

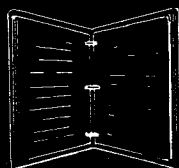
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**ENGINEERING  
TECHNICAL  
INFORMATION  
SYSTEM**

FIELD NOTES • TECHNICAL REPORTS  
DATA RETRIEVAL • MANAGEMENT  
PROFESSIONAL DEVELOPMENT

VOLUME 8 NUMBER 4

Field



Notes

Surfacing Treated Decks with Bituminous Materials

Hierarchy of Transportation Planning

Resistivity Method for Predicting the Service Life of  
Corrugated Metal Pipe Culverts

Washington Office News



**FOREST SERVICE**

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**U.S. DEPARTMENT OF AGRICULTURE**





## **ENGINEERING FIELD NOTES**

**Volume 8 Number 4**

**April 1976**

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**FOREST SERVICE  
U.S. DEPARTMENT OF AGRICULTURE  
Washington, D.C. 20250**



## **SURFACING TREATED DECKS WITH BITUMINOUS MATERIALS**

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### ***INTRODUCTION***

A key requirement for an adequate timber bridge is an economical, serviceable wearing surface. Past experience has shown that requirement to be a major maintenance problem with all of the common types used: timber running plank; steel plate; aggregates; and bituminous materials. Of these types, the latter seems to have the most promise; however, satisfactory performance has been limited for several reasons. One of the major problems, differential deflection between deck lams or planks, can be eliminated by using the dowelled glu-lam deck panels. The other major problem, a satisfactory bituminous material properly bonded to the treated timber, is the subject of this discussion.

Two recently completed timber bridge projects serve to demonstrate the problem. Briefly, on both projects significant quantities of free, oil-borne preservatives were in evidence on the surface of the installed deck panels. The free preservatives may have been on the panel surfaces when the timber came out of the treating cylinder, or they may have bled to the surface prior to installation. In one case, the asphalt surfacing, placed directly over the free preservative, was softened and was easily removed by lateral forces. In the other case, a mixture of sand and fines was used to blot up the free preservatives prior to application of the asphalt surfacing; that surfacing appears to be adequately bonded and is functioning properly. These field experiences and technical advice from the concerned industries lead us to recommend use of a blotter to neutralize the free preservative.

Little has been written specifically for design and construction of a bituminous surface for a timber deck. A significant number of successfully applied surfaces exist, but the criteria leading to such successes have not been published or widely circulated. The following material is presented as a first step toward developing adequate guidelines. It has been prepared in consultation with the Asphalt Institute of Timber Construction. Field experience with respect to existing practice, as well as the proposed remedial measures, is needed. The reader's comments and recommendations are invited.

## ***SUGGESTED GUIDELINES***

### **Preservatives**

*Types:* Past experience supports use of creosote or heavy oil-borne preservatives for overall protection of timber bridge materials. Use of waterborne preservatives and pentachlorophenol-LPG treatments would eliminate the bleeding problem, but timber so treated is more susceptible to moisture changes. The subsequent swelling and shrinking may produce checking that will expose untreated wood.

*Exudates-Volatiles:* Freshly treated panels (oil treatments) may have a considerable amount of free material on the surface, or may exude solids and volatiles for several weeks when the temperature is above a certain minimum. Depending on the quantity exuded, remedial measures may be required before application of bituminous materials.

*Blotter:* A blotter of fine material is recommended as a remedial measure for treating decks with free-standing creosote or oils. Spread an aggregate or dust to act as an absorbent and to increase surface roughness for a better bond. Use a mixture of dust and 10-20 percent crushed material passing the No. 8 sieve. Spread at a rate of 10-15 pounds per square yard. Roll immediately with a rubber tire roller. After excess exudates have been absorbed (about 1 week), broom off loose material. Repeat if necessary to blot free exudates.

*Treatment Procedures:* Except as required by AWPAs specifications, the empty cell process should be used.

As a last step in the treatment process, panels may be subjected to an expansion bath and steam cleaning; this process will not eliminate exudates but will greatly reduce them. This benefit must be weighed against the loss of the protective coating that the free creosote and oils provide against penetration of moisture. Use of the blotter described above appears to be the better remedial measure.

### **Bituminous Materials**

*Surfacing:* Use an RS-2 or CRS-2 emulsified asphalt. A prime coat is not necessary. Treatments should not be applied when the ambient temperature in the shade is below 50°F and when the deck surface temperature is below 70°F. For additional information, see the *Asphalt Institute Construction Leaflet No. 14*.

*Surfacing Thickness:* There are no guidelines for an optimum thickness for bridge deck surfaces. Under light loading conditions (campgrounds, administrative traffic, etc.), a single thickness (seal coat or surfacing) may be satisfactory; however, as a minimum, two courses for a total thickness of 3/4" are recommended. Under loading conditions (typical of timber sale roads) coarser size aggregates and/or additional thicknesses of 1 to 1-1/2 inches should be used.

## Other Considerations

*Scheduling:* In some instances, it may be possible to schedule construction to allow the deck to “cure” prior to surfacing. Ideally, the treated panels should be exposed to the maximum summer temperatures for several weeks prior to surfacing to bring exudates (oils and volatiles) to the surface.

*Unfinished Panel Surface:* To facilitate shear resistance and bond, panels may be fabricated with an unplaned top surface and, in addition, from lams surfaced S2S1E. Since one of the above remedial measures may still be necessary, this nonstandard fabrication procedure should be used with discretion. The effectiveness of unfinished surfaces needs to be substantiated by more field experience.

*Existing Aggregate Surfacing:* Where an existing aggregate wearing surface is to be used as a base, it should be checked for fines. If the aggregate surface contains a clayey matrix and the surface is subsequently sealed with asphalt, the clayey matrix — when wet — will act as a lubricant and result in an unstable base.

*Deck Drainage:* Design to facilitate drainage. On most structures, this is limited to providing adequate openings through the curbs.

