Controls	C5.46
15.25	Obliteration of Temporary Roads	B6.62, B6.5, C6.6, C6.601
18 - Fire Suppression and Fuels Management		
18.02	Formulation of Fire Prescriptions	none
18.03	Protection of Soil and Water From Prescribed Burning Effects	none

SOIL AND WATER CONSERVATION PRACTICE DESCRIPTIONS

PRACTICE 11.05 - Wetlands Analysis and Evaluation
PRACTICE 14.16 - Meadow Protection During Timber Harvesting

OBJECTIVE: To maintain wetland functions and avoid adverse soil and water resource impacts associated with any disturbance of wetlands, bogs, and wet meadows.

EFFECTIVENESS: High

IMPLEMENTATION This is covered by standard TSC Provision B6.61 (Meadow Protection) which is a standard provision in all contracts. When it is necessary to identify

these areas on the SAM, direction to do so and protective requirements will be incorporated into C6.61 (Wetlands Protection). Vehicular or skidding equipment shall not be used on meadows except where roads, landings, and tractor roads are approved. Unless otherwise agreed, trees felled into meadows shall be removed by end-lining, and resulting logging slash shall also be removed. Damage to meadows, stream courses, and riparian areas caused by unauthorized purchaser's operations shall be repaired by the purchaser in a timely manner to restore and prevent further damage.

No known wetlands exist within any regeneration or commercial thin harvest units.

PRACTICE 11.07 - Oil and Hazardous Substance Spill Contingency Planning
PRACTICE 15.11 - Servicing and Refueling of Equipment

OBJECTIVE: To prevent contamination of waters from accidental spills of fuels, lubricants, bitumens, raw sewage, wash water, and other harmful materials by prior planning and development of Spill Prevention Control and Countermeasure (SPCC) Plans.

EFFECTIVENESS: Although SPCC Plans cannot eliminate the risk of materials being spilled and escaping into waters, they can be effective at reducing adverse effects to tolerable levels. Depending on the location and quantity of a spill, a properly implemented plan can provide for up to 100% containment of a spill.

IMPLEMENTATION: TSC provision C6.341 holds the purchaser responsible for taking appropriate preventive measures to ensure that any spill of oil or oil products does not enter any stream or other waters of the United States. If the total oil or oil products storage exceeds 1320 gallons or if any single container exceeds a capacity of 660 gallons, the purchaser will prepare a SPCC Plan. The plan shall meet EPA requirements including certification by a registered professional engineer. If necessary, specific requirements for transporting oil to be used in conjunction with the contract will be specified in TSC provision C6.53.

The Contracting Officer Representative will designate the location, size and allowable uses of service and refueling areas. The criteria below will be followed at a minimum:

1. Petroleum product storage containers with capacities of more than 200 gallons, stationary or mobile, will be located no closer than 100 feet from stream, water course, or area of open water. Dikes, berms, or embankments will be constructed to contain the volume of petroleum products stored within the tanks. Diked areas will be sufficiently impervious and of adequate capacity to contain spilled petroleum products.

2. Transferring petroleum products: During fueling operations or petroleum product transfer to other containers, there shall be a person attending such operations at all times.

3. Equipment used for transportation or storage of petroleum products shall be maintained in a leakproof condition. If the Forest Service Representative determines there is evidence of petroleum product leakage or spillage he/she shall have the authority to suspend the further use of such equipment until the deficiency has been corrected.

4. For longer term storage, a sump pond lined with plastic will be constructed equal to the volume of fuel stored on the site.

In the event any leakage or spillage enters any stream, water course or area of open water, the operator will immediately notify the COR who will be required to follow the actions to be taken in case of hazardous spill, as outlined in the Forest Hazardous Substance Spill Contingency Plan.

PRACTICE 11.09 - Management by Closure to Use

OBJECTIVE: To exclude activities that could result in damages to facilities or degradation of soil and water resources.

EFFECTIVENESS: High

IMPLEMENTATION: Specific guidelines for closure of roads during the period of the contract and at the end of the purchasers operations will be spelled out in the TSC provision C5.51.

There are no identified restrictions or closures associated with this project.

PRACTICE 13.02 - Slope Limitations for Tractor Operation
PRACTICE 14.07 - Determining Tractor Loggable Ground

OBJECTIVE: To reduce gully & sheet erosion and associated sediment production by restricting tractor operation to slopes where corrective measures for proper drainage are easily installed and effective.

EFFECTIVENESS: High. In general, the less the slope percentage, the less are the chances of rilling, gullying, and soil displacement as a consequence of tracked or wheeled skidding.

IMPLEMENTATION: Tracked or wheel skidding shall not be conducted on slopes greater than 45%. When slope exceeds 35%, a constructed skid trail should be used to concentrate traffic on one route with a pitch of less than 20%.

PRACTICE 13.04 - Revegetation of Surface Disturbed Areas
PRACTICE 14.14 - Revegetation of Areas Disturbed by Harvest Activities

OBJECTIVE: To protect soil productivity and water quality by minimizing soil erosion.

EFFECTIVENESS: Revegetation can be moderately effective at reducing surface erosion after one growing season following disturbance and highly effective in later years. Effectiveness has been shown to vary from 10 percent on 3/4:1 slopes to 36 percent on 1:1 slopes to 97 percent on 1:1 slopes in later years (King, John G. and E. Burroughs. Reduction of Soil Erosion on Forest Roads. Intermountain Research Station General Technical Report, 1988).

IMPLEMENTATION: All temporary roads, landings, and skid trails in the sale area will be seeded within one year after harvesting is completed. Approved seed mixes and fertilizer specifications will be incorporated into TSC provision C6.601# (Erosion Control Seeding). TSC provision C6.623# (Temporary Road, Skid Trail/Skid Road and Landing Scarification) will identify that scarification/ripping of compacted landings and closed roads will be a minimum of 6 inches, not to exceed 14 inches.

PRACTICE 13.06 - Soil Moisture Limitations for Tractor Operation

OBJECTIVE: To minimize soil compaction, puddling, rutting, and gullying with resultant sediment production and loss of soil productivity by ensuring that activities are done when ground conditions are such that erosion and sedimentation can be controlled.

EFFECTIVENESS: Responsible implementation and enforcement are required for high effectiveness.

IMPLEMENTATION: Tractor operations will be limited to periods when the soil moisture content is sufficiently so low that excessive rutting or other soil damage does not occur. In this project area, equipment operation (tracked or wheeled) will be restricted to the normally drier mid through late summer or winter period to avoid rutting and puddling in units that have wet areas. In addition filter cloth and fill material should be used when crossing wet areas rather than cut and fill operations.

All commercial logging will be accomplished during winter months, with soils frozen to a depth of 4 inches or a snow cover of approximately 20-24 inches.

PRACTICE 14.02 - Timber Harvest Unit Design;
PRACTICE 14.08 - Tractor Skidding Design;
PRACTICE 14.10 - Log Landing Location and Design

OBJECTIVE: To ensure that timber harvest unit design will maintain water quality and soil productivity by locating/designing landings and skidding patterns to best fit the terrain and avoid soil erosion.

