5 titles

ENGINEERING TECHNICAL INFORMATION SYSTEM

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Field Notes

Volume 7 Number 3 March 1975

FOREST SERVICE ● U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

This publication is a monthly newsletter published to exchange engineering information and ideas of a technical or administrative nature among Forest Service personnel. The text in the publication represents the personal opinions of the respective author and must not be construed as recommended or approved procedures, mandatory instructions, or policy, except by FSM references. Because of the type of material in the publication, all engineers and engineering technicians should read each issue; however, this publication is not intended exclusively for engineers.

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Invitation to Readers: Every reader is a potential author of an article for FIELD NOTES. If you have a news item or short article you would like to share with other Engineers, we invite you to submit it to FIELD NOTES for publication.

Material submitted to the Washington Office for publication should be reviewed by the respective Regional Office to see that the information is current, timely, technically accurate, informative, and of interest to engineers Service-wide (FSM 7113). The length of material submitted may vary from several short sentences to several typewritten pages. However, short articles or news items are preferred. The Washington Office will edit for grammar only. All material submitted to the Washington Office should be typed double-spaced, and all illustrations should be original drawings or glossy black and white photos.

Each Region has an Information Coordinator to whom field personnel should submit both questions and material for publication. The Coordinators are:

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Coordinators should direct questions concerning format, editing, publishing dates, etc., to Rita Wright, Editorial Assistant, Engineering Staff Unit, Forest Service, USDA, Washington, D.C. 20250.

ALTERNATIVES WITH DIFFERENT STRUCTURAL LIVES

By Theodore E. Gump
Transportation Systems Analyst, Siuslaw National Forest, Region 6

Many times, in analyzing structures, alternative systems with different structural lives must be evaluated. This raises the question, "How can you evaluate alternatives with different structural lives?"

This question is answered by applying the mathematics of compound interest, as demonstrated in *Principles of Engineering Economy.*[1] It was also alluded to in a recent FIELD NOTES article by Ron Schmidt, "Large Arch Culverts Versus Bridges."[2]

Let's take the example of a bridge study. The two alternatives which we will consider are an untreated wooden bridge and a treated wooden bridge.

- Alternative **A** (untreated) has an initial cost of $5,000 and a life span of 10 years.
- Alternative **B** (treated) has an initial cost of $6,000 and a life span of 15 years.

Here we have alternatives with different structural lives. Actually, it is extremely difficult to select alternatives which serve the design objective and have the same structural life, so we are compelled to deal with different structural lives, different initial costs, and different maintenance costs. In this discussion, we are ignoring any annual savings or cost in maintenance and will assume that this is the same for each structure. Our comparison, therefore, will be concerned with the premise that the additional investment of $1,000 for the treated bridge could be an advantage in that we will get an additional 5 years of use.

Since we do not have any other choice but to compare alternatives with different structural lives, how do we proceed? One of the first steps is to select a least common denominator in terms of time. In the case under discussion, this would be 30 years. We can display this situation with cash flow diagrams, such as Figure 1.

[1] *Grant, Eugene L. and W. Grant Ireson,* ***Principles of Engineering Economy****, 5th Ed., Ronald Press Co., 1970.*
[2] *Schmidt, Ron, "Large Arch Culverts Versus Bridges," FIELD NOTES, Vol. 6, No. 7, July 1974.*