## HIERARCHY OF TRANSPORTATION PLANNING

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Region 1

The “doing” job of transportation planning is embodied in a process fondly referred to as the “systems approach.” Basically, the systems approach looks at “things” (things may be physical and/or ideas and/or processes) in light of what they do and how they interact with their surrounding environment. For example, a transportation system is a “thing” that functions to move goods and people from place to place. It provides a service to users and, in turn, it creates impacts on surrounding areas and populations. In order to comprehensively analyze a transportation system using the systems approach, we must look well beyond the physical confines of its right-of-way.

When we set out to analyze something like a transportation system, care must be taken to define the system and its environment. Transportation systems are particularly difficult in this aspect because of their dynamic nature and their large interconnected geographic extent. In systems analysis we try to set limits on the system by including only the portion of the system that lies within our objectives. Yet, for analysis, the defined system must be manageable in size or extent. Often it is difficult to determine what system is within our objectives. Experience has shown that frequently we do not look far enough (geographically) to include features of real significance. In recent years, the development of computer techniques has made it possible to analyze large complex transportation systems at a level of detail that staggers the imagination.

To maintain the manageable proportions mentioned above and meet overall Forest Service objectives we propose to divide transportation systems into a five-level hierarchy. The levels are *Region, Area, Forest, Unit, and Project*. This breakdown roughly coincides with administrative divisions in resource planning. In planning, it is imperative that compatibility and homogeneity be maintained between levels of resource and transportation planning if we are to effectively meet Forest Service objectives. Further, it is imperative that resource and transportation planning be simultaneous activities. Neither can be effectively performed in isolation.

In discussing the five proposed levels of transportation systems two aspects are readily apparent. First, there is no clear-cut dividing line between the levels; only shades of grey exist. The division can be realistically resolved only after thoroughly analyzing the unique objectives of a particular study. Again, it is the combination of transportation and resource planning that determines the system and environment of transportation systems analysis. Second, every system (particularly transportation systems) is a subset of some larger system. While the systems interact with each other at their interface, the direction of focus (or impact) is usually from general to specific. For example, planning a forest development road has little influence on the planning of interstate highway systems. Conversely, however, highway system planning may affect the Forest development system.

Similarities and differences between elements of the transportation hierarchy with respect to some aspects of Forest Service transportation planning are shown in figure 1. Most of the aspects are self-explanatory. The discussion that follows expands upon aspects that are particularly important to the Forest Service.

### ***PLANNING TIME HORIZON***

Time horizons relate to prediction of future activities and their economic impact. We try to look as far into the future as possible so that today's decisions involving irreversible commitment of resources will contribute to overall objectives. It is important to establish direction or a goal to work toward and yet keep options open for future decisions.

FSM 7711 (Forest Service Manual—System Planning) gives two criteria for time horizons: (1) 7711.11 (Plan Preparation) states that, "For the long-range transportation system plans, the design year will be 2000"; and (2) 7711.31 (Economic Life) states that, "Assumed economic life used in economy studies . . . should not exceed 20 years." These FSM directions bring up two interesting points; first, time horizons vary in length depending on the study objectives; and second, no mention is made of *Financial Time Horizons*. Virtually all Forest Service transportation programs are tied to available dollars, and here the financial time horizons range between three and ten years.

### ***ECONOMIC VS. FINANCIAL***

To help understand the implications of economic and financial considerations we have defined them as follows:

**Economic** — The alternative future use of resources (people - time - money - materials) in transportation from "whomsoever they accrue."

**Financial** — Money contributed, spent, or saved on transportation; that is, "Who pays, how much, when, and from what account."

At the broad Regional level of the transportation hierarchy emphasis is on serving the best interest of the Nation as a whole. All future use of resources must be considered, regardless of who provides them or who benefits from their expenditure. As we work down the hierarchy, however, emphasis shifts from economical toward financial considerations. At the Forest level of transportation planning we are at a middle ground. Economics are important in that maximum net benefits should be obtained but financial restrictions in the form of budgets are imposed. Here, also, economics is de-emphasized because of economically derived criteria dictated from higher levels and from other planning processes. Finally, at the project level of transportation hierarchy, we are "locked in," to some extent, to other or prior economic analyses and are therefore leaning toward financial analysis to help analyze alternatives.

### ***STRUCTURE OF THE PLANNING PROCESS***

Virtually without regard to the level in the hierarchy the planning process remains constant. That is, we study transportation systems by the same orderly procedure whether the system is

