



# Engineering Field Notes

## Engineering Technical Information System

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## 1996 *Engineering Field Notes* Article Awards

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Another year has passed, and it's time for you to let us know which articles you believe were most informative, beneficial, and interesting; which articles helped your office save money; and which articles helped you accomplish your work more effectively and efficiently.

We are only printing three issues a year, but the quality and diversity of the articles have not diminished. We still share information in many diverse fields—geometronics, ecosystem roads management, facilities and other structures, and geotextiles. Through *Engineering Field Notes* (EFN), we continue to provide Forest Service engineers, at all levels and from all Regions, a way to share their knowledge and experiences. We believe sharing is vital in these days of doing more with less, and we applaud each of our authors.

After selecting your three favorite articles, please complete the rating sheet on the following page. Rate the three articles from 1 (best) to 3 (third best). If you believe an article has or will help the Forest Service save money or other resources, please let us know. Remember, this is a one-person, one-vote system—so your vote really does count!

Once you have voted, cut the rating sheet along the dotted line, fold and staple or tape it closed, and mail it back to us. Your rating sheet must be received no later than June 1, 1997, or it won't count.

Contests aside, we would like to thank each of our EFN authors, as well as our readers, who made 1996 another great year. Each of you deserves a pat on the back for helping to foster an environment where information and experience are viewed as valuable resources and are shared accordingly.

Think about some of the projects you've worked on, and the experiences you've had. Why not take the time to record at least one of them on paper and submit it (with pictures if you have them) as an EFN article for 1997. Who knows, next year you could be one of our winners!





## 1996 *Engineering Field Notes* Awards

| Article                                                                                                        | Author(s)                                                | Choice<br>(1,2,3) | \$ Saved<br>(✓) |
|----------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|-------------------|-----------------|
| <b>January-April</b>                                                                                           |                                                          |                   |                 |
| A Course Filter Method for Determining the Economic Feasibility of Helicopter Yarding                          | Stephen (Obie) O'Brien<br>Ervin J. Brooks                | _____             | _____           |
| Full Recontouring and Channel Crossing Restoration Techniques for Closure and Obliteration of Low-Volume Roads | Jeff Moll<br>Ed Lider<br>Robert Harper<br>John Neirinckx | _____             | _____           |
| How To Submit Proposals to the Technology and Development Centers' Engineering Technology Program              | Keith Simila                                             | _____             | _____           |
| Load Rating of Single-Span Steel Girders for an HS20 Vehicle Using Mathcad® 5+                                 | James S. Groenier                                        | _____             | _____           |
| <b>May-August</b>                                                                                              |                                                          |                   |                 |
| Bioremediation Using Land Treatment for Hydrocarbon-Contaminated Soils                                         | Allan K. Porter                                          | _____             | _____           |
| Bridges: Some Old, Some New; Some Needed, Some Not                                                             | Bill Renison<br>Kathleen Tillman                         | _____             | _____           |
| Improved Autonomous Accuracy for Forest Service GPS Receivers                                                  | Bill Kilroy                                              | _____             | _____           |
| Integration of Remote Sensing Into Resource Data Collection: Working With Imagery in ARC/INFO                  | Vicky Varner<br>Paul Maus<br>Henry Lachowski             | _____             | _____           |
| The Wood River Project                                                                                         | Christina Lilienthal                                     | _____             | _____           |
| <b>September-December</b>                                                                                      |                                                          |                   |                 |
| The Bridge Brothers More-With-Less Solution                                                                    | Tom Gillins                                              | _____             | _____           |
| Cost Estimators in Region 6 Join FORCES To Get the Job Done                                                    | John Johnston                                            | _____             | _____           |
| A History of the Forest Highway Program                                                                        | Richard Sowa                                             | _____             | _____           |

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Name \_\_\_\_\_

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Forest Service—USDA  
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## 1997 Forest Service Engineers of the Year

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Congratulations to the winners of the 1997 Engineer of the Year awards:

- Managerial Engineer—Laurence Gruver from the Tahoe National Forest in Region 5.
- Technical Engineer—Gordon Keller from the Plumas National Forest in Region 5.
- Engineering Technician—Thomas Hooker from the Kaibab National Forest in Region 3.

An award ceremony was held April 1, 1997, in Washington, DC, to recognize the winners for their achievements. The Acting Director of Engineering will present each winner with a special plaque and a cash award. A summary of the winners' accomplishments is included on the following pages.

The winners were selected from an excellent list of Regional and Station candidates. Congratulations to the following finalists in all categories:

| Management        | Technical             | Technician          |
|-------------------|-----------------------|---------------------|
| William K. Duryee | Michael R. Mitchell   | Daniel E. Neuman    |
| Robert Sieger     | Michael Burke         | Mike Murphy         |
| Michael J. Wilson | Robert Freel          | Donald G. Jankovsky |
| James Simpson     | Richard Kennedy       | Dennis McKinnon     |
| Chuck Tietze      | Louis F. Janke        | Gary V. Bieberdorf  |
| Mickey Martin     | Roger Mizell          | Steve Cromer        |
| Fred Hintsala     | Dean Klicker          | Mary C. Doran       |
| Joseph F. Murphy  | Lawrence A. Soltis    | Victor J. Hager     |
|                   | Marcia Patton-Mallory |                     |



## **Laurence Gruver, Managerial Engineer of the Year**



As the Tahoe National Forest's Technical Support Staff Officer in charge of Engineering, Lands, GIS, and Land Management Planning, Laurence Gruver is a recognized leader in forest management. Evidence of Larry's leadership, managerial, and technical skills is reflected in the many performance and other awards he has received. These include awards for Outstanding Leadership, initiated and given by his employees; Performance as Forest Administrative Officer; and Contribution to the Forest Civil Rights Program.

Because of his excellent leadership and managerial skills, Larry is frequently asked to serve on task groups. His participation has included the following:

- Leading a budget team that implemented a unified budget concept for the Tahoe.
- Leading a team that accomplished a successful reorganization of the Tahoe.
- Helping to initiate a Regional Office effort to streamline and downsize administration.
- Serving on a task group that initiated the R-5 Excellence in Administration effort.
- Being the only forest representative on a Regional Office task group looking at the Engineering Skills Plan for the year 2000.

Larry is also a proven technological leader. In a time when budgets have been reduced and skills lost, Larry has worked to build and maintain a computer group that has outstanding CAD, GIS, and GPS skills. During a Washington Office Engineering Applications review, the Tahoe was commended for its capability and leadership in the computer applications arena.

Larry is leading an effort to “hot link” the Tahoe’s hazardous materials inventory to the forest recreation map. With e-mail, this information will be available to local fire departments. He is also working with his Road Operation and Maintenance group to develop maps and information on the Tahoe’s road system to be made available on the Internet.

Larry has encouraged his employees to be innovative in their approach to new engineering problems. Through his leadership, the Tahoe was able to design new water source facilities that enabled the Forest to meet the requirements of the Safe Water Drinking Act at all drinking sites within the Act’s short timeframes. Some of these facilities involved new technology, and designs have since been passed on to other forests.

Working closely with Recreation, the Engineering section manages the Tahoe’s trail program. As a result of Larry’s encouragement, there have been many innovations in trail location, OHV trail systems, and trail bridge design. Evidence of his excellent program management can be seen in the selection of the Tahoe’s Trails Manager to work on the National Trail Construction Specifications.

Larry has built a strong organization, with program managers who are committed to providing timely and expert advice and products. His support group works closely with all functional areas on the Forest and, in fact, is considered an integral part of those activities.

Because of Larry’s proactive leadership in downsizing and reorganizing the Tahoe, his organization has been able to provide necessary support. This support was provided despite the unusually high level of Engineering effort required as a result of the large Cottonwood and Crystal fires of 1995, and the P.L. 104 timber sale program in 1996. Through Larry’s leadership, the Tahoe has one of the most active Forest Highway and Public Lands Highway programs in the Region, with five active projects this year alone.

Larry works closely with Civil Engineers at the Federal, State, and county levels. The Tahoe’s extremely successful Forest Highway and Public Lands Highway programs have required close coordination with FHWA, the State of California, and local counties. He is also working closely with the State on a highway relocation that crosses a parcel of Forest land set aside for administrative site development.

Larry has repeatedly volunteered or been selected for challenging special assignments. In 1992, he led an effort to prevent the controversial relocation of the Downieville District Office from Camptonville to Downieville. This move would have resulted in serious inefficiencies for the Tahoe. More recently, he helped achieve a land exchange that had been in the making for 25 years. The exchange resulted in the Forest moving its WCF shop,

a radio shop, and a warehouse out of downtown Nevada City to a commercial area nearby. This exchange has tremendous local support and gained the Forest credit for its willing effort to work with local interests.

Larry is an active member of his community. Examples of his leadership and management skills include the following:

- Receiving the Coast Guard Commendation Medal for Leadership.
- Serving as a member of the Engineering Technology Advisory Group for Sierra College, advising the college on what local industry and government agencies need from graduating students in several engineering and surveying disciplines.
- Serving as head coach for the local year-round swimming team, the Penguins, and coaching the local high school men's and women's swimming teams.
- Serving as Wellness Coordinator for the Tahoe and coordinating a yearly community Wellness Fair at the County Fairgrounds.
- Organizing an educational field trip to the Forest Service for local sixth-grade classes and making himself available for a career shadow program offered by the local high school.

Larry received a B.S. in 1968 and an M.S. in civil engineering in 1972 from the University of California. He has been a Registered Professional Civil Engineer in California since 1978. Larry has a secondary teaching credential in mathematics and science, has junior college credentials in engineering and physical education, and has been a part-time junior college instructor since 1984.

Larry considers learning a lifelong pursuit and has taken extension courses in the design of small dams and construction of wood-frame buildings, a recreation correspondence course from Colorado State University, and an undergraduate course in geography at Sierra Junior College. He is also a member of a local Toastmasters International group and has won speaking contests to the area level.