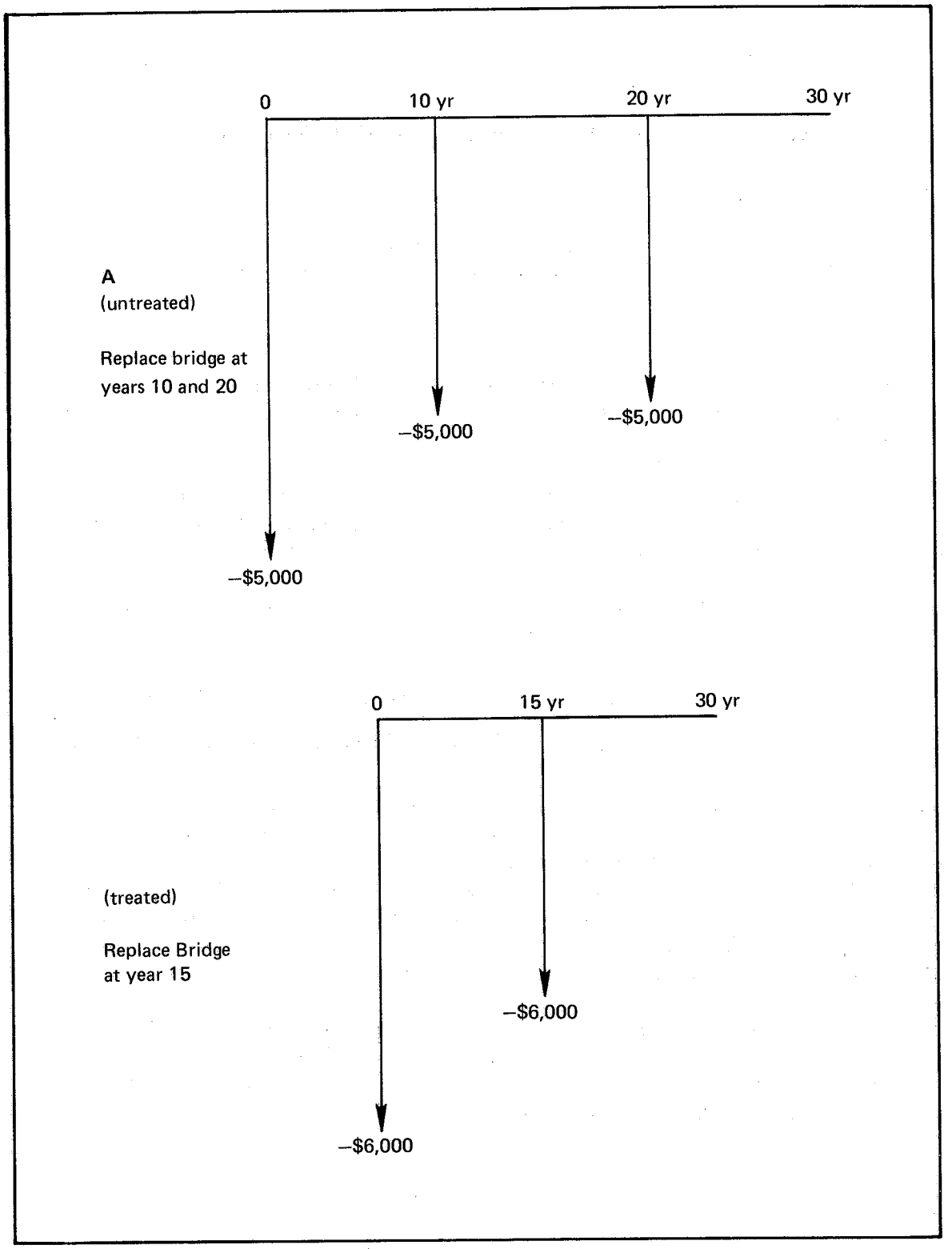

Figure 1. – Cash Flow Diagrams.

The next step is to determine the present worth or the annual cost of both. It does not make any difference in the ranking which method is used.

PRESENT WORTH

To use the Present Worth method, take all costs, discount them by compound interest back to the present time, and total them to provide the present value of all the costs.

Present Worth = Present cost plus later costs times a Present Worth Factor P/E

Present Worth Factor is derived from interest tables which consider the interest rate selected and the years back to the present. A formula will show this notation by (pwf %, n), which means present worth factor for x% interest for n years.

A (untreated)

PW = \$5,000 + \$5,000 (pwf, %, n) + \$5,000 (pwf, %, n)
= \$5,000 + \$5,000 (pwf, 6%, 10 yr) + \$5,000 (pwf, 6%, 20 yr)
= \$5,000 + \$5,000 (0.5584) + \$5,000 (0.3118)
= \$5,000 + \$2,792 + \$1,559
PW = \$9,351.00

B (treated)

PW = \$6,000 + \$6,000 (pwf, 6%, 15 yr)
= \$6,000 + \$2,503.59
PW = \$8,503.59

We see that alternative **B** has the lower present worth and is, therefore, the better economic solution.

ANNUAL COST

To use the Annual Cost method, take all costs and convert them to an annual cost per year during the time span being considered. It is like the conversion made to obtain annual monthly payments on a car.

Capitol Recovery Factor is derived from interest tables which consider the interest rate selected and the span of years being considered and convert the cost to annual cost. A formula will show this notation by (crf, i, n).