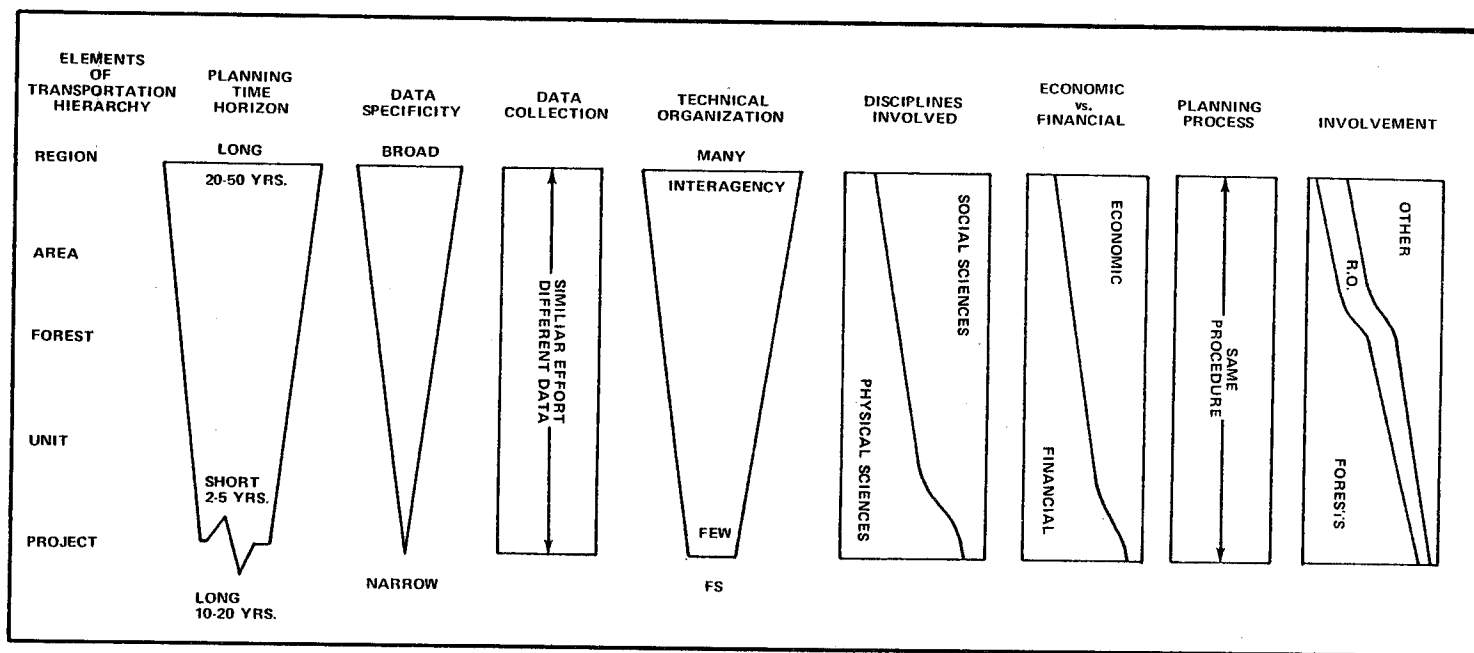


Figure 1. – Similarities and differences between elements of transportation planning hierarchy.

“Regional” or a “project”. The transportation planning process begins by clearly stating the objectives. This is followed, in turn, by specifying data required, collection and preliminary analysis of data, defining alternatives, analysis, and evaluation. The final result is the selection of a plan or determination of a course of action.

The important idea here is not what goes on in each step of the process but rather that the same general procedure is required for any level of planning in the hierarchy. Naturally, the activities that make up each phase of the process depend almost entirely on the hierarchy level. Further, the computer programs that assist the analyst are frequently tailored to a particular level. Data requirements are different and so forth. The systematic analysis procedure we call the transportation planning process, however, stays the same regardless of the position in the hierarchy.

### ***FOREST SERVICE INVOLVEMENT***

In looking at Forest Service involvement it is important to keep in mind that we are involved two ways. First, the Forest Service is involved with Out-Service agencies, groups, and individuals; and second, is the internal involvement between administrative levels of the Forest Service. Regional and area transportation planning is primarily concerned with interstate, state primary, and state secondary highways. Here, primary responsibility rests with the Federal Highway Administration of the Department of Transportation and the State Highway Departments. Forest Service involvement is minimal except when Forest highways are concerned. The Forest Service role is to provide advice and consultation to other agencies who are performing the “doing” phase. Both Forest and Regional Office personnel are involved but much of the emphasis rests with the Regional Office.

At the Forest level of the hierarchy (and below) emphasis is shifted to the Forest staff. Each Forest provides the leadership for planning and executing the plans. The 7700 section of the Manual (and Regional Supplements thereto) are quite explicit in this regard. Here the Forests have a responsibility to coordinate with Out-Service agencies such as counties, individual landowners (cooperators), and the public. The Regional Office role is in consultation, policy, standardization, and implementation of techniques including implementation and training in analysis techniques.

This discussion should leave the clear understanding that: (1) most Forest Service transportation planning effort is at the Forest-Unit-Project level in the hierarchy; and (2) that the primary responsibility for transportation planning activities is at the Forest level.

## **RESISTIVITY METHOD FOR PREDICTING THE SERVICE LIFE OF CORRUGATED METAL PIPE CULVERTS**

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Culverts are structures that convey water through an embankment that has been constructed for a highway, railway, street, industrial roadway, spoil bank, dam or levee. Corrugated metal pipe (CMP) was first developed and used for culverts in 1896. In certain instances CMP is used to carry different types of domestic, commercial, and industrial effluents; however, the principal use of CMP is for storm drainage culverts. In predicting the service life of CMP, the corrosivity of the effluents, along with other factors is a prime consideration.

Many studies have been made to determine a better method for predicting the service life of existing CMP culverts and of proposed new installations. The Rating System, a standard method of inspecting and rating existing culverts, was developed in the 1920's by various State and Federal agencies, and by pipe producers (2). The most significant studies to modern criteria are those made after 1950. The Soil Correlation Method and the Lost Metal Method are the most recent methods of estimating the remaining life of existing culverts.

Two other approaches, the Resistivity Method and the Average Metal Loss Method, have gained acceptance and have been used extensively in estimating the service of proposed culvert installations.

The Resistivity Method (RM) is the most widely used and has the largest statistical base for correlation of the variables affecting the life of culverts.

The articles of Messrs. J. L. Beaton and R. F. Stratfull, California Department of Transportation (CALTRANS), are the most published on service life of culverts. Their articles on RM are based on the investigation of 12,000 CMP culverts in every type of environment in California (3).

The RM predetermines corrosion rate based on the concentration of hydrogen ions (pH) in water and the electrical resistance of the soil measured in ohms/cm.<sup>3</sup> According to Beaton and Stratfull, the possible factors influencing corrosion were correlated with the observed corrosion rates. All the significant factors were found to interrelate with the pH and electrical resistance of the water environment around culverts; these two factors affect corrosion rates because of the effect of the salt on the conductivity of minute electrical flows.

The measure of electrical resistance of the soil and water of these minute electrical flows provide the common factor as to the type of salt and soil, the moisture in the soil and air, and the

temperature. The environment (the natural soil and water in the region) may be classified by its level of pH: a pH of 5.8 or more is classified as normal, while a pH of less than 5.8 is classified as acidic.

Combining all the information and data from its surveys, CALTRANS designed a chart (see appendix, fig. 2) so that measured values of pH and electrical resistivity may be used to estimate the number of years it takes for CMP to be perforated by corrosion.

