



# Engineering Field Notes

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1998

## Engineering Technical Information System

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## 1997 *Engineering Field Notes* Article Award Winners

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Our sincere thanks to all who took time from their busy schedules to vote for their favorite *Engineering Field Notes* articles published during 1997. With fewer people trying to do the work of many, we truly appreciate your taking the time to vote, to let our authors know that their efforts are read and appreciated.

Putting your thoughts and experiences on paper takes time, and not many of us have any extra. So, a very special thanks to all of you who submitted articles. For us to remain a valuable resource to our field personnel, we rely on people who are willing to share—their time, knowledge, experiences, successes, and even their failures. According to our readers, your articles continue to save the Forest Service time and resources.

Let's hear a big round of applause for the recipients of the cash awards for submitting the winning *Engineering Field Notes* articles for 1997! The winners are:

- Robert L. Freel for "Retaining Wall With an Eye on the Past"
- Richard Kennedy for "Road Maintenance Frequency vs. Sediment Production"
- Kathy Foster for "Water Quality Effects of Three Dust-Abatement Compounds"

Congratulations to all of our winners and to all the authors who make this publication possible. Keep those articles coming, and next year you could be one of our winners.



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# New & Revised Federal Recreation Symbols

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**Fred Cammack**  
**Senior Project Leader**  
**San Dimas Technology and Development Center**

## Introduction

In fiscal year (FY) 1996, Washington Office Engineering assigned the San Dimas Technology and Development Center (SDTDC) the task of reviewing Federal recreation symbols currently in use by the Forest Service. The symbols are located in the *Sign and Poster Guidelines for the Forest Service*, EM 7100-15, pages 15-17 through 15-21. These existing Federal recreation symbols were developed and adopted for use in the early 1970's as a coordinated effort among several Federal agencies. They were subsequently categorized, renumbered, and placed in the Manual on Uniform Traffic Control Devices (MUTCD).

Although recreation uses and activities have changed somewhat since these symbols were developed, only the wildlife viewing symbol has been officially added to the original list. As a result, some Forest Service units have taken it upon themselves to develop their own symbols. While this may solve a local problem, it often results in duplication of effort, different symbols for the same activity used in different locations, symbols with dual interpretations, and other problems.

## Defining Needs

To determine if the symbol set in current size was meeting Forest Service needs, SDTDC formed a National Ad hoc Committee composed of Forest Service signing and recreation specialists to evaluate current Forest Service symbol needs and problems. Prior to the committee's first meeting Regional Sign Coordinators were asked by SDTDC to pool their forests for needs and problems. The information collected from this pool as well as symbols currently in use by other agencies were evaluated by the committee in June 1996. As a result of that evaluation SDTDC facilitated the preparation of artwork that reflected the committee's recommendations for new symbols and for revisions to existing problem symbols. The artwork was placed in an SDTDC-prepared report and sent out to Forest Service Regional Office Engineering and Recreation Staff for review and comment.

## Implementation

In October 1996, the committee reviewed the comments received from each Region and their respective field units in terms of the artwork in the report and gave SDTDC final instruction for implementation of the committee's work. Since that meeting, SDTDC has facilitated the committee's instructions concerning revisions to the artwork. The preparation of symbol artwork and the design of new symbols were accomplished by the use of sign software. This resulted in all of the current symbol set and new symbols being placed in commonly used computer file formats. During the process of developing the artwork, sign manufacturers were contacted to determine what, if any, problems would be encountered, cost and otherwise, in the

production of these new designs. It was determined that providing computer files to the manufacturers would support automation of sign production and would be the best way to ensure exact reproduction and standardization of all symbols.

## Where We Are

As a result of this project, in FY 1998, SDTDC placed all the currently approved symbols along with the new symbols approved by Washington Office Engineering on the Forest Service Intranet where they can be reviewed and downloaded by any Forest Service user. The Intranet address is <http://fsweb.sdtc.wo.fs.fed.us>. The symbols can be found in the *Engineering and Watershed* page, subcategory *Federal Recreation Symbols*.

To support the needs of sign manufacturers and Federal and State agencies who do not have current access to the web site, SDTDC is publishing the symbols on CD-ROM. The CD-ROM will also include an indexed copy of the new edition of *Sign and Poster Guidelines for the Forest Service*, EM 7100-15. The CD-ROM version is expected to be distributed to all Forest Service Regions by the end of November 1998.

The committee's recommendations have been submitted by Washington Office Engineering to the Federal Highway Administration (FHWA) for review and ultimate approval and incorporation into the MUTCD for general use. The FHWA review segregated the symbols into the following categories:

1. Approved for immediate general use.
2. Not approved for maintenance level 3 and above roads; Forest Service restricted use only.
3. Considered for general use approval by FHWA. These symbols have begun the FHWA approval process, which generally takes about 2 years. Currently, these symbols are *not approved for maintenance level 3 and above roads and, until their approval by FHWA, are for Forest Service restricted use only.*

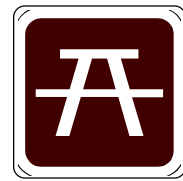
The new symbols are identified and grouped by their respective categories in figures 1-3.