Larry encourages his employees to better themselves through education or experience. His GIS group is now the technology center for the Tahoe, offering training in GPS, GIS, and CAD for all employees. His technology support staff group offered training for the Tahoe and other forests in engineering certification, use of GPS equipment, lands techniques, and use of uniform building codes.





## Gordon R. Keller, Technical Engineer of the Year



Gordon Keller is a Regional expert in many aspects of geotechnical engineering and has a reputation throughout the Forest Service for his expertise in the fields of retaining structures, slope stability, and aggregate resource management.

Gordon is a staff engineer on the Plumas National Forest and a technical specialist in geotechnical engineering on a shared-services basis in northeastern California. He provides consulting services to other forests, State-wide and nationally, on a case-by-case basis. Gordon has been recognized by many forests and other agencies for his expertise in various aspects of specialized engineering. In addition to his performance ratings, Gordon has also received the following:

- An award for Superior Performance as Acting Assistant Forest Engineer.
- A Special Act Award from Region 5 in Recognition of Outstanding Contribution to the Regional Minerals and Reclamation Program.
- A Plumas Employees Recognition Award for Engineering Professionalism and Contribution to a Quality Work Environment.
- A Region 5 Technology Transfer Award for Information Sharing.
- A Special Act Award for Contributions to Resolving the Buzzards Roost Timber Sale Lawsuit.
- A Certificate of Honor for the *Engineering Field Notes* article, "Tire Retaining Structures."

Gordon provides technical leadership by developing practical design standards and guidelines and by providing training and program development from the forest level on through the international level.

Areas in which Gordon has provided design standards and guidelines include geotechnical project investigation and design, materials management, high- and low-standard roads, watershed restoration and erosion control, project environmental analysis, and mine reclamation. He has written or reviewed many specifications, including the following:

- Practical design standards and guidelines for use of aggregates, dust palliatives, geotextiles, drainage, design in erosive soils, and the like.
- Standards for the use of alternative earth-reinforced structures and reinforced fills as a less expensive alternative to conventional retaining walls.
- Many low-cost solutions for slope stabilization, including earth buttresses, drainage techniques, soil nailing, and use of biotechnology.

He has published articles and papers on standards and guidelines, including the following:

- “Caminos Rurales con Impactos Minimos—Manual de Capacitacion con Enfasis Sobre Planificacion Ambiental, Drenajes, Estabilizacion de Taludes y Control de Erosion,” coauthored with J. Bauer and M. Aldana, *US AID/IF, USFS*, 800 p., September 1995.
- “Experiences with Mechanically Stabilized Structures and Native Soil Backfill,” *Transportation Research Record 1474*, TRB, Washington, DC, pp. 30–38, 1995.
- “Alternative Wall and Reinforced Fill Experiences on Forest Roads,” ASCE Geotechnical Division, *Proceedings, Symposium on Design and Performance of Earth Retaining Structures*, Ithaca, NY, pp. 155–169, 1990.
- “Geotechnical Design Considerations in Decomposed Granitic Soils,” *Proceedings, 29th Engineering Geology and Geotechnical Engineering Symposium*, University of Nevada, Reno, NV, pp. 1–21, 1993.
- “Landslide Considerations in Project Design—Region 5 Experiences,” *Proceedings, National Geotechnical Workshop*, USDA, Forest Service, Denver, CO, 1984.
- “History and Repair of the Doyle Reservoir Dam,” coauthored with Leslie Fisher. *Association of State Dam Safety Officials Newsletter*, Vol. 8, No. 1, January 1993.
- “Low-Cost Asphalt Surfaced Roads,” coauthored with J. Mandigo and S. Johnson. *Proceedings, 5th International Conference on Low-Volume Roads*, Transportation Research Record 1291, Vol. 2., pp. 84–90, 1991.

Gordon has conducted training on many forests and in Regional training sessions in Regions 5, 6, and 8 on aspects of geotechnical, geologic, and materials engineering work, including roadway drainage, dam design, retaining structures, use of materials, aggregate management, erosion control, and mine reclamation. He is on the training cadre with the Colorado Transportation Institute for MSB technology and has conducted walls training in Regions 5 and 8 at T<sup>2</sup> conferences and State DOT workshops. He cochaired and taught parts of the Regional Slope Stability Workshop and served on the committee that prepared the *Slope Stability Reference Guide for National Forests in the United States*. He also worked on the national committee that revised and updated the *Retaining Wall Design Guide*.

Because of his strong technical background, practical experience, and knowledge of the Spanish language and culture, Gordon has been involved in many International Forestry assignments in Latin America, dealing with rural roads. He represented the Forest Service at an International Conference on Environmental Management of Roads in Colombia. He has been involved in reviews or provided training on aspects of rural roads design in Guatemala, Bolivia, Mexico, and Colombia. He has worked with hundreds of local engineers and technicians in these countries, teaching the value of environmental analysis, planning, and design techniques appropriate for low-volume roads. He has also been involved in recent TRB International Low-Volume Roads Conferences.

Gordon works with the public and other agencies on many issues, such as requests for geologic information, contracts, International Forestry assignments, Federal Highway Administration projects, county liaison, ERFO storm damage repairs, mining plans of operation, and watershed repairs and studies. He deals with other agency representatives on project and program management levels and on a daily working level with technical specialists on design details.

Gordon's technical leadership can be seen in the following accomplishments:

- More than 300 storm damage sites and \$4 million in damage occurred as a result of storms in the 1980's and 1990's. Gordon was directly involved in the repair of all sites, including assessing damage, developing design repairs, and serving as ERFO program manager. The innovative designs and mix of contract and force account work resulted in substantial savings to the Government in both time and dollars.
- Gordon has provided technical materials input, project liaison, and program management for several Federal Highway Program projects. Cost savings from on-forest materials sources located by Gordon are estimated at more than \$1 million. Other projects proposed by Gordon include three 3R paving projects, two of which are awarded, and three bridge replacements. He has also completed geotechnical and materials investigation reports for other, off-forest FHWA projects.

- The Plumas bridge program managed by Gordon includes almost 100 structures that require inspection, maintenance, repair, and some replacement. He is currently reorganizing the bridge files and completing the database updates for the National Bridge Inspection Standards. This past summer he wrote and administered a bridge inspection contract for 38 bridges that he did not have time to inspect.
- The Plumas currently has a very active watershed and stream restoration program coordinated by Forest hydrologists and two engineers working on watershed. Gordon wrote the job description and helped establish the watershed engineering position in response to the need for engineering input on watershed repair designs and contracts.
- Gordon is one of the six remaining Geotechnical Engineers in the California Region. Shared-services positions covering multiple forests have been set up to provide services with the limited resources available. Gordon helped establish the first position in northern California.

Gordon received a B.S. in civil engineering from UCLA in 1968, and an M.S. in geotechnical engineering from the University of California at Berkeley in 1972. He is currently licensed as a civil engineer and geotechnical engineer in the State of California. He is a member of several professional groups, including the University of California at Berkeley Geotechnical Society, the American Society of Civil Engineers, the International Society of Soil Mechanics and Foundation Engineers, and the Association of Engineering Geologists. He is also involved with Transportation Research Board committees on Geosynthetics and Low-Volume Roads.

Gordon supports professional development and stays current with technology. He shares his knowledge and actively promotes continued education and training for his employees and coworkers. He is the Engineering Career Counselor for the Plumas. He has received training or taken continuing education courses in hydrology, groundwater evaluation, air photo interpretation, retaining wall design, advanced blasting techniques, rock mechanics, soil cement, pavements, highway drainage, FHWA bridge inspection, testifying as "expert witness," effective briefing techniques, use of geotextiles and geomembranes, mine waste management, biotechnical slope protection, and supervision and management.

Gordon is very active in his community in the following ways:

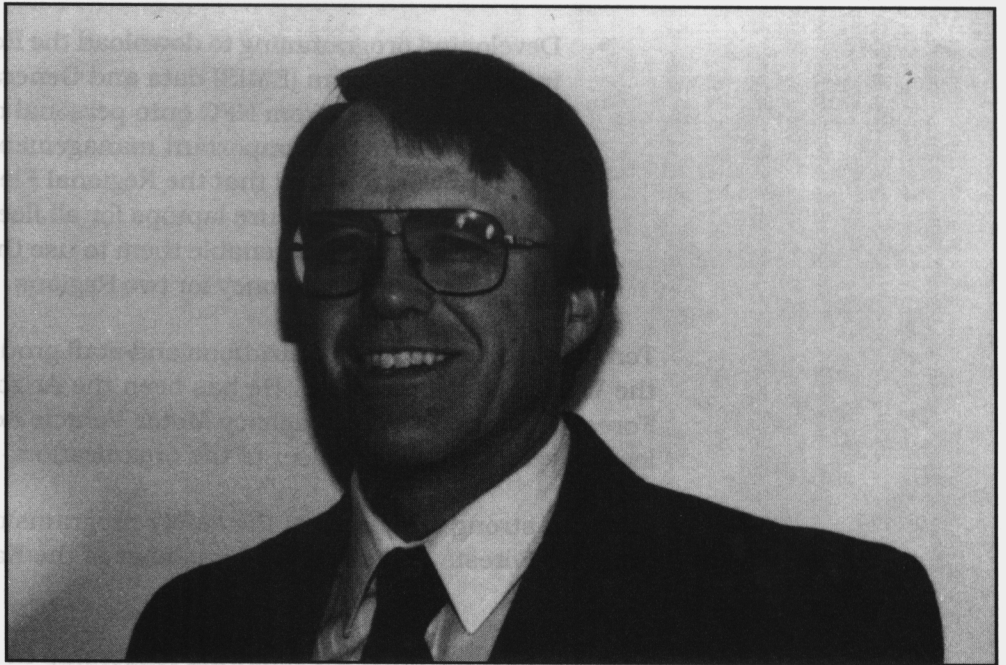
- He is involved with Forest Service and local area recycling issues. He is the Plumas Forest Recycling Coordinator and serves on the Plumas County Recycling Committee.
- He is the current chairman of the Genesee Area Planning Committee. He helped to get the Genesee Valley Special Management Area Plan adopted by the local Board of Supervisors.