A (untreated)	PW	= $9,351
	AC	= PW (crf, i, n)
		= $9,351 (crf, 6%, 30 yr)
		= $9,351 (0.07265)
	AC	= $679.34
B (treated)	PW	= $8,503.59
	AC	= PW (crf, 6%, 30 yr)
		= $8,503.59 (0.07265)
	AC	= $617.78

Alternative **B** (treated bridge) has the lower annual cost and, therefore, it appears to be the better economic choice. Both the present worth and annual cost methods show the treated bridge to be the better economic solution.

SHORTCUT

In reality, we can compare these two alternatives by ignoring the differences in the time frame. If we use the annual cost method for the actual length of life, we obtain the shortcut approach below:

A (untreated)	AC	= Construction cost (crf, 6%, 10 yr)
		= $5,000 (.13587)
	AC	= $679.34
B (treated)	AC	= Construction cost (crf, 6%, 15 yr)
		= $6,000 (.10296)
	AC	= $617.78

Note that we came up with the same annual cost as by using the time common denominator method. The time frame method is best used when you can forecast different costs and interest rates for the future and you want present worth or annual costs.

The shortcut method will not give you the true present worth; for example, the present worth using the shortcut method would be $5,000 for the untreated bridge and $6,000 for the treated bridge. The reason why the shortcut method works for annual cost is that the estimated life is reflected in the annual cost calculation factors (called "capitol recovery" by economists).

It is not the purpose of this article to get involved in the decisionmaking process, or to deal with sensitivity analysis or probability analysis. The purpose is to illustrate that alternatives with different lives can be compared.

***Editor's Note**: Readers may question the use of this article since it provides a textbook analysis of a very simple problem. We believe that the occasional use of such writeups as this will remind many engineers that a long-forgotten procedure may have application to present problems and will inform other readers that such a solution to a problem exists. In engineering economics, compound interest is usually applied to complex problems involving many time flows and a difficult selection of interest rates. Persons using this method should request help if there are questions concerning the process.*

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THE TIMBER SALE ACTION PLAN; PROPOSED APPLICATION OF EDP TECHNIQUES

By John F. Daniel
Program Engineer, Region 2

The correlation of the forest road development and maintenance (FR&T) program with the Timber Sale Action Plan has been a major concern at all levels of management for some time. The basic problem appears to be that the worksheet form used for the Timber Sale Action Plan, the basis for correlation, is developed and updated by handwritten entries. This manual method causes a significant degree of inflexibility in reporting the project changes on all copies of the Timber Sale Action Plan maintained by the Ranger District, the Forest Supervisor's Office, and the Regional Office.

Any changes in the timing of an individual timber sale may necessitate a complete revision of the Timber Sale Action Plan as well as the FR&T program of work when the change revises the needs for system road development. Also, a change in the FR&T program of work may have an impact on the Timber Sale Action Plan and necessitate a change in the preparation activities of one or more individual timber sales.

Seldom, if ever, does the Timber Sale Action Plan, at all levels of management, reflect all the changes that have occurred during the fiscal year. By using electronic data processing procedures, the Timber Sale Action Plan and the associated FR&T program of work can be developed, kept up to date, and made available to all levels of management.

Using two data input forms for initial entry and update – R2-2430-21, Timber Sale Data Input Sheet–Timber Related Activity, and R2-7700-27, Facility Data Input Sheet – the following information printouts can be provided through Electronic Data Processing (EDP) procedures:

- 2430-10 (CPO) – Timber, Timber Sale Data and Activity Schedule (by Sale)
- 2430-10 (CPO) – Road, Timber Sale Data and Activity Schedule (by Sale)
- 2430-11 (CPO)[3] – Timber, Timber Sale Action Plan for Fiscal Year _____ (Timber Related Activities listed by sale with summaries by District, Forest, State, and Region)
- 2430-11 (CPO)[3] – Road, Timber Sale Action Plan for Fiscal Year _____ (System Road Related Activities listed for each road development and maintenance project by sale with summaries by District, Forest, State, and Region)

[3] *The data on 2430-11 (CPO) and 2430-12 (CPO) can be combined and presented on a single printout.*

- 2430-12 (CPO)[4] – Timber, Timber Sale Action Plan for Fiscal Year _____ (Estimated Costs for Timber Related Activities listed by sale with summaries by District, Forest, State, and Region)

- 2430-12 (CPO)[4] – Road, Timber Sale Action Plan for Fiscal Year _____ (Estimated Costs for Road Related Activities listed for each road development and maintenance project by sale with summaries by District, Forest, State, and Region)

The Timber Sale Input Data for the timber related and road related activities for the individual sale, being current and up-to-date, will provide information in a readily available form for all levels of management. EDP techniques provide excellent opportunities for disseminating information without having to request it from the field. For instance, the Regional Office can obtain such information as the number of sales, sale names, and sale volumes planned in which the timber purchaser will provide the road survey, supplemental FR&T funds are required, and the timber purchaser is required to perform the construction staking.