EFFECTIVENESS: Restricting tractor skidding to designated skid trails can reduce the aerial extent of soil disturbance from the typical 18-36% to 10% or less. Properly located landings and skid trails produce similar results. Effectiveness is expected to be moderate

IMPLEMENTATION: TSC provision B6.422 (Landings and Skid Trails) requires that the location of all skid trails and landings must be agreed upon before construction. Specific criteria that will be addressed during sale-layout and pre-work with the operator will include:

Skid Trails-

1. Locate skid trails and design skidding operations to minimize soil disturbance.

2. Locate skid trails to avoid concentrating runoff. Provide breaks in grade and effective waterbars.

3. Locate skid trails and landings away from natural drainage systems, and divert runoff to stable areas.

4. A minimum spacing of 80 feet is required between skid trails except where trails begin to merge near landings. Movement of yarding equipment to retrieve a turn of logs or mechanized felling equipment is permitted if only one or two passes are involved and sufficient ground debris exist to somewhat protect the soil.
5. Severely disturbed areas should be minimized to the extent practical. These areas include skid trails, heavily used landings, and excessive site preparation. Regional soil quality guidelines require that at least 85% of the timber sale unit must have soil that is in satisfactory condition.

6. Slash will be retained over winter prior to treatment to allow nutrients to leach and return to the soil.

7. Approximately 1/3 to 1/4 of the tops will be retained on site in whole tree yarding regeneration units for nutrient cycling and to provide a seed source.

8. Coarse woody debris will be retained in amounts recommended by Graham and others in INT-RP-477 "Managing Coarse Woody Debris in Forests of the Rocky Mountains".

Landings-

1. Landings and log decks will not be located on riparian or wet areas.

2. Landings and/or burn piles will be located a minimum of 100 feet from streams and/or riparian zones, far enough away that direct (unfiltered) entry of sediment, bark, or ash and burning products, will not occur. (C6.50)

PRACTICE 14.03 - Use of Sale Area Maps for Designating Soil & Water Protection Needs

OBJECTIVE: To delineate the location of protection areas and special treatment areas, to ensure their recognition, proper consideration, and protection on the ground.

EFFECTIVENESS: High

IMPLEMENTATION: The following features will be designated on the SAM:

1. Streamcourses (perennial and ephemeral) to be protected under B6.5. Streamside Management Zones (SMZs) will be marked on the ground as required in the Montana SMZ law. The following unit has identified SMZs: 4.

2. Wetlands and Riparian Areas (meadows, lakes, pot holes, etc.) to be protected per C6.61.

3. Special treatment areas, including riparian areas with planned harvest where logging and site prep will differ from adjoining units as identified in TSC provision C6.50 (Riparian Areas)

These features will be reviewed on the ground by the Purchaser and the Sale Administrator prior to harvesting.

PRACTICE 14.04 - Limiting the Operating Period of Timber Sale Activities;
PRACTICE 15.04 - Timing of Construction Activities

OBJECTIVE: To minimize soil erosion, sedimentation and soil productivity loss by insuring activities, including erosion control work, road maintenance, etc., are done: (1) within the time period specified in the TSC; or (2) when ground conditions are such that erosion and sedimentation can be prevented.

EFFECTIVENESS: Moderate

IMPLEMENTATION: Within the sale area, the following specifications relating to operating periods have been identified and recommended:

1. Earthwork shall be postponed during wet periods if, as a result, erodible material would enter streams.

2. TSC provision B6.31 allows operations to occur outside Normal Operating Season subject to requirements in B6.6, B6.65, and C5.23. The following requirements apply to operations outside the Normal Operating Season:

   a. Drain dips will be built into skidtrails and temporary roads at the time of construction, where feasible. Where draindips are not feasible, or are not functioning, trails and temporary roads will be waterbarred and maintained as necessary and/or prior to any prolonged shutdown.

   b. Temporary Roads will be seeded immediately following completion of use.

   c. All surface erosion and stabilization activities will be placed prior to November 1 of each year.

3. The following requirements apply to winter operations:

   a. Skid trails will be constructed with waterbars and/or draindips, and allowed to freeze prior to skidding operations.

   b. Prior to spring shutdown, slash and/or cull logs will be placed into skidtrails to approximate waterbars.

   c. All streams and channels within harvest units will be flagged or otherwise identified. (Predesignated under C6.50#).

   d. Operations will be discontinued if conditions change and activities are no longer operating on frozen or snow covered ground, the intent of winter logging.

PRACTICE 14.06 - Riparian Area Designation and Protection

OBJECTIVE: To minimize the adverse effects on riparian areas with prescriptions that manage nearby logging and related land disturbance activities.

EFFECTIVENESS: High

IMPLEMENTATION: Riparian areas will be clearly marked prior to ground disturbing activities. Riparian areas will be identified and located on the SAM. Requirements for protection of these areas will also be in TSC provision C6.6. The following practices in SMZs will be prohibited:

1. Broadcast burning

2. The operation of wheeled or tracked vehicles will be prohibited except on established roads.

3. The forest practice of clearcutting

4. The construction of roads except when necessary to cross a stream or wetland.

5. The handling, storage, application, or disposal of hazardous or toxic materials in a manner that pollutes streams, lakes, or wetlands or that may cause damage or injury to humans, land, animals, or plants

6. The side-casting of road material into a stream, wetland, or watercourse.

7. The deposit of slash in streams or other water bodies.

8. Retention of trees in the SMZ will comply with the Montana SMZ law and rules.

The following units have identified SMZs: 413, 498, 521, 534, 548, 558, 572, 670, 672, 705, 738, 747, 1688, 1700, 1704, 1710, 1711 and 1712.

PRACTICE 14.11 - Log Landing Erosion Prevention and Control;
PRACTICE 14.12 - Erosion Prevention & Control During Timber Sale Operations;
PRACTICE 14.15 - Erosion Control on Skid Trails.

OBJECTIVE: To protect water quality by minimizing erosion and subsequent sedimentation derived from log landings and skid trails.

EFFECTIVENESS: Moderate

IMPLEMENTATION: The following criteria will be used in controlling erosion and restoring landings and skid trails so as to minimize erosion:

General-

1. Deposit waste material from construction or maintenance of landings, skid and fire trails in geologically stabilized locations at least 100 feet outside of any SMZ.

2.Skid trails and landings will be seeded with a mix specified in C6.601#.

Landings-

1. During period of use, landings will be maintained in such a manner that debris and sediment are not delivered to any streams.

2. Landings shall be reshaped as needed to facilitate drainage prior to fall and spring runoff. Landings shall be stabilized by establishing ground cover or by some other means within one year after harvesting is completed.

3. Landings will drain in a direction and manner that will minimize erosion and will preclude sediment delivery to any stream.

4. After landings have served the Purchaser's purpose, the Purchaser shall ditch or slope them to permit the water to drain and disperse [TSC Provision B6.63 (Landings)].

Skid Trails-

1. Skid trails and fire trails shall be stabilized whenever they are subject to erosion, by waterbarring, cross draining, outsloping, scarifying, seeding, or other suitable means. This work shall be kept current to prevent erosion prior to fall and spring runoff.

2. Skid trails will be water-barred, using the cross-drain spacing guide from the R1-R4 Guide for Controlling Sediment From Secondary Logging Roads.

PRACTICE 14.17 - Stream Channel Protection (Implementation and Enforcement)

OBJECTIVES: (1) To protect the natural flow of streams; (2) to provide unobstructed passage of stormflows; (3) to reduce sediment and other pollutants from entering streams; and (4) to restore the natural course of any stream as soon as practicable if the stream is diverted as a result of timber management activities.

EFFECTIVENESS: High

IMPLEMENTATION: The following items will be incorporated into the TSC via the identified B and C provisions:

1. Location and method of stream crossings will be agreed upon prior to construction (B6.422 Skid Trails and Landings).

2. Purchaser shall repair all damage to a streamcourse if the purchaser is negligent in his operations, including damage to banks and channel, to an acceptable condition as agreed to by the certified sale administrator and purchaser's representative.