- He is working with the local Boy Scout chapter as an ongoing Geology Merit Badge Counselor.
- He is an active member of the local volunteer fire department.
- He is actively involved in local musical events and is a member of a local music group, playing the guitar and mandolin, with vocals. He has been involved in the Music-in-the-Schools program, supported the local Arts Commission, and provided entertainment for local fundraisers and groups such as Elderhostel.

Gordon also does private consulting work as time and interest dictate. These projects involve working with land surveying, parcel divisions, residential foundations, retaining walls, slope stability assessment, seismic and structural designs, groundwater locations, road standards analysis and structural section design, and hydrologic engineering and flood plain analysis.



## **Thomas Hooker, Technician of the Year**



Thomas Hooker directly supports ecosystem program management as the Fleet Manager for the Coconino and Kaibab National Forests. Tom also provides technical guidance and oversight for the fleet manager of the Prescott National Forest.

Tom has a history of superior performance and has been recognized at the Regional level for his work in the fleet management area.

He is a leader in his field, and his many contributions include:

- Advancing Servicewide and national programs in alternative-fuel vehicles by successfully championing the use of compressed natural gas (CNG) in Forest Service fleets. By obtaining grants, installing fuelmakers, and modifying vehicles, Tom achieved CNG vehicle operation on the Prescott, Kaibab, and Coconino National Forests. Because of his efforts, CNG rigs are operating in a rural area.
- Developing many personal and laptop computer applications for fleet management and other functions, including a program for tracking required training for Kaibab employees.
- Sharing technological innovation with his counterparts throughout the Region at Regional Fleet Managers' meetings.
- Assisting the San Dimas Equipment Development Center with the evaluation of the "Silent Witness" technology in vehicles. The Kaibab National Forest fleet had 10 vehicles equipped. Over the 3-year test period, Tom helped demonstrate the advantages of the equipment to a forest and was a major contributor to the San Dimas effort.



- Working as a Ground Support Unit Leader with fire teams in the Southwest, where his evaluations for work on fires have been outstanding.
- Developing programming to download the Equipment Management Information System (EMIS) data and General Accounting Transaction Register data from NFC onto personal computers, then manipulate the data to gain important management information. The program works so well that the Regional Fleet Manager for Regions 3 and 5 is trying to procure laptops for all fleet managers in those Regions, which would enable them to use the program. Tom has saved large sums of money for two Regions.

Tom works with many organizations and staff groups, from the District to the Washington Office level. He has been the Arizona representative for the Forest Service on the Interagency Motor Vehicle Advisory Committee for at least 5 years and is an officer of the organization.

Tom is a strong supporter of the safety programs of the Kaibab and other National Forests and serves as a member of the Kaibab's Forest Safety Committee.

Tom has also provided the following leadership in his community:

- Serving in VISTA (the Domestic Peace Corps) in the early 1970's. He received his Forest Service appointment as a result of his work with VISTA.
- Assuming responsibility for the Region's project to restore the 1926 Dodge, the oldest vehicle owned by the Forest Service. He manages and maintains the car, and drives it in parades wearing the 1926-style Forest Service uniform that he made. The car appears in about 20 parades a year and provides community outreach and fire prevention education.
- Serving as Vice President in the Williams Lions Club and being actively involved in that organization for more than 25 years.
- Serving as the Scoutmaster of Boy Scout Troop 140 and scheduling at least one field trip for the troop each month.



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# Water/Road Interaction Technology Series

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***Jeff Moll***

***Senior Project Leader***

***San Dimas Technology and Development Center***

The Water/Road Interaction Technology Series of publications is part of an effort coordinated by the San Dimas Technology and Development Center (SDTDC) and sponsored by Washington Office Engineering Staff to identify and deliver to the field information relevant to interactions between hydrology and transportation systems. The series identifies gaps in knowledge and provides a framework for addressing future research and technology development needs. The three components of the series are surface drainage, drainage crossings, and subsurface drainage.

Surface drainage involves the concentration and flow of surface water on cut-and-fill slopes; on travelways; and in ditches, cross-drains and water bars, lead-out-ditches, and other road-related drainages. Alternative templates, surfacing materials, and maintenance techniques fall under this component, as do most erosion and many sedimentation concerns.

The drainage crossings component involves selection of type and sizing of stream-crossing structures; passage of debris, bedload, fish, and water; capacity improvement; end treatments; trash racks; low-water crossings; fill encroachments; reducing modifications to stream hydraulics and hydrology; diversion prevention; and risk assessment.

Subsurface drainage involves any below-ground drainage related to or influenced by roads: infiltration, permeability, interception of subsurface flow, saturated fills, groundwater conductance and monitoring, and related risk assessment. Methodologies, models, instrumentation, field installations, and data analysis and interpretation on groundwater response to roads will be documented.

The initial series output is a number of technical reports dealing with transportation system interactions with forest hydrology. Technology transfer formats for future development work may include additional publications, video productions, training and workshops, software, expert contacts, the World-Wide Web, CD-ROM, or symposia, and will generally be accompanied by reports in the series. New knowledge will be disseminated in appropriate formats.

Forest Service employees are encouraged to participate and can contribute information by contacting the senior project leader for the Water/Road Interaction Projects, SDTDC, at (909) 599-1267.

To be included in the series, subject material should fit into one or more of the following categories:

- Be of interest from a professional or land-ethics standpoint.
- Stimulate applications development based on site-specific conditions.
- Be directly applicable.

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# Restoration of the Historic Vierhus Playhouse

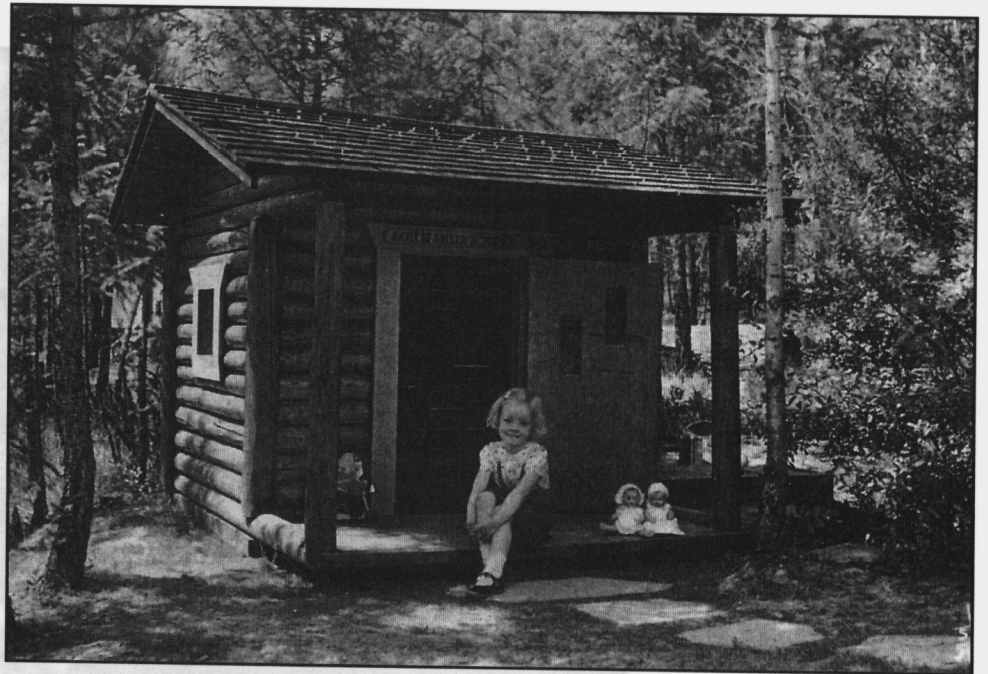
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**Cherie Peacock, P.E.**  
**Supervisory Civil Engineer**  
**Lolo National Forest**

## Introduction

Every once in a while in the life of an engineer, one gets to work on a project that warms the heart. The stabilization and restoration of the historic Vierhus Playhouse at the Ninemile Ranger Station in Montana was one such project.

The Vierhus Playhouse was constructed in 1937 by enrollees of Civilian Conservation Corps (CCC) Camp Nine Mile for Lou Marilyn Vierhus, daughter of the camp superintendent (see Figure 1). Lou Marilyn was 4 years old at the time and the only child in camp. Crew Leader Paul Hendershot is credited with the idea of constructing the playhouse as a gift for Miss Vierhus, and Foreman Charles Engbretson turned it into a training opportunity for his CCC crew. Most were young men from eastern Montana, and the foreman felt the playhouse construction would be good experience for those who wished to construct log homes. The playhouse was built at no expense to the Government. The 4-inch diameter logs were considered scrap, and the shingles, paint, and floor lumber were donated. The crew of 15 worked on three consecutive Saturdays and occasional weeknights in between.



**Figure 1.** Lou Marilyn Vierhus and her mini-cabin in the woods. Courtesy of Montana Historical Society, Helena, Montana.

Lou Marilyn used the playhouse until 1942, when the CCC camp closed, her father left for World War II, and she and her mother moved to Seattle. Before leaving, Lou Marilyn closed the door to her tiny log house and nailed up a "Keep Out" sign. She never returned as a child.

After the Vierhus family left, the playhouse was moved to the Ninemile Remount Depot and Ranger Station, which had been built by the crews of nearby CCC Camp Nine Mile. The children of Forest Service residents have played in it ever since. Unfortunately, the structure fell victim to weather and lack of maintenance (see Figure 2). The sill logs were badly rotted (Figure 3), the roof shingles missing, and the sheathing in need of replacement (Figure 4). Essentially, all features of the playhouse—flooring, door, log walls, and windows—needed repair or replacement.