The program is so flexible that the planning input information would be the only constraint in regard to the time period of program data output. For instance, it would be possible to schedule an entire timber sale program for a given subunit over a 10-year period. It is also possible that the input data can be manipulated by EDP techniques to furnish information to be included in the budget program. The resultant program data will provide the output information that is now contained in Form 7700-30 (CPO), Timber Purchaser Construction and Maintenance, as well as that included in Form 7700-16 (CPO), Annual Program of Work on Transportation System, for those items of work pertinent to the timber sale program.

The correlation between the timber related activities and the system road related activities pertaining to a given timber sale has been attained through the use of a project number and type in the basic address portion of the data input sheets for each activity. The letter *T* is the designated type code for system road development and maintenance activities associated with the Timber Sale Action Plan. The project number is that number shown on the Form 2400-25a, Timber Inventory Adjustment, or as assigned by the Forest.

The major change in the proposed FR&T program data input Form 7700-27, Facility Data Input Sheet, is that the present form is a single-fiscal-year input while the proposed form is a multi-fiscal-year document. This feature is accomplished through the use of activity code numerics for various system road related activities and the assigned responsibility for the accomplishment of the activity on a fiscal year basis.

The input documents are to be submitted by the District Ranger with assistance from the Forest Engineer. Output printouts are to be returned to the Ranger District. Copies of these printouts, as well as summary data outputs, can be provided to the Forest Supervisor's Office and to the Regional Office when requested.

[4] *The data on 2430-11 (CPO) and 2430-12 (CPO) can be combined and presented on a single printout.*

Region 2 is planning to have the EDP program for accomplishing this application "up and running" by February 1, 1975. For further information call John F. Daniel on 303-234-4892.

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HELICOPTER LIFT AIDS TRAIL-BRIDGE CONSTRUCTION

By Ted Zealley
Sierra National Forest, Region 5

BACKGROUND

The Quail Meadow Bridge over Mono Creek in the Sierra National Forest is approximately 2 miles by trail above Lake Thomas A. Edison at an elevation of 8,000 feet.

Earlier structures over Mono Creek failed because of heavy eccentric snow loads. The most recent structure was a two-span truss structure, one span being 60 feet long and the other 15 feet long. Because there was no safe alternate route for hikers and stock traffic, the bridge had to be rebuilt when the 60-foot span needed to be replaced.

DESIGN CONSIDERATIONS

Since the bridge is located in the John Muir Wilderness, it could not be replaced by conventional means. After considering alternative methods of construction, it was decided to replace the main span with two, 60-foot, glued-laminated girders to be set in place by helicopter. Therefore, weight became an important design consideration.

Steel beams were considered but rejected because of weight and the shortage of structural steel. The short time between the date of authorization of the project and the end of the fiscal year, and the need to replace the span before the heavy use season, did not permit waiting for delivery of structural steel. Similar problems, plus long erection time, were deciding factors against a truss structure.

The selection of the glu-lams did present a problem of matching deck elevations between the remaining 15-foot span and the new 60-foot span. Abutment elevations could not be changed and the required depth of the glu-lams raised the top of the girders above the deck elevation of the existing span. This problem was solved, as shown in Figure 1, by constructing hips or steps in the glu-lams.

