

**ENGINEERING
TECHNICAL
INFORMATION
SYSTEM**

FIELD NOTES • TECHNICAL REPORTS • TEXTS
DATA RETRIEVAL • CURRENT AWARENESS

Field **Notes**

Volume 6 Number 12 December 1974

Calculating Weight in Pounds from Liquid Flow in Gallons
per day and Subject Chemical or Contaminant in Milligrams
per liter.

Aggregate Base Reduction by Grid Rolling

Washington Office Engineering News



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.

This publication is not intended to be exclusively for engineers. However, because of the type of material in the publication, all engineers and engineering technicians should read each issue.

This publication is distributed from the Washington Office directly to all Regional, Station, and Area Headquarters. If you are not now receiving a copy and would like one, ask your Office Manager or the Regional Information Coordinator to increase the number of copies sent to your office. Use Form 7100-60 for this purpose. Copies of back issues are also available from the Washington Office and can be ordered on Form 7100-60.

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 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:

R-1	Bob Hinshaw	R-6	Kjell Bakke
R-2	Allen Groven	R-8	Ernest Quinn
R-3	Bill Strohschein	R-9	Ron Pokrandt
R-4	Fleet Stanton	R-10	Bill Vischer
R-5	Jim McCoy	WO	Al Colley

Coordinators should direct questions concerning format, editing, publishing dates, etc., to Fran Owsley, Editor, Division of Engineering, Forest Service, USDA, Washington, D. C. 20250.

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FIELD NOTES

CALCULATING WEIGHT IN POUNDS FROM LIQUID FLOW IN GALLONS PER DAY AND SUBJECT CHEMICAL OR CONTAMINANT IN MILLIGRAMS PER LITER

By Bill Sweany
Region 8

The Environmental Protection Agency generally requires that weight in pounds of BOD-5 and suspended solids be reported at least once each month to comply with National Pollutant Discharge Elimination System (NPDES) discharge permits. This information must be calculated from flow and BOD-5 and suspended solids concentrations.

A circular calculator devised in Region 8, that will make these calculations fast and simple, is shown in Figure 1. As an added benefit, this calculator may be used to calculate pounds of chlorine or other chemical additives, computed from gallons per day (GPD) and milligrams per liter (mg/l).

The calculator is based on a circular logarithmic scale. The examples below will give an idea of how it can be used.

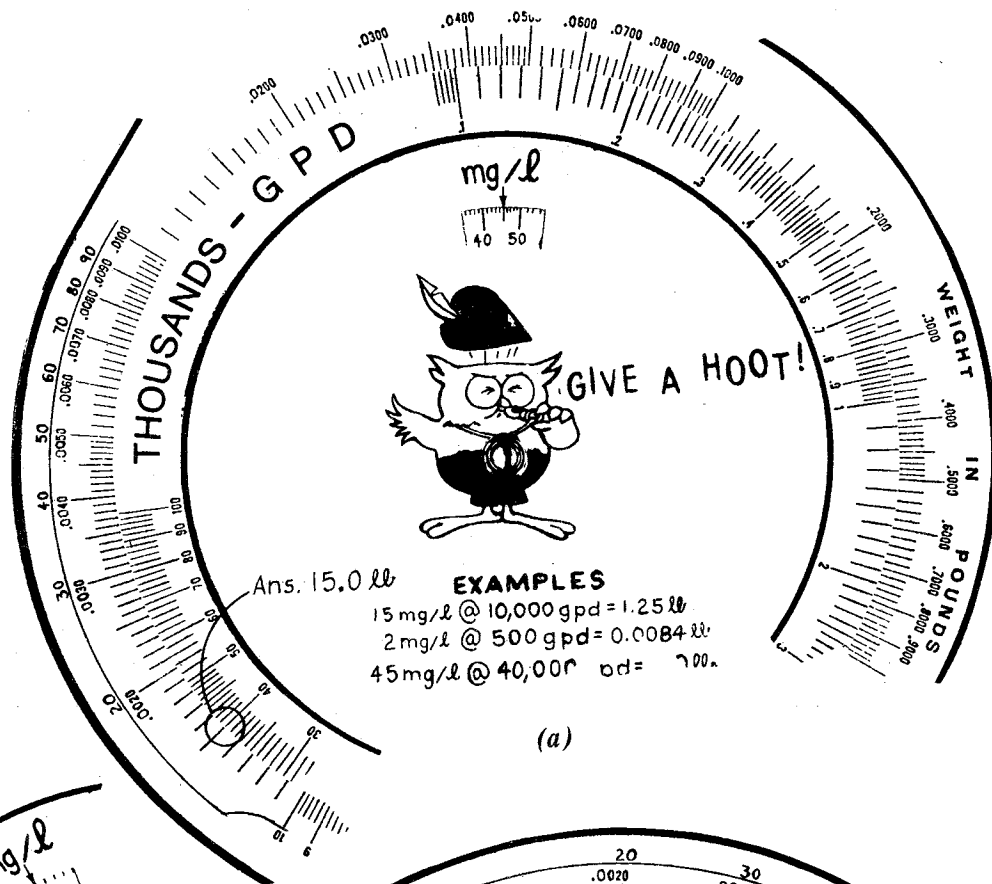
Problem: Determine the weight in pounds of BOD-5 when 40,000 GPD are flowing from a sewage treatment plant and the lab report for that day shows an effluent of 45 mg/l of BOD-5.

