

Spring 2008

# WSA *Currents* & **PROFILES**

INFORMATION WITHIN REACH

## *Welcome*

to the spring issue of "Currents & Profiles," the National Watershed, Soil, and Air (WSA) Technology and Development Centers' news and notes to the field. "Currents & Profiles" updates the watershed community on the progress of our projects and newly available publications.

This issue provides information on projects the steering committee selected for study in 2009. It also includes the following topics:

- **HIGHLIGHTS – NEW PROJECTS FOR 2009**
- **CURRENT PROJECTS – UPDATES**
- **NEWS FROM THE WSA T&D STEERING COMMITTEE**
- **PUBLICATIONS AND TRAINING AIDS**
- **LINKS OF INTEREST**
- **STEERING COMMITTEE MEMBERS AND WSA T&D STAFF**

## *Mission Statement*

To systematically apply scientific knowledge and advanced technology to create new or substantially improved equipment, systems, materials, processes, techniques, and procedures to meet the challenges and objectives of sustainable forest ecosystems management.



Watershed, Soil, and Air Technology & Development Program  
0825 1810—SDTDC

## • HIGHLIGHTS - NEW PROJECTS FOR 2009

The WSA steering committee and T&D staff met April 8-10, 2008, to review current project status and to prioritize and select new projects for 2009. A total of 26 project proposals were submitted, covering a broad range of soil, water, and air subjects. Proposals are posted at <http://sdtcd.wo.fs.fed.us/programs/wsa/wsaproposals.shtml>.

The committee sent several projects to other steering committees (Remote Sensing Applications, Engineering, Fire, and Health and Safety) for their consideration and set others aside because they dealt with issues similar to previous projects. Proponents whose projects were not selected can contact their regional WSA steering committee member to discuss the reasons why their projects were not selected and any follow up. Where possible, they will share relevant information that is already available.

One project that was about washing fire equipment to avoid spreading aquatic invasive species was not selected but the committee recognized the topic's critical importance. To highlight the issue for the Forest Service watershed community, Mike Ielmani, National Invasive Species Program Coordinator, offers some updates, recommendations, and Web links in this issue of *Currents & Profiles* (see "News from the WSA T&D Steering Committee" and "Publications and Training Aids").

Two proposals requested T&D find or develop moderate-to-low cost fish screens for diversions on small streams. Both proposals aim to provide reasonably effective protection for adult and juvenile fish from entrainment in diversion ditches.

One proponent focused on situations where there are no legal or agency requirements for fish protection, but where a diversion manager may be willing to screen voluntarily if installation and maintenance are simple and cost effective.

The other proposal suggested producing a new screen to be used with an intake located away from stream margins where most young-of-the-year fish are found. This topic will be folded into the existing diversion project. The first task will be to review recent developments in fish screening to see to what degree these objectives may have already been met.

Below is a list of projects selected for FY 2009; T&D staff will scope these topics by September. In September, the steering committee will review work-plan options for each of these projects along with approximate costs. At that time, the committee will make a final decision on project priorities.

### **Biomass/Whole-Tree Harvesting, Soil Impacts, and Measurement Methods**

*Proposed by: Jim Gries (Region 9, Hiawatha NF)*

Utilization of down woody material—resulting from timber harvest and other land management activities—as a source of biomass fuels is a rapidly emerging issue throughout the United States. The importance of this issue has increased dramatically in scope over the past year. There are many valid reasons to harvest this material. It can potentially be used as an energy source to meet the nation's needs and provide needed industrial compounds. Second, in some locations this down fuel is a fire hazard, which is difficult to manage with prescribed burning techniques either because of short burning windows, lack of funding and personnel, or it is in the wildland urban interface. Third, it is another potential source of revenue for the local logging industry and may make some economically unfeasible sales profitable, allowing the forest to improve stand conditions, enhance forest health, and provide other ecological benefits. Lastly, in some situations we are currently paying to have some of this material removed, piled, burned, or chopped and these techniques would further minimize our reliance on appropriated funds to meet management objectives.



Even when removal of this material is otherwise environmentally appropriate, there is concern that removal may have negative impacts to long-term soil productivity. Although some studies have documented that full-tree harvest and biomass removal is detrimental to some sites, it is not clearly established how much material can be removed before negative impacts occur. There have been mixed findings on this issue on the Long Term Soil Productivity Web sites and other published literature. Further, even if some removal could occur without significant impacts, it is not clear how this could be measured during operations. It has been suggested to use some of the visual guides for estimating fuel loads. This has applicability but before it can be effectively implemented some estimate of the amount of down material that needs to be left must first be determined.