RG-170  
Ranger Station



RG-130  
Litter Container



RM-120  
Picnic Area



RA-110  
Sleeping Shelter



RA-060  
Laundry



RL-130  
Interpretive Trail  
Recommended for Use  
with Educational Plaque

**Figure 1.** Category 1: Modification to existing symbols that are approved for immediate use.



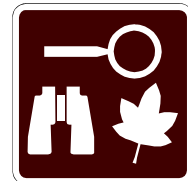
NA-RG-220  
No Alcohol



NA-RG-230  
Cultural Interest



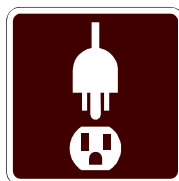
NA-RG-250  
Pickup



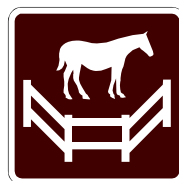
NA-RG-270  
Nature Study  
Area



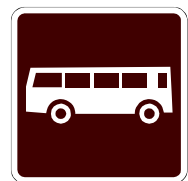
NA-RL-220  
Walk-In Camp



NA-RM-180  
Electrical Hookup



NA-RL-190  
Corral



NA-RA-140  
Bus



NA-RS-110  
Dog Sledding



NA-RS-120  
Snow Tubbing



NA-RS-130  
Snowboarding

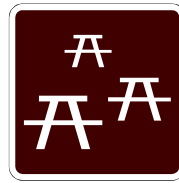


NA-RL-210  
Rollerblading

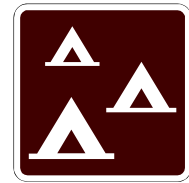
**Figure 2.** Category 2: New recreation and cultural use symbols not approved for maintenance level 3 and above roads, Forest Service restricted use only.



RM-200  
Motorhome



RM-210  
Group Picnicking



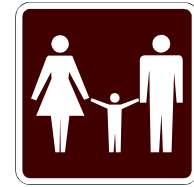
RM-210  
Group Camping



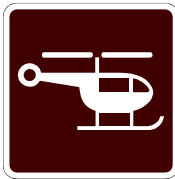
RG-240  
Dog



RG-260  
Seaplane



RA-150  
Family Restroom



RA-160N  
Helicopter



RL-170  
All-Terrain Vehicle



RL-190  
Archer



RL-210  
Hanglider



RW-160  
Fishing Pier



RW-170  
Hand Launch



RW-190  
Kayak



RW-210  
Wind Surf



RS-100  
Chairlift

**Figure 3.** Category 3: New recreation and cultural use symbols considered for general use approval by FHWA. Not currently approved for maintenance level 3 and above roads, Forest Service restricted use only.

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# Risky Business

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**Bill Renison**  
**North Zone Engineer**  
**Mt. Baker-Snoqualmie National Forest**

## The Forecast

It was the week following Thanksgiving, when an announcer on television gave a forecast: "A warm air front with considerable moisture is moving in from the Pacific. ...The storm will arrive by nightfall. ...Residents of Seattle and the Puget Sound area can expect from 4 to 6 inches of rain during the next few days. ...Due to heavy snowfall in the Cascades during the past 2 weeks, the Weather Service has issued flood advisories for all rivers..."

The above forecast is not a true quotation, but the scenario is typical for the Northwest between November and March, several times every year. The announcement acts as an alert to public officials who are responsible for roads, bridges, dams, levies, and other facilities. It describes a recipe for what is commonly referred to as a "rain-on-snow" event.

Precipitation along the west side of the Cascade Range ranges from 30 to 180 inches, annually. Generally, storms arrive in alternating weather patterns of rain and snow, depending on elevation, terrain, and local conditions. Sometimes there are long periods of rainfall of light to moderate intensity, allowing soils to reach saturation, followed by high-intensity rainfall. Other storms bring a heavy snowfall followed by clear skies and warm, dry air with high winds. Another type may consist of heavy rainfall combined with warmer air and wind on an existing snowpack. Each of these events will cause a unique hydrograph with respect to runoff within a river basin.<sup>1</sup>

## Forest Plans, Change, and Risks

The Mt. Baker-Snoqualmie National Forest (MBS) comprises 1.7 million acres and extends for 140 miles along the west flank of the Cascade Range between Mt. Rainier and the Canadian border (figure 1). It might be said that the MBS exists to lighten the burden of storms as they move eastward, providing sunny, dry conditions for forests on the east side. On the serious side, however, road and river systems on the forest are at risk.

During the 1980's, the MBS was actively involved in a timber program exceeding 300 million board feet. Recreation use was increasing in response to population growth in Seattle and the surrounding communities. The road system had expanded to include over 3,000 miles and 260 bridges with a value exceeding \$400 million.<sup>2</sup> Road reconstruction and maintenance were being accomplished by timber purchasers and Forest Service crews and contractors. The system was well maintained, structures were replaced at the end of their useful life, and improvements were made as warranted.

However, by the late 1980's, the timber program was declining in response to environmental concerns: spotted owl, marbled murrelet, deer, elk, mountain goats, grizzly bear habitat, and anadromous and resident