Calculator method: Set BOD-5 of 45 mg/l in the window under the mg/l arrow as in Figure 1 (a). Find 40 on the inner circle (thousands of GPD) and read the answer on the outer circle (pounds of BOD-5). **Answer:** 15.0 lb of BOD-5.

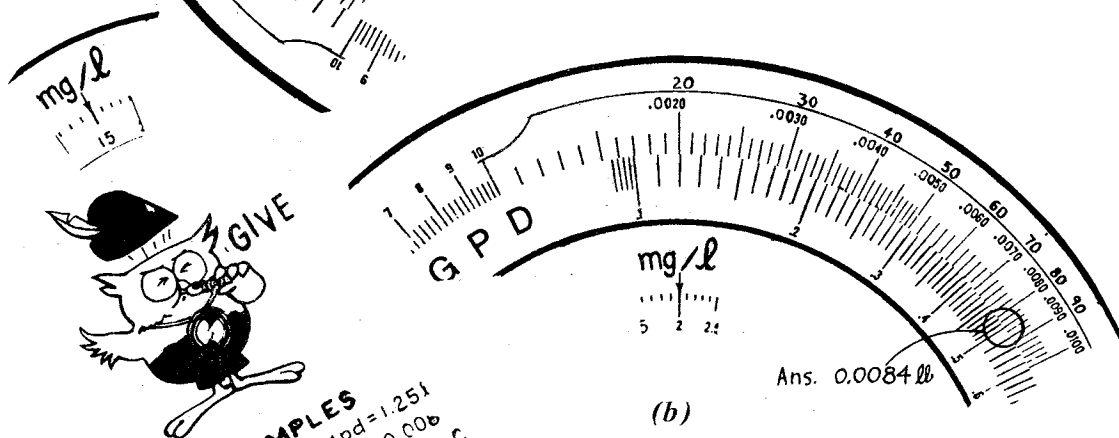
Problem: For a suspended solids reading of 2 mg/l and a flow of 500 GPD, determine the weight in pounds of suspended solids. **Calculator method:** Set a 2.0 mg/l in the window as shown in Figure 1 (b). Find 0.5 (thousands of GPD) on the inner circle, and read the suspended solids value on the outer circle. **Answer:** 0.0084 lb.

Problem: Calculate the gas chlorinator setting necessary to achieve a 15 mg/l dose rate for a 10,000 GPD flow. **Calculator method:** Set 15 mg/l in the window as in Figure 1 (c). Read the answer on the outer circle opposite 10 on the inner circle. **Answer:** 1.25 lb.