The RM used by CALTRANS to estimate service life of culverts was divided into the following parts:

- (1) field resistivity survey and sampling for corrosion tests;
- (2) preliminary field determination of pH and water samples;
- (3) determination of pH of soils;
- (4) laboratory determination of minimum resistibility; and
- (5) estimation of service life of metal culverts from test data.

The detailed test procedure for estimating service life of culverts is given in the appendix.

For determining individual installations, the use of statistics based on the average life of CMP culverts is questionable, because service life of CMP culverts depends on the specific climate and the surrounding topography. Corrosion rate variables are so numerous and indeterminate that they are generally determined by field test rather than from calculations based on corrosion theory (3).

In 1965, over 100 pipes throughout Idaho were inspected; the observed corrosion was checked against the California RM. It was found that the California RM was satisfactory, but conservative (1). The Kansas Highway Commission studied 810 CMP culverts in 1968. The objective of the study was to correlate pH and electrical resistance of water and soil, and to adjust the California RM chart for estimating years to perforation in Kansas. A very narrow range of pH and resistivity was found; therefore, the California RM was unsuitable for Kansas, since it frequently predicted too short a CMP service life (5).

The Washington State Highway Commission attempted to use the California RM in a 1965 study involving about 500 culverts. There was little success in this study; it was found that the "Years to Perforation" had such a large safety factor that the results were insignificant for the intended use (4). The term "Years to Perforation" does not mean that the culvert will fail at that time, but it is used as a base for common measurement for all culverts. The rationale for this is that after a perforation is detected, maintenance costs begin, even though it may only be a decision not to take action until later inspections show repair or replacement is needed. Thus, according to Stratfull, a safety factor was intentionally included in the California method because it is academic to worry about whether a culvert will last 20 to 50 years on a road designed for 20 years. The cost of the culvert material is insignificant when compared to the cost of removal and replacement if a culvert fails.

Idaho concluded that the California method was satisfactory, while Kansas and Washington found that the method was too conservative. This is related to the range of pH and resistivities within the State, and to differences in policies regarding relative economies between material

costs and replacement costs. In addition, changes in population growth and transportation modes (i.e., State highways to Interstate highways) are considered and limit the design requirement for Interstate highways to a design life of 50 years, while State requirements are of a shorter duration.

Most National Forests road systems were not designed for a specific service life, but mainly for the purpose of access to a short-term timber sale or as a bypass through the forest. However, with the build up of campgrounds and recreation sites, and recurrent timber sales, these roads are becoming more permanent. Some forests have a large number of CMP culverts (many of which are over 40 years old) that need replacing because of bottom corrosion. The replacement of these culverts will require a large outlay of funds.

Although consideration of bituminous coatings and abrasion is beyond the scope of this article, they are important enough to be mentioned. The data used to produce the chart for estimating years to perforation (appendix, fig. 2) were obtained from thousands of culverts in service up to 40 years. For this reason, the average effect of abrasion on the corrosion rate is included in the chart (3). However, for severe abrasion which usually occurs when flow velocity exceeds 15fps and contains a bedload, additional metal or invert paving should be added to obtain the desired service life (6). Reducing the flow velocity within the culvert is frequently the most successful means of preventing severe abrasion. The following table (extracted from the California Highway Design Manual) provides a guide for estimating additional service life for bituminous coated steel and aluminum pipe (6).

**GUIDE FOR ANTICIPATED SERVICE LIFE ADDED  
TO STEEL AND ALUMINUM PIPE BY BITUMINOUS COATING<sup>1</sup>**

| Flow Velocity (fps) | Channel <sup>2</sup> Materials | Bituminous Coating (yr) | Bituminous Coating and Paved Invert (yr) | Asbestos Bonded Bituminous Coated and Paved Invert (yr) |
|---------------------|--------------------------------|-------------------------|------------------------------------------|---------------------------------------------------------|
| Less Than 5         | Abrasive                       | 6                       | 15                                       | 20                                                      |
|                     | Nonabrasive                    | 8                       | 15                                       | 20                                                      |
| 5 to 7 Incl         | Abrasive                       | 6                       | 12                                       | 20                                                      |
|                     | Nonabrasive                    | 8                       | 15                                       | 20                                                      |
| Greater Than 7      | Abrasive                       | 0                       | 5                                        | 8                                                       |
|                     | Nonabrasive                    | 2                       | 10                                       | 20                                                      |

<sup>1</sup> Any bituminous coating may add up to 25 yr of service on the backfill side of the culvert.

<sup>2</sup> If there is no existing culvert, it may be assumed that channel is potentially abrasive to culvert if sand and/or rocks are present. Presence of silt, clay, or heavy vegetation may indicate a nonabrasive flow. For continuous flow, the years of invert protection can be expected to be one-half of that shown.

With an eye to economics, the Forest Service engineer usually does not build drainage structures or conduits to last forever, but considers the following factors:

- (1) a conservative life expectancy for the project or structure,
- (2) possible future change causing inadequacy or obsolescence, and
- (3) cost or inconvenience of replacing or perpetuating a structure.

For some structures, 25 years may be a sufficient life expectancy; for others, 50 years. Therefore, considering the environmental factors surrounding existing CMP culverts and that of proposed new installations, the RM will provide Forest Service road designers with an effective tool for estimating the service life of CMP culverts, along with the design procedures contained in the "Handbook of Steel Drainage and Highway Construction Products" (1).

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## APPENDIX

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State of California  
Department of Public Works  
Division of Highways

MATERIALS AND RESEARCH DEPARTMENT

Test Method No. Calif. 643-C  
October 2, 1972  
(5 pages)

### METHOD FOR ESTIMATING THE SERVICE LIFE OF METAL CULVERTS GENERAL SCOPE

Two environmental factors are combined for estimating the service life of metal culverts. These environmental factors are the hydrogen-ion concentration (pH) and the electrical resistivity of the site and backfill materials.

The hydrogen-ion concentration (pH) of the soils and waters indicates the degree of acidity or alkalinity, while the resistivity measurements indicate the relative quantity of soluble salts.