The historic significance of the Vierhus Playhouse was initially overlooked in 1980, when the Ninemile Ranger Station was nominated to the National Register of Historic Places. It wasn't until 1992 that the story behind the Vierhus Playhouse began to unfold. Marilyn Tutwiler (formerly Lou Marilyn Vierhus) and her mother visited the Ninemile Ranger Station. Marilyn noticed the sad state of repair of the playhouse and contacted Lolo National Forest archaeologist Milo McLeod to express her dismay. Milo recognized the uniqueness of her story and the history embodied in the playhouse. Historic research was completed, including oral history from Marilyn. The playhouse was determined eligible for the National Register as a "contributing element to the historic Ninemile Ranger Station."

Too often, historic buildings are seen as a liability and as beyond repair. Scarce maintenance dollars cannot begin to pay the bills, so the structures are razed. However, there are solutions to a lack of money. For example, the Vierhus Playhouse presented a unique training opportunity in historic



**Figure 2.** *Vierhus Playhouse in disrepair*



**Figure 3. Rotted sill logs**



**Figure 4. Missing shingles and broken shingles**

preservation, much like the original construction did for log home building. The playhouse comprised all the components of typical log structure restoration: wood-shingle roofing, log walls, windows, and doors. Thus the idea was born to use the playhouse once again as a training tool, and at the same time accomplish the much-needed maintenance.



Section 106 of the National Historic Preservation Act of 1966 requires consultation with the State Historic Preservation Office (SHPO) before any undertaking affecting structures listed on or eligible for the National Register of Historic Places. The Montana SHPO was consulted early in the planning stages of the playhouse restoration, thus allowing for incorporation of their comments and ideas. The compliance process flowed smoothly, and a Scope of Work was completed in 1993.

## Scope of Work

A Scope of Work lays out in detail the work planned to restore or preserve an historic structure. Thorough study of historic photographs and clues from the structure are needed to understand how the building was originally constructed. The following is a synopsis of the information included in the Scope of Work for the Vierhus Playhouse:

- **Foundation.** The playhouse currently rests on sill logs, which are badly rotted. The structure needs to be elevated. Photographs of the playhouse show what appear to be 4 by 4's or 4 by 6's serving as a foundation. Pressure-treated lumber should be used for the foundation.
- **Roof.** The playhouse was originally covered by green cedar shingles—the type used on the structures at the remount depot (that is, No. 1, blue label, cedar shingles). The shingles were applied in a triple course over 1 by 8 shiplap siding, which served as roof sheathing and ceiling (the original materials are still in place and show evidence of nails). The structure has no rafters; the boards covering the roof are nailed directly to the sidewall logs, which make up the gables. The sheathing should be replaced because it is rotten. Replacement sheathing will have to be special ordered or ripped from larger lumber because actual dimensions of modern 1 by 8's do not match the actual dimensions of the original sheathing, which is  $\frac{3}{4}$ -inch by  $7\frac{1}{2}$  inches. The rabbet cuts for the laps need to be  $\frac{1}{2}$ -inch deep to produce a face width on the sheathing of 7 inches.
- **Walls.** Four-inch peeled logs were used for the walls, which were joined by utilizing a “hog-trough” corner-post system whereby the log posts have one-quarter of the diameter removed lengthwise and a 4 by 4 saline inserted (see Figure 5). The wall logs were nailed to the 4 by 4 and the log corner posts attached by nailing from the outside. Nails or spikes joining the walls are not visible. The wall log that projects to support the porch roof on the left side needs to be replaced with a splice because of extensive rot. One of the porch posts is missing and needs to be replaced. It measures 4 inches in diameter and is  $46\frac{3}{4}$ -inches long. The sill logs and the fourth log from the bottom on the right side also need replacing because of extensive rot. The original surface treatment of the logs is not documented, but the 1937 photo shows that the logs were lighter in color than the current paint. The wall logs will need to be stripped by either heat guns and scrapers or chemical stripping.
- **Door.** The door of the playhouse is missing, but hinge outlines remain on the casing. It appears they were either screen-door or



**Figure 5.** "Hog trough" corner-post system

cabinet hinges. A photo shows that the door is some type of veneer construction with two narrow, offset windows with approximate dimensions of 4 inches by 10 inches. Wooden quarter-round mouldings retained the glass in the door windows. The door should be replicated as closely to the original as can be determined from the photographs. Photographs also show that the name Lou Marilyn Vierhus was placed in raised letters on a plaque above the door. The false head casing is 4½ inches wide. Scaling from the photos, it appears that the letters were approximately 1 inch to 1½ inches high, mounted on a plaque which may have been 2 inches to 3 inches wide and 28 inches long. The color scheme will be determined from an oral interview.

- **Floor.** The flooring was 1 by 8 shiplap siding, the same used for the roof. A newspaper account of the cabin reveals that the floor was varnished. All the flooring, with the exception of one board, has long since rotted away and should be entirely replaced with material similar to that discussed in the roofing section. Exterior spar varnish (or floor varnish) should be used to cover the floor.
- **Windows.** Three windows were installed in 11-inch by 10½-inch openings (finished dimensions), one in the center of each wall. Single panes of glass ¾-inch thick were held by sill, jamb, and casing stops. The sill stops were two pieces of wood, 1 inch by 2 inches, cut to fit on either side of the glass, serving also as the sill. There is no evidence that putty was used, but some glass fragments still remain. If children are to still use the restored playhouse, it is advisable to install at least a ¾-inch double-tempered glass or some type of safety glass which doesn't leave a jagged edge when broken. The

false casings were originally painted red or were red scrap material. A coat of white paint partially covers the red pieces. The false casings and sills around the windows need to be removed to clean trapped dirt and broken glass, then scraped, treated with FPL (Forest Products Lab preservative), and repainted. Gouges in the surface trim should be filled with an auto-body type of putty and sanded smooth.

- **Interior Details.** The interior of the playhouse contained a cupboard, a sink, a counter, and child-sized furniture. The cupboard is still attached to the rear of the right wall, but the doors are missing. Clips attached under the cupboard shelf show that there were two doors. A wooden rail attached to a log below the cupboard served to fasten a counter. The width of the counter can be determined from a paint stripe at the proper level on the rear wall of the playhouse. Above the corners of each window can be found bent finishing nails to which small, torn pieces of fabric are affixed. These are no doubt remnants of curtains, but whether or not they were originally installed in 1937 or later is unknown at this time. The current plan of work does not include replacement of the interior details.

The Scope of Work was completed by David McEldery, a civil engineering technician with an avid interest in the preservation of historic structures. It was then submitted to the Montana SHPO, and approval was obtained in only a few weeks.

A training session titled “Preservation for Managers” was devised and developed around the restoration of the Vierhus Playhouse. Rangers, facilities engineers, resource assistants, and archaeologists from around the country learned hands-on skills in wood-shingle roofing, restoration of historic doors and windows, matching materials, and conservation of historic fabric. Through the training, they also developed a sensitivity to and awareness of historic values.

Time did not allow for completion of the playhouse restoration during the training session, so the final touches were carried out by Forest Service employees over Christmas break and by youth participating in the Montana Conservation Corps. These volunteers included people experienced in hands-on historic preservation skills working alongside those just learning. The Vierhus Playhouse once again provided valuable training.

With the much-needed restoration, the playhouse is back in use by the children of the Ninemile Ranger Station (see Figure 6).

## Conclusions

“The difficulty lies not in the new ideas, but in escaping from the old ones.”

—John Maynard Keynes, 1936

Too often in the past, historic structures were seen as just old buildings falling apart. As a result, we have lost many relics of the past. The historic significance of older buildings and their eligibility for the National Register should be evaluated prior to undertaking any management action. Even routine maintenance can cause irreparable damage. If a structure is deter-





**Figure 6.** Restored Vierhus Playhouse is enjoyed by Lou Marilyn (Vierhus) Tutwiler's grandchildren

mined to have historic value, options for management include no action, elimination, stabilization, or complete restoration. The key is to make these decisions with full understanding of what is at stake.

If stabilization or restoration is warranted, then a plan should be developed to preserve the structure in a way that maintains its historic value and integrity. Here there is no substitute for the involvement and advice of people trained and experienced in historic preservation skills. Historic preservation requires a new way of thinking for most of us, and the experts in the field already know the way.

This Vierhus Playhouse restoration project is part of the greater historic Ninemile District of the Lolo National Forest. Several buildings on the Ninemile District have been restored by the Northern Region's Historic Preservation Crew (HPC). The HPC is into its sixth season preserving and restoring the many historic buildings in the Region, of which the Ninemile District is a major project. This "white hat" program is vital to our mission of preserving historic resources. Our highly skilled HPC is an "enterprise unit" that not only works for the Northern Region, but also other Regions and agencies. The HPC is also active in training other employees in historic building preservation and restoration. For more information, call Bruce Crockett at (406) 329-3161.

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# New Facilities Program at the Missoula Technology and Development Center

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**Steve Oravetz**  
**Program Leader**  
**Missoula Technology and Development Center**

**Keith Simila**  
**Technology and Development Centers Program Manager**  
**Washington Office Engineering Staff**

## Introduction

The Engineering Program at the Missoula Technology and Development Center (MTDC) is broadening into the area of facilities, while retaining some of the program's focus on roads projects. The program is being expanded with the arrival of Steve Oravetz, who became the Engineering Program Leader at MTDC in the spring of 1996. Steve previously worked in facilities management as the Northeastern Forest Experiment Station Engineer. He also has 12 years of experience working on forest roads and facilities in Region 6.

The Washington Office wanted a facilities program at MTDC to give facilities engineers and architects an opportunity to better use technology advances in design, construction, maintenance, and operations. With projected budgets showing no increases in either construction or maintenance, solutions are needed to help the Regions, Stations, and forests do more (or maybe just as much) with less. Implementing new technology offers the opportunity to better use the resources we do have.