3. All project debris shall be removed from streamcourse in an agreed upon manner that will cause the least disturbance (B6.5 Streamcourse Protection).

4. Wheeled or tracked equipment shall not operate within 50 feet (100 feet where SMZ law requires it) slope distance of the apparent high water mark of streamcourses designated for protection on the Sale Area Map (C6.6 Erosion Prevention and Control).

5. When ground skidding systems are employed, logs will be end-lined out of streamside and Riparian Areas. Equipment is permitted to enter streamside areas only at locations and times agreed to by the certified sale administrator and the purchaser (C6.50#, SMZ and Riparian Area Protection) and only after Alternative Practive Approval is granted by the Montana Department of Natural Resources and Conservation, per the Montana SMZ law.

6. Material from temporary road and skid trail stream crossings will be removed and streambanks restored to an acceptable condition. (B6.62 Temporary Roads)

7. A Montana Stream Protection Act (SPA, FWP-124) permit will be obtained in advance where the bed or bank of the stream will be affected.

No activity is planned in or near stream channels.

PRACTICE 14.18 - Erosion Control Structure Maintenance

OBJECTIVE: To ensure that constructed erosion control structures are stabilized and working effectively.

EFFECTIVENESS: High

IMPLEMENTATION: TSC provision B6.66 requires that during the period of the contract, the Purchaser shall provide maintenance of soil erosion control structures constructed by the Purchaser until they become stabilized, but not for more than one year after their construction. After 1 year, any erosion control work needed is accomplished through performance bond earmarked for that use. TSC provision C6.6(F) requires the Purchaser to maintain erosion control structures concurrently with his operations under the sale and in any case not later than 15 days after completion of skidding each unit.

PRACTICE 14.19 - Acceptance of Timber Sale Erosion Control Measures Before Sale Closure

OBJECTIVE: To assure the adequacy of required timber sale erosion control work.

EFFECTIVENESS: High

IMPLEMENTATION AND RESPONSIBILITY: TSC provision B6.35 requires that upon the Purchaser's written request and assurance that work has been completed the Forest Service shall perform an inspection. One area the Purchaser's might request acceptance for are specific requirements such as logging, slash disposal, erosion control, or snag felling. In

evaluating acceptance the following definition will be used by the Forest Service: "Acceptable" erosion control means only minor deviation from established standards, provided no major or lasting impact is caused to soil and water resources. Certified TSAs will not accept as complete erosion control, measures which fail to meet this criteria.

PRACTICE 14.20 - Slash Treatment in Sensitive Areas

OBJECTIVE: To protect water quality by protecting sensitive tributary areas from degradation which would result from using mechanized equipment for slash disposal.

EFFECTIVENESS: Moderate

IMPLEMENTATION: All such sensitive areas, including riparian harvest areas, bogs and meadows will be identified on the sale area map, the slash treatment map, and in the contract. TSC Provision C6.7 will include the following:

1. Jackpot burning within Streamside Management Zones will be utilized rather than broadcast burning.

2. Grapple piling of slash will be used in all machine pile units.

PRACTICE 14.22 - Modification of the Timber Sale Contract

OBJECTIVE: To modify the Timber Sale Contract if new circumstances or conditions indicate that the timber sale will cause irreversible damage to soil, water, or watershed values.

EFFECTIVENESS: High

IMPLEMENTATION: Over time, the Forest Service adopts new policies and direction that amend how we address timber harvest operations. An example is the recent change in direction to leave some large organic debris in stream channels instead of removing it all. In cases such as this, modifications to the TSC would occur under provision B2.37 (Minor Changes).

If evidence indicates that unacceptable impacts would occur to soil and water resources, when the sale was harvested as planned, the Forest Service Representative will request the Contracting Officer to gain Regional Forester advice and approval to proceed with a resource environmental modification, mutual cancellation, or unilateral cancellation of the Timber Sale Contract as allowed by TSC Provision B8.3. If the decision is for a resource environmental modification, once the action is approved by the Regional Forester, the appropriate Line Officer will assign an interdisciplinary team to make recommendations for implementation.

PRACTICE 14.23 - Reforestation Requirement

OBJECTIVE: To promote prompt reforestation and to limit disturbance on areas with limited regeneration potential.

EFFECTIVENESS: High

IMPLEMENTATION: All areas projected for regeneration harvest have been reviewed for silvicultural opportunities and have been certified that regeneration with five years is achievable. Project KV Plans will include funding for surveys as well as planting and site prep if necessary

PRACTICE 15.02 - General Guidelines for the Location and Design of Roads and Trails

OBJECTIVE: To locate and design roads and trails with minimal soil and water resource impact while considering all design criteria.

EFFECTIVENESS:

1. Route location ground-truths the results of transportation planning and provides site-specific information on possible problem areas (Gray and Megahan, 1981; Megahan and Kidd, 1972; King and Gonsior, 1980).

2. Designed and controlled cut slopes, fill slopes, road width, and road grades effectively reduce sediment production by fitting the roads to the land (King, 1979; Megahan, 1978).

IMPLEMENTATION: The following listed items are incorporated in general road location and design guidelines for minimizing impacts on water quality:

Design-

1. Roads shall be planned no wider than necessary to safely accommodate the anticipated use and equipment needs. Cut and fill volumes shall be minimized by designing the road to fit natural terrain features as closely as possible. As much of the excavated material as possible shall be used in fill sections. Minimum cuts and fills shall be planned, particularly near stream channels.

Location-

1. Utilize natural benches, follow contours, avoid long, steep road grades. Balance cut/fill where possible to avoid waste areas.

2. Embankments and waste shall be designed so that excavated material may be disposed of on geologically stable sites.

3. Avoid slumps and slide-prone areas, and steep sidehills.

4. Road construction shall be minimized within stream protection zones. Areas of vegetation shall be left or re-established between roads and streams [Standard Road Specifications-Special Project Specification 204.01].

5. Where possible, locate turn-outs and turn-arounds at least 200 feet from water bodies or riparian zones. Where placement within 200 feet is necessary due to safety considerations, emphasize erosion control measures to protect water quality; i.e., additional windrowing, seeding, etc.

Road Drainage-

1. Locate and design roads and trails to drain naturally by appropriate use of out-sloping, rolling dips, and grade changes, where possible. Dips, water bars and/or cross drainage will be planned when necessary. Cross drains will be installed in ditched areas to 1) carry intercepted flow across constructed areas; 2) to relieve the length of undrained ditch; and 3) to reduce disruption of normal drainage patterns. Road and trail drainage should be channeled to effective buffer areas, either natural or manmade, to maximize sediment deposition prior to entry into live water.

2. Ditch lines and road grades will be designed to minimize unfiltered flow into streams. A rolling dip, relief culvert or similar structure will be installed as close as practical to crossings to minimize direct sediment and/or water input directly into streams. Route the drainage through SMZ, buffer strips, or sediment settling structures where possible.

3. Relief culverts and roadside ditches shall be planned whenever reliance upon natural drainage would not protect the running surface, excavation, or embankment. Culvert installations shall be designed to prevent erosion of the fill. Drainage structures shall be planned to achieve minimum direct discharge of sediment into streams.

PRACTICE 15.03 - Road and Trail Erosion Control Plan

OBJECTIVE: To prevent, limit, and mitigate erosion, sedimentation, and resulting water quality degradation prior to the initiation of construction and maintenance activities through effective contract administration during construction and timely implementation of erosion control practices.