Using these values, the probable service life of a metal culvert in a given location is estimated by means of the Chart shown on Figure II.

This information, combined with observations of existing culverts, if any, provides a basis for (1) estimating the service life of galvanized metal culverts and (2) estimating the additional life that would be obtained by coating the culverts to reduce the corrosion rate.

This test method is divided into the following parts:

- I. Method of Field Resistivity Survey and Sampling for Corrosion Tests.
- II. Preliminary Field Method of Determining pH of Water Samples.
- III. Method of Determining pH of Soils.
- IV. Laboratory Method of Determining Minimum Resistivity.
- V. Estimating Service Life of Metal Culverts from Test Data.

#### PART I. METHOD OF FIELD RESISTIVITY SURVEY AND SAMPLING FOR CORROSION TESTS

##### Scope

The field resistivity test is an indication of the soluble salts in the soil or water, and is used primarily as a guide for selecting samples that will be further tested in the laboratory to obtain data for estimating the service life of culverts. The natural soil in each channel or culvert location and the structural backfill material are tested by a portable earth resistivity meter, and samples are selected on the basis of these tests.

##### Procedure

###### A. Apparatus

1. Portable earth resistivity meter, suitable for rapid in-place determinations of soil resistivity.
2. Field probe.
3. Steel starting rod, for making hole (in hard ground) for inserting probe.
4. Sledge hammer (4 lbs.)

###### B. Materials

Distilled, de-ionized or other clean waters that measure greater than 20,000 ohm-cm.

###### C. Recording Data

Record test data in a field notebook for use in selecting samples and also for use as needed in analyzing laboratory test data.

###### D. Test Procedure

1. In the channel of a proposed culvert site, insert the field probe into the soil for a depth of between 6" and 12" and measure resistivity. Remove the field probe and pour about 2 ounces of clean water into the hole.
2. Re-insert the probe, while twisting to mix the water and soil, then measure the resistivity. Follow manufacturer's instructions for correct use of meter.
3. Withdraw the field probe and add an additional 2 ounces of clean water.
4. Re-insert the probe and again measure the resistivity of the soil.
5. Record the lowest of the readings as the field resistivity of the soil.

###### E. Selection of Soil Samples for Laboratory Tests

1. Make sufficient resistivity determinations at various locations in the channel or culvert site area to represent adequately the entire area.
2. If the resistivity is reasonably uniform within the limits of the project, three soil samples from different locations will be sufficient. If, however, some locations show resistivities that differ significantly from the average of the determinations for the area being surveyed, additional soil samples should be taken to represent these locations—particularly those with resistivities significantly below the average.

a. For example, if the soil resistivities throughout the surveyed area are all at or near an average value of 2000 ohm-cm, three samples will be enough. If any of the locations tested have resistivities markedly below this average, for example 800 ohm-cm, then these "hot spots" should definitely be represented by additional samples. Scattered locations of higher resistivity, for example 3000 ohm-cm or more, do not necessarily require additional samples.

b. Judgment must be exercised both in the field testing and sampling and in evaluating the laboratory tests.

c. In all cases, do not take less than 3 samples.

###### F. Precautions

In field testing and sampling, follow very carefully the test method instructions and also the manufacturer's instructions for use of meters.

###### Notes

If the minimum resistivity of a soil is determined to be less than 1000 ohm-cm in the laboratory, a representative sample weighing 2 to 5 lbs. which passes the No. 8 sieve will be needed for a sulfate ( $\text{SO}_4$ ) analysis. This should be taken into account in field

## Test Method No. Calif. 643-C

October 2, 1972

sampling and is to be used for evaluating the effect of the environment on the stability of normal concrete.

### PART II. PRELIMINARY FIELD METHOD OF DETERMINING pH OF WATER SAMPLES

#### Scope

This method is suitable for use in the field or laboratory for determining the pH of water samples.

#### Procedure

##### A. Apparatus and Materials

1. 2 oz. or larger wide-mouth container, e.g. glass jar, beaker, or dry wax paper cup.
2. pH meter, suitable for either field or laboratory testing.
3. pH standard solution of pH 7.

##### B. Recording Data

Record test data in a field notebook.

##### C. Method of Sampling

1. Dip the wide-mouth container into the water to be tested. Swirl to rinse and pour out contents to avoid contamination from container.
2. Dip into the water again for obtaining a sample.
3. Pour off any film which is on the surface of the sample before testing.

##### D. Standardizing pH Meter

Follow the instructions provided with the type of pH meter being used.

##### E. Use of pH Meter to Determine pH of Water

Follow the instructions provided with the type of pH meter being used.

##### F. Precautions

Follow the manufacturer's instructions for use of the meter and observe the usual precautions for making chemical tests.

#### Notes

pH readings may be taken at any period other than flood flow. All waters which have a pH of less than 6 should be sampled for further analysis, in one quart bottles.

### PART III. METHOD OF DETERMINING pH OF SOILS

#### Scope

This method is suitable for use in determining the pH of soil samples.

#### Procedure

##### A. Apparatus and Materials

1. Paper cups, 2 oz. wax coated type.
2. Teaspoon or small metal scoop.
3. Wash bottle containing distilled water.
4. pH meter suitable for field or laboratory testing.
5. pH Standard solution of pH 7.

##### B. Recording Data

Record data in a field notebook or on Form T-619.

##### C. Preparation of Test Specimens

1. Place 2 rounded teaspoonsful of the soil to be tested into a 2-oz. paper cup.
2. Add about 2 teaspoonsful of distilled water to the sample in the cup.
3. Disperse soil in water by stirring. The specimen is now ready for testing.

##### D. Standardization of pH Meter

Follow the instructions provided with the pH meter.

##### E. Use of pH Meter to Determine pH of Soil

Follow the instructions provided with the pH meter.

##### F. Precautions

Carefully follow the above procedure and the manufacturer's instructions.

If the pH reading is unstable when the electrode is immersed in the soil slurry, leave the electrode immersed until the pH reading has stabilized. In some cases this waiting period for the stabilization of the pH reading may take 5 minutes.