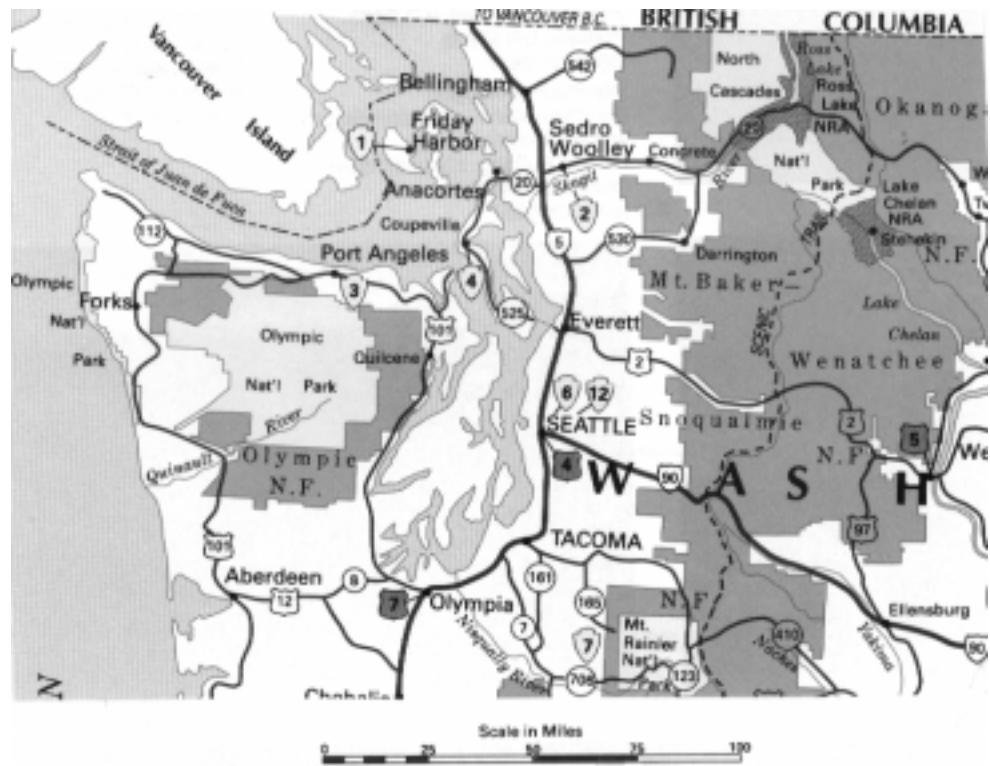


**Figure 1.** The Mt. Baker-Snoqualmie National Forest is situated east of Interstate 5 along the western slope of the Cascade Range.

fisheries, to list a few. Assessments were completed to determine the condition of all watersheds. A high percentage were found to be unacceptable. The forest plan, issued in June 1990, reduced the allowable harvest to less than half the prior volume.

In 1994, the Northwest forest plan<sup>3</sup> was published, and new land allocations were merged with the existing forest plan. The timber volume for the MBS was further reduced, eventually reaching its current level of 12 million board feet. The Northwest plan contained an aquatic conservation strategy that established guidelines for the restoration of watersheds. Special watershed restoration funding was created using numerous fund codes.

**Access and Travel Management**

For the most part, the MBS road system was built by and for the harvest of timber. The rapid decline in the harvest left the forest with a dilemma: A system too large and expensive to maintain without support from the timber program. The several million dollars a year that was being invested in reconstruction and maintenance by timber purchasers was no longer available. Yet, storms continued to arrive on schedule. There have been five major storms causing more than \$15 million in damage since 1989, most of which (\$12.7 million) qualified for funding by the Federal Highway Administration's Emergency Relief for Federally Owned Roads Program, which included the upgrading of drainage to meet the requirements of the Northwest plan (for example, a 100-year storm).

Between 1991 and 1994, the forest updated the access and travel management plan (ATM plan) to be consistent with the merged forest and Northwest plans. There was considerable public involvement because of high recreation use and the anticipated reduction in open roads.

**Unneeded Roads and Bridges**

As shown in table 1, the ATM plan identified 1,100 miles of road for level 0 or 1 status. Climatic conditions and steep terrain often preclude closing or abandoning roads without treatment. The obvious solution would be to decommission<sup>4</sup> these roads to eliminate maintenance cost and the chance for failure. During the past 7 years the MBS has decommissioned about 200 miles of road. Early unit costs varied between \$6,000 and \$40,000 per mile (average was about \$10,000). The wide variance in cost was associated with the size and number of culverts removed, the amount

**Table 1.** Mileage from the *revised* access and travel management plan

| Maintenance Level   | Miles                   |
|---------------------|-------------------------|
| 3,4,5               | 980                     |
| 2                   | 810                     |
| 1                   | 430 (storage)           |
| 0                   | 670 (unneeded—see note) |
| <b>Total (1994)</b> | <b>2,890</b>            |

Note: Level 0 in the ATM plan represented roads no longer needed for access.

of earthwork associated with restoring the roadway to its original contours, and with various techniques utilized for soil stabilization and revegetation. In general, subsequent monitoring did show a relationship between lower risk for failure and the higher unit cost—but that is only part of the story.

Decommissioning 1,100 miles at \$10,000 per mile would cost \$11 million, an amount far greater than the forest had expected to be available from the watershed restoration program for this work. Also, a maintenance backlog on the entire system was developing. It was becoming impossible to maintain all the level 2 roads listed on the ATM plan to an acceptable standard. The probability that some level 2 roads would be added to the 1,100 miles was increasing.

## Risk Assessment

The Forest Supervisor charted a team<sup>5</sup> in 1995 to resolve the dilemma. The team's charter was to determine which decommissioning techniques had been most effective in reducing road failures, then to develop and implement a process to determine which roads should receive full decommissioning, receive partial decommissioning (some level of treatment), or be closed without any treatment.

Full decommissioning (possibly obliteration<sup>6</sup>) would essentially eliminate the risk for failure. Partial treatment might include only a few work activities, such as installing waterbars or relief cross-ditching adjacent to culverts, or it might be more extensive with removing culverts and fill material at perennial stream crossings or at those with high cover, and pulling side-cast material back on the road at some locations. However, to reduce cost most of the road prism would remain intact. Revegetation would include only the application of sterile grass seed and straw mulch, thus relying on natural regeneration to complete the work (instead of more expensive techniques to accelerate revegetation).

The team developed a method for evaluating the 1,100 miles (a total of 1,365 roads). The result was a screening process to determine which roads presented the highest risk watershed quality, as displayed by the following relationship:

$$\text{Risk Rating} = \text{Potential for Failure} \times \text{Consequence of Failure}$$

The guidelines for determining the “potential” for road failure are shown in figure 2. The nine factors represented the most critical indicators for predicting failure on the MBS. A chart for selecting the “consequence” of failure is shown in figure 3. Because of limited time available for specialists<sup>7</sup> the assessment required use of data that were available for existing, easily acquired sources. With the exception of a few field visits to confirm some consequence ratings, the entire process was done in the office using maps, geographic information system (GIS) products, and existing inventories. The final assessment was reviewed in the field by a group including rangers, staff officers, and specialists. The group's findings confirmed that the assessment provided an adequate screening for potential road failures and their consequences.