EFFECTIVENESS: Moderate

IMPLEMENTATION: The following erosion control objectives and mitigation measures have been developed by the IDT and will be reflected in contract specifications and provisions. The Engineer will certify that the Contractors Erosion Control Plan meets the specifications of Std. FS Spec. Section 204:

1. Vegetation will be re-established as soon as possible on exposed cut and fill slopes. Various operating seasons on varied units and sales within the analysis area will require seeding and fertilization specs to vary. Mulching will be required on erodible slopes where difficulty in re-establishing vegetation is anticipated.

2. Prompt attention to potential erosion problems, both anticipated and un-anticipated, before they become a water quality issue, will be required. On-site stock piling of straw bales for immediate availability and erosion cloth or a suitable substitute stored off-site, but available, will also be required.

3. Windrows will be used on all significant fill slopes where there is a possibility of erosion or sedimentation into a nearby stream or channel (Std. FS Spec. 201).

4. Cross drains and relief culverts will be installed so as to minimize effects from the intercepted water (see also Practice 15.02 f.(3)).

5. Equipment shall not be operated when ground conditions are such that excessive ground impacts will occur unless these impacts are documented and mitigated through other BMPs.

Prior to the start of construction, the Contractor shall submit a schedule for proposed erosion control work as required in the Standard Specifications. The schedule shall include all erosion control items identified in the specifications. Erosion control work to be done by the Contractor will be defined in Standard Specification 204 and/or in the Drawings. The schedule shall consider erosion control work necessary for all phases of the project. The Contractor's construction schedule and plan of operation will be reviewed in conjunction with the erosion control plan to ensure their compatibility before any schedules are approved.

PRACTICE 15.06 - Mitigation of Surface Erosion and Stabilization of Slopes

OBJECTIVE: To prevent, limit, and mitigate erosion, sedimentation, and resulting water quality degradation prior to the initiation of construction and to minimize erosion from road cutslopes, fillslopes, and travelways during and after construction.

EFFECTIVENESS: Seeding and fertilizing cut slopes, fill slopes, and other disturbed areas reduces erosion from these sources after one growing season. Effectiveness has been rated at 85% or better once the vegetation has become established (King and Burroughs, 1989).

IMPLEMENTATION: Areas requiring mitigation of surface erosion will occur during the life of the contracts. When these are found, the following provisions will be implemented:

1. Where surface erosion is occurring because of inadequate vegetative cover, additional seeding and refertilization will occur using recommended seed and fertilizer mixes. A T108 spec covers reseeding of cut slopes, if bared by the purchaser's maintenance operation. If the purchaser has done his required seeding, or bare spots are not caused by the purchaser, revise the KV Plan to cover costs.

2. Where ditches are carrying sediment into stream channels, straw bale and/or erosion cloth ditch blocks will be installed to induce deposition. Seeding of the eroding surfaces, and seeding of the stored sediment in the ditch will also be accomplished. If problem areas are known before contract award, add C6.602# to require cross ditching on segments of road.

3. Where straw bale/erosion cloth structures either fail or effectiveness is doubtful, additional relief culverts will be installed to drain the ditches out onto suitable ground to at least minimize delivery of erosion products to the stream. If problem areas are known before contract award, add C6.602# to require cross ditching on segments of road.

4. Slumping of cutslopes may require a combination of both mechanical and vegetative controls. If/when this problem is found, a solution will be determined in consultation with the engineers and the soil scientist.

Unless caused by the purchaser during his maintenance operations or known before sale award, or are part of a recurrent slide area these items will be beyond the scope of purchaser responsibility. Repair and/or improvement will be handled under reconstruction modified into the contract under C8.3 or KV Plan revision.

PRACTICE 15.07 - Control of Permanent Road Drainage

OBJECTIVE: To minimize the erosive effects of concentrated water and the degradation of water quality by proper design and construction of road drainage systems and drainage control structures.

EFFECTIVENESS: Designed and controlled ditches, cross drain spacing, and culvert discharge prevent water from running long distances over exposed ground. Dewatered (dry) culvert installations and special drainage such as rock filter blankets and rock buttresses have been demonstrated to be effective. Moderate

IMPLEMENTATION: The following items will be included in the timber sale contract provisions or road contract special project specifications.

All roads-

1. Drainage ways shall be cleared of all debris generated during construction and/or maintenance which potentially interferes with drainage or water quality [Timber Sale Contract Clause C5.4, and Standard Road Specifications-Special Project Specification 204.04].

2. During and following operations on out-sloped roads, out-slope drainage shall be retained and berms shall be removed on the outside edge except those intentionally constructed for protection of road grade fills [Timber Sale Contract Clause C5.4].

3. Cross drains and relief culverts will be installed so as to minimize concentrations of intercepted water (see also Practice 15.02 f.(3)).

Existing Roads- At a minimum, the following items will be added to or improved in the existing road system that will be used for proposed timber haul:

1. Rock energy dissipators or downspouts will be placed below problem culvert outlets (Reconstruction Item).

2. In all areas where ditch erosion is significant at this time, relief culverts that drain onto suitable areas will be installed (Reconstruction Item).

3. Roads restricted after use will also have erosion control measures in place prior to final pull-out. (TSC B/C 6.6, B6.65)

4. For all native surface roads to be closed, the travelway will be scarified, seeded and fertilized. (TSC C6.601).

PRACTICE 15.08 - Pioneer Road Construction

OBJECTIVE: To minimize sediment production and mass wasting associated with pioneer road construction.

EFFECTIVENESS: Moderate

IMPLEMENTATION: The following contract specifications will be required:

1. Construction of pioneer roads shall be confined to the roadway limits unless otherwise approved by the Contracting Officer (Std. FS Spec. 203.11).

2. Pioneering shall be conducted so as to prevent undercutting of the designated final cut slope, and to prevent avoidable deposition of materials outside the designated roadway limits (Std. FS Spec. 203).

3. Erosion control work will be completed concurrent with construction activity or prior to the wet season. During the wet and winter season, no more than 1000 feet of road can be in the pioneer state without the required erosion control work at any time (Std. FS Spec. 204).

4. Permanent culverts will be installed during the pioneer phase unless positive control of sediment can be accomplished during installation, use, and removal of the temporary structure.

There is no planned pioneer road construction planned for this project.

PRACTICE 15.09 - Timely Erosion Control Measures on Incomplete Road and Streamcrossing Projects

OBJECTIVE: To minimize erosion of and sedimentation from disturbed ground on incomplete projects.

EFFECTIVENESS: Moderate

IMPLEMENTATION: The following preventive measures will be implemented during projects:

1. The removal of temporary culverts, culvert plugs, diversion dams, or elevated streamcrossing causeways;

2. The installation of temporary culverts, side drains, flumes, cross drains, diversion ditches, energy dissipaters, dips, sediment basins, berms, debris racks, or other facilities needed to control erosion;

3. The removal of debris, obstructions, and spoil material from channels and floodplains;

4. Grass seeding, planting deep rooted vegetation and/or mulching.

Erosion control measures must be kept current with ground disturbance, to the extent that the affected area can be rapidly "closed," if weather conditions deteriorate. Areas must not be abandoned for the winter with remedial measures incomplete.

PRACTICE 15.10 - Control of Road Construction Excavation and Sidecast Material
PRACTICE 15.18 - Disposal of Right-of-Way and Roadside Debris

OBJECTIVE: To ensure that unconsolidated excavated and sidecast material, construction slash, and roadside debris, generated during road construction, is kept out of streams and to prevent slash and debris from subsequently obstructing channels.