Project objectives:

1. Develop tools to help determine the amount of down material needed to maintain or enhance long-term soil productivity.
2. Identify method to describe/designate the amount of material to be left in a timber sale contract or similar contract.
3. Identify practical monitoring methods, measures, and tools that can be used in the field to determine the amount of down material to be retained or removed on treated areas.

For more information on this project contact Carolyn Napper at SDTDC.

### **Training for National BMP Monitoring Program**

*Proposed by: Sherry Hazelhurst (WO)*

A Best Management Practices (BMP) program is being developed by a team of specialists from forests, regional offices, and the WO. It includes two components: (1) a set of Forest Service BMPs, and (2) a monitoring program to document the implementation and effectiveness of the BMPs. A team is currently working to develop/refine sampling protocols and associated reporting forms for each set of BMPs. There are 10 sets, which include the major categories of Forest Service management activities, e.g., forest harvest and regeneration; grazing; fire; recreation; roads and trails; facilities; etc. The BMP monitoring program is being tested as it is developed and is planned to be implemented throughout the Forest Service in 2010. Software for an associated field data recorder system for the monitoring forms is a project currently in development by SDTDC. Data collected will be stored in a corporate data system. Technology training and transfer will be an essential element of this program in order to successfully implement the protocols nationally over a sustained period of time.

Project objectives:

1. Develop a comprehensive set of curricula, training manuals, and other media for each of the 10 BMP monitoring modules (both train-the-trainer and student; for in-person and electronic venues).
2. Produce an interactive Internet and CD/DVD-based training application for each of the BMP modules (introduction and refresher segments possible; multimedia formats).
3. Develop a testing program or practicum to evaluate student understanding.
4. Participate as trainers for at least the first round of training.



**Training Curriculum for Potential Users of the National Soil Quality Monitoring Field Guide**

*Proposed by: Steve Howes (Region 6)*

This is the final phase of a 3-phase program to develop a standard, scientifically defensible, and easily implemented soil disturbance assessment protocol for the Forest Service. Phase I, a 2005 Inventory and Monitoring T&D project to collect photographs and publish a soil quality monitoring field guide containing schematic and photographic examples of defined, visually identifiable, soil disturbance categories is nearing completion (visit the following Web page for more information on Phase I). [http://fsweb.sdtcd.wo.fs.fed.us/programs/im/soil\\_field\\_guide/soil\\_field\\_guide.shtml](http://fsweb.sdtcd.wo.fs.fed.us/programs/im/soil_field_guide/soil_field_guide.shtml)

Phase II developed sampling protocols and other analysis tools for conducting rapid, accurate, and consistent pre- and post-project assessments of soil quality. A standard protocol (or set of protocols) for monitoring soil quality, guiding project design, and determining sampling intensity is available to be used in conjunction with the soil field guide.

This proposal addresses Phase III and provides for the development of a training curriculum to ensure that soil scientists, timber sale administrators, silviculturists, fuel specialists, and others conduct reliable and repeatable assessments of soil disturbance for use in project planning and environmental analyses.

**Project Objectives:**

The proposed project would involve the development of a training curriculum and task book, which will ensure soil quality is maintained or improved as we implement ground disturbing projects. Components of the curriculum development include:

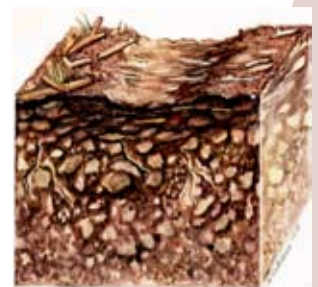
- 2-day training course on how to evaluate soil conditions including use of the soil resource inventory, risk assessment categories, stratifying the survey area, and collecting and describing soil conditions using standardized data collection forms (R-1 /RMRS).

- Preparation of standardized course – training materials for use throughout every region and allowing region-specific references to be added as needed.
- Preparations of “task book” to ensure participants have mastered key elements of the training and are consistent in their evaluation of soil conditions.
- Development of Web site for project including reference material, example monitoring documents, and training material for collecting and analyzing data linked to ecoregions.

For suggestions, comments, or recommendations on this project contact Carolyn Napper at [cnapper@fs.fed.us](mailto:cnapper@fs.fed.us).



