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FOREST SERVICE — USDA
Engineering Staff — Washington Office
Att: D.J. Carroll, Editor
P.O. Box 2417 — Washington, D.C. 20013
Telephone: Area Code 703/FTS—235-8198

The Ouachita National Forest Deluge of '82

Charles Donahue
Construction/Maintenance Engineer
Ouachita National Forest
Region 8

RAIN, RAIN, & MORE RAIN

In November 1982, heavy rain fell throughout Arkansas. Then, from December 1 to December 5, even more rain fell. The State suffered what was reported to have been its most widespread and intense flooding in recorded history. Many "old timers" commented that the water was the highest they had ever seen. Estimates have placed the intensity of the December storm at well over the 100-year level. As much as 13 inches of rain was reported in some areas of the Ouachita National Forest. In many areas, normal travel routes became inaccessible even for ambulance and State police traffic.

On that first weekend, Maintenance Technician Royal Smith was called out with his crews to help restore the roads for essential, emergency services. At the same time, a major effort was being made to identify and properly sign and barricade the numerous serious safety hazards that had developed. On December 6, 1982, the Forest dispatched more than a dozen damage-assessment teams to document the extent of the disaster and gather data concerning specific damage. Those teams were in addition to the road maintenance crews and Ranger District personnel already in the field. Examples of the damage are shown in figures 1 through 6.

The full impact of the natural disaster was not yet known; we knew we had serious localized damage, but no one realized how extensive it was. In some areas it would be weeks before anyone could get in to evaluate the damage. The decision was made to request Federal Highway Administration (FHWA) emergency relief assistance for the repair and reconstruction of the damaged transportation system through the emergency relief program established for Federal Roads off the Federal Aid System (ERFO). The ERFO program provides both emergency relief and payment

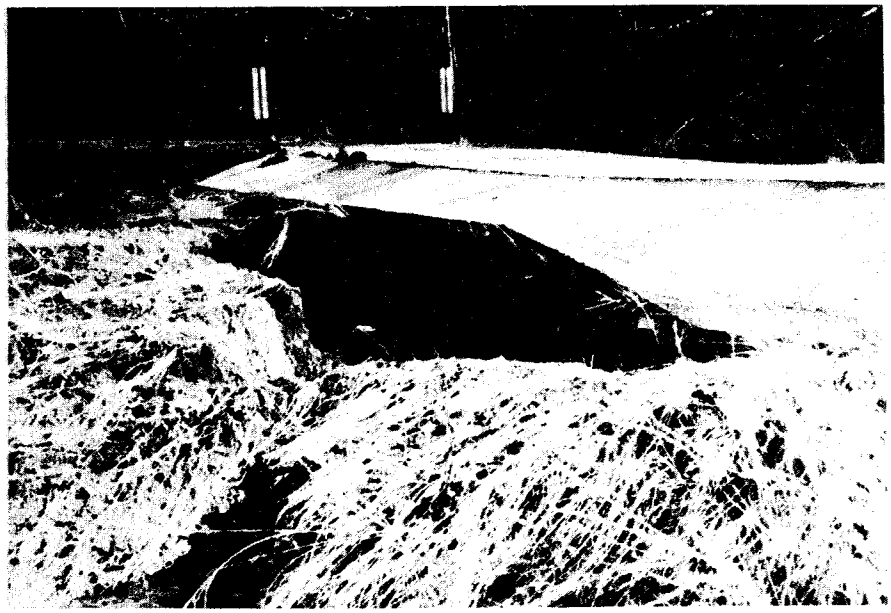

Figure 1.--Typical washout of foundation from concrete structure.

Figure 2.--Typical section of road with cushion and aggregate base washed away. Many miles of this type of damage were not eligible for ERFO funding.

of all costs resulting from natural disasters to transportation facilities, where the disaster itself and the damage caused meet prescribed criteria.

DAMAGE ASSESSMENT

Our initial assessment identified more than 400 individual damage sites (spread over all nine of our Arkansas Ranger Districts). Several hundred other marginally heavy maintenance sites, as well as an untold amount of surface aggregate loss, were identified but not recorded. Given that the distinction

between excessive damage and heavy maintenance is one of judgment, it may be that some sites were misclassified. However, later reviews indicate that our thinking was essentially in line with that of the administrators of the ERFO Program.

During the week of December 13, 1982, three representatives of FHWA visited the Forest to review the damage. Their original intent was to visit every damage site and complete the assessment and cost estimates for each. However, it was not possible for the three teams, even with extra-long work hours, to cover all the sites in 1 week--even though we were able to help them speed up their progress by making available our data, photographs, maps, cost estimates, and guides. In nearly all cases, our preliminary data proved suitable for their official site damage report. Their cost estimates and judgments closely approximated ours. Even with the prior identification of sites and direct travel routes allowed by our previous reconnaissance, the FHWA teams only were able to visit less than half the identified sites. In late December, two additional FHWA representatives made a second visit to the Forest to complete their review, but even then about 80 of the sites could not be visited in their allotted time. At that point, they essentially agreed to accept our site damage reports for the remaining sites.