EFFECTIVENESS: High

IMPLEMENTATION: Construction debris and other newly generated slash developed along roads near streams shall be disposed of by the following means as applicable (Std. FS Spec. 210, and SPS 201):

1. On-Site by windrowing, scattering, burying, chipping, disposal in cutting units, piling and burning, or embankment placement.

2. Removal to agreed upon locations.

3. A combination of the above.

In the construction of road fills near streams, compact the material to reduce the entry of water and minimize the amount of snow, ice, or frozen soil buried in the embankment. No significant amount of woody material shall be incorporated into fills. Slash and debris may be windrowed along the toe of the fill, but in such a manner as to avoid entry into a stream and culvert blockage.

Where slash windrows are not desirable or practical, other methods of erosion control such as erosion matts, mulch, and straw bale or fabric sediment fences will be used.

Where exposed material (excavation, embankment, borrow pits, waste piles, etc.) is potentially erodible, and where sediments would enter streams, the material will be stabilized prior to fall or spring runoff by seeding, compacting, rip-rapping, benching, mulching or other suitable means. The following standard specs will be included in all road contracts which include clearing and excavation.

1. Standard Specification 201 (Slash Treatment)

2. Standard Specification 203 (Excavation and Embankments)

PRACTICE 15.12 - Control of Construction in Riparian Areas
PRACTICE 15.13 - Controlling In-Channel Excavation

OBJECTIVE: To minimize stream channel disturbances and related sediment production, and to make sure activities comply with the SPA (124) permit process as agreed upon between the Forest Service and the State of Montana.

EFFECTIVENESS: High

IMPLEMENTATION: Construction equipment may cross, operate in, or operate near streamcourses only where so designated by the Forest Service or as necessary in the construction or removal of culverts and bridges. This will be done in compliance with the specifications and mitigation required in the SPA (124) permit and included in the project specifications.

Unless otherwise approved, no in-channel excavation shall be made outside of de-watered areas, and the natural stream bed adjacent to the structure shall not be disturbed without approval of the Engineer. If any excavation or dredging is made at the site of the structure before caissons, cribs, or cofferdams are sunk in place, all such excavations will be restored to the original ground surface or the stream bed will be protected with suitable stable material. Material from foundation or other excavation shall not be discharged directly into live streams but shall be pumped to settling areas shown on the drawings or approved by the Engineer. If the channel is damaged during construction, it should be restored as nearly as possible to its original configuration without causing additional damage to the channel. Excavations for stream crossings will conform to the SPA (124) permit criteria, including timing restrictions (as well as Std. FS Spec 206, 206A, and applicable SPS's).

PRACTICE 15.15 - Stream Crossings on Temporary Roads

OBJECTIVE: To keep temporary roads from unduly damaging streams, disturbing channels, or obstructing fish passage.

EFFECTIVENESS: Moderate

IMPLEMENTATION: Culverts, temporary bridges, low-water crossings, or log-fords will be required on all temporary roads and crossings. Streams that will have flowing water during the life of the temporary crossing will normally use culverts or a bridge. The number of temporary crossings will kept to the minimum needed for access.

1. Temporary crossings on temporary roads will be removed when no longer needed, and any fills will be removed and the channel restored to pre-project condition (TSC B5.2, B6.5, C5.2). A SPA (124) permit will also be required.

2. Temporary crossings on system roads will be removed following use but protected fills, including constructed abutments, may remain.

PRACTICE 15.21 - Maintenance of Roads

OBJECTIVE: To maintain all roads in a manner which provides for soil and water resource protection by minimizing rutting, failures, sidecasting, and blockage of drainage facilities.

EFFECTIVENESS: Moderate

IMPLEMENTATION:

1. For roads in active timber sale areas standard TSC provision B5.4 (Road Maintenance) requires the purchaser to perform or pay for road maintenance work commensurate with the purchasers use. Road maintenance is the preservation of the road facility including surface, shoulders, miscellaneous structures, drainage, sight distance, and all such traffic control devices required to ensure safe and efficient use by established road users and adequately protect adjacent resources. Purchaser's maintenance responsibility shall cover the before, during, and after operation period during any year when operations and road use are performed under the terms of the timber sale contract.

Purchaser shall perform road maintenance work, commensurate with purchaser's use, on roads controlled by Forest Service and used by purchaser in connection with this sale except for those roads and/or maintenance activities which are identified for required deposits in C5.411# and C5.412#.

All maintenance work shall be done currently, as necessary, in accordance with T-specifications, except for agreed adjustments (TSC C5.4- T301, 310).

2. For roads not in an active timber sale area, road maintenance must still occur at sufficient frequency to protect the investment in the road as well prevent deterioration of the drainage structure function. This will be accomplished by scheduling periodic inspection and maintenance, including cleaning dips and cross drains, repairing ditches, marking culvert inlets to aid in location, and cleaning debris from ditches and culvert inlets to provide full function during peak runoff events (FSH 7709.15).

PRACTICE 15.22 - Road Surface Treatment to Prevent Loss of Materials

OBJECTIVE: To minimize the erosion of road surface materials and consequently reduce the likelihood of sediment production.

EFFECTIVENESS: Stabilization of road surface and ditch lines over 6% with competent rock (rock that does not rapidly disintegrate) is often over 90% effective. High

IMPLEMENTATION: On timber sale roads, the Purchaser shall undertake measures to prevent excessive loss of road material if the need for such action has been identified. Road surface treatments may include: watering, applying magnesium chloride, or aggregate surfacing.

PRACTICE 15.23 - Traffic Control During Wet Periods

OBJECTIVE: To reduce the potential for road surface disturbance during wet weather and to reduce subsequent sediment delivery to streams.

EFFECTIVENESS: Moderate

IMPLEMENTATION: Haul restrictions are placed on asphalt-surfaced roads, based on interpretation of thermistor data. Restrictions are placed on native and aggregate-surfaced roads when a FS representative feels that damage will occur with further use. Roads that are restricted are so indicated in Forest Supervisor Orders, posted at FS Stations and in local media.

PRACTICE 15.24 - Snow Removal Controls

OBJECTIVE: To minimize the impact of snow melt on road surfaces and embankments and to reduce the probability of sediment production resulting from snow removal operations.

EFFECTIVENESS: Moderate

IMPLEMENTATION: For Forest roads that will be used throughout the winter, the following measures will be employed:

1. The Purchaser is responsible for snow removal in a manner which will protect roads and adjacent resources.

2. Rocking or other special surfacing and/or drainage measures may be necessary, before the operator is allowed to use the roads.

3. During snow removal operations, banks shall not be undercut nor shall gravel or other selected surfacing material be bladed off the roadway surface. Ditches and culverts shall be kept functional during and following roadway use. If the road surface is damaged, the Purchaser shall replace lost surface material with similar quality material and repair structures damaged in blading operations.

4. Snow berms shall not be left on the road surface or shall be placed to avoid channelization or concentration of melt water on the road or erosive slopes. Berms left on the shoulder of the road shall be removed and/or drainage holes opened at the end of winter operations and before the spring breakup. Drainage holes shall be spaced as required to obtain satisfactory surface drainage without discharge on erodible fills. On insloped roads, drainage holes shall also be provided on the ditch side, but care taken to ensure that culverts and culvert inlets are not damaged.

PRACTICE 15.25 - Obliteration of Temporary Roads

OBJECTIVE: To reduce sediment generated from temporary roads by obliterating them at the completion of their intended use.