### PART IV. LABORATORY METHOD OF DETERMINING MINIMUM RESISTIVITY

#### Scope

This method covers the procedure for determining the minimum resistivity of soil or water samples selected as indicated in PART I. These resistivity values are used in estimating culvert life as described in PART V.

#### Procedure

##### A. Apparatus

1. Resistivity meter suitable for laboratory testing.
2. Soil box calibrated for use with resistivity meter. See Figure I for details.
3. No. 8 Sieve.
4. Round tin pans, 12" diameter and 2" deep.
5. 200° F. oven.
6. One balance, 5 Kg. capacity, accurate to 10 g.

##### B. Materials

Distilled or de-ionized water.

##### C. Recording Data

Record data on Form T-619 or in notebook.

##### D. Preparation of Soil Samples

After thorough mixing of sample, screen it through a No. 8 sieve. If the sample is too moist to be sieved, it may be dried and crushed. Do not crush rocks. Only the natural material that passes the No. 8 sieve is to be used for the test.

##### E. Measuring the Resistivity of Soil Sample

1. Quarter or split out about 1300 grams of the passing No. 8 material.

2. If the sample was dried, add about 150 grams of distilled water to the 1300 grams of soil and thoroughly mix.

3. After the soil sample is thoroughly mixed, place and compact it (moderate compaction with the fingers is sufficient) in the soil box.

4. Measure the resistivity of the soil in accordance with the instructions furnished with the meter.

5. Remove the soil from the soil box and add about 100 additional grams of distilled water and again thoroughly mix.

6. Again place and compact the soil in the soil box and measure its resistivity.

7. Repeat this procedure once more.

8. If the resistivity of the soil has not followed a trend of high resistivity, low resistivity, and then an increase in resistivity for the preceding additions of distilled water, continue to add water in about 50 gram increments to the soil; mixing, placing, compacting, and measuring resistivity for each increment, until the minimum resistivity is obtained.

9. If the sample was not dried, begin the test procedure by adding 50 grams of water in lieu of 150 grams specified above in 1. Continue to add 50 gram increments of water followed by mixing, placing, compacting, and measuring until a minimum value of resistivity is measured.

10. Record the test value that is the minimum value of soil resistivity at any moisture content.

#### **F. Measuring the Resistivity of a Water Sample**

1. Thoroughly clean the soil box of all soil particles and rinse the soil box a minimum of three times with distilled or de-ionized water.

2. Fill the soil box with distilled water and measure its resistivity.

3. If the distilled water in the soil box measures infinite resistivity, empty the soil box of distilled water, fill with the test water, measure its resistivity, then record the measured value.

4. If the distilled water in the soil box did not measure infinite resistivity, continue to rinse the box with distilled or de-ionized water until the box is thoroughly clean, which is indicated by an infinite resistivity measurement.

#### **G. Recording Data**

Record data in notebook or on Form T-619.

#### **H. Precautions**

Follow the above instructions very carefully.

### **PART V. ESTIMATING SERVICE LIFE OF METAL CULVERTS FROM TEST DATA**

#### **Procedure**

##### **A. Calculations**

Using the minimum resistivity and the pH values of the soils or waters, obtained as described in Parts II, III, and IV of this test method, determine the estimated service life (years to perforation) from the Chart shown on Figure II.

#### **Reporting**

District reports which include evaluation of data obtained from tests and observations of existing culverts, as well as test data, shall be made and the results noted in the District Materials Report.

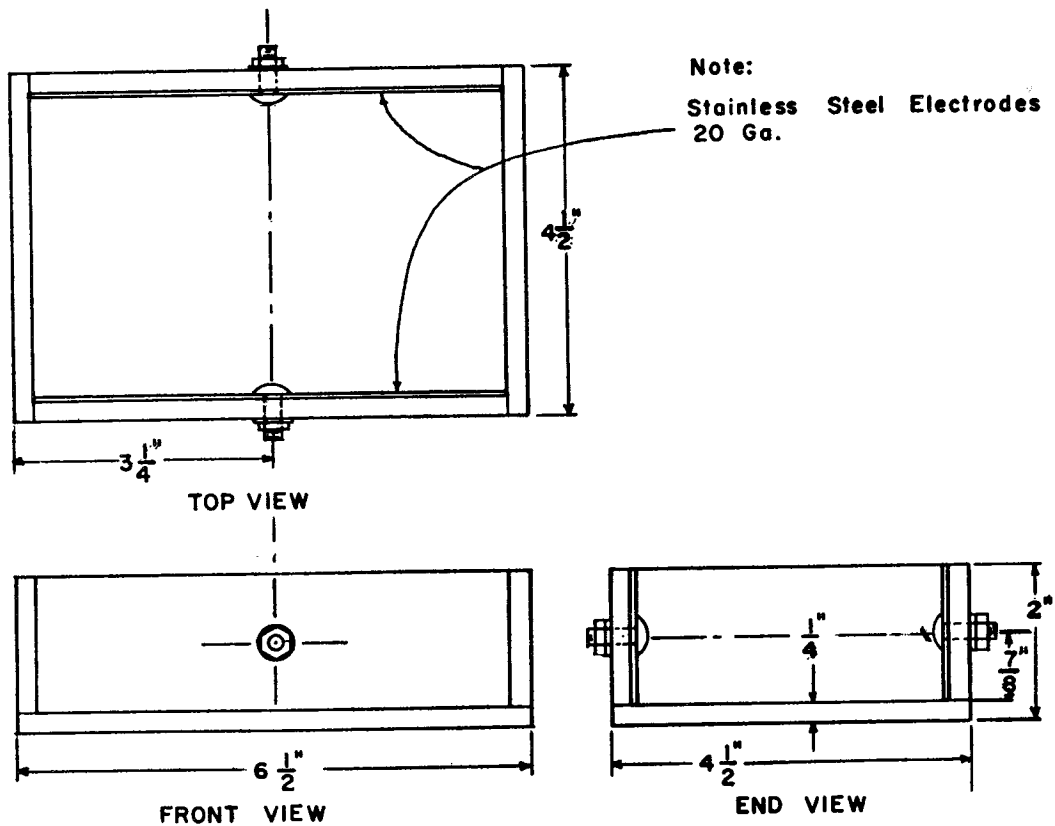
#### **REFERENCE**

##### **A California Method**

1. Field Test for Estimating Service Life of Corrugated Metal Culverts, by J. L. Beaton and R. F. Stratfull. Proc. Highway Research Board Vol. 41, P. 255, 1962.
2. Field Method of Detecting Corrosive Soil Conditions. By R. F. Stratfull. Proc. 15th Calif. Street and Highway Conference, held at U.C.L.A., Jan. 24-26, 1963, I.T.T.E. P. 158.