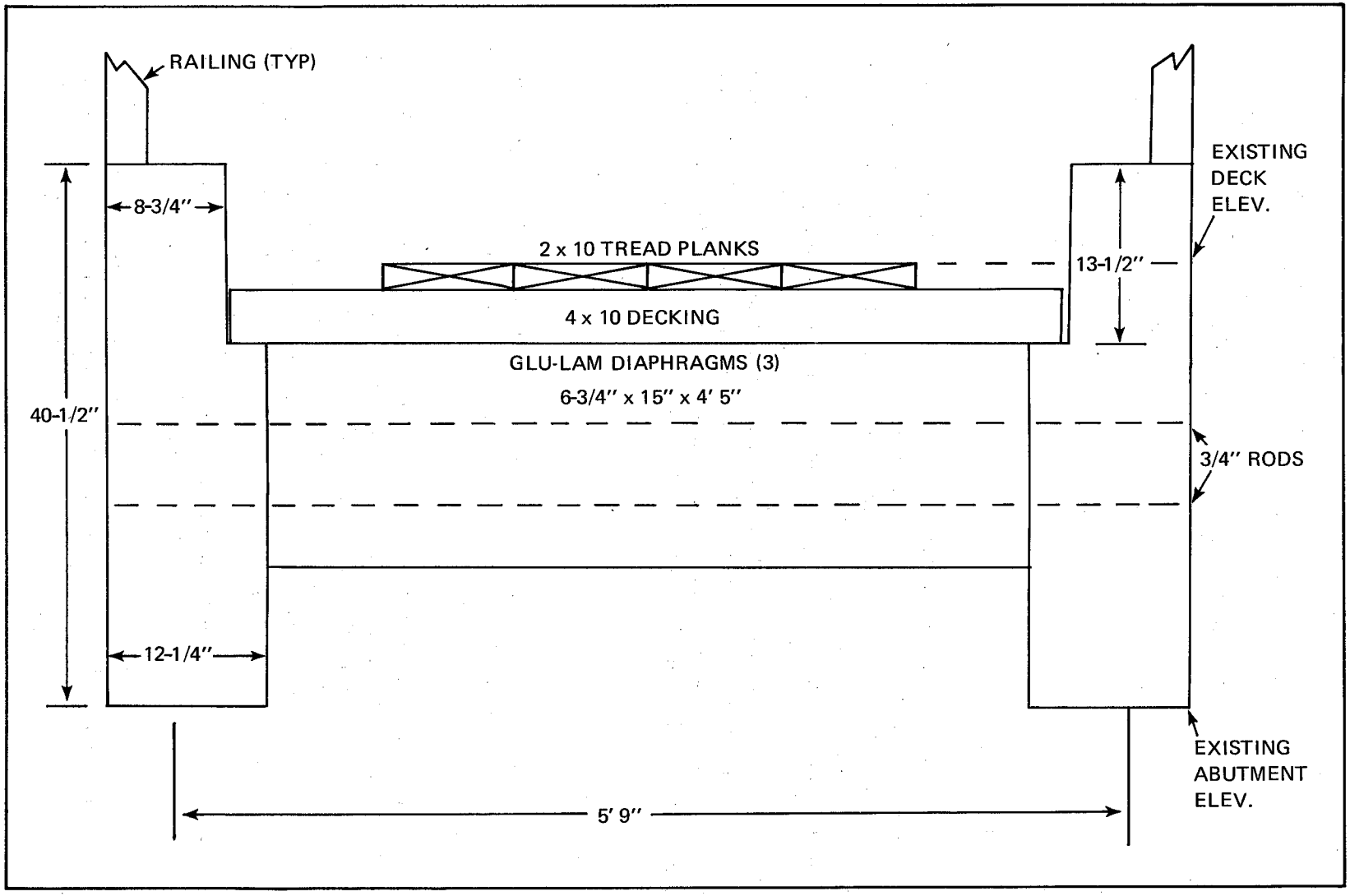

Figure 1. — Construction of Hips or Steps to Obtain Abutment Elevation.

The glu-lam girders were fabricated by Architectural Wood Products of Fresno, California. Pentachlorophenol in hydrocarbon solvent Type B, full ground contact preservative treatment, was specified to reduce girder weight by approximately 500 pounds each below the weight of the girders if heavy, petroleum-borne preservative had been used. Incidentally, this treatment resulted in a natural wood finish, rather than the dark creosote color normally associated with treated timber bridges, which was compatible with the surroundings. Individual laminate members of the girders had to be treated with this LP gas-borne treatment prior to fabrication. Fabrication of the treated lumber presented a safety hazard to the fabricator, since the residual LP gas can and did cause small fires during the gluing and electronic drying of the butt joints.