EFFECTIVENESS: High

IMPLEMENTATION: Effective obliteration is generally achieved through a combination of the following measures (TSC B6.62, C6.622, C6.623):

1. Road effectively drained and blocked.

2. Temporary culverts and bridges removed and any modified channel slopes stabilized and revegetated.

3. Road returned to resource production through revegetation (grass, browse, or trees).

4. Sideslopes reshaped and stabilized.

PRACTICE 18.02 - Formulation of Fire Prescriptions

OBJECTIVE: To provide for soil and water resource protection while achieving the management objective through the use of prescribed fire.

EFFECTIVENESS: High

IMPLEMENTATION: The prescription elements are defined by the interdisciplinary team during the environmental analysis. Field investigations are conducted to identify site specific conditions which may affect the prescription. Both the optimum and tolerable limits for soil and water resource needs should be established. Prescription elements will include such factors as fire weather, slope aspect, soil moisture and fuel moisture which influence the fire intensity. These elements have a direct effect on whether or not a litter layer remains after burning and whether or not a water repellent layer is formed. The amount of remaining litter significantly affects erosion rates, water quality and runoff volumes.

PRACTICE 18.03 - Protection of Soil and Water from Prescribed Burning

OBJECTIVE: To maintain soil productivity, minimize erosion, and prevent ash, sediment, nutrients, and debris from entering surface water.

EFFECTIVENESS: High

IMPLEMENTATION: Forest Service and/or other crews are used to prepare the units for burning. This includes water barring firelines and reducing fuel concentrations. The interdisciplinary team identifies Riparian Areas and soils with water repellant tendencies as part of the environmental analysis. Unit 731, a stand replacement burn in the Dry Fork headwaters has riparian areas of concern that will be incorporated into burn prescription plans. Some of the techniques used to prevent soil erosion and water quality degradation are: (1) construct water bars in fire lines; (2) reduce fuel loadings in drainage channels; (3) maintain the integrity of the Riparian Area; (4) avoid intense fires, which may promote water repellency, nutrient leaching, and erosion; (5) retain or plan for sufficient ground cover to prevent erosion of the burned sites and (6) removal of all debris added to stream channels as a result of prescribed burning, unless debris is prescribed to improve fisheries habitat.

Appendix E

Benchmark Fuels Project Monitoring Plan

Introduction:

The Benchmark road fuels project is designed to reduce the buildup of hazardous fuels along the Benchmark road in order to lower associated risk to human life, private property, and administrative sites. The project area will be managed through the utilization of three treatment methods strategically located across the landscape. In order to assess the effectiveness of the treatments over time a monitoring plan and schedule will be required. Given the availability of resources and the project budget, the subsequent monitoring of the project area must be done efficiently and with minimal resources.

Considering these variables, the relevé monitoring approach is the most viable option for this project. The relevé approach will allow monitors to locate plots in representative areas that will be affected by the prescription, in contrast to random samples which may not. Although the resulting data will not be statistically valid, it will provide qualitative data that can be used to assess the effectiveness of the initial treatment and help to determine when a subsequent entry may be necessary.

Management objective:

The objective of this project is to reduce the buildup of hazardous fuels which create an increased risk to human life, private property, and administrative areas. Treatments will include:

1. Commercial thinning to increase crown spacing to 20-30 feet between clusters of dominant and codominant trees, followed by piling and burning ground fuels in order to reduce residual material to fuel model 8 guidelines.
2. Hand treatment with power saws to reduce conifer encroachment on mountain grasslands followed by broadcast and jackpot burning, aimed at increasing the size of natural openings and creating conditions favorable to aspen regeneration.
3. Commercial harvest of 0.25 to 2 acre patches to reduce continuity of fuels and crown bulk density, as well as create conditions favorable to aspen regeneration. The treatment will be followed by piling and burning surface fuels in order to reduce the fuel loading to those associated with NFFL (FB) fuel model 8.

Monitoring objective:

The objective is to assess the impact of each management action on fuel loading, understory species composition, crown spacing and overstory composition immediately following the treatment and over a set schedule of succeeding years thereafter to evaluate success and need for subsequent treatments.

Methods:

All information gathered will be documented using the FIREMON database. Sampling procedures will follow established FIREMON protocols except where otherwise noted. All data will be inputted into the appropriate FIREMON form: Plot Description (PD), Tree Data (TD), Fuel Loading (FL), and Species Composition (SC).

***Establishing plots**:*

Nine plots, including one control plot in a representative untreated area, will be located strategically throughout the project area on sites that best represent all ranges of variability. **Note: When establishing plot location take special consideration to minimize bias and pick a representative site within the treatment unit.** Permanently mark plot centers with a 3-foot 5/8-inch diameter steel bar (rebar). Place rebar 1 to 2 feet in the ground, to prevent accidental misplacement, while leaving approximately 6-inches showing above ground level. To aid in relocating plots paint the exposed end with bright orange automotive paint and wrap with brightly colored tape.

***The plot center will be marked using three methods**:*

- Latitude/longitude (d° m.mmm')
- Photo points

***Suggested plot location**:*

- Ford Creek Unit #1
- Ford Creek Unit #2
- Aspen Unit #1
- Double Falls Unit #2
- Mule Creek Unit # 2
- Benchmark Unit #1
- Benchmark Unit #3
- Control Plot (Locate on a non-treated representative site)

Plot Layout:

The primary plot used in the Plot Description (PD), Tree Data (TD), and Species Composition (SC) will consist of a 0.1 acre (37.2 –foot horizontal radius) circular plot from the established plot center (rebar). A brass plot identification tag will be attached to the rebar identifying the plot number.

The Fuel Loading (FL) plot starting point begins at the plot center. From plot center follow an azimuth of 90° for 75-feet. No data will be collected for this plane. From the terminus of the previously mentioned plane take an azimuth of 330° and begin data collection continuing in a counter clockwise direction until fuel inventory guidelines are met (see Monitoring Procedures: *Fuel Loading*).

MONITORING PROCEDURES:

Plot Description (PD):

This form is used to describe the general characteristics of the plot. When completing the PD form there are four REQUIRED entries; registration code, project code, plot number, and date sampled. Complete all fields that are not blacked-out on the data collection sheet.

Tree Data (TD):

Tree data will be collected using the 0.1 acre macro plot. All trees within the plot greater then 6 inches DBH will be tagged using numbered brass tree tags.

- Mature Trees: The following information will be recorded on all trees greater then 6-inch DBH (measurements to the nearest 0.1-inch): Tag number, species, tree status, DBH, height, live crown ratio, crown fuel base height, crown class, decay class, mortality code, char height, and crown scorch.
- Saplings: All trees taller than 4.5 feet with DBH under 6-inches will be tallied by species-diameter-status class.
- Seedlings: Trees 4.5-feet and shorter will be tallied by species-height-status class and will be sampled using a 0.01 (11.77 –foot horizontal radius) acre microplot centered at the plot center within the 0.1 acre macroplot.

*Crown bulk density will be estimated using the measurements gathered in this plot.

Fuel Loading (FL):

Course woody debris (CWD), fine woody debris (FWD), duff depth, and understory vegetation cover will be measured using Browns method of planar transects as described in the FIREMON handbook. Each of these variables has a profound effect on predicting potential fire behavior and will verify the effects of treatments on the project area. Plots will be located from the established macroplot center. No measurements will be recorded on the first 75-foot plane of the transect thus preventing collection of erroneous data resulting from tree data sampling activities. Collection of data will begin from the terminus of the first sample plane until either 100 pieces of down woody debris is tallied or the remaining six sampling planes are completed. Duff measurements will be taken at the 3, 45, and 75-foot marks on each plane of the transect completed (excepting plane 1). Understory Vegetation will be sampled at the 45 and 75-foot marks by estimating the vertically projected cover, as outlined in the FIREMON handbook.