When all the data were gathered and compiled, we found that we could group the damage into several categories. We had suffered:

(1) About 165 washed-out and severely damaged culvert pipes of various sizes.

(2) Over 100 damaged or washed-out concrete low-water structures and fords.

(3) About 50 significant cutbank slides.

(4) About 50 major roadway embankment failures.

(5) About 30 damaged or washed-out bridges. (Most of these had extensive debris deposits in adjacent stream channels.)

(6) About 230 separate roads with at least one major damaged site. (Many had three or more damaged sites; some had as many as six damaged sites.)

Figure 3.--Concrete-paved ford washed out completely.

Figure 4.--Typical pipe washout in stream crossing.

(7) About 75 roads damaged sufficiently to require closure. (Most of these have been reopened with emergency temporary corrective measures.)

Based on the early FHWA reports, Mr. H. C. Wieland, Division Engineer of FHWA, notified Regional Forester Alcock that emergency relief funds would be made available for restoration of the damaged areas on the Ouachita National Forest. All we had to do was finalize the damage reports, prepare justification statements and engineering reports for requested betterment projects, and submit the program request through our Regional Forester to FHWA.

It was February 17, 1983, before we could submit the formal detailed program request to FHWA. During this time, we maintained close contact with the FHWA Environmental Planning Engineer assigned to our disaster.

Our initial request totaled about $1,700,000. The unique feature of this disaster, however, was its widespread nature, <u>not</u> its dollar value. It is not common for more than 400 individual damage sites to result from a single disaster, or for the damage to spread over more than a million and a half acres. After many months, even more damage sites were being discovered, and detailed design procedures were

identifying more extensive damage than originally reported in many of the known sites. Final needs for some of the identified sites have yet to be determined.

RESTORATION BEGINS

Obtaining the funds for this work was only half the problem. Our road maintenance crews, Designers, Construction Inspectors, Contracting Officers, and other personnel, already loaded with existing projects, rose to the challenge. For those projects needing immediate attention, we used a combination of force accounts, equipment rental contracts, and public exigency contracts to keep the road system functioning.

The remaining projects were grouped by location and type of work into separate contract packages, each with about a $50,000 to $100,000 estimated value. About 35 of these groupings resulted--with another 12 groups set aside for force account crews.

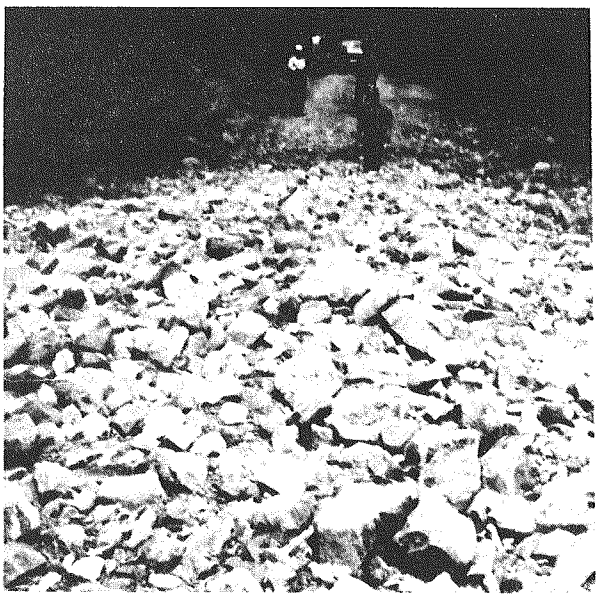

Figure 5.--Typical stream crossing debris deposit making for impassable road. (Note size of rocks.)

Figure 6.--Streambed deposit. (Note plugged culverts and channel.)

LESSONS LEARNED

Looking back on the incident and the subsequent development of our formal request to FHWA reveals several items in the process that, when handled correctly, will minimize confusion and duplication of effort, and that can be the difference between approval or rejection of a program. The most important of these are listed here so that anyone with a similar natural disaster can avoid some of the pitfalls we discovered.

(1) One person should be assigned as the overall coordinator and should be responsible for gathering and compiling the data and maintaining contact with the FHWA coordinator. If computer access is available, use it for tracking projects. Verify that data entered into the computer are in the format that will be required for later reporting fiscal controls.

(2) Keep copies of all local newspapers and other periodicals describing the incident. Often, that is the best, or only, source of background data available.

(3) Maintain close contact with the FHWA Environmental Planning Engineer assigned to your disaster.

(4) Before any damage assessment teams are dispatched, obtain the exact format requirements from FHWA; require all teams to follow the required format. Use uniform symbols and observations. Be consistent in the numbering sequence for sites.