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## Numerical Failure Potential Values

### **A Rain on Snow Zone (0 to 2)**

Location of the road and upslope area. Based on Washington State rain-on-snow zones. Rain-on-snow = 2; Rain or snow dominated = 1; Lowland & Highland = 0

### **B Geology and Soil Stability (0 to 5)**

Percent of road on unstable soils (SRI), highly eroded glacial, alluvial, recessional outwash deposits, etc. Under 10% = 0 ; 10–30% = 2; 31–50% = 3; Over 50% = 5.

### **C History of Failures (0 to 2)**

Road failures not permanently corrected. None = 0; Some = 1; Repeated = 2

### **D Major Stream Crossings (0 to 2)**

Number of major stream crossings with a culvert > 30" or with deep fills. None = 0; One crossing = 1; More than one = 2.

### **E Perennial Stream Crossings (0 to 2)**

Number of perennial stream crossings per 500 lineal feet of road. None = 0; One stream crossing = 1; More than one = 2

### **F Method of Construction (0 to 2)**

Construction utilized when built. Full bench = 0; Layer placement = 1; Sidecast = 2

### **G Average Sideslope**

Terrain sideslope for most of road. Under 40% = 0; 40–60% = 2; over 60% = 3

### **H Vegetative Cover (0 to 3)**

Percent of the area above the road segment having a timber stand age of over 35 years. Over 70% = 0; 50–70% = 1; 20–50% = 2; <20% = 3

### **I Road Stacking (0 to 3)**

Number of roads above, including switchbacks. None = 0; One road = 2; More = 3

**Figure 2.** Definition of the nine factors used to determine the potential for failure. These were found to be the most representative factors associated with failures, and the information was readily available from GIS, special maps, office records, and personnel memory. Note that some factors have a maximum value of 2, while others have a higher value possible. This was done to provide an overall weighting of factors.

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The database was created by extracting the road number and name, the mileage, and both the operational and objective maintenance levels from TMS for levels 0 and 1 (ATM plan = the objective level). This data file was transferred to a computer spreadsheet. Additional columns were added to the spreadsheet for displaying potential and consequence factors, the risk rating (calculated by the spreadsheet), and the notes recorded by the evaluators. After the numerical values were entered, the spreadsheet was sorted on the “risk rating” from high to low (figure 4). Figure 5 is the first page (1 of 4) of the assessment for the Darrington Ranger District. Figure 6 contains a chart created by the spreadsheet that displays the distribution of mileage and risk ratings.

| Numerical Consequence Values |                                  |         |           |         |         |         |
|------------------------------|----------------------------------|---------|-----------|---------|---------|---------|
| Distance<br>to Stream (ft)   | Average Sideslope Below the Road |         |           |         |         |         |
|                              | < 20%                            |         | 20 to 40% |         | > 40%   |         |
|                              | Interm.                          | Perenn. | Interm.   | Perenn. | Interm. | Perenn. |
| < 50                         | 1                                | 2       | 2         | 3       | 3       | 4       |
| 50–500                       | 1                                | 1       | 2         | 3       | 3       | 4       |
| 500–1,000                    | 1                                | 1       | 1         | 2       | 2       | 3       |
| 1,000–1,500                  | 1                                | 1       | 1         | 1       | 2       | 3       |
| >1,500                       | 1                                | 1       | 1         | 1       | 1       | 2       |

Notes: Where a stable bench exists that prevents material from reaching riparia, use value = 1. Intermittent and perennial refers to the stream that may be affected by a failure.

**Figure 3.** A numerical table for selecting a value for the consequence of failure. For example, a road with an average sideslope of 50 percent and located 1,200 feet from a perennial stream or valuable riparian habitat will have a consequence rating of 3.

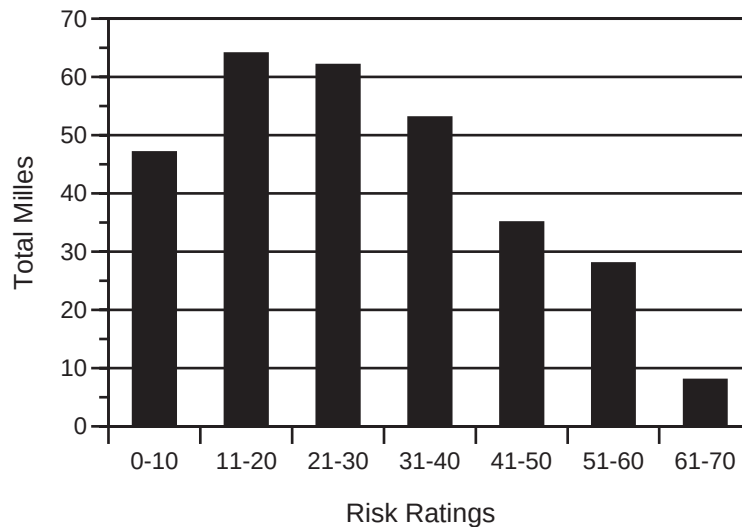
| Road No. | Potential for Failure (A-I) |   |   |   |   |   |   |   |   | Sum<br>(A-I) | Conseq.<br>of Failure | Risk<br>Rating |   |    |
|----------|-----------------------------|---|---|---|---|---|---|---|---|--------------|-----------------------|----------------|---|----|
|          | A                           | B | C | D | E | F | G | H | I |              |                       |                |   |    |
| 2560120  | 1                           | 2 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 5            | ×                     | 2              | = | 10 |
| 2250115  | 2                           | 3 | 1 | 1 | 1 | 2 | 3 | 1 | 0 | 14           | ×                     | 2              | = | 28 |
| 2250300  | 2                           | 3 | 2 | 1 | 1 | 1 | 0 | 0 | 1 | 11           | ×                     | 1              | = | 11 |
| 2620100  | 2                           | 1 | 2 | 0 | 2 | 1 | 3 | 2 | 0 | 13           | ×                     | 3              | = | 39 |