Species Composition (SC):

The species composition sample will be conducted within the same 0.1 acre macroplot as the tree data sample. This sample provides qualitative data of the vegetative cover within the plot area. While the method does not allow monitors to detect statistically significant changes overtime due to subjectivity, the ocular estimates will record changes in the vegetation of the plot. Only species with 5-percent cover will be included in this sample, excluding noxious weeds. Any presence of noxious weeds will be recorded and reported to the district range specialist.

Photo Points:

Photo documentation will be taken at each plot. A minimum of four photos per plot will be taken. Take into consideration the following procedures when taking photo points:

- Photos will be taken using a digital camera four mega pixel or higher at the lowest zoom setting (1:3.2)
- Take at least two photos from each position
- Locate tripod outside of the 0.1 acre macroplot to avoid trampling vegetation
- Camera will be placed on a **level** tripod approximately 4 feet above ground
- A Photo board will be present in photo including date, plot #, direction photo is facing
- Photos will be taken facing: 90°, 180°, 270°, 360° with plot center being the midpoint of the photo
- Plot center will be marked by a range pole or similar implement to give scale to the photograph
- Document all photos in photo log

If situations require deviation from established procedures DOCUMENT CHANGES in field notebook AND photo log

Resources Required:

The most efficient monitoring crew consists of a crew boss and two crewmembers. It will take a crew approximately 4 to 5 work days to install and sample the nine plots in the project area. Once the plots have been established subsequent monitoring time per plot should be reduced.

Table E-1. Required Equipment for Installing Plots and Sampling

Item	Qnty	Item	Qnty
100-foot tape measure (cloth)		Orange Paint & tape (to Mark rebar)**	1
5/8-inch rebar (per plot)**	1	Pencils	Many
Calculator	1	Photo Board	1
Clear plastic ruler 12-inch	2	Photo record sheet	Many
Clinometers	2	Plant identification guides	1
Clipboard and pencils	1	plastic straws (for core samples)	Many
Compass	2	Plot identification tags(oblong brass)**	Many
Diameter tape	2	Range Pole	1
Digital Camera (4-mb or greater)	1	Poles fiberglass 3-foot	2
Field notebook	2	Steel nails	Many
FIREMON data sheets	Many	Survey flags	Many
Flagging	2	Topographic map of area	
Go/No-go Gauge	2	Tree tags (brass, pre-numbered)**	Many
GPS Unit	1	Tripod with level	1
Graph paper (pad)	1	Wire to attach tags (roll)	1
Hand sledge**	1	yard stick (can be folding)	2
Indelible ink pen (sharpie)	2		
Loggers tape (recommended)	2	**** Only needed for plot installation**	
Masking tape	1		

Monitoring Schedule

A detailed inventory of all plots will be conducted pre-treatment to establish a base starting point from which to judge the effectiveness of the treatments. In order to meet post treatment project objectives with the given constraints, photo points will be taken every two years and full plot sampling will be done every five years following a unit's completion. This will result in each plot being visited six times in ten years. Thus, measurements will be conducted in years two, four, five, seven, nine and ten post treatment. Given the potential for staggered completion dates for each unit, it should take a monitoring crew approximately 2-3 days each year to complete associated field work. In addition to established plots all rehabilitated landing sites, firelines and temporary roads within the project area will be monitored on a semiannual basis for noxious weeds and drainage issues.

Appendix F

Fire Weather, Fuels, and Behavior Report

The following report contains information on the data and parameters utilized in the Benchmark Fuels Reduction Project Fire, Fuels, and Air Quality Effects Analysis. The Historical Weather Data was utilized to define inputs to the Behave and Nexus Programs. For the Nexus program, the parameters utilized below were used to model "typical" fire weather patterns. The Design Weather and Fuel Parameters listed in the following paragraphs were utilized for Behave and Nexus runs modeled to reflect extreme fire conditions. The third section of this report delineates some of the fuels characteristics that were used to obtain Nexus outputs. Finally, inputs and outputs for Behave runs are included at the end of this document.

Historical Weather Data

This section is intended to document the type of weather and the resulting fire behavior that can be expected in the Benchmark drainage. Weather data was derived from the Benchmark Remote Automated Weather Station (RAWS) #241901. The data set used was 1984 through 2006. This RAWS station is located near the packer corrals on Benchmark Creek. There were 4692 weather observations in this weather set. The Fire Family Plus program was used to analyze the weather data and the Behave program was used to produce the fire behavior outputs.

Analysis of the wind data showed that there have been 211 days with winds at 12 miles per hour (mph) or greater at that station, or 4.5% of the days in the weather set. This revealed that it is fairly common for that station to experience 20 foot winds at 12 mph or greater.

In looking at wind direction, 30% of the days the wind was out of the south, south west or west. However, 31% of the days the wind was out of the north east, east, or south east direction. Winds with a northerly component were the least common.

Temperature values for this weather station were easier to assess. The average high dry bulb temperature goes above 70 degrees Fahrenheit on approximately the 4th of July and the daily high dry bulb temperature stays above 70 degrees through August. The highest temperature recorded at this station was 91 degrees Fahrenheit.

The low relative humidity value was harder to assess. I looked at the all time low values for that station and compared them to dates to determine the relative humidity values. I used the low value because of its importance in the fire behavior calculations and they are values that this station has recorded. The low relative humidity value drops below and stays between 10 and 20 percent through October.

Behave runs were made using the following values based on the weather described above:

1 hour fuel moisture	7%
10 hour fuel moisture	9%
100 hour fuel moisture	11%
slope	25%
midflame wind speed	4 mph (12 mph 20 foot wind speed, partially sheltered)
live woody fuel moisture	100%

The following outputs were produced by the BEHAVE Program:

Fuel Model 8

Rate of Spread	2 Chains/hour
Heat per Unit Area	180 BTU/Sqft
Fire Line Intensity	5 BTU/Foot/Second
Flame Length	1 foot
Reation Intensity	884 BTU/SQft/M
Effective Windspeed	4.4 mph

Fuel Model 10

Rate of Spread	7 Chains/hour
Heat per Unit Area	1232 BTU/Sqft
Fire Line Intensity	4.6 BTU/Foot/Second
Flame Length	4.6 foot
Reation Intensity	5662 BTU/SQft/M
Effective Windspeed	4.4 mph

Design Environmental Conditions

Design Environmental Conditions were utilized in assessing Crown Bulk Density and Fuel Loadings for the proposed treatments. The intent of selecting specific windspeeds, slopes, and fuel moistures was to evaluate the effectiveness of fuels treatments under drought conditions utilizing the Nexus spreadsheet and Behave. Rothermel provided fuel moistures representative of drought conditions in the Rocky Mountain Region, while Scott provided direction in applying design criteria and suggested the use of 25 mph 20-ft windspeeds as a default. Most treatments occur in areas with 0-35% slope--15% slope was utilized as a default.

Design Conditions (Drought Summer)

Fine Dead Fuel Moisture:	1-h	4%
	10-h	5%
	100-h	7%
	Live	78%

Wind: 20-ft windspeeds of 25 mph from the west were used for the Nexus spreadsheet.