(5) Establish firm guidelines for qualification. For example, how large does a slide on a cutbank have to be--50 cubic yards? 2,000 cubic yards?

(6) Identify all site damage reports and photos with complete location information. Identify the beginning point for milepost designation. Prepare a uniform individual site map for each site. Also, prepare a master map showing all the sites in relation to one another.

(7) Identify the limits of each site, and describe them while you are at the site.

(8) Take an abundance of pictures (several sets if possible). Carefully select the view to show before/after differences. Label all photographs with complete site information. Do not wait until you get dozens of pictures before you sort them. FHWA needs a complete set.

(9) Do not overlook emergency costs or work already done in preparing the cost estimate; include safety signing, barricades, and initial temporary work. Do not overlook the expense of the assessment itself.

(10) Be thorough and professional in preparing the justification statement and engineering reports required. FHWA needs factual data--not opinions or shortcuts. FHWA has the authority to approve requests for betterment, but cannot do so unless the conditions justify it. Drainage areas must be calculated--not estimated or guessed.

(11) Never send the last copy of any document off to another unit. This applies to photographs, especially originals that cannot be duplicated.

The Ouachita National Forest would like to acknowledge the cooperation and assistance it received from FHWA and especially from Mr. Louis J. Mattia of agency. His counsel and advice were instrumental in the development of our proposed program and its prompt approval.

WO AFTERWORD

The material in this article presents some helpful suggestions if you should encounter a disaster situation involving the ERFO program. Please remember though, that all dealings in the ERFO program are guided by our agreement with FHWA (FSM 7713.51). The FHWA publication (T 5180.2), Emergency Relief Manual for Federal Roads Off the Federal-Aid System, describes the entire process for implementing the ERFO program.

Outdoor Testing of Reflective Sign Materials

Tom Nettleton
Project Leader
& Dale Mrkich
Engineering Technician
Missoula Equipment Development Center

BACKGROUND

The number of reflective signs on National Forest lands has increased steadily in recent years. The Forest Service uses these signs to conform to the Manual on Uniform Traffic Control Devices (MUTCD) and the Highway Safety Act of 1966. Reflective signs increase traffic safety because they communicate effectively at all hours and in all weather conditions.

When the Forest Service began extensive installation of outdoor reflective signs, most of these signs required maintenance after a service life of 6 months to 2 years; field units noted that the reflective sheeting peeled from sign edges after as little as one winter. Investigation by the Missoula Equipment Development Center (MEDC) revealed that temperature extremes throughout the year and constant exposure to ultraviolet radiation and smog combined to accelerate sign deterioration. Deterioration included peeling of sign messages (legends), premature separation of reflective sheeting from the base material (substrate), and actual substrate destruction.

It was important to find a solution to the deterioration for two reasons:

(1) Deterioration, peeling, and delamination destroy the sign's reflectivity and undermine its effectiveness.

(2) Reflective signs currently cost about $12 per square foot, so maintenance or replacement resulting from premature failure is expensive.

TESTING BEGINS

In 1972, MEDC began outdoor testing of signs with reflective materials to determine which combinations of materals and manufacturing techniques would produce signs that remained maintenance free for 7 years. Sign materials tested included different substrates, various types of reflective sheeting, silk screen inks, applied legends, edge seals, clear tapes, clear coatings, and protective primers and paints. MEDC also examined many different manufacturing techniques to determine which produced the most durable reflective signs for outdoor use. The tests provided unbiased, objective evaluations of signs and materials available on the market.

MEDC established 3 test sites: Hopewell Lake, New Mexico (elevation 10,000 feet), Donner Summit, California (elevation 7,000 feet), and Mount Adams, Washington (elevation 4,600 feet). These sites provide exposure to extremes of temperature, weather (including rain and snow burial), and ultraviolet radiation. Figure 1 shows the reflective signing test site at Donner Summit.

INDUSTRY & GOVERNMENT COOPERATION

3M Company, one of the largest reflective sheeting manufacturers, has participated in the tests from the beginning of the project. In 1976, Avery International and Mitsubishi/Seibu, two other manufacturers of reflective sheeting, provided products for