*Class 0 - Undisturbed soil.*



*Class 1 - Disturbed soil.*



*Class 2 - Disturbed soil.*



*Class 3 - Disturbed soil.*

**Low-Cost Fish Screens at Irrigation Diversions**

*Proposed by: Mark Weinhold (Region 2, White River NF) and Robert H. Deibel (WO)*

Two proposals requested T&D find or develop moderate-to-low cost fish screens for diversion on small streams. Both proposals aim to provide reasonably effective protection for adult and juvenile fish from entrainment in diversion ditches. One proponent focused on situations where there are no legal or agency requirements for fish protection, but where an irrigator may be willing



to screen voluntarily if installation and maintenance are simple and cheap enough. The other proposal suggested producing a new screen to be used with an intake located away from stream margins where most young-of-the-year fish are found.

This topic will be folded into the existing diversion project. The first task will be to review recent developments in fish screening to see to what degree these objectives may have already been met.

**Sampling Streams and Lakes for Chemical Analysis**

*Proposed by: Cindy Huber (Region 8, George Washington and Jefferson NFs)*

This proposal is for a training video on the Air Quality Program’s water chemistry sampling procedures. The Air Program uses water chemistry monitoring as an indicator of pollution effects in wilderness and other areas. The video will reduce training costs. It is also expected to improve sampling consistency and accuracy by making a Web-based, on-demand video available for samplers’ annual refresher training.

Script writing for this video is already underway at the Missoula T&D Center. Filming and editing are planned for this summer. The video should be available on the Web in flash video format by December of this year. For more information about the project, contact project leader Mary Ann Davies at (406) 329-3981, or mdavies@fs.fed.us.

**Water Level Data Logger Upgrade**

*Proposed by: Bob Kenworthy (Region 4)*

A proposal to upgrade the AquaRod (see Currents & Profiles, Spring 2007) was selected, although it was given the lowest priority and may not be reached depending on funding. The project’s objective is to upgrade the AquaRod’s data transmission/download capability to avoid the need to download to a laptop or PDA, to permit data transfer without removing or resetting the instrument, and to retain settings when batteries are changed. The instrument should cost no more than \$500. The proposal cites recent in-stream flow

agreements that are expected to generate a wider need in the near future to install flow measurement devices in many diversion ditches on National Forest System lands in Idaho. Current demands on surface water throughout the west suggest that the need for measurement of ditch flows will continue to expand in the future.

• **CURRENT PROJECTS – UPDATE**

**Development of Science-Based Winter Guidelines for Mechanical and Fuels Treatment Operations**

*Proposed by: John Townsley, Randy Tepler, and Brad Flatten (Region 6)*

Several forests responded to our outreach for information on existing methods to measure and determine winter guidelines for mechanical operations. This field season we will work with Rocky Mountain Research Station and the following forests to assess appropriate winter logging conditions.

- Okanogan-Wenatchee National Forest  
Washington (R-6)
- Idaho Panhandle National Forest  
Idaho (R-1)
- Chequamegon-Nicolet National Forest  
Wisconsin (R-9)
- Hiawatha National Forest  
Michigan (R-9)

Study objectives include:

1. Identify and test robust indicators of soil conditions including frozen ground and snow conditions that are suitable for winter logging by measuring the following:
  - Soil temperature.
  - Soil moisture.
  - Air temperature.
  - Surface ground temperature.
2. Correlate the above indicators of frozen soil, snow, and air and ground temperature with mechanical operations (size and type of equipment, volume removed, number of passes).





3. Provide a low-cost, quantifiable technique for determining when ground conditions are suitable to support winter logging without detrimental impacts to the soil resource that can be used nationally.

The draft Northern Region Soil Monitoring Protocol and the Soil Disturbance Field Guide will be used to identify soil conditions on the winter logging test sites before and after logging to determine if soil guidelines have been met. A training overview on how to use these two tools will be conducted in Regions 6 and 9 prior to gathering soil condition information. Soil scientists or other resource specialists interested in participating should contact Carolyn Napper at [cnapper@fs.fed.us](mailto:cnapper@fs.fed.us) for time and location information.

Field data collection is scheduled for the week of August 6-13 at the Wenatchee-Okanogan and Idaho Panhandle National Forests, and week of September 15 for the Chequamegon-Nicolet and Hiawatha National Forests.