For Behave runs a range of midflame windspeeds were used. For Fuel Models 8 and 10, a wind adjustment factor of .3 (partially sheltered) was used to obtain a midflame windspeed of 7.5 for 25 mph 20-ft windspeeds. The range included values to 25 mph to model extreme conditions.

Slope: 10%

Design environmental conditions for the Benchmark Fuels Reduction project were derived from the following documents.
Scott, J.H. 2003. Canopy Fuel Treatment Standards for the Wildland-Urban Interface. USDA Forest Service Proceedings RMRS-P-29. P 29-37.
Rothermel, Richard. C. 1991. Predicting behavior and size of crown fires in the Northern Rocky Mountains. Res. Pap. INT-438. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain forest and Range Experiment Station. 46 p.

Notes on Nexus Runs

Several runs were made in Nexus utilizing the values offered above for typical and extreme conditions. Values for the runs were also derived from site visits, as well as the *Stereo Photo Guide for Estimating Canopy Fuel Characteristics in Conifer Stands*, authored by Joe H. Scott and Elizabeth Reinhardt. The data offered for Douglas-fir/lodgepole pine and for lodgepole pine is representative of stands in the Benchmark area. The data for Sierra Nevada mixed conifer was also used for comparative purposes. The following site-specific stand data was also used for Nexus Runs (these stands occur along the Benchmark Road).

Table F-1. Stand Data from Benchmark Project Area

Stand	CBH (ft.)	CBD (kg/m3)	Crown Fuel Load (tons/ac.)	Fuel Model	Unit
01150149060015	6	0155	6.2	10	
01150149060009	3	.205	10.5	10	
01150149060003	5	.275	9.1	8/10	
01150149060001	4	.033	13.4	1	
01150149050024	6	.171	7.7	10	
01150149020022	2	.02	.4	5	
01150149020012	2	.07	3.3	8	
01150149020003	8	.298	9.2	8/10	
01150149020002	4	.116	5.4	8/10	
01150149010022	3	.022	.7	5	
01150149010019	4	.105	5.1	8	
01150149010016	2	.173	7.4	8/10	
01150149010008	7	.35	9	8/10	
01150149010001	6	.238	9.3	8/10	
01150150010020	6	.238	9.3	8/10	
01150150010014	7	.335	10.6	10	
01150150010010	9	.35	9.9	8/10	

01150150010003	2	.21	6.9	8/10	
01150150010001	2	.173	4.9	8	
01150151060015	14	.084	208	2/8	
01150151060014	4	.079	2.3	8	
01150151060007	20	.091	2.7	2/8	
01150151060003	5	.19	5.1	8/10	
01150151050024	18	.144	6.5	8/10	
01150151050018	8	.061	2.4	2/8	
01150151050017	4	.072	3.9	8	
01150151050011	27	.004	.1	5	
01150151050008	3	.052	1.5	1	
01150151030033	5	.194	6.7	8/10	
01150151030030	6	.174	6.5	10	
01150151030025	3	.175	6.1	10	
01150151030024	4	.184	6.5	10	
01150151030023	15	.19	5.9	8	
01150151030004	5	.152	4.8	8/10	
01150151030003	3	.35	15.8	8/10	
01150151010025	7	.152	6.1	8/10	
01150151010023	5	.193	7.9	10	
01150151010017	4	.121	3.6	8/10	
01150151010010	7	.082	3.4	8	
01150152020017	11	.350	15.7	8/10	
01150152020014	6	.171	6.8	8/10	
01150152020001	5	.214	7.9	8/10	
01150157040041			.1	5	
Stand	CBH (ft.)	CBD (kg/m3)	Crown Fuel Load (tons/ac.)	Fuel Model	Unit
01150157040035	39	.002	.1	5	
01150157040023				2	
01150157040020				5	
01150157040013				2	
01150157040011	4	.219	6	8	
01150157040010				2	
01150157040005				2	
01150157040002				2	
01150157030042	2	.201	9.8	8/10	
01150157030039	4	.118	4.3	8/10	
01150157030022	5	.054	1.6	1/8	
01150157030018	3	.074	1.8	8	
01150157030016	6	.177	4.7	8/10	
01150157030013	17	.159	5.2	10	
01150157030012	3	.350	11.7	8	
01150157030011	6	.214	5.5	10	
01150157030001	6	.115	2.6	8	
01150157020040	7	.14	5.3	8	

01150157020038	15	.067	2.5	5/8	
01150157020037	4	.098	2.4	1/8	
01150157020022	11	.114	5	8	
01150157020012	23	.056	2.6	8	
01150157020009	5	.13	7	10	
01150157020004	6	.093	3.9	8/10	
01150157010026	5	.209	9.2	10	
01150157010024	9	.178	4.3	8/10	
01150157010020	6	.111	4.8	8/10	
01150157010009	4	.094	3.2	8/10	
01150157010008	7	.126	5.2	8/10	
01150157010004	16	.072	2.8	8/10	
01150162010024				2	
01150162010022				5	
01150162010014	35	.003	.1	5	
01150162010009	29	.002	.1	2	
01150162010008				2	
01150162010004	29	.002	.1	1	
01150162010002				5	
01150149050020	6	.204	9.4	8/10	
01150149050011	2	.107	1.8	8	

BEHAVE RUNS

The Following Behave Runs are referenced in the Benchmark Fuels/Vegetation Report.

WELCOME TO THE BEHAVE SYSTEM
BURN SUBSYSTEM
FIRE1 PROGRAM: VERSION 4.4 -- FEBRUARY 1997

DEVELOPED BY: THE FIRE BEHAVIOR RESEARCH WORK UNIT
INTERMOUNTAIN FIRE SCIENCES LABORATORY
MISSOULA, MONTANA

YOU ARE RESPONSIBLE FOR SUPPLYING VALID INPUT AND FOR CORRECTLY INTERPRETING THE FIRE BEHAVIOR PREDICTIONS.

ASSUMPTIONS, LIMITATIONS, AND APPLICATION OF MATHEMATICAL MODELS USED IN THIS PROGRAM ARE IN:
Andrews, Patricia L. "BEHAVE: Fire behavior prediction and fuel modeling system--BURN subsystem, Part 1", INT-GTR-194, 1986.
Andrews, Patricia L., and Chase, Carolyn H. "BEHAVE: Fire behavior prediction and fuel modeling system—BURN subsystem, Part 2", INT-GTR-260, 1989

INPUTS

1 hour fuel moisture	7% (used 20% or less minimum RH)
10 hour fuel moisture	9%
100 hour fuel moisture	11%
slope	25%
midflame windspeed	4 mph (12 mph 20 foot windspeed, partially sheltered)
live woody fuel moisture	100%

Note: these values were developed using 23 years of weather data from the Benchmark RAWS #241901.

Fuel Model 8

RATE OF SPREAD, CH/H	2.
HEAT PER UNIT AREA, BTU/SQFT	180.
FIRELINE INTENSITY, BTU/FT/S	5.
FLAME LENGTH, FT	1.0
REACTION INTENSITY, BTU/SQFT/M	884.
EFFECTIVE WINDSPEED, MI/H	4.4

(VERSION 4.4)

Fuel Model 10

RATE OF SPREAD, CH/H	7.
HEAT PER UNIT AREA, BTU/SQFT	1232.
FIRELINE INTENSITY, BTU/FT/S	157.
FLAME LENGTH, FT	4.6
REACTION INTENSITY, BTU/SQFT/M	5662.
EFFECTIVE WINDSPEED, MI/H	4.4

(VERSION 4.4)