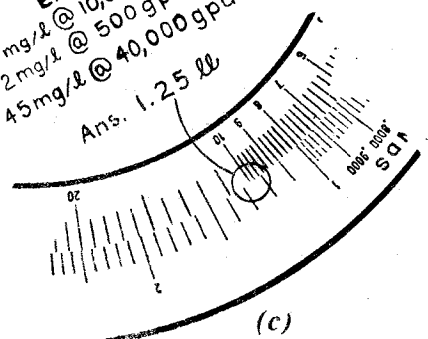
The components necessary to make these calculators are shown in Figures 2 and 3. They are made of cardboard and may be laminated with clear plastic prior to assembly for greater durability. The components are available from Region 8 Engineering, if you need them.



(a)



(b)



(c)

Figure 1. — Circular Calculator

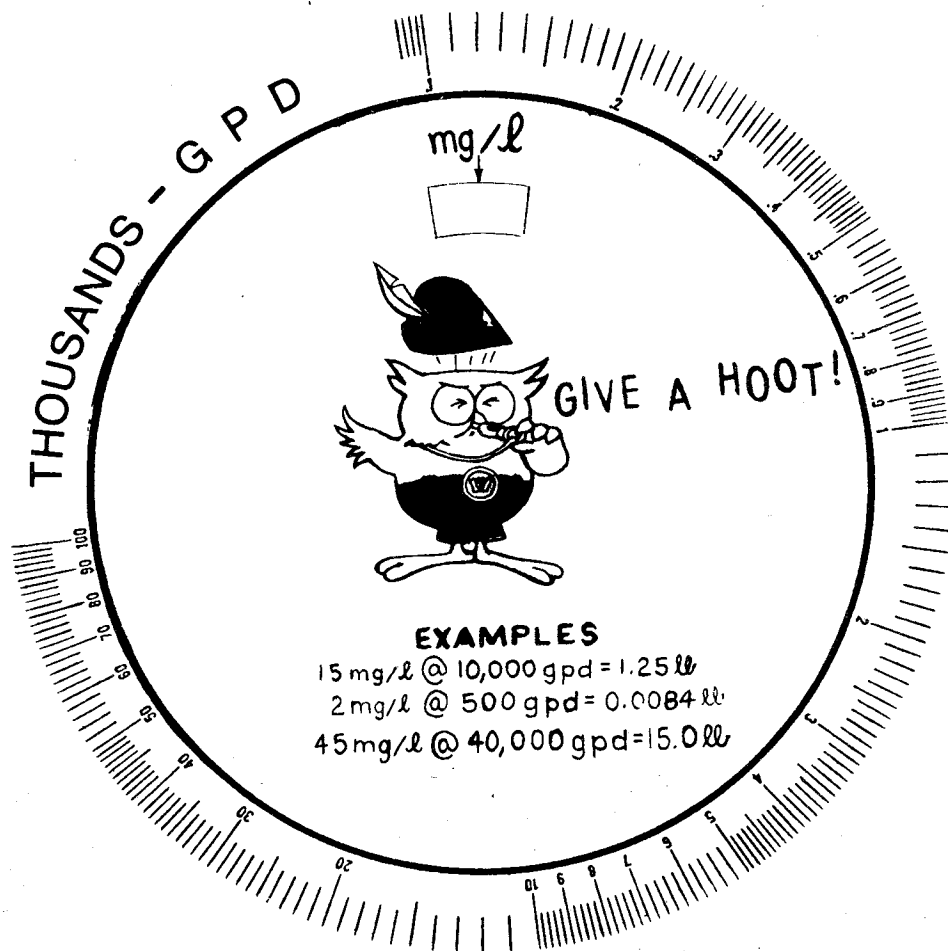


Figure 2. — Inner Circle Component

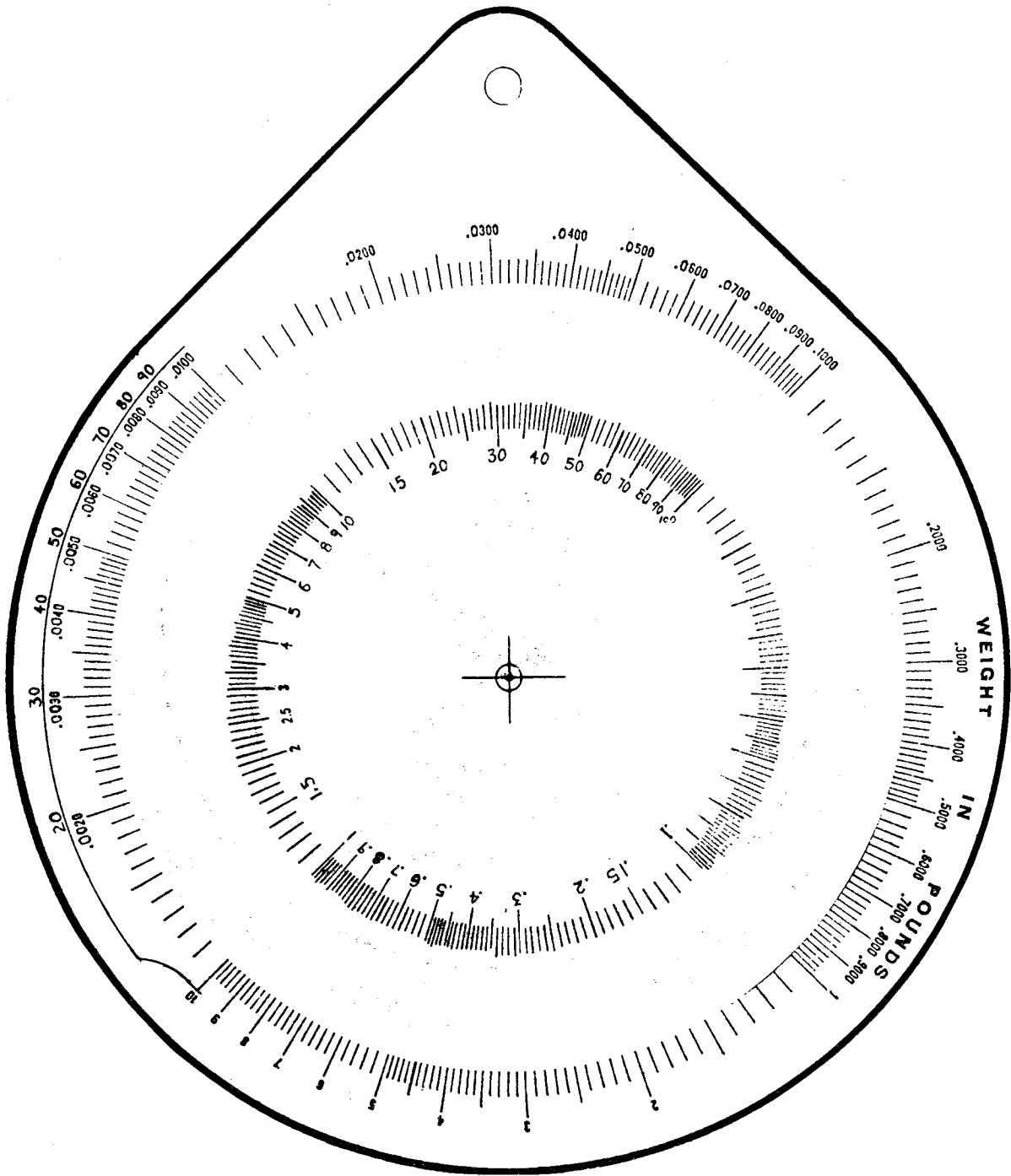


Figure 3. — Outer Circle Component

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AGGREGATE BASE REDUCTION BY GRID ROLLING

By Pat Riley

Materials Engineer, Shasta-Trinity National Forest

Grid rolling as a means to obtain reduction of aggregate material has been employed on the Shasta-Trinity for a number of years. A wide variety of materials has been processed in this manner, ranging from cinders to chert. This method, with minor exceptions, has proven to be a satisfactory and economical means of providing structural stability to the roadbed. By applying the principles of soil mechanics to past experiences we have empirically derived a process of analysis based on rock behavior and properties. We have found that certain lithologies do not produce material suitable for grid rolling. Specifically, granite, ultrabasic rocks, and schist may produce too many fines with high plastic properties. This results in poor riding quality, poor weathering quality, or low stability during traffic and moist conditions. The subgrade moisture content is vital to the control of aggregate depth and breakdown.