Figure 5. Winter log 1 - Treatment unit identified for winter logging (Okanogan NF).



Figure 6. Winter log 2 - PVC pipe with soil temperature probe is buried within the unit to determine soil temperature.



Figure 7. Winter log 3 - Simple tool to measure depth of frozen soil (Hiawatha NF).

For further information about this project, contact SDTDC project leader Carolyn Napper at (909)-599-1267, ext 229, or [cnapper@fs.fed.us](mailto:cnapper@fs.fed.us).

### Software Application for BMP Monitoring Field Data Recorder

Proposed by: Sherry Hazelhurst and Rick Henderson (WO)

The National office is working with a small cadre to finalize the National BMP handbook and to develop the BMP monitoring questions and protocol. As this work proceeds, SDTDC is working to determine which electronic data recorders are commonly used and what recorders would best meet both district and national monitoring needs.

This spring we mailed a short questionnaire to solicit information on software and hardware. Over 50 survey replies were received regarding the type of hardware and software hydrologists use most in the field. The responses indicate that most hydrologists don't use any type of electronic data recorder for field work. However, for those that did use a recorder, the Trimble was the most popular.





Figure 8. BMP 1- Recording data on a field form.



Figure 10. BMP 3 - Tablets may be the wave of the future for data collection.



Figure 9. BMP 2- PDA used to collect data.

Currently, SDTDC is working to develop software that would work with a variety of tools (paper data forms to tablets) so that as the BMP monitoring questions are completed, they can be formatted for electronic storage and analysis in corporate databases. At this time, no corporate database exists for BMP monitoring, but we hope to be able to build the necessary links so national BMP monitoring can be standardized with similar forms and protocols.

For further project information, contact SDTDC project leader Carolyn Napper by phone (909) 599-1267, ext 229, or [cnapper@fs.fed.us](mailto:cnapper@fs.fed.us).

**Forest Roads Best Management Practices: Bibliography and Synthesis of Research on Effectiveness**

*Proposed by: Carolyn Napper, SDTDC*

The goal of this project is to produce a comprehensive technical reference on the effectiveness of Forest Service national BMPs for limiting erosion on forest roads and protecting water quality. A previous project made a good start on the bibliography, and it will be completed during this project. We are investigating the possibility of working with the Environmental Protection Agency, which has a similar—although not identical—effort on-going.



This winter, we worked with Pam Edwards of the NE Research Station to write a prospectus that will guide development of the literature synthesis. Literature syntheses are notoriously difficult to write, because the author needs to be thoroughly familiar with the full breadth of the literature on the subject. The author must be able to integrate results from disparate studies into a coherent well-supported picture of what we know and what we don't know about effectiveness. Finding such a person with the time to devote to the project is a challenge, and we are currently seeking the requisite funding. For more information, see the project Web site at [http://fsweb.sdtc.wo.fs.fed.us/programs/wsa/watqual/bmp\\_eff.htm](http://fsweb.sdtc.wo.fs.fed.us/programs/wsa/watqual/bmp_eff.htm).

### **Water Diversion Control Structures**

*Proposed by Dave Gloss, Medicine Bow NF (Region 2)*

The Diversion Field Guide will assist irrigators and special uses evaluate and plan upgrades to surface water diversion facilities based on stream and site characteristics.

Until recently funding limited progress on the field guide this year. Neither NRCS nor FWS were able to enter into a partnership, in spite of great interest by some of their field units in the project. T&D is currently extending the existing contract to cover finishing the rough draft and finalizing the guide.

The diversion control system for variable in-stream flows phase project objective is to find or develop systems capable of maintaining various in-stream flows in the main channel. Water districts are beginning to use automated diversion control systems where headgates are remotely controlled by managers relying on telemetered data from on-site sensors (see [www.sevierriver.org/faq/t1.html](http://www.sevierriver.org/faq/t1.html)). We are in discussions with Bureau of Reclamation hydraulic engineers, who assist water districts with these systems, to assess the effort that would be needed to develop them to meet our objectives. At a minimum, we anticipate putting together a tech tip describing the suite of sensors, data loggers, solar power and communications equipment, and gate actuators that make up the current systems.

### **Smoke Monitoring Training Aid**

*Proposed by Pete Lahm, WO Fire*

A Flash Media training video on how to use the E-BAM (Environmental Beta-Attenuation Monitor) smoke monitor to determine particulate concentrations in the air is nearing completion and should be available on the Web in June. Check MTDC's publications Web site at <http://fsweb.mtdc.wo.fs.fed.us/search/>, search the Watershed, Soil and Air program area for a list of products, including the DataRam4 training video.