Facilities engineers should feel free to contact Steve Oravetz with technical problems when expertise at the Region or Station is not available. Many facilities engineers do not have the time and resources to be experts in various technologies. Steve and others at MTDC can help you find ways to do your job better, cheaper, and more effectively.

## How Can I Find Solutions to MY Technical Problems?

One of the Center's projects is Technical Services. This project is designed to provide the resources to scope new problems and answer routine questions from Forest Service employees. If a problem is widespread and takes more than a few hundred dollars to assess, it will be developed into a project proposal. A call letter requesting proposals is issued each November, but you don't have to wait for the call letter. Send your proposal to Steve at any time. The proposal will be forwarded to the Engineering Technology Steering Committee. Each spring, usually during the first week in March, the Committee meets to evaluate proposals. Once projects are funded, the Center develops solutions. Projects usually last between 1 and 3 years. So if you have a problem you believe technology can help solve, call Steve Oravetz. He will work with you to find a solution.

## **Fiscal Year 1997 Engineering Projects**

Brief descriptions of the projects in MTDC's Engineering Program follow.

### **Facilities Technical Services**

This project allows the Center to offer field assistance or answers to inquiries and questions, conduct data and information surveys to determine field use of technology, review employee suggestions, test and evaluate new technology being considered for field use, assist with specifications and drawings needed to purchase equipment or technology from commercial sources, and participate in the planning of the overall facilities T&D program.

### **Refrigeration**

This project will investigate the newer refrigerants and systems available, develop alternative strategies, determine whether systems will work in Forest Service applications, and develop guidelines for phasing out the use of chlorofluorocarbons (CFC's). It also includes suggestions as to the new projects and strategies that seem to be the most viable and economical.

### **Renewable Energy**

The National Renewable Energy Laboratory (NREL) has offered to help find viable renewable energy technology specifically suited to Forest Service applications. This project should enable the Forest Service to develop a partnership with the NREL in developing and applying new technology. The NREL could fund the development of the technology; the Forest Service would find and monitor applications of the technology.

The Center will work with the NREL to maintain the beneficial relationship begun by the Tonto National Forest. The MTDC will become the Forest Service contact for information relating to renewable energy and will coordinate with the Washington Office.

### **Energy Conservation**

The Department of Energy (DOE) has funded more than \$500,000 in energy audits and retrofits at Forest Service facilities. The Washington Office Facilities Group anticipates that the DOE's audits will recommend many energy- and water-saving technologies that are unfamiliar to many facility engineers. This project will allow the MTDC to assist the Forest Service in meeting energy conservation requirements established by law and Executive order. The legal requirements have timelines that require energy conservation measures to be installed and to begin saving energy in the near future. Energy Savings Performance Contracting (ESPC) is just one of the tools available to the Forest Service for accomplishing its goals for energy savings. The MTDC is working to provide critical information to the field on using these measures.

### **Technical Services, Roads**

Throughout the year, many problems, employee suggestions, and questions from the field are brought to the MTDC. Questions pertaining to areas that are not covered by other current projects are handled under this project. Investigations of new equipment are conducted when field units and the T&D sponsor feel there is justification. The MTDC provides information, drawings, reports, and assistance to field units attempting to use the results of completed projects.

### **Lead Paint Study and Information Sharing**

Many bridges and structures were painted with lead-based paint that presents a hazard to Forest Service employees, contractors, and visitors. In the past, employees and contractors may have been at risk when

repainting and cleaning bridges, buildings, and other structures such as picnic tables. Many bridges and structures are deteriorating because methods of dealing with lead-based paint have not been identified. This issue further hinders disposal of bridges and structures because there are no remedial actions for dealing with lead-based paint. There is a need to develop methods to test for, treat, and dispose of the lead-based paint hazard on all types of bridges and structures. Further, remedial actions that can treat soils near these structures that may have been contaminated by lead-based paint must be established.

#### Sign Installation Field Guide

Many signs are installed or maintained by crews composed of volunteers, older Americans, and other persons who may need training. The majority of these crews do not have a good understanding of the requirements for sign installation, such as clearance from the travel way. A straightforward field guide consisting of photographs of proper installations labeled with descriptive information is being developed for these crews. These photographs depict typical Forest Service signing, such as barricade markers on gates, warning signs, and recreation destination signing.

#### Pin Roller

The Nez Perce National Forest submitted a project for the development of a specialized roller. It consists of pin-on rollers (13 offset swivel wheels) that operate from the ripper bar of a road grader.

This roller's benefits apply primarily when maintaining roads constructed of either native soils or aggregate. By compacting these roads immediately after grading, the amount of erosion and sedimentation can be reduced for most roads. This project will design and test hydraulics to maintain constant downward pressure on the toolbar. The design will be documented with drawings and instructions.

#### TDR Forest Floor Moisture Measurement

The MTDC has been working with the Intermountain Research Station's Fire Research Group to develop an electronic device that provides instantaneous readings of forest floor duff moisture to help managers make informed decisions when handling prescribed and wildland fires. The technology is also useful when applied to other soil-moisture measurement applications, such as determining roadbed moisture.

This project is designed to apply Time Domain Reflectometry (TDR) technology to measuring road moisture. Road-moisture measurements can be correlated to soil strength and corresponding allowable loads during spring breakup and other high-moisture periods. This project is intended to develop an inexpensive instrument to replace the expensive TDR analyzer currently being used, and to evaluate other equipment options, including various sensors.

#### Partnership Projects

Other staff have agreed to work as partners with the Engineering staff to complete the following projects:

#### Technical Services— Explosives

This project provides continuing technical support, technology transfer, and assistance for the explosives program to the Washington Office, field units, and Regional blasters. This work includes providing technical liaison with the Society of Explosives Engineers and various other Federal, State,

and private agencies. It also includes monitoring new technology and materials development and testing.

A recently developed device can shatter large boulders using a 12-gauge shotgun shell and water in a specially built cannon. The "boulder buster" can break rocks up to 5 feet in diameter, break up rock walls (in 6-foot lifts), and break concrete slabs (indoors and outdoors). Because the device does not use explosives, there are no special storage and transportation requirements. Special certification and training is minimal. Rock does not fly after the low-order blast, so the user can be just 20 feet away. This project will evaluate the usefulness of this device in typical conditions encountered on the National Forests.

#### **Operational GPS Support**

The Global Positioning System (GPS) is a satellite-based radio navigation system with outstanding potential for streamlining land-management tasks. In fiscal year 1984, the MTDC began to evaluate the use of GPS for determining location coordinates in Forest Service field applications. The MTDC project team works with field personnel to identify tasks that might be facilitated by GPS technology. The MTDC continues to work with industry to obtain GPS equipment that is smaller, lighter, and more accurate under typical Forest Service field conditions. The Center evaluates commercial units to determine their suitability for Forest Service use and compares them with other units that are available. The Center also facilitates training Forest Service personnel in the use of this technology.

The MTDC maintains the Communication Security (COMSEC) account for procurement and keying (installing computer code) of the Precise Positioning Service (PY code) GPS receivers. These receivers provide better real-time navigation accuracy than the Standard Positioning Service (C/A code) GPS receivers under selective availability (SA) and anti-spoofing (AS) conditions.

#### **General Blaster's Training**

A new training package has become available from the International Society of Explosives Engineers for general and construction blasting. The MTDC will review this package and develop supporting documentation for Forest Service blaster examiners to integrate this package into their existing training programs.

#### **How Do I Get More Information?**

For more information on these or other projects at the Center, contact—

Steve Oravetz  
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Building 1, Fort Missoula  
Missoula, MT 59804-7294  
Phone: (406) 329-1037  
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For further information on GPS, contact—

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For further information on blasting and explosives, contact—

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# Water Quality Effects of Three Dust-Abatement Compounds

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## Abstract

Dust-abatement compounds are applied to National Forest roads for dust control and surface stabilization. The compounds most commonly used by the Forest Service are calcium, magnesium chloride, and ligninsulfonates. Because they are used on a limited basis, little is known about the effects of these compounds on water quality and fisheries.

A literature search, conducted to determine any effects of these dust-abatement compounds, concluded that the use of calcium and magnesium chloride has some environmental effects. The chloride ion found in these compounds exhibits toxicity toward plants and animals. In areas where high concentrations of salts are used for winter de-icing and dust abatement, typically in the northeastern United States, the cumulative effects are most noticeable.

Ligninsulfonate is highly stable in the environment. However, it is also water soluble. The greatest concern in using this product is that it increases the biochemical oxygen demand to receiving waters. While fish have a high tolerance to ligninsulfonates, this effect may result in reduced productivity and fish kills.

Based on the literature review and typical application rates for dust abatement, the effects of these compounds on plants and animals would be negligible. For the purposes that the Forest Service uses these compounds, the use of one over another would be more dependent on cost, availability, and local conditions than effects to the environment.

## Calcium and Magnesium Chloride

### Chemical Properties

Calcium and magnesium chloride are simple salts that can be found in natural brine deposits within the earth. Their chemical formulas are  $\text{CaCl}_2$  and  $\text{MgCl}_2$ , respectively. Calcium chloride is available commercially as a solid (flakes or pellets) and as a colorless, odorless liquid. Magnesium chloride is available only as a colorless, odorless liquid. Calcium chloride is a byproduct of soda-ash manufacturing, while magnesium chloride is produced from natural sea water. Both are able to adsorb moisture from the air (deliquescence) and hold it as a liquid for a long time by resisting evaporation (hygroscopicity). Calcium and magnesium chloride cease to adsorb moisture from the air when the humidity falls below 30 to 40 percent (Langdon et al. 1980). However, magnesium chloride appears to work better in desert regions, while calcium chloride may work better in

higher altitudes with more rain (Idaho Department of Environmental Quality Fact Sheet). Calcium and magnesium chloride will completely dissociate in excess water into its constituent ions of  $\text{Ca}_2^+$ ,  $\text{Mg}_2^+$ , and  $\text{Cl}^-$ .