In quantifying rock processing we recognize that there are three areas over which control must be exercised: (1) source, (2) method of process, and (3) achievable, *acceptable* end product. In the case of grid rolling, we must be particularly confident about the selection of source because of the limited control available in processing when grid rolling. This is why past experience is important in identifying what combinations of input and processing will produce an acceptable end product. Crushing offers control from input through output. The cost, however, is proportional for the greater degree of control obtained by this method. Grid rolling cost for the benefit of the acceptable product is small compared to crushing.

The typical equipment used in grid rolling operations weighs between 25,000 and 30,000 pounds. The GMP spacing is about 3 inches by 3 inches with a 1-inch bar diameter. The grid rollers are manufactured by such construction equipment companies as Ateco, Caterpillar, Euclid and Hyster. These grid rollers are usually towed by dozers in the D-7 class. However, larger dozers, such as the D-9, are also used in grid rolling operations.

In the determination of grid rolling properties there are several characteristics of rock behavior which must be judged to qualify within the narrow band of acceptable material. The properties sought in base material are low moisture susceptibility, high stability, and low mechanical degradation. In order to achieve these properties of quality base material by grid roll processing, the following identifiable rock parameters have been empirically determined to indicate behavior:

- **Type of lithology (igneous, sedimentary, metamorphic)**
 - Mineralogy and type of origin – durability and weathering properties
 - Rock cleavage or foliation – gradation and maximum size
 - Existence of weather stain – ease of crushing and weathering
 - Hardness – durability
 - Estimated compressive strength – crushing ability
- **Properties exhibited in field**
 - Weathered in-place gradation – actual gradation performance after rolling
 - Fracturing properties – maximum size to be expected
 - Type of fines – stability
 - Behavior in road after weathering and traffic if previously used
 - Lab test as to prediction and verification: (1) breakdown during compaction (T-180 and sieve analysis); (2) sand equivalent
 - Subgrade properties – depth and crushing control: (1) R value at ambient water content; (2) percent fines – infiltration problem

Representative samples of the material are obtained from the aggregate source and analyzed in laboratory tests attempting to duplicate actual field conditions. Sand equivalency and gradation are determined. This may require laboratory crushing if material exceeds 3-inch minus. The material is then compacted to T-180 specifications, and sand equivalency and gradation tests are performed again. The difference between the two tests is indicative of field performance.

The following items are considered after comparing the results of the above tests:

- Examine the percent passing 3/4, #4, and #200 sieves. If an increase occurs after T-180, consider durability and mineralogy in decision to accept or reject. MOH hardness greater than 5.
- If sand equivalency decreases, examine mineralogy and percent passing #200 after T-180. If the increase exceeds 10 percent the material should be rejected.
- No sacrifice in durability will be acceptable.

Other factors to be considered are:

- Purpose and maintenance level of road
- Availability and type of rock in area
- Haul distances from crusher sites or commercial sources

- Type of surfacing (i.e., dust oil, penetration, or road mix)
- Quantity of rock to be used

In summary, the grid rolling properties of a rock type are predictable. Not all types of geologies produce grid rolling material, nor is the grid rolled end product desirable in terms of some engineering or management needs. We have found that the metasedimentary geology produces the greatest amount of grid rollable material. Quality engineering judgment can be exercised in determining types of material that can be effectively processed by the grid roll method.