*Figure 11. The E-BAM smoke particulate monitor.*

For further project information, contact MTDC project leader Mary Ann Davies by phone at (406) 329-3981 or [mdavies@fs.fed.us](mailto:mdavies@fs.fed.us).





**DataRam Tripod Mount Enclosure**

*Proposed by: Trent Wickman, Superior NF (Region 9)*

Many air-quality specialists use the DataRam to monitor smoke concentrations. The DataRam is not weatherproof, nor does it come with a tripod mount, which is desirable. MTDC is developing an environmental enclosure to house the DataRam that can easily mount on a tripod. The enclosure will protect the DataRam from the elements and provide venting to keep the instrument from overheating. The enclosure will mount on a tripod similar to other environmental monitoring equipment. A prototype will be fabricated and tested this summer.

For further project information, contact MTDC project leader Andy Trent by phone at (406) 329-3912, or [atrent@fs.fed.us](mailto:atrent@fs.fed.us).

## • NEWS FROM THE WSA T&D STEERING COMMITTEE

This spring, the steering committee received a proposal titled "Aquatic Nuisance Species Washing System" from Shane Hendrikson, fishery biologist on the Lolo NF in Montana. Other projects were considered higher priorities, and this one was not selected for work in 2009. However, the committee did identify the issue as a national crisis going beyond the Forest Service, and SDTDC staff consulted Mike Ielmini, National Invasive Species Coordinator in the WO, for information about this hot-topic area. Here are some notes from Mike to watershed specialists who may or may not be familiar with on-going developments in the general arena of invasive species control.

- The issue of invasive exotic species control is much bigger than just the Forest Service. Other Federal and State agencies are doing a lot of work we should be aware of in the general area of cleaning equipment and vehicles of all types. Universities also have worked with some agencies investigating the effectiveness of vehicle washing procedures. The Forest Service continues to collaborate with

public and private organizations to improve the design and use of washing systems for invasive species prevention.

- The issue is especially big for the military. The U.S. Army Corps of Engineers has produced a technical report on the transfer of invasive species associated with the movement of military equipment (<http://el.erd.usace.army.mil/elpubs/pdf/trel07-8.pdf>). Some of that information is pertinent to vehicles used by other federal agencies.
- The Bureau of Reclamation, with support from the Corps of Engineers and an editorial review by the Forest Service, has completed a large guide to equipment and vehicle cleaning that will be published online soon. This Bureau of Reclamation Technical Memorandum is titled "Inspection and Cleaning Manual for Equipment, Vehicles, and Personnel to Prevent the Spread of Invasive Organisms".
- Cleaning needs vary between vehicles, and even specific models may have different cleaning needs because of differences in design details. The cleaning job includes the interior of the machinery—not just the paint job. Water-cooled boat motors are notorious for harboring invasive organisms. Invasives also travel inside pumps and hoses that were used in contaminated bodies of water.
- Besides being equipment specific, protocols for cleaning are also species specific. Procedures are often developed locally for particular vehicles or pieces of equipment and species that pose a special risk in that locality. The key to success with any set of protocols for washing vehicles or equipment is visual inspection. Proper inspection will add time to the cleaning operation, but will increase effectiveness.
- Given the high cost of washing, decisions on what and how to clean should be based on an informed assessment of the risk associated with the species of concern, and on a thorough understanding of the invasion pathway for that species. Line officers will have to decide what level of risk is worth the cost in specific instances.



- A clear expectation of the level of effectiveness should be articulated in the planning process. Think about what level of effectiveness will be adequate to meet the project objective – 90 percent? or 95 percent? Even where the precise degree of effectiveness for the particular type of equipment and the targeted invasive species cannot be demonstrated, this thought process will inform the cost/risk assessment.
- Effectiveness is extremely hard to demonstrate. A few studies have been undertaken to assess effectiveness of some washing systems, but to no great extent. No cleaning protocols exist that have a known degree of effectiveness for all species or equipment types. Contractors' claims of effectiveness cannot be verified in most cases.
- Nonetheless, the case for prevention through equipment and vehicle cleaning is still strong. The general consensus is that doing something is better than doing nothing.
- Many contractors offer washing services and/or equipment, some modeled on equipment tested or developed at the Forest Service Technology and Development Centers. They are believed to vary tremendously in effectiveness. Let the buyer beware!
- Solutions offered by some contractors may or may not be helpful in specific cases. For example, hot water washing may generate wastewater that is difficult to dispose of because it contains oil and grease (creating a hazardous materials containment issue). Depending on the equipment and the species, higher pressure may not increase the cleaning effectiveness. Additives, such as chlorine can increase risks associated with contaminated washwater and may contribute to human health risks and resource damage in some cases.