End of Text on Calif. 643-C

October 2, 1972



**Material —  $\frac{1}{4}$ " Plastic**

Bottom — 1 Pc.  $6\frac{1}{2}$ " x  $4\frac{1}{2}$ " x  $\frac{1}{4}$ "

Ends — 2 Pcs.  $4\frac{1}{2}$ " x  $1\frac{3}{4}$ " x  $\frac{1}{4}$ "

Sides — 2 Pcs.  $6$ " x  $1\frac{3}{4}$ " x  $\frac{1}{4}$ "

Electrodes — 2 Pcs. 20 Ga. Stainless Steel  $6$ " x  $1\frac{3}{4}$ "

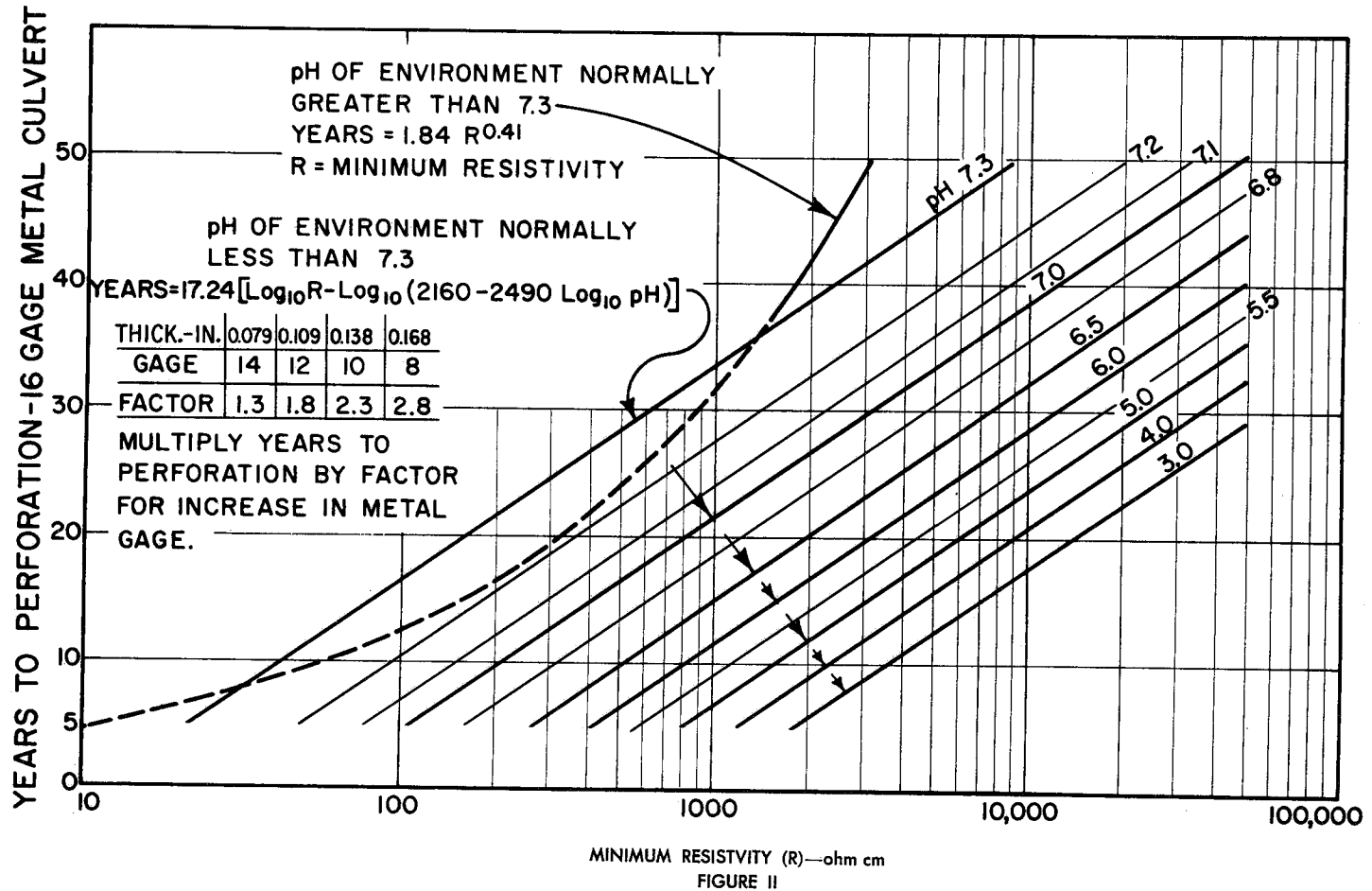
2 Ea. No. 8-32 x  $\frac{3}{4}$ " Round Head Stainless Steel

Machine Screw With Rubber Washer & Stainless

Steel Washer & Nut.

FIGURE I  
SOIL BOX FOR LABORATORY RESISTIVITY DETERMINATION

# CHART FOR ESTIMATING YEARS TO PERFORATION OF METAL CULVERTS



**WASHINGTON OFFICE NEWS**  
**TECHNOLOGICAL IMPROVEMENTS**

H. T. Taylor  
Assistant Director

***ED&T PROGRAM EVALUATION***

During the week of January 12, the Directors and Assistant Directors of the Equipment Development Centers met in the Washington Office to evaluate the ED&T Program, and to determine its level of response to field needs.