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WASHINGTON OFFICE ENGINEERING NEWS

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

OBSERVATIONS ON LOW-COST ROADS IN SOUTHERN AFRICA

Professor W.R. Hudson of the University of Texas is the principal investigator for a Forest Service-sponsored study of surfacing system design and management. In August 1974, Professor Hudson was invited to attend the Conference on Asphalt Paving for South Africa. He was also invited to visit the National Institute of Road Research in Pretoria, South Africa, and, in addition, had the opportunity to meet with highway engineers from the Republic of Rhodesia and the U.N. Protectorate of Southwest Africa.

It was recognized that it would be of mutual benefit to the Forest Service and Professor Hudson if he made an assessment of low-volume road technology in southern Africa. Accordingly, Professor Hudson was asked to seek out sources of low-volume road information and to observe low-volume roads during his stay in South Africa. He was also asked to prepare a report recording his observations on low-volume road technology in southern Africa.

Professor Hudson delivered his report to the Washington Office in October. A limited number of copies of the 15-page report are being reproduced and sent to the Regional Information Coordinators for further distribution within the Region. The following highlights have been extracted from the report and are presented here for your information:

- The road systems in the African wildlife reserves and parks come closest to approximating the Forest Service transportation system.
- On the roads in the dry, desert-like climate of the Protectorate of Southwest Africa, the average daily traffic (ADT) is typically 100 to 500 units mostly consisting of light vehicles, but including 60 to 70 produce and cattle trucks with 18,000-pound axle loads. Road surfacing is as follows:
 - A pitrun base of 6 to 8 inches is placed on a prepared subgrade.
 - Strength tests are used to assure high quality; however, judgment of well-trained engineers is also deemed very important in assessing quality.
 - The base is rolled to 95 percent of AASHTO T-180. A stone mosaic protruding through waterbound fines is deemed essential.

- The base is primed with a light application of MC or emulsion.
- After drying, .18 to .20 gallon per square yard of 200± penetration asphalt is applied by distributor and blotted by sand (locally available and without clay-like fines).
- Expected life of these sand-seal surfaces is up to 10 years.
- In Rhodesia, slurry seal, single-surface treatments are used with 1/2- to 3/4-inch stone.
- In Transvaal, low-volume roads are gravel surfaced and asphalt surfaced. Asphalt surfacing is used when vehicle count exceeds 100 ADT. The three low-cost asphalt surfaces that are used are sand seal; single-surface treatment with .25 gallon per square yard of 150 to 200 penetration asphalt covered with 3/8- to 1/2-inch stone; and a slurry seal mixture of emulsified asphalt and sand applied as a secondary coverage over an older, but still sound, chip seal.
- In Krueger National Park, recreation traffic on some roads is in the range of 1,000 to 1,200 ADT.
 - Paving is done by the park's own crews.
 - Average cost is about \$25,000 per mile.
 - The program costs about \$1 million per year.
 - Sand seals last 5 to 7 years.
 - Gravel loss is between 1/2 inch and 1 inch per year.
 - The CBR test is used in pavement thickness design.
 - There is no systematic procedure for maintenance. Blading is done on some aggregate surfaced roads about once or twice a year.
 - Contrary to expectations, paving existing dusty roads improved the visitor's opportunity to view wild animals in the park. Before paving, wildlife would not graze in the areas where dust had settled near the road. After paving and after the dusty foliage had been cleaned by rainfall, more animals and "better game" grazed much closer to the road. This situation permitted much better viewing situations for the park visitors.

Professor Hudson's investigation of low-volume roads in South Africa uncovered no new methods or technology. It is interesting to note that much of the experience of South African authorities with low-volume roads parallels our own. However, it is doubtful that any of our managers have had to contend with elephants as users of the road system!

One very useful reference acquired by Professor Hudson is a publication by the South Africa National Institute for Road Research entitled, *Bituminous Surface Treatments for Newly Constructed Rural Roads*. This publication is being reproduced and will be sent to the Regional Information Coordinators for further distribution within the Regions.