#### Movement Through the Soil

Calcium and magnesium chloride are highly soluble and move through the soil with water. Their movement is largely dependent upon the rate and frequency of rainfall, the drainage characteristics of the area of application, and the chemical and physical nature of the soil.

In periods of light rainfall, calcium and magnesium chloride remain as hydrated complexes and move vertically with soil surface moisture. During wet periods, they will move deeper into the soil strata; during periods of evaporation, they will move toward the surface. Because of their deliquescence, calcium and magnesium chloride remain liquid under these conditions and stay dispersed within the top few inches of the soil.

Lateral movement of calcium and magnesium chloride does occur, but at a much slower rate. One study was conducted based on an unpaved sandy clay test road with a 55-month weathering period. Only 4.1 percent of the original amount of calcium chloride that was applied to the road surface was detected at 24 inches from the edge of the road section. Another study, using a coarse-textured base and fine-textured subgrade, found it 12 inches away from the edge of the road section after a 25-month weathering period. The application concentrations used for the previous studies is unknown, and no information on rainfall conditions was presented. However, since chloride solutions tend to move through soils at virtually the same speed as the wetting front (Martin 1989), it could be expected for calcium chloride to move laterally at about 6 inches per year.

With rainfalls of higher duration or intensity, or in areas with exceptionally high drainage rates (rapid change in topographical elevation, impervious soil, or low cation binding capacity soil), calcium and magnesium chloride can move considerable distances either as surface runoff or as soil leachate. Surface runoff typically drains into streams, rivers, ponds, or lakes, whereas leachates feed groundwater aquifers. Under these conditions, it is principally the constituent ions,  $\text{Ca}_2^+$ ,  $\text{Mg}_2^+$ , and  $\text{Cl}^-$ , that migrate through the environment.

The  $\text{Ca}_2^+$  and  $\text{Mg}_2^+$  ions are readily adsorbed by soil particles that usually carry a net negative charge on their surface. Under normal conditions, this electrical charge is neutralized by an equivalent amount of oppositely charged cations. Most soils display a net negative charge and are quite limited in the anion adsorption capacity. The  $\text{Cl}^-$  must compete with the exchangeable anions and cannot effectively displace the bound anions in neutral soils except at extremely high levels. As a result, chlorides will tend to remain in solution and can potentially infiltrate and enter the groundwater or drain as runoff into surface waters.

#### Effects on the Environment

The dissociated calcium, magnesium, and chloride ions migrate through the environment rather than the hydrated calcium and magnesium chloride. Because of its widespread occurrence in rocks and soils, and its ready solubility, calcium and magnesium are present in nearly all waters. Calcium is more abundant than any of the other alkaline-earth metals.

The addition of calcium and magnesium from a dust suppressant would probably be insignificant when compared to the amount already present in the environment. Except in rare circumstances, calcium and magnesium generally will not migrate far from the site of application. Therefore, its toxicity pertains only to the immediate area around the application site. Chloride is present in all natural waters, although, in many areas, the amounts are less than 50 parts per million (ppm). Chlorides are also basically unaffected by ion exchange reactions in the soil and are capable of widespread movement.

Chloride is a common component of many dust suppressants and road de-icers. Numerous studies have been documented about chloride ground-water pollution, mainly in the northeastern United States. Most studies found that concentrations vary from season to season and year to year. Typically, more salt is used in the winter, and the total amount depends on the severity of the winter. Also, the closer the sampling site is to the highway, the higher the concentrations. The Environmental Protection Agency uses 250 ppm as an upper limit for chloride in drinking water in its secondary regulations. Kunkle found that peak chloride concentrations occurred during the dry summer period (1972). This indicates that some of the road salt found its way into soils, then moved into subsurface flows, and finally emerged in the summer's groundwater inputs into streams. Chloride levels in the streams did not exceed 100 ppm, and the mean levels were below 50 ppm. Although magnesium and chloride cause hardness in water, no regulation exists which limits their concentrations found in drinking water (Schwendeman 1981).

Pond and lake contamination has not been extensively studied, even though there are potential effects. Because of its higher density, the salt will sink to the bottom and stratification could result if little mixing occurs. These bodies of water also tend to vary in concentration from year to year. The chloride could leach into the bottom muds and enter the groundwater, contaminating local aquifers. Chloride pollution could also produce anaerobic conditions which could ultimately result in fish kills. It could also interrupt the lake food chain, as the bottom feeders are most likely to be affected by chloride contamination.

#### Toxicity of Chloride to Plants and Fish

The potential toxicity to plants from the use of salts is based on the type of plant and on the amount of exposure to the salt solution. Exposure could occur through direct contact to leaves and stems or by indirect contact via the plant root zone. Direct contact of plant leaves with the salt has an adverse affect by creating an osmotic imbalance. The subsequent dehydration ultimately results in defoliation of the plant. Indirect contact could also result in chloride toxicities. Excessive levels of chloride in plant tissues may lead to necrosis, burn of leaf tips and margins, and eventual death. Generally, irrigation and runoff waters containing less than 70 ppm chlorides are safe for most plants. Predicted worst-case chloride levels in runoff from areas receiving calcium or magnesium chloride applications would probably drop to less than 70 ppm within 5 to 30 feet of the application area (Martin 1989).

Some freshwater fish exhibit a great deal of tolerance to salts in general and chloride in particular. One study showed that pike, bass, and perch

can tolerate chloride levels exceeding 4,000 ppm. Trout, however, could only withstand chloride levels of 400 ppm. Salt concentrations greater than 10,000 ppm place all freshwater species of bacteria, algae, invertebrates, fish, and higher plants in immediate jeopardy (Schwendeman 1981) .

## Conclusions

Based on the literature review, it was recognized that calcium and magnesium chloride have some harmful environmental effects, especially to roadside vegetation. That possible damages can occur on a yearly and cumulative basis is also recognized. Martin reported that concentrations of magnesium chloride in a loam soil after 50 years of consecutive applications at a rate of 1.0 gallon per square yard would be estimated at 24,609 ppm to a depth of 7 feet (1989). This implies that a water table with an average depth of 20 feet would have a chloride concentration of approximately 197 ppm after 50 years of application. Therefore, the quantity of soluble salts that may enter a shallow water table (less than 25 feet) beneath the area of application after years of repeated treatment may be significant (Martin 1989).

Most studies focused on winter de-icing practices where large quantities of salt were used. One study reported that wells contaminated with chloride (in excess of 250 ppm) were on average 24 feet away from the treated highway. Martin showed that a worst-case scenario for a 20-cubic-feet-per-second (cfs) stream results in a chloride concentration of 274.5 ppm in a 24-hour period (1989). This is slightly above the drinking water standard and below the tolerable limits for trout.

The typical dust-abatement application rate of calcium chloride flake varies from 5 to 7 tons per mile per year at 1.5 pounds per square yard, depending on the width of the treated road surface (Langdon et al. 1980; Schwendeman 1981; Moses 1981; Singer et al. 1982) (average road width for most calculations was 14 feet). The typical application rate of magnesium chloride in a brine solution is usually 0.5 gallons per square yard or 3,500 gallons per mile, equating to 18 tons per mile per year (Schwendeman 1981; Martin 1989). The 18 tons per mile per year includes the weight of the water. Since magnesium chloride is in a brine solution and is further diluted with water, a conversion factor was needed in order to make a comparison: 1.5 pounds per square yard of calcium chloride equals 0.4 gallons per square yard of magnesium chloride (Tom Oxford, personal communication). Using this conversion factor and the usual application rate of magnesium chloride, it was determined that 7.5 to 9 tons per mile per year of actual magnesium chloride is applied for dust- control purposes.

The typical application rate of sodium chloride, as a road de-icer and as a solid, is 20 tons per mile per year. More runoff to the shoulder of the road and higher concentrations in drainage areas would be expected when it is applied to paved roads. At 20 tons per mile per year, the chloride concentrations start to rise above 250 ppm. Dust-abatement solutions usually are applied once or twice per year. If applied a second time, the concentration is less than the first application. The environmental effects following the use of calcium chloride as a dust suppressant should be considerably less than those observed from its use as a road de-icer (Singer et al. 1982). Therefore, it is unlikely that receiving waters could have concentrations

high enough to cause growth or survival problems for fish. However, fish avoidance of areas where the treated road segment is within 25 feet of the creek would be expected.

The influences from using dust-abatement compounds could be reduced by restricting the use of these compounds within 25 feet of a water body. Martin found that in areas of shallow groundwater (less than 25 feet) there could be a potential for the chloride to move through the soil and encounter the groundwater (1989). Martin also found that vegetation more than 25 feet away from the treatment area did not show any signs of stunting (1989).

## Ligninsulfonates

### Chemical Properties

All tree species are composed of three major chemical components: cellulose, hemicellulose, and lignin. Lignin encompasses a complex group of high-molecular-weight polymers. As a group, the lignins are second only to cellulose in abundance as natural polymers. Since very few biological agents can degrade the lignin molecule (bacteria can only desulfonate and degrade the smaller aromatic groups in lignin), the molecule is extremely environmentally stable. Fungi seem to be the most active at biodegrading ligninsulfonates.