Here are some things resource managers, aquatic specialists, and others can do to inform themselves and assist in preventing the spread of aquatic nuisance species.

- Get to know the invasive species with the potential to affect your area. Research their invasion pathways. For example: What form/lifestage is

of concern? How does it move? Where is it likely to be on a specific vehicle or piece of equipment? How long can it survive out of the water?

- Consult regional aquatic or invasive species coordinators for information about local washing contractors, equipment, and methods. Consider developing bid specifications based on your particular project needs. One size does not fit all.
- Prepare for fire operations by proactively identifying water bodies free from invasives that could be used as clean water sources.
- Consider the possibility that firefighting equipment (such as hoses, pumps, aerial water buckets (pumpkins), siphons, nozzles, etc.) may arrive on the fire already contaminated, and could accidentally spread a new invader to a "clean" water body. On the other hand, some invaders will not survive out of water for a certain length of time; for example, zebra mussel larvae in water dropped onto a fire along a high ridge far from any water body would not survive. Weigh the risks.
- Prevention planning should include follow-up monitoring of the area to detect and eradicate any new invaders that slip through the prevention gauntlet. Don't assume that the procedure was 100-percent effective and that no follow-up is required.

## • PUBLICATIONS AND TRAINING AIDS

T&D products related to invasives (mostly focusing on terrestrial species) include:

- Vehicle Cleaning Technology for Controlling the Spread of Noxious Weeds and Invasive Species (2005): <http://fsweb.sdtc.wo.fs.fed.us/pubs/pdf/05511203.pdf>.
- MTDC Portable Vehicle Washer (2004): [http://fsweb.mtdc.wo.fs.fed.us/php/library\\_card.php?num=0434%202819](http://fsweb.mtdc.wo.fs.fed.us/php/library_card.php?num=0434%202819)



• **LINKS OF INTEREST**

**Aquatic Invasive Species Control**

- Forest Service Invasive Species Program: [www.fs.fed.us/invasivespecies](http://www.fs.fed.us/invasivespecies). This site is rich with links and documents. A link to the new guide by the Bureau of Reclamation will be posted here as soon as the manual is published. The site also includes links to cleaning equipment and educational videos produced by the T&D centers.
- Region 4 Aquatic Invasive Species Web site: <http://www.fs.fed.us/r4/resources/aquatic/index.shtml> provides guidelines, links, and literature pertinent to the region.
- Protect Your Waters Web site sponsored by the U.S. Fish and Wildlife Service and the U.S. Coast Guard: <http://www.protectyourwaters.net/prevention/>.
- Intergovernmental Aquatic Nuisance Species Task Force: <http://www.anstaskforce.gov/default.php>.

**Motor Vehicle Access Controls**

This new Web page provides information and tools on ways to control vehicles, including a compilation of photos, drawings, and specifications for closure techniques and solicits input from the field on effective closures. The objective of this project is to improve the ability of field personnel to identify and properly implement appropriate traffic control techniques, for greater closure efficacy, and increased public acceptance, that helps to achieve the desired road management objectives. To see the new Web page, go to: [http://fsweb.sdtcd.wo.fs.fed.us/programs/eng/Motorized\\_Vehicle\\_Control/index.shtml](http://fsweb.sdtcd.wo.fs.fed.us/programs/eng/Motorized_Vehicle_Control/index.shtml).



Figure 12. Boulder barricade used to restrict vehicle access

**Soil Water Condition Rating Form**

The finalized soil water condition rating form is available for field use. The final photo guide and desk reference is in publications and should be available before our next newsletter. In the meantime, consult the following Web page for project information: [http://fsweb.sdtcd.wo.fs.fed.us/programs/eng/SWRCI/project\\_index.shtml](http://fsweb.sdtcd.wo.fs.fed.us/programs/eng/SWRCI/project_index.shtml).



Figure 13. Identifying the surface drainage pattern is a key indicator in the SWRCI form.



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