CHIEF VISITS SAN DIMAS EQUIPMENT DEVELOPMENT CENTER

On October 11, 1974, Chief John McGuire, Deputy Chief for Research M.B. Dickerman, PSW Director Bob Harris, and Region 5 Regional Forester Doug Leisy, along with others of their party, visited the San Dimas Equipment Development Center. After being greeted by Center Director Boone Richardson, they were given a short briefing on the Center's activities and also some research work being conducted. Following this session they were given a tour of the Center highlighted by demonstrations in the slash lab, a chain flail cleaner for processing of dirty or charred residue prior to chipping, a fire pump test in progress, and a solid waste disposal system. The party returned in the evening to be given rides in helicopters equipped for night flying. The first was in a Los Angeles County helicopter where night vision goggles were used, and the other in an Army helicopter on loan to the Forest Service and equipped with forward looking infrared (FLIR).

PERSONNEL CHANGE IN THE WASHINGTON OFFICE

Farnum Burbank arrived in the Washington Office on October 15 to assume the duties of Staff Engineer for Equipment Development. This is the position vacated by Boone Richardson, who moved to the San Dimas Equipment Development Center as Director during the summer.

EQUIPMENT DEVELOPMENT PROJECT RECORDS

Project Records are documents prepared by the Equipment Development Centers for the benefit of the sponsors of the equipment development projects. They generally provide much more detailed information than the other center publications such as ED&T Reports and Equip Tips. They are intended to cover project milestone events, a phase of a project, progress, results of investigations, and similar project activities. Distribution is most often limited to the Washington Office, sponsors, and project cooperators. However, Project Records are available for answering questions and providing information as requested or directed. In order to provide an idea of the scope of these reports, a list of those written during the last six months is given below:

ED&T No.	Title
2423	<i>Fuel Treatment Systems for Partially Cut Stands</i> , August 1974
1904	<i>Weathermeasure Corporation Model WS 750 – Automatic Weather Station</i> , August 1974
2004	<i>Linear Fireline Explosive System</i> , July 1974
2129	<i>Fire Detection Systems for Seed Orchards or Small High Value Areas</i> , May 1971
1710	<i>Helicopter Mounted Grenade Dispenser and Incendiary Grenades</i> , August 1974
1983	<i>Road Traffic Counters Recommended</i> , August 1974 <i>Firefighters Physiological Study</i> , June 1974
2240	<i>Site Preparation Machine – Phase I – Investigation</i> , May 1974
2340	<i>Investigation – Small Seed Lot Processing Equipment</i> , August 1974
2354	<i>Spray Aircraft Tracking/Guidance System: A Concept</i> , May 1974
2431	<i>An Investigation – Survey to Analysis, Forest Service Posters</i> , July 1974
2427	<i>Investigation of Fish Passage Problems through Culverts</i> , May 1974
2432	<i>Investigation of Equipment Needs in U.S. Nurseries</i> , September 1974

If you are interested in one of the topics, please address your request to the Equipment Development and Test Office, Engineering Staff Unit, Washington Office.

CONSULTATION AND STANDARDS

Charles R. Weller
Assistant Director

SERVICE-WIDE TRANSPORTATION ANALYSIS MEETING

This meeting was held October 7-11, 1974, in Concord, California. The purpose of the meeting was to provide a forum where Regional managers could learn about the application of new transportation analysis techniques and could advise Washington Office managers of what is necessary to ensure application on the ground.

All Regions except one were represented by Regional Engineers or their assistants. In addition, Regional Transportation Planners, Recreation Planners, Land Use Planners, and Regional Forester delegates participated.

This discussion will highlight some of the results of the meeting. Later FIELD NOTES articles will focus on the separate experiences and explorations presented. In addition, papers will be sent to the field in the form of a booklet of the proceedings. Some of the areas of discussion are indicated below.