Sum of Numerical Values = Potential for Failure × Consequence (multiplier) = Risk Rating (0 to 96)

**Figure 4.** Example of a risk matrix table that combines the potential for failure with the consequence of failure. The result is subsequently sorted from high to low risk values. The highest risk roads will be given priority for field inventory to determine appropriate closure or decommissioning work activities.

| Road No. | Road Name   | Mile | Length | Oper. | Obj. | A | B | C | D | E | F | G | H | I | Sum (A-I) | Fail Cons. | Risk Rate | Notes                                                                                                                                                   | Sign Type |
|----------|-------------|------|--------|-------|------|---|---|---|---|---|---|---|---|---|-----------|------------|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|
| 1870000  | SEGEL       | 0.00 | 2.20   | 1     | 1    | 2 | 2 | 2 | 2 | 0 | 2 | 3 | 3 | 3 | 19        | 4          | 76        | Mine. Has been previously identified as a problem area. Needs review. Crosses Segelsen, PFB. Segelson is major crossing problem. Highly fractured rock. |           |
| 2083000  | PEEKABOO    | 0.00 | 3.20   | 2     | 1    | 2 | 4 | 1 | 2 | 0 | 2 | 3 | 2 | 1 | 17        | 4          | 68        | Needs review of problems. Drains to Peek-a-Boo, fish-bearing. Access to Peek-a-Boo Thin? Crosses risk soils, Brown and Peek-a-Boo (66)                  |           |
| 2435014  | 24 SPUR     | 0.00 | .40    | 2     | 0    | 1 | 4 | 1 | 1 | 0 | 2 | 3 | 2 | 3 | 17        | 4          | 68        | On Decline. Blow out near end of this road or 016? Adjacent to stream. Faulted highly fractured rock.                                                   |           |
| 2435016  | 25 SPUR     | 0.00 | .60    | 1     | 0    | 1 | 4 | 1 | 1 | 0 | 1 | 3 | 2 | 3 | 16        | 4          | 64        | On trib. to Decline. Stream crossing on fault. Highly fractured rock.                                                                                   |           |
| 2641000  | JUG CREEK   | 0.00 | 1.30   | 1     | 0    | 2 | 4 | 0 | 1 | 0 | 1 | 2 | 3 | 3 | 16        | 4          | 64        | Bad stream crossing.                                                                                                                                    |           |
| 2010000  | FRENCH CR   | 3.66 | 8.34   | 1     | 1    | 2 | 2 | 1 | 2 | 0 | 2 | 2 | 2 | 2 | 15        | 4          | 60        | Needs review. Some areas have rd. stacking on steeper hills. French Creek, PFB. French Thin access. (B--rate of "3" for first 1.5 miles)                |           |
| 2640000  | GRADE CR    | 3.70 | 1.10   | 2     | 0    | 2 | 4 | 0 | 2 | 0 | 0 | 2 | 2 | 3 | 15        | 4          | 60        | Grade Creek all adjacent. On major fault zone. On ??? soils over creek.                                                                                 |           |
| 2640000  | GRADE CR    | 4.80 | 5.40   | 1     | 0    | 2 | 4 | 1 | 2 | 0 | 2 | 2 | 2 | 0 | 15        | 4          | 60        | Grade Creek all adjacent. On major fault zone. Crosses 5 bad soil crossings.                                                                            |           |
| 4114011  | HAWK        | 0.00 | .20    | 1     | 0    | 1 | 3 | 0 | 2 | 0 | 1 | 3 | 3 | 2 | 15        | 4          | 60        | Fault, soils. (PC = 3)                                                                                                                                  |           |
| 4140000  | STIRRUP     | 1.00 | 1.70   | 1     | 1    | 2 | 5 | 1 | 1 | 0 | 1 | 2 | 1 | 2 | 15        | 4          | 60        | Needs review. Potential concern area. Possible bull trout below. After Jct. with 012, foliation strikes downslope right above soil 26.                  |           |
| 2084000  | DUTCH CR    | 0.00 | 1.80   | 2     | 1    | 2 | 4 | 2 | 2 | 0 | 2 | 3 | 1 | 2 | 18        | 3          | 54        | Needs review of problems. Drains to Dutch & Sauk, fish-bearing. Switchback rd. that crosses and parallels SRI soil unit 78.                             |           |
| 4100021  | 4100021     | 0.00 | 1.10   | 1     | 1    | 2 | 5 | 1 | 1 | 0 | 1 | 3 | 2 | 3 | 18        | 3          | 54        | Spoon road. Fault soils 358 & 18, 3 crossings.                                                                                                          |           |
| 2430000  | DECLINE     | 3.50 | 5.25   | 2     | 0    | 1 | 3 | 1 | 2 | 0 | 2 | 3 | 2 | 3 | 17        | 3          | 51        | Phyllite, highly fractured.                                                                                                                             |           |
| 2440000  | BLACKOAK    | 0.00 | 3.10   | 2     | 1    | 2 | 4 | 1 | 2 | 0 | 2 | 3 | 3 | 0 | 17        | 3          | 51        | Black Oak bridge. Drains to Black Oak & tribs to White Chuck, fish-bearing below. Blackoak and stream crossing are on fault contacts and 78, 66 soils   |           |
| 1891000  | VALLEY VIEW | 1.50 | 2.10   | 2     | 1    | 2 | 2 | 0 | 2 | 0 | 1 | 2 | 3 | 0 | 12        | 4          | 48        | Thinning access. Crosses several fish-bearing tribs to NF Silly (tribs are fish-bearing near confluence). Potential aquatic impacts. Pull crossing.     |           |
| 1891000  | VALLEY VIEW | 3.60 | .59    | 2     | 1    | 2 | 2 | 0 | 2 | 0 | 1 | 2 | 3 | 0 | 12        | 4          | 48        | Thinning access. Crosses several fish-bearing tribs to NF Silly (tribs are fish-bearing near confluence). Potential aquatic impacts. Pull crossing.     |           |

**Figure 5.** Page 1 of the completed risk matrix listing for the Darrington Ranger District. The spreadsheet was sorted by the final rating (numerical value for risk ranging from 3 to 76). Forest-wide, 1,365 roads totaling 1,100 miles were evaluated.