Pulp and paper mills generate lignin as a waste byproduct. Of the four major pulping processes used in the United States (draft, sulfite, semi-chemical, and groundwood), only the sulfite (or acid) process generates ligninsulfonates. Wood chips are cooked with salts of sulfurous acid to remove the lignin. In this process, lignin is solubilized through degradation and sulfonation. The dark solutions containing the degraded lignin are called spent sulfite liquors (SSL); the solubilized lignin derivatives are called ligninsulfonates. The SSL also contain appreciable quantities of the naturally occurring wood sugars. Approximately 55 percent of the liquor consists of these polymers, with the remainder composed of sulfurous acid and either Ca-bisulfite, Na-bisulfite,  $\text{NH}_4$ -bisulfite, or Mg-bisulfite and humic acid. If these liquors are to be utilized as dust suppressants, the concentrate is normally available in a 50-percent solid and 50-percent water mixture (Langdon et al. 1980; Schwendeman 1981). Application rates for dust suppression vary, but the most recommended rate was 0.5 gallons per square yard of road surface using the 50:50 solution (Van Belle 1977; Langdon et al. 1980; Schwendeman 1981). This equates to about 2.5 pounds per square yard, which equals about 10.3 tons per mile.

The Food and Drug Administration (FDA) currently allows for the use of ammonium-, calcium-, magnesium-, and sodium-ligninsulfonates in animal feeds. They may be used as pelleting aids, as binding aids, or as metabolizable energy, with the provision that the amount does not exceed 4 percent of the finished product. Liquid ligninsulfonates may also be used as surfactant in molasses for feeds, with the provision that the amount does not exceed 11 percent of the molasses. The FDA also allows for the use of ligninsulfonates and its calcium, potassium, and sodium salts as components in paper or paperboard, which comes into direct contact with aqueous or fatty foods.

## Movement Through the Soil

Unlike lignin, ligninsulfonates are considered water soluble. Like calcium chloride, ligninsulfonates move through the environment with water. With increasing amounts of rainfall, ligninsulfonates are easily washed away. Clay holds the ligninsulfonates more tightly than other soil particles, but not tightly enough to hold them in the presence of passing water flow. Even in regions where annual rainfall is relatively high (60 to 80 inches), there is good evidence that leaching of ligninsulfonates from stabilized road soils is minor, providing such soils contain enough clay (10 to 20 percent) to absorb the lignin material (ITT Rayonier Inc. 1973). Schwendeman reports that soils best suited for ligninsulfonate treatment are those where 70 to 100 percent of the particles pass through a  $\frac{3}{4}$ -inch sieve and 20 to 50 percent are silt or clay (1981). He also reported that in some circumstances the road could become slippery when wet.

## Effects on the Environment

Because of their low penetrability through soils, lignin sulfonates pose little, if any, threat to groundwater aquifers when applied on the surface. The same would be true for plants. Probably for this reason, few or no studies addressing these topics have been conducted.

There are several studies showing that where lignin and ligninsulfonates were discharged into water bodies, pollution problems resulted. Receiving waters exhibited excessive foaming and discoloration with the introduction of lignin sulfonates. This discoloration is theorized to be responsible for reducing the biological activity in the polluted water.

## Toxicity of Ligninsulfonates to Fish

When used as a dust suppressant, ligninsulfonate will primarily affect the area in or around the area of application, with the exception being the aquatic biota.

When introduced into a waterway, ligninsulfonate will increase the biochemical oxygen demand of the water and could impart a light yellow tint to the water (Schwendeman 1981).

A number of studies have been conducted on the toxic effects of pulp effluents. One study reported toxic effects of sulfite effluents on fish and aquatic organisms. As stated earlier, ligninsulfonates constitute approximately 55 percent of the waste effluent, with the remainder consisting of such materials as acids and bisulfites.

Ligninsulfonates have been shown to exhibit direct toxic effects on rainbow trout. The  $LC_{50}$  at 48 hours (concentration of ligninsulfonates which would be lethal to 50 percent of the test population within 48 hours) was calculated to be 7,500 ppm. Other studies for various types of ligninsulfonates calculated the  $LC_{50}$  at 96 hours ranging from 2,125 to 7,300 ppm (Adams 1988). A retarding effect on growth was observed at sublethal concentrations as low as 160 ppm because ligninsulfonates seem to impair the activities of several digestive enzymes.

With respect to other aquatic organisms, biota living in the lower levels of lakes and rivers are likely to be at greater risk from ligninsulfonate pollution because of the effects they exert on the availability of oxygen. First, the color resulting from the presence of lignin reduces the penetrability of



light, which subsequently inhibits the photosynthetic activity of algae. The supply of oxygen to the system is diminished by this reduced activity. Second, due to their negative surface charge, ligninsulfonates adsorb other materials such as proteins that are in the water. The heavier particle that is formed is insoluble and settles to the bottom, where it adds to the oxygen demand. If the oxygen demand exceeds the supply, a die-off of those organisms that require oxygen to sustain life may occur.

## Conclusions

Except for trout, ligninsulfonates seem to pose little direct systemic toxicity problems in aquatic organisms, animals, and humans, or any problem with local vegetation. Because of associated microbial slime growths, problems with potable water treatment and unpleasant environmental conditions might occur downstream from an application site. It is recommended to determine prior to application if significant migration (water drainage) of ligninsulfonates might occur from the area to be treated into local streams, ponds, and lakes. To achieve the most effective treatment, specific soil-aggregate surface is required.

## Summary

There is a greater volume of information on the use and effects of calcium chloride than there is on lignin sulfonates. For this reason, Singer et al. prefer the use of calcium chloride (1982). Since most of the environmental problems appear to be associated with pulp and paper mill general effluents and not with ligninsulfonates specifically, they recommend not using waste sulfite liquors as dust suppressants. While Schwendeman reported that the most environmentally compatible dust palliative is ligninsulfonate, he recommended the use of either calcium or magnesium chloride because of their lower cost (1981).

The British Columbia Ministry of Environment conducted a study on several road-dust abatement chemicals (1990). The results of this test, shown in Table 1, indicate that all of the dust-abatement compounds evaluated, with the exception of emulsion oil, were in the range of practically nontoxic to nontoxic (for example,  $LC_{50}$  of  $>1,000$  ppm to  $>10,000$  ppm). The Ministry of Environment has no objections to the continued use of these products.

The most commonly used dust-abatement compounds by the Forest Service are calcium and magnesium chloride and ligninsulfonates. They are used on a limited basis and at low application rates, as compared to areas where the most noticeable effects are seen. Based on the literature review and typical application rates for dust abatement used by the Forest Service, the effects from these compounds to plants and animals would be negligible. The use of one compound over another would be more dependent on cost, availability, and local conditions than effects to the environment.

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The majority of the discussion on calcium chloride and ligninsulfonates was taken from Singer et al. (1982). Martin contributed most of the discussion on magnesium chloride (1989).

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**Table 1. Rainbow Trout 96-hour LC<sub>50</sub> Dust-Suppressant Results**

| Type                                        | ppm    |
|---------------------------------------------|--------|
| 25 percent Calcium Chloride . . . . .       | 52,000 |
| 35 percent Calcium Chloride . . . . .       | 45,000 |
| 77 percent Calcium Chloride Flake . . . . . | 11,000 |
| 35 percent Magnesium Chloride . . . . .     | 9,000  |
| Sodium Ligninsulfonate . . . . .            | 6,400  |
| Calcium Ligninsulfonate . . . . .           | 5,200  |
| Emulsion Oil . . . . .                      | 200    |
| Sunlight Laundry Detergent . . . . .        | 10     |

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# Construction Certification Program

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## Background

In 1973, the Forest Service initiated a Servicewide Construction Certification Program to ensure quality engineering on all construction activities. The program provides a process for developing necessary skills and measuring the qualifications of personnel administering construction contracts.

It has been very successful—so successful, in fact, that it caught the attention of others, particularly contracting officers. Increased litigation and claims against contracts have increased the need to have qualified contracting officer representatives (COR's) to administer contracts. Property and Procurement is proposing a certification program, mirrored after the Construction Certification Program, for all COR's (service/supply and construction contracts).

In this article, we will take a look at the history of the Construction Certification Program and address areas where ongoing support is needed to ensure the continuing success of the program.

## History

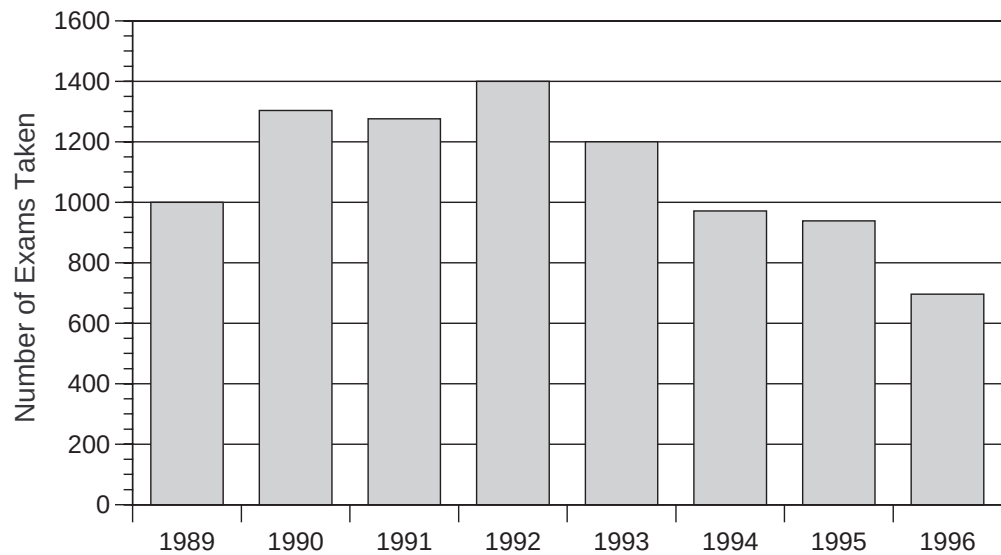
The Construction Certification Program consists of 13 categories—9 technical and 4 administrative. Included in the administrative area are timber sale and public works administration for the inspector and the COR or engineering representative (ER). Each category has a self-study course for reference. Training requirements for certification categories used to help develop individual developmental plans (IDP's) are outlined in each self-study training course.

Figures 1 through 3 show the number of tests administered over the past 6 years and the passing rates of each exam.