HELICOPTER SELECTION

After procuring Regional Forester approval to use a helicopter in the Wilderness prior to the recreation season, selection of the helicopter commenced. Negotiations to secure helicopter services and select the helicopter for the lift were conducted as the design was being completed. The design weight had to match the lift capabilities of the helicopter. Lifting a weight of 6,500 pounds (final weight of each girder) would not present a great problem in some locations. However, the elevation and temperature considerations narrowed possible helicopter choices to two. One was eliminated because a minor temperature increase above ideal conditions at the project elevation would have forced cancellation of the lift by that helicopter. The helicopter selected for the lift was a Sikorsky S-64 Sky Crane owned and operated by Erickson Air Crane, Inc. of Marysville, California.

CONSTRUCTION

In late May, a Forest Service crew under the direction of Don Clark and Hugh Smith started preparation of the site for the new span. The old span was removed and the glu-lams were trucked to Edison Lake Dam in early June.

The actual lift was postponed twice because of mechanical problems with the helicopter. However, the chopper arrived at Edison Lake the morning of June 17. Once crews were in place at the dam and the bridge site, the 6-mile lift of girders and decking material commenced. Rigging and hookup at the dam and spotting of the girders at the bridge site was conducted under the direction of personnel from Erickson Air Crane, Inc. Three lifts were made to the bridge site, with material salvaged from the old structure being lifted out of the Wilderness on return trips. Total flight time for all lifts was approximately 1 hour. The girders were placed within 3 inches of the predrilled abutment holes despite a 25-knot wind blowing up the canyon, perpendicular to the long axis of the girders.

Once the girders were set in place, the bridge was completed by Forest crews within a week. A safe bridge, compatible with its surroundings, had been placed in time to meet the demands of the heavy recreation season. The photographs in Figures 2, 3, and 4 show the bridge in various stages of construction.

Figure 2. – Bridge Site Ready for Placement of Beams.

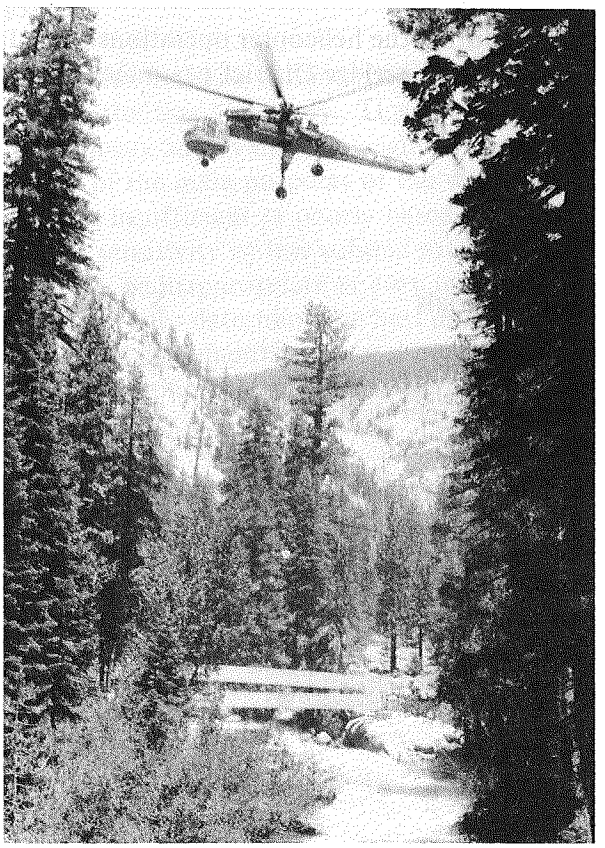

Figure 3. – Second Beam Being Lowered.