Note: A total of 296 miles was rated. Other districts have a similar distribution.

**Figure 6.** Distribution of mileage and risk ratings for the Darrington Ranger District.

After ratings were completed for all five districts, the forest leadership team set the following guidelines for establishing work priority:

| Risk Rating  | Recommendation                                                                                                                  |
|--------------|---------------------------------------------------------------------------------------------------------------------------------|
| Highest 1/3  | Perform field reconnaissance and prescribe appropriate closure or decommissioning work activities; survey and design as needed. |
| Middle Group | Begin work on these roads after completing the higher risk group.                                                               |
| Rating < 15  | No treatment planned; close and allow to revegetate naturally.                                                                  |

## Funding and Priorities

Why not fully decommission all 1,100 miles to eliminate the risk of failure by using road maintenance funding; or, why not use all available restoration funding for this work? These questions were addressed by the team during the analysis of the situation and with the public during the ATM planning meetings. The answers to both questions concern priority and available funding.

About 75 percent of the current road maintenance funding is allocated to slide removal, slump repair, windfall removal, roadside brushing, and the cleaning, repair, and replacement of culverts. With approximately 40,000 culverts on the system, keeping the drainage functional requires continuous attention. Roadside brushing is a high-cost item that should be done every 2 or 3 years for sight distance. If not done within 5 to 10 years, the road becomes impassable and maintenance equipment cannot be used for drainage work. Diverting funds from this effort to decommissioning would cause serious problems.

The remaining 25 percent of maintenance funding is judiciously spent on bridge maintenance, road grading, spot rocking, signing, and pavement patching on roads with the highest recreation use.

Watershed restoration funding has been available since the Northwest plan was completed. Although 50 percent of the funding has been authorized for decommissioning, the forest has chosen to spend only an average of 20 percent each year. The reason, again, is setting priorities based on a holistic view of watershed conditions and selecting projects that will have the highest benefit-to-cost ratio.

The majority of restoration projects have been either instream improvements for fish habitat, correction of fish passage problems at road crossings, or upgrading of sites along roads with a history of failures and severe consequences<sup>8</sup>. For example, concrete fords have been effective at major stream crossings where debris flows had repeatedly destroyed culverts and fill. Rock deflectors (spurs) have prevented road failures where roads lie adjacent to streams. Figures 7 through 11 provide examples of several storm damage sites on level 3, 4, and 5 roads where subsequent upgrading has greatly reduced the chance for road loss and sediment in streams. These figures demonstrate that there are storm prevention needs on the entire road system and available funding is allocated based on overall risk.

As shown in figures 7–9, most of the primary access roads within the forest are located on the floors of canyons and adjacent to major streams. A major portion of repair, restoration, and prevention work is associated with primary routes. Figure 10 provides examples of the challenges of providing cross drainage for major streams due to high energy and debris flow. The forest has approximately 35 concrete fords that have proven effective in reducing debris on the surface and damage at the outlet (figure 11).



**Figure 7.** *Suiattle River scours about a quarter mile of road.*



**Figure 8.** *Bedal Creek flows over the top of a bridge.*

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**Figure 9.** *Canyon Creek skirts around a 100-foot bridge, removing the entire approach.*

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**Figure 10.** *Providing cross drainage for major streams is a challenge due to high energy and debris flow.*

## Summary

It is now estimated that about one-half of the 1,100 miles will be treated for some level of storm protection before closure. Figures 12–14 are examples of the 1,100 miles of level 0 and 1 roads that have been evaluated for risk. These show typical failures on level 0 and 1 roads, a road closing naturally, and a road with full decommissioning treatment. Roads having the highest risk will be done first and will probably have the highest unit cost. But, instead of an average cost of \$10,000 per mile, the expected average will be closer to \$2,000. Obviously, the risk of failures will be far higher, but it is planned risk—a strategy to balance the highest needs with available dollars.

As quoted from the Northwest plan, “The decision to apply a given treatment depends on the value and sensitivity of downstream uses, transportation needs, social expectations, assessment of probable outcomes for success at correcting problems, costs, and other factors.” Perhaps what the authors of the plan meant by “and other factors” was “and available funding”?

The forest and its informed public have accepted the reality that the future MBS road system will have fewer miles and will access fewer acres. Watershed quality will continue to be at risk for a period of time. The road system will, however, continue to serve multiple access needs and will become more resistant to storms off the Pacific.



**Figure 11.** A ford follows a storm, with debris on the surface and minor damage at the outlet (upper-right photo). Subsequent designs include large riprap at the outfall as an energy dissipator (lower-left photo).



**Figure 12.** Slumping and side-cast failures are typical along hundreds of miles of local road on the forest.



**Figure 13.** A low-risk road is being closed naturally by vegetation and windfalls.

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**Figure 14.** A decommissioned road has been seeded and mulched with straw.