The San Dimas and Missoula staffs discussed the Centers' problems associated with development projects, personnel, budgeting, planning, and communications.

Washington Office participants were Russ McRorey (NFS); Mike Howlett and Sterling Wilcox for Engineering; Georgia Sherman of Personnel Management provided guidance and advice on personnel problems; Blaine Bowen, Administrative Services, discussed procurement and contracts, purchasing, and cooperative agreements; Neal Smith, from Program Development and Budget, advised on budgeting procedures.

***PROGRAM PLANNING***

The Equipment Development and Test Program for FY 1976-Transition and FY 1977 will be planned and formally organized by Farnum Burbank and Mike Lambert of WO-EDG, with considerable assistance from the staffs at both Centers.

The new program will be completed and approved by June 30, and will reflect the inputs that have been received by the Centers from Regions, sponsoring staff units, and field units. That information is the basis for a program that meets the Chief's goals.

The Centers currently are applying their capabilities to new areas such as solar energy and cable transport systems, and are working with the problems of "Technology Transfer." The engineering staffs at San Dimas and Missoula have technical skills in many disciplines; it is their job to apply their skills and experience to develop the equipment and techniques that will fill your needs.

Are they meeting the challenge of helping you to solve your problems? Let them know! With your cooperation, the Centers will continue to give you a meaningful and responsive program.

## OPERATIONS

Harold L. Strickland  
Assistant Director

### *VISITOR INFORMATION MAPS*

In recent years, the public has requested more and more information on recreation facilities and areas; most of these requests are for visitor information-type maps. In meeting these demands, several problems have developed.

Forest Visitor Maps available throughout the Forest Service are highly variable in content and scale. Because of increasing costs, some Regions have started charging for maps, and a majority of other Regions have expressed the need to charge for these maps. Considerable interest has been shown in providing a pocket-size "mini-map". In order to get on top of these problems, the Forest Service has initiated several actions.

To determine whether we have authority to sell Forest Visitor Maps and deposit the proceeds to the credit of the appropriation, an opinion from the Office of the General Counsel (OGC) was requested. OGC's response was, "It is our opinion that pursuant to 7 U.S.C. 1387 the FS may credit the appropriation used to make or purchase the maps with the proceeds from the sale of such maps."

Engineering, Recreation, Fiscal and Accounting Management, and the Office of Information have developed the basic guidelines for the Visitor Information Maps, and have prepared the appropriate manual supplements. Recreation is coordinating this effort and the final package will be ready shortly for review by the Chief and staff.

The Visitor Information Map series will consist of four maps or guides:

Forest Visitor Guide,  
Forest Visitor Map,  
Wilderness Map, and  
Regional Information Guide.

The *Forest Visitor Guide* is to be provided to the public at no charge. The map will be of a size that can be conveniently folded to fit a shirt pocket, and it will carry information on National Forest recreational opportunities, National Recreation Areas, Wildernesses, Trails, VIS developments, and topics to develop public awareness of resource management objectives.

The *Forest Visitor Map* will be available to the public for a price which will recover the cost of its printing and distribution. This map will generally be at a scale of 1/2 inch to the mile, and will provide detailed information on National Forests, National Recreation Areas, and special interest areas.

The *Wilderness Map* will be available to the public on a similar cost-recovery basis. The map will generally be at a scale of 2,000 feet to the inch and will depict detailed information on Wilderness areas within National Forest boundaries.

The *Regional Information Guide* will be available to the public at no charge. It will give general information for the Region, including National Forests; National Grasslands; Experimental Forests; Purchase Units; Wilderness and Primitive Areas; Land Utilization Areas, Regional, Forest and District headquarters; and any other pertinent recreation or use restriction information.

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## **CHANGES TO FEBRUARY FIELD NOTES**

Volume 8 Number 2

### ***OPERATIONS: GEOMETRONICS***

*Correct the last paragraph of this article (page 15) to read as follows:*

Should you desire additional information on these topics, or on the Geometronics Development Unit, itself, please submit your request to the Geometronics Engineering Staff, Washington Office.

### ***TECHNOLOGICAL IMPROVEMENTS: FOREST SERVICE GETS BRASS AT FCCC***

*Correct the last paragraph of this article (page 13) to read as follows:*

If you want more information on this system, please contact the appropriate people in your Regional Office (Bridge Engineer or Engineering ADP Coordinator), or the Systems Development Engineer in the Washington Office (703/FTS-235-8024).

## CONSULTATION & STANDARDS

Charles R. Weller  
Assistant Director

### *NEW LASER RANGE POLE*

We have just received two new Laser Range Pole units. The transmitters are basically the same as the first model. The receiver has been redesigned to improve its performance. It is now mounted on a DKM2 Theodolite Frame, instead of the DKM3. This and other improved components make the new units about 30 pounds lighter. The receiver now has different-colored directional and gate lights, as well as an auto gate signal for ease of operation. A new light filtering system has increased the range from one to three miles in daylight and from two to six miles at night. The new units are easier to operate and are more reliable in delineating the laser light source. The false light problems experienced with the old unit have been virtually eliminated. The directional arrows incorporated with the centering lights speed-up locating the center of the laser light column. First indications are that this system is superior in all respects to the old model. The systems are in the field and working well and we suggest you make it a point to see them in operation when a unit comes to your area.

## **INVITATION TO READERS OF FIELD NOTES**

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 Service 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. 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 | Bill McCabe      | R-4 | Ted Wood     | R-9  | Norbert Smith |
| R-2 | Allen Groven     | R-5 | Jim McCoy    | R-10 | Bill Vischer  |
| R-3 | Bill Strohschein | R-6 | Kjell Bakke  | WO   | Al Colley     |
|     |                  | R-8 | Ernest Quinn |      |               |

Coordinators should direct questions concerning format, editing, publishing dates, and other problems to:

Forest Service, USDA  
Engineering Staff, Washington Office  
Attn: Gordon L. Rome or Rita E. Wright, Editorial Services  
Washington, D.C. 20250

Telephone: Area Code 703-235-8198

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