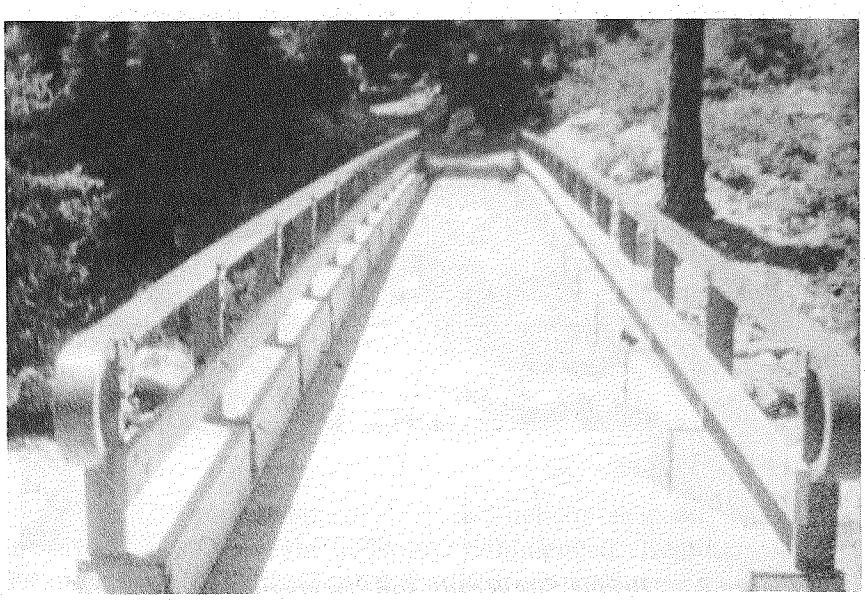

Figure 4. – Completed Structure.

Safety was of prime importance during the helicopter operations. The task of controlling tourists and the general public fell to Pineridge District personnel, thus freeing engineering personnel for the construction job.

APPROXIMATE PROJECT COSTS

Bridge materials	$ 9,500
Helicopter	$12,250
Labor, travel, per diem	$18,000

It should be noted that labor costs were increased by about $3,000 due to dry runs to the bridge site caused by helicopter mechanical failures. Use of the helicopter greatly reduced the length of time needed to do the job and allowed installation of a more suitable bridge for this site.

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TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

LOW VOLUME ROAD WORKSHOP

Plans are well under way for the Transportation Research Board's (TRB) workshop on low volume roads in Boise, Idaho, June 16–19, 1975. The meeting has received the support and endorsement of many segments of the highway profession. This will be an important workshop for the Forest Service. The Forest Service is one of the cooperators, along with the Federal Highway Administration, the World Bank, the International Road Federation, the National Association of County Engineers, the Idaho Department of Transportation, and the University of Idaho.

It is becoming increasingly clear that low volume roads in the United States and elsewhere have not received sufficient attention and study. These roads have generally been overlooked and neglected by highway administrators, engineering practitioners, researchers, and engineering educators. One of the main purposes of the workshop will be to identify those areas where our knowledge is insufficient or poorly based with respect to low volume roads. Because of the extreme cost sensitivity of low volume roads, the methods and practices used for higher standard roads may be inappropriate or even incorrect when applied to low volume roads. Our challenge and need is to determine the best mix of cost restraint and efficiency in planning, designing, constructing, maintaining, and operating low volume roads. The TRB Workshop is only one step, but nonetheless a very important one, toward determining what the mix should be.

The TRB task force that is planning this workshop has established the agenda outlined below. Please bear in mind that the agenda is tentative and is subject to changes, particularly with respect to the availability of the identified speakers. It is presented here so that you can get an overview of the subject matter of the workshop.

June 16

Welcoming remarks:

- Governor of Idaho, C. Andrus
- Idaho Director of Transportation, D.V. Manning

- Executive Director of TRB, W.N. Carey, Jr.
- TRB Task Force Chairman, E.J. Yoder, Purdue University

Invited Papers:

- *Are Low Volume Roads Unique?* – C. Oglesby, Stanford University
- *The Importance of Low Volume Roads in Developing Countries* – C. Harral, World Bank
- *Construction in Developing Countries* – W.C. LaBaugh, Consultant
- *Transportation Planning for Forest Service Roads* – E.C. Sullivan, University of California
- *Transportation Planning for County Roads* – W.G. Harrington, National Association of County Engineers
- *Low Volume Roads in Military Operations* – J.P. Sale, U.S. Army Corps of Engineers
- *Managing a 200,000 Mile Road System – Opportunity and Challenge* – M.R. Howlett, Forest Service

June 17

Field Trip to Boise National Forest:

- Boise Cascade Mill, Oregon Trail, Diversion Dam, Lucky Peak Dam
- Tree Nursery, Old Toll Road, State Highway 21, Thorn Creek Fire, Dredging, Idaho City
- Forest Highway 21, Mores Creek Summit, Idaho Batholyth, Edna Creek Campground
- Smokejumping Demonstration, Little Owl–Willow Creek Road, Road Widening, Timber Sale
- Slash Disposal, Dust Abatement, 25% Fund, Crooked River Bridge, Helicopter Logging, Rabbit Creek–Granite Creek Road
- Maintenance by Road Crews, Tributary Road, Terminal Road, Erosion Control, Bank Stabilization
- And much more