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## Endnotes

1. The term “rain-on-snow” is used locally to describe several different weather patterns involving rain on a snowpack. Although the rain does have the ability to melt snow, the rapid melting of a snowpack is more dependent on warm air, strong winds, and high humidity—heat of condensation at 596 calories per gram vs. heat of fusion at 80 calories per gram (Linsley and Franzini, *Water Resources Engineering*).
2. Estimated from recent average MBS cost of \$120,000 per mile for new road and \$150,000 per bridge.
3. The Northwest forest plan contains land allocations and guidelines for national forest and Bureau of Land Management lands within the range of the northern spotted owl (Washington, Oregon, and California).
4. Full decommissioning, as defined in the Northwest plan, is closing and stabilizing a road to eliminate potential for storm damage and the need for maintenance.
5. Team coleaders: Bob Hulet, civil engineer, and Gary Ketcheson, hydrologist. Team members: Marilyn Johnson, civil engineering technician; Allison Warner, soil scientist; Laura Potash, botanist; John Gier, hydrologist; Bill Renison, civil engineer; and Kathe Tillman, civil engineering technician. All districts provided additional specialists for implementation of the risk assessment.
6. An obliterated road (R-6 Supplement FSH 7709.55-98-1) is no longer suitable for travel, drainage is not in need of further attention, vegetation cover is complete or will be within 10 years (per section 8 of the National Forest Management Act of 1976), and the roadway has been returned to resource management purposes.
7. The MBS has reduced its staffing levels by more than half since 1989 because of the reduction in the timber program. Ratings were done by district teams with one or more of the following specialists: hydrologist, engineer, soil scientist, geologist, fisheries biologist.
8. The Northwest plan defines road upgrading as “work on open roads such as removing soil from locations where there is a high potential of triggering landslides, modifying road drainage systems to reduce the extent to which the road functions as an extension of the stream network, and reconstructing stream crossings to reduce the risk and consequences of road failure or washing out at the crossings.”

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## Bibliography of Washington Office Engineering and Detached Units' Publications

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This bibliography contains information on publications produced by the Washington Office Engineering staff and its detached units. Arranged by series, the list includes the title, author or source, document number, and date of publication.

This issue lists material published since our last bibliography (*Engineering Field Notes*, Volume 29, September-December 1997). Copies of *Engineering Field Notes*, *Technology & Development News*, and most Engineering Management Series documents can be obtained from the Washington Office Engineering staff. Copies of *Tech Tips*, project reports, and special and other reports can be obtained from the technology and development center listed as the source.

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Missoula, Montana 59801  
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## Engineering Field Notes (EFN)

This publication, which is published every 4 months, provides a forum for the exchange of information among Forest Service personnel. It contains the latest technical and administrative engineering information and ideas related to forestry.

### EFN by Title

|                                                                                                                         |                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1997 <i>Engineering Field Notes</i><br>Articles Awards                                                                  | Editor. EFN 30<br>(January–April 1998): 1–4                                                                                                                                                                                                 |
| 1998 Forest Service Engineers<br>of the Year                                                                            | Editor. EFN 30<br>(January–April 1998): 5–17                                                                                                                                                                                                |
| Application of Methods for Estimating<br>the Bearing Capacity of Spread<br>Footings in Bridge Approach Fills            | McClelland, Douglas E. EFN 30<br>(May–August 1998): 23–25                                                                                                                                                                                   |
| Cadastral Boundary Survey Using Global<br>Positioning System Equipment                                                  | Hildebrand, Rocky. EFN 30<br>(January–April 1998): 9–25                                                                                                                                                                                     |
| Coconino National Forest Bridge<br>Inspection and Maintenance Trailer                                                   | Powell, Robert H. EFN 30<br>(May–August 1998): 1–6                                                                                                                                                                                          |
| Funding Energy Conservation Projects:<br>An Overview                                                                    | Oravetz, Steve. EFN 30<br>(May–August 1998): 37–41                                                                                                                                                                                          |
| GIS Data Collection Project                                                                                             | Sutton, Frank. EFN 30<br>(January–April 1998): 27–34                                                                                                                                                                                        |
| New and Revised Federal Recreation<br>Symbols                                                                           | Cammack, Fred. EFN 30<br>(September–December 1998):<br>3–6                                                                                                                                                                                  |
| Relative Effects of Landslides Resulting<br>from Episodic Storms on a Low-Volume<br>Road System in Northern Idaho (The) | McClelland, Douglas E.;<br>Fultz, Dr. Randy B.;<br>Falter, Dr. C Michael;<br>Wilson, W. Dale;<br>Cundy, Dr. Terrance;<br>Schuster, Dr. Robert L.;<br>Saubier, Jim;<br>Rabe, Craig; and<br>Heinemann, Rob. EFN 30<br>(May–August 1998): 7–22 |
| Risky Business                                                                                                          | Renison, Bill. EFN 30<br>(September–December 1998):<br>7–18                                                                                                                                                                                 |

### EFN by Author

|                                                            |                                                       |
|------------------------------------------------------------|-------------------------------------------------------|
| Cammack, Fred, EFN 30<br>(September–December 1998):<br>3–6 | New and Revised Federal Recreation<br>Symbols         |
| Editor. EFN 30<br>(January–April 1998): 1–4                | 1997 <i>Engineering Field Notes</i> Article<br>Awards |