As shown in Figure 1, we are administering about half the number of exams we were 6 years ago. This is due primarily to the downsizing of the work force. The overall passing rate has had its highs and lows, but it is slowly creeping downward (see Figure 2). The passing rate in 1996 was just 61 percent, the second consecutive year with that rate, which isn't much higher than our all-time low of 58 percent. As shown in Figure 3, it is apparent which exams are contributing to the downward trend.

## Areas of Concern

A downward trend in certain exam scores is nothing new! Problems usually occur because of insufficient training or because of problems with the content of the exams, such as confusing or misinterpreted questions. In the past, the downward trends have been reversed through increased training opportunities or minor exam modifications. The passing rate for the water

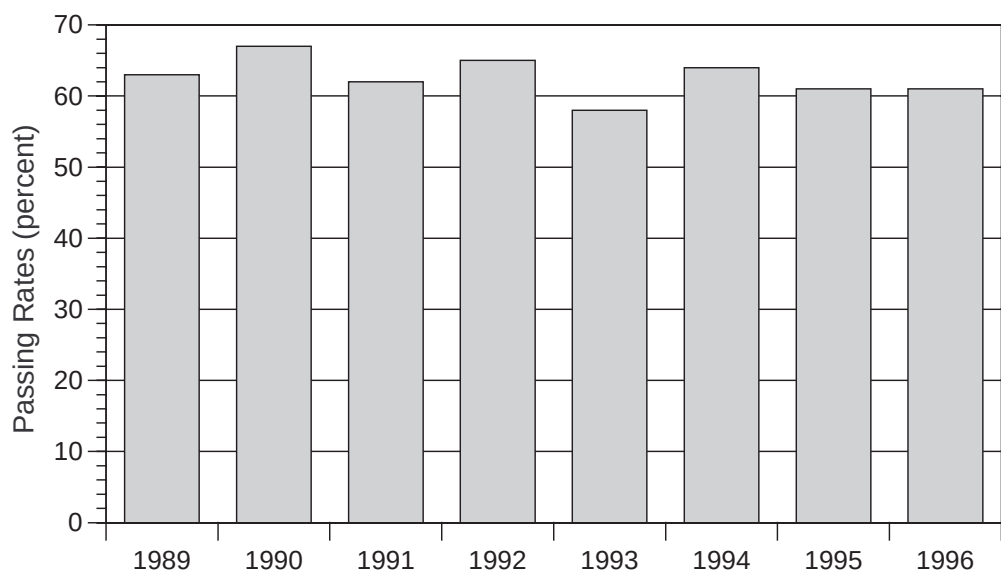


**Figure 1.** *Number of Construction Certification Program Exams Taken, 1989–1996*

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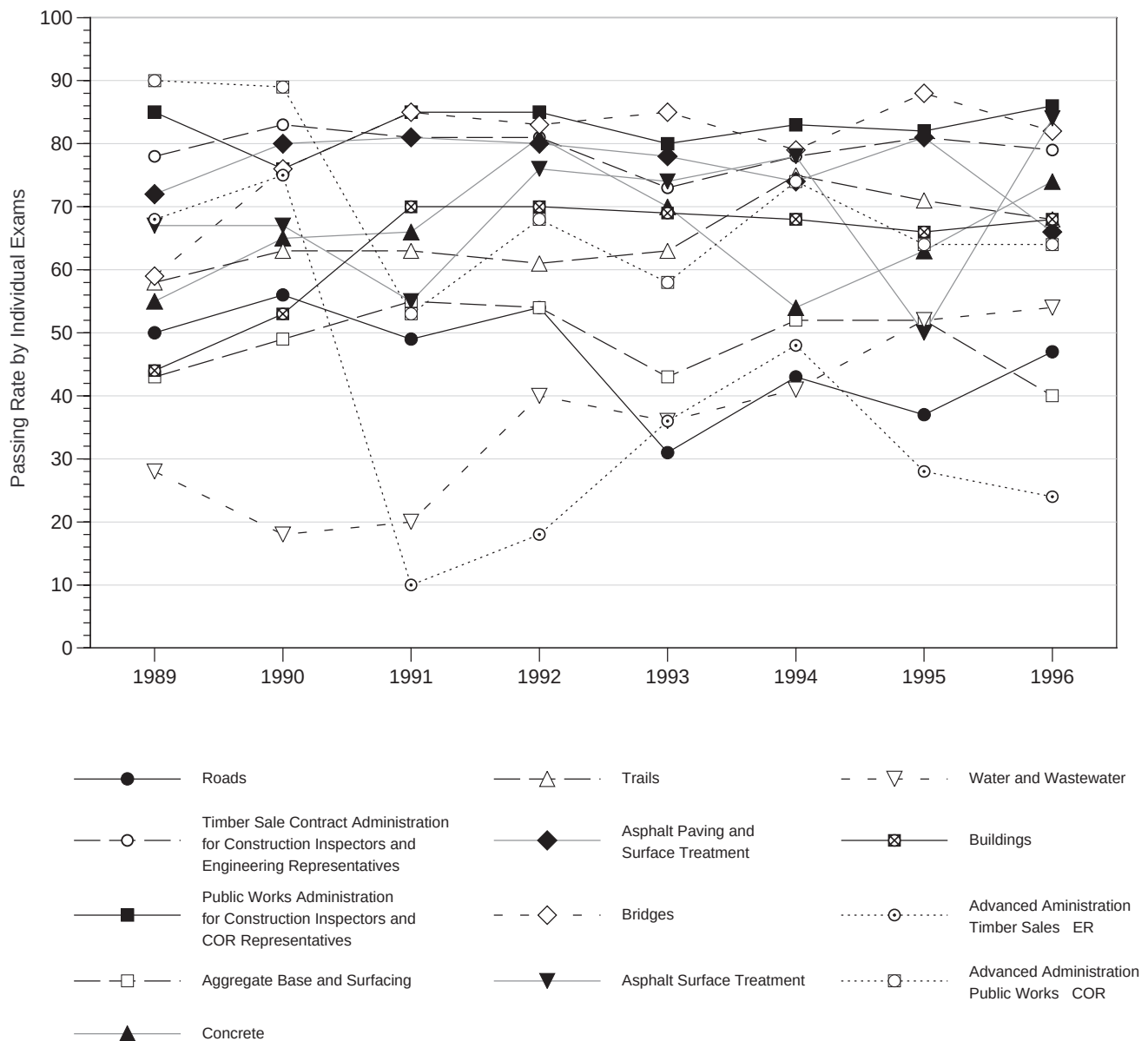
and wastewater exam, which started low, has been slowly but steadily creeping up. This can be attributed to several revisions and improvements that have been made to this exam over the past few years.

Because of the downsizing and the shift of work emphasis, many changes are occurring in our organization. If we look at the passing rates for employees seeking certification, particularly in the areas of timber sale administration, roads, and aggregate base and surfacing, we begin to see



**Figure 2.** *Passing Rates for Construction Certification Program Exams, 1989–1996*

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**Figure 3.** *Passing Rates for Individual Construction Certification Program Exams, 1989–1996*

another downward trend—a result of the changes. The following is a list of possible reasons for these low scores:

1. Time has become a rare commodity. In the past, employees had sufficient time during the normal workday to read through the study guides and prepare for exams. Now we expect the majority of our employees to prepare for exams outside of the workplace. This is not necessarily voiced, but, when no time is left in the workday, no other option is available.
2. On-the-job training is suffering:
  - a. The number of qualified people has dwindled, reducing the opportunities for potential mentors.

- b. The qualified, skilled people who remain are really strapped for time. Demands on these employees are great, and it is understandable how mentoring would have to take a back seat to other demands that hold hard, fast deadlines.
- 3. On the job experience is suffering:
  - a. Budgets are decreasing, which means construction work is down. Types of projects have changed. For example, as the timber sale program declines, so do our timber sale administration test scores. People can't get the experience if the work isn't out there.
  - b. The background of our employees going through the certification program has changed. In the past, it was strictly employees with an engineering background. Now, employees with backgrounds other than engineering are becoming certified and administering construction-type contracts. These folks have little opportunity to gain contract administration experience as part of their normal job.
- 4. Formal training is suffering:
  - a. As previously mentioned, time is a rare commodity. In an attempt to speed up the process, many employees are sent through the exam process by their forest engineers without the formal training or experience.
  - b. Our resources are low. People with the appropriate expertise to conduct a formal training session are in short supply.
- 5. The tests themselves may be contributing to the low passing rates. They may not have changed enough to compensate for the changing scope of work. For example, we are doing more administrative work and less sampling and testing or technical work.
- 6. Attitude may be hurting the program:
  - a. The objective of the exams is to verify that an employee has adequate training and experience to successfully administer construction contracts. Some employees or supervisors see the exams as obstacles. When exams are viewed in this manner, employees are usually given neither adequate training nor sufficient opportunity to gain experience. Some supervisors with this attitude send employees through the exam process first, just to see if they can save time and effort on training. This misses the point! We do not train just to pass the exam; we train to gain competency. At most, the test is only 4 hours long, and we count on statistical averaging to make up for not testing every concept. Would you want to have surgery performed on you by a "doctor" who skipped medical school but learned just enough to pass the medical exam?

- b. People are using the exam as an on-the-job training experience. Employees are nominated for oral exams without adequate training and experience, wasting the time of the oral exam panel and other employees.

## **Conclusion**

I want to stress that the items I have mentioned are generalizations—they are not occurring everywhere. Certainly, item 6 is happening on a very small scale. We may be on the decline, but we're definitely not in the basement. We are still maintaining high passing rates on several exams. We have some very bright, qualified employees currently joining the ranks as certified inspectors and contracting officer representatives.

However, since our work force has changed so drastically, it is important to take a good, hard look at how we can continue to accomplish the work without sacrificing quality. We have a system in place that has served us well, but it takes commitment and resources to make it work.







# Engineering Field Notes

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