June 18

Six concurrent workshops and discussions covering the following accepted papers (abbreviated titles):

Simplified Slope Design
Construction Staking
Timber Cribs
Precast Bridges
Decision Criteria for Retaining Walls
Minimizing Flood Damage
Drainage Design Procedures
Computer Aided Design
Analysis of Route Alternates
Soil Lime Stabilization
Load Support Capability for Low Volume Roads
Pavements for Low Volume Roads
Performance of Asphalt Stabilized Sand Road
Benkleman Beam on Canadian Forest Roads
Thickness Equivalency Values
Asphalt-Rubber for Low Volume Roads
Estimating Traffic
Operating Costs
Rates of Deterioration
Cost Models
The Kenya Road
Economical Bridge Structures
Minutemen Roads
Canadian Forest Road Classification
Optimizing the Transport of Rock
Maintenance Criteria
Maintenance Levels for Forest Roads

June 19

- Reports of the Workshop Session Chairmen
- Summary of Workshop – TRB Task Force Chairman

Announcements regarding the workshop are beginning to appear in industry newsletters, technical journals, and professional magazines. More announcements are expected in March, April, and May. Preregistration information should be available from the Transportation Research Board some time in March. A substantial discount will be offered for early registration.

The Forest Service administers one of the largest road systems in the world. We should have much to contribute and much to learn at this workshop. A letter of authorization for attendance at this meeting will be issued by the Washington Office.

OPERATIONS

Harold L. Strickland
Assistant Director

FOREST HIGHWAY SYSTEM AND PROGRAMS

The Federal-Aid Highway Act of 1973 established a requirement that Forest Highways be on the Federal-Aid System. This has caused the effectiveness of the Forest Highway System to erode severely.

The Federal-Aid System (FAS) is being aligned under newly established National Highway Functional Classification criteria. Realignment under the new criteria will greatly reduce the number of miles eligible for the Forest Highway System. It will shift the system to include major highways and delete important rural highways. Significant access gaps will be created between the National Forest development road system and the new FAS. In addition, highways formerly eligible for the Forest Highway program, which are of great importance to counties and communities dependent upon the resources of the National Forests, will be without an important source of funding.

This past summer, the Federal Highway Administration (FHWA) had field trips with Department of Transportation (DOT), and Office of Management and Budget (OMB) officials. As a result, these officials obtained a better understanding of the uniqueness, need, and importance of the Forest Highway program. An opportunity to reexamine the Forest Highway program was opened for FHWA.

In November 1974, Bruce Meinders of Region 1, Stan Thorn of Region 6, and Cliff Miller of Region 4 worked with Washington Office Engineering and Federal Highway Administration members in an effort to change the Forest Highway System, programs and procedures. Washington, Idaho, and Utah were selected as samples to study for a fresh look at the

Forest Highway System. State FHWA Division Engineers prepared maps showing the situation created by current highway functional classification. Regions 1, 4, and 6 prepared maps as they foresaw the revised Forest Highway system. These maps, together with the current Federal-Aid Highway Act and regulations for Administration of the Forest Highway System, were reviewed.

The following changes in the Forest Highway System were proposed to emphasize that its primary purpose is to fulfill needs in rural areas:

- Change the law to eliminate the requirement that Forest Highways must *all* be on the Federal-Aid System.
- Through new Joint Regulations between DOT, FHWA, and USDA, Forest Service redefine the Forest Highway System to fit new needs effected by the FAS realignment.
- Establish two classes of Forest Highways:

  Class 1 – Not coincident with the Federal-Aid System
  Class 2 – Coincident with the Federal-Aid System
- Establish a mandatory allocation level for Forest Highway funds to the new Class 1 highways.
- Establish new criteria for the Forest Highway System.
- Spell out procedures for adopting and modifying the Forest Highway System.

A draft of proposed new Joint Regulations has been prepared and is being reviewed by the Regions. In addition, the Federal Highway Administration is initiating action to effect the law change through an upcoming Omnibus Bill and coordination proposals with States.

Hopefully, through the coordinated efforts of the Forest Service and the Federal Highway Administration and States, the Forest Highway System and programs can be reoriented to better serve the needs of communities dependent on the resources of the National Forests.

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GPO 886-504