|                                                                                                                                                                                                                                             |                                                                                                                               |
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| Editor. EFN 30<br>(January–April 1998): 5–17                                                                                                                                                                                                | 1998 Forest Service Engineers<br>of the Year                                                                                  |
| Hildebrand, Rocky. EFN 30<br>(January–April 1998): 9–25                                                                                                                                                                                     | Cadastral Boundary Survey Using<br>Global Positioning System Equipment                                                        |
| McClelland, Douglas E. EFN 30<br>(May–August 1998): 23–25                                                                                                                                                                                   | Application of Method for Estimating<br>the Bearing Capacity of Spread Foot-<br>ings in Bridge Approach Fills                 |
| McClelland, Douglas E.<br>Fultz, Dr. Randy B.;<br>Falter, Dr. C. Michael;<br>Wilson, W. Dale;<br>Cundy, Dr. Terrance;<br>Schuster, Dr. Robert L.;<br>Saubier, Jim;<br>Rabe, Craig; and<br>Heinemann, Rob. EFN 30<br>(May–August 1998): 7–22 | Relative Effects of Landslides Result-<br>ing From Episodic Storms on a Low-<br>Volume Road System in Northern<br>Idaho (The) |
| Oravetz, Steve. EFN 30<br>(May–August 1998): 37–41                                                                                                                                                                                          | Funding Energy Conservation Projects:<br>An Overview                                                                          |
| Powell, Robert H. EFN 30<br>(May–August 1998): 1–6                                                                                                                                                                                          | Coconino National Forest Bridge<br>Inspection and Maintenance Trailer                                                         |
| Renison, Bill. EFN 30<br>(September–December 1998):<br>7–18                                                                                                                                                                                 | Risky Business                                                                                                                |
| Sutton, Frank. EFN 30<br>(January–April 1998): 27–34                                                                                                                                                                                        | GIS Data Collection Project                                                                                                   |

## Technology & Development News

*Technology & Development News* contains information on specific projects, ideas, and technologies being developed by the technology and development centers to help solve many resource management problems.

| <b>Title</b>                                                  | <b>Issue</b>           |
|---------------------------------------------------------------|------------------------|
| Aerial Spray Model A Optimization                             | July–August 1998       |
| Approved Refrigerant Replacement                              | July–August 1998       |
| Automated Root Pruning                                        | January–February 1998  |
| GIS Data Collection Project                                   | May–June 1998          |
| Bridge and Major Culvert Design                               | May–June 1998          |
| (The) Continuing Search for Alternatives<br>to Methyl Bromide | January–February 1998  |
| Controlling Downhill Water Pressure<br>in Hose Lays           | March–April 1998       |
| Cruising Timber With Voice Data Recorders                     | September–October 1998 |

|                                                                |                        |
|----------------------------------------------------------------|------------------------|
| Digital Tallymeter                                             | September–October 1998 |
| Dust Abatement and Asphalt Seal Coat Publications              | January–February 1998  |
| Estimating Log Weights                                         | March–April 1998       |
| FS Composite Trail Bridge Study                                | March–April 1998       |
| Harrisonburg Spray Aircraft Navigation Final Report            | September–October 1998 |
| Harvesting Systems: Tools for Resource Management (Video)      | September–October 1998 |
| Measuring Stem Diameters                                       | March–April 1998       |
| Mountain Bike Accessories for Trail Work                       | May–June 1998          |
| MTDC Gets a Look at the New Military GPS Receiver              | September–October 1998 |
| National Wildfire Suppression Technology Unit Merges With MTDC | September–October 1998 |
| New Personnel                                                  | January–February 1998  |
| Nonchemical Seed Tree Orchard Sanitation                       | March–April 1998       |
| Nozzle Placement Spray Aircraft                                | May–June 1998          |
| Pedestrian Trail Bridge Catalog Project                        | March–April 1998       |
| Personnel Change in Specifications                             | July–August 1998       |
| Photovoltaic Power for Water Systems                           | March–April 1998       |
| Powered Guns for Tree Marking Paint                            | March–April 1998       |
| Prototype “Water Clean-Up” Tree Marking Paint                  | March–April 1998       |
| Quench the Thirst of Type 1 Helicopters                        | July–August 1998       |
| Rangefinder Comparison                                         | September–October 1998 |
| Rockwell P(Y) Code GPS Receiver Availability                   | July–August 1998       |
| Scaling Frequency Cards                                        | September–October 1998 |
| Signposts for Snow Trails                                      | May–June 1998          |
| Standardized Retardant Mixing System                           | March–April 1998       |
| Surviving Fire Entrapments                                     | January–February 1998  |
| Sustainable Resources                                          | May–June 1998          |
| Tree Girdling <i>Tech Tip</i>                                  | July–August 1998       |
| VALDRIFT—An Atmospheric Dispersion Model                       | March–April 1998       |
| Video—Handtools for Trail Work                                 | May–June 1998          |
| Video—Surviving Fire Entrapment                                | May–June 1998          |
| Water/Road Interaction Software Applications                   | January–February 1998  |

## Engineering Management Series and Other Publications

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| <b>Title</b>                                                                                                                        | <b>Number</b>   |
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| Asphalt Self-Study Training Course: Construction<br>Certification Program (Revised August 1998)                                     | EM 7115-507-100 |
| Implementation of Remote Sensing for Ecosystem<br>Management (October 1998)                                                         | EM 7140-28      |
| Roads Self-Study Training Course: Construction<br>Certification Program (Revised August 1998)                                       | EM 7115-501-100 |
| Sign and Poster Guidelines for the Forest Service<br>(Revised August 1998)                                                          | EM 7100-15      |

## Tech Tips

*Tech Tips* are brief descriptions of new equipment, techniques, materials, or operating procedures.

| <b>Title</b>                                                                            | <b>Source</b> | <b>Number</b> | <b>Date</b> |
|-----------------------------------------------------------------------------------------|---------------|---------------|-------------|
| Commissioning Existing Buildings                                                        | MTDC          | 9871-2301     | 2/98        |
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| Digital Tallymeter                                                                      | SDTC          | 9824-1313     | 10/98       |
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| Graffiti Removers                                                                       | SDTC          | 9823-1302     | 4/98        |
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| Low-Cost Tools for Skyline Corridor<br>Location and Simple Point-to-Point<br>Navigation | SDTC          | 9824-1306     | 6/98        |
| New Aerosol Can Puncturer for Tree<br>Marking Paint                                     | SDTC          | 9824-1309     | 6/98        |
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## Project, Special, and Other Reports

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Project Reports are detailed reports that generally include procedures, techniques, systems of measurement, results, analysis, special circumstances, conclusions, and the rationale for recommendations.

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## Special and Other Reports

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# Engineering Field Notes

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