- It was recognized that the Forest Service Timber Allocation Model can be used for analyzing differences between design alternatives on a single road at a very low cost as well as for analyzing large networks in a more expensive activity.
- The Forest Service has just received the final report from the consultant describing a process for implementing the transportation analysis techniques developed by the Transportation Analysis Group in Berkeley. This process includes four activities: an awareness program, a management support program, a user training program, and a monitor activity which coordinates the other three. The participants recommended that immediate emphasis be placed on the awareness program.
- Copies of a rough draft manual section on the new Transportation Information System (TIS) were handed out and discussed. It was suggested that Regions give the hand-outs advance review so that, when the manuscript for the manual is formally sent to the Regions in November, Regional critique can be expedited. A target date for conversion is March 1975.
- Participants were surprised that the information system was designed to handle a very small information need, even less than the present Road Inventory Record, as well as a complex informational package. Either approach is to be at the option of field units.

OPERATIONS

Harold L. Strickland
Assistant Director

PROFESSIONAL DEVELOPMENT AND TRAINING OPPORTUNITIES

The following vacancy announcement was transmitted to Regional Foresters, Directors, Area Directors, and Forest Supervisors by J.W. Deinema's 6140 letter of October 18, 1974. Interested persons should contact their supervisors.

REPLY DUE JANUARY 20, 1975

VACANCY ANNOUNCEMENT

Career development and professional specialization opportunities are available in two challenging specialty programs. This announcement is open to all Forest Service engineers and foresters who meet the requirements listed below. We urge all who are qualified to give careful consideration to these continuing Service-wide programs and the opportunity for career enhancement.

The development programs will consist of 9 months' formal, graduate-level training, and the remainder of the 2 years in a planned on-the-job development program at the same location. The Transportation System Analysis Program will be located in Berkeley with participants attending the University of California in Berkeley and assigned to Region 5. The Advanced Logging Systems Program will be located in Corvallis, Oregon, with participants attending Oregon State University and assigned to Region 6.

When considering candidates for these positions, we ask that you carefully consider each applicant's qualifications, motivation, and professional interests. At least a "B" average in their previous undergraduate work is required for admission to most graduate schools. In addition, candidates must be capable of passing a graduate record examination if required by the graduate school. Each candidate must be strong in management and mathematics and have a working knowledge of Forest Service resource management objectives and land use planning systems. Each candidate should also have a strong desire to work as a staff specialist in a Regional Office or Forest Supervisor's Office.

Suggested Chart of Qualifications

- A. Engineer or Forester — B.S. or M.S. degree
- B. Grade point average — minimum "B" in undergraduate studies
- C. Minimum of 2 years with Forest Service in related work
- D. Willingness to relocate for up to a 2-year period (permanent transfer of station)
- E. Presently GS-9 or GS-11 (GS-12 will be considered)
- F. Up-to-date 6100-10 (PRI) — AAA for promotion to next higher grade (ABA will be considered)
- G. A strong background in mathematics (through calculus), analytical mechanics, and communicative arts

The Washington Office, through Region 5 for Transportation System Planning or Region 6 for Advanced Logging Systems, will provide funding to cover the cost of

transfer of station, salary, tuition, books, and supplies. Return transfer of station costs will be furnished by the receiving Region when the training period is completed. Regions will provide personnel ceilings to cover each candidate.

Regional Offices should identify target staff positions to which the nominees will return after satisfactorily completing the program. If promotions are anticipated at that time, a promotion certificate must be prepared listing all Regional applicants for the program, and documenting the basis for selection.

Candidates should submit applications, through the Regional Forester, to the Chief, attention: Engineering Staff Unit, by January 20, 1975. The following should be included with the applications:

- A. Updated SF-171
- B. Current 6100-10 (PRI) reflecting qualifications in this specialized field
- C. Statement of interest from the candidate
- D. Four copies of candidate's undergraduate grade transcripts
- E. Justification statement, including Regional placement plans for candidate, endorsed by the Regional Forester

Candidates who pass a preliminary screening process *may* be sent to the project location for a 2-day orientation on the program, its goals, and its future implications. Travel and per diem expenses will be covered by the Washington Office Engineering and Timber Management Staff Units.

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