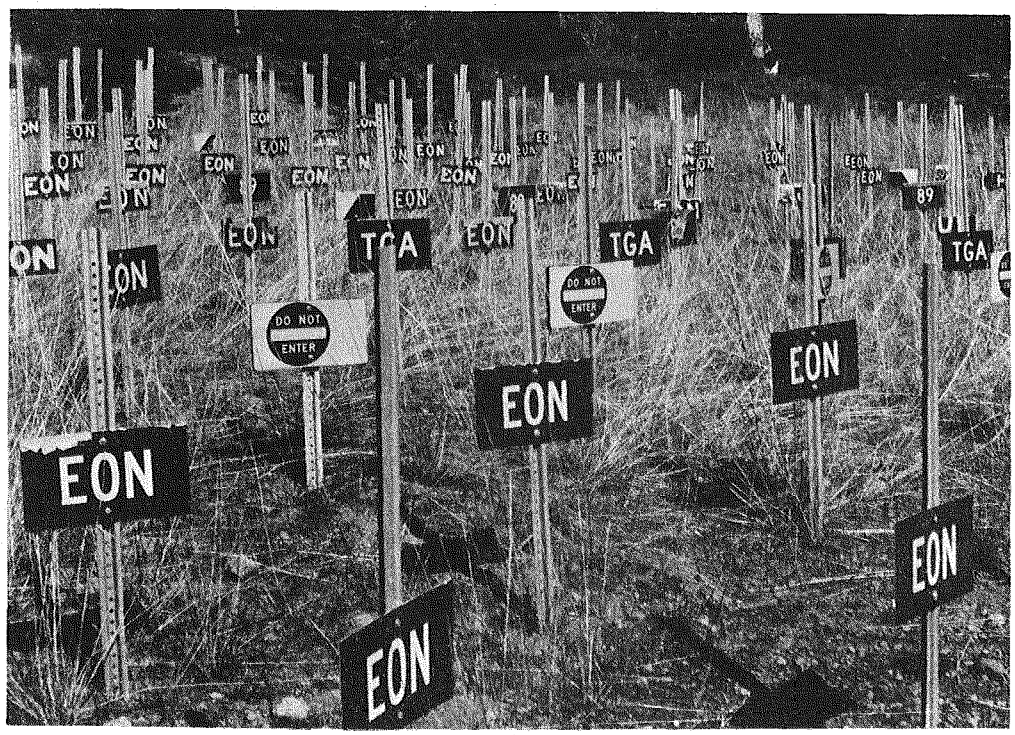

Figure 1.--MEDC's reflective signing test site at Donner Summit, California.

testing. In 1977, the Finnish Plywood Association provided plywood substrate materials for testing. The Reflexite Corporation, a maker of reflective sheeting, and Carsonite International, a manufacturer of flexible delineator posts, joined the tests in 1979. Recently, two more manufacturers requested permission to participate in the tests. In the summer of 1984, the program was scheduled to begin evaluating Cataphote reflective sheeting and Sequentia, Inc.'s fiberglass-reinforced plastic, Polyplate T, as a substrate material.

Many Federal and State agencies, as well as private companies, have monitored the tests as interested observers. These include the Federal Highway Administration, the Bureau of Land Management, the National Park Service, the General Services Administration, various State and county transportation departments, the American Plywood Association, Federal Prison Industries, Inc., other sign manufacturers, and the Canadian Forest Service.

By identifying problems with sign materials, the tests enable the Forest Service to save money by avoiding products that weather poorly. For example, the first evaluation of sign material from one manufacturer took place in June 1977, following 1 year of exposure. The evaluation revealed that most of that manufacturer's signs failed. Specifically, sheeting often peeled from substrates and also showed internal delamination. Following this disclosure, the manufacturer removed its materials and replaced them with new products that have proved more durable and weather resistant in subsequent MEDC tests.

The tests also have included evaluations of tamper-resistant hardware for sign installation. In 1978, the Forest Service began using vandal-resistant hardware on all new signs, and it plans to replace regular hardware with vandal-resistant hardware on all Forest Service signs. Consequently, two manufacturers of vandal-resistant sign hardware joined the test program: Simi Fastening Systems (formerly Voi-Shan Company), Simi Valley, California, which produces Vandalgard hardware; and the Tufnut Works, Santa Fe, New Mexico, which produces Tufnut hardware. Since 1978, vandal-resistant sign installation hardware has eliminated sign thefts from the test sites.

PROJECT RESULTS

MEDC's sign materials test program has identified specific combinations of substrate materials, reflective sheeting, edge seals, and manufacturing techniques that extend the usable life of outdoor reflective signs. Vandal-resistant installation hardware has reduced vandalism. Current Service-wide specifications for reflective signs, given in FSH 7109.11b, chapter 20, are based largely on the results of MEDC's tests.

Thanks to outdoor testing, the maintenance-free service life of signs has been extended from 2 years or less to 7 years. This means Forest Service dollars for signs go further, and it represents a savings over the years in the millions of dollars.

The most recent information on test results is available from MEDC in the report "Outdoor Testing of Reflective Sign Materials" (8372 2206, revised January 1984). This publication recommends specific combinations of materials, manufacturing techniques, and installation hardware for maximum durability of outdoor reflective signs.

Maximizing Results in a Volunteer Program

Jerry D. Greer
Project Leader
Nationwide Forestry Applications Program
Houston, Texas

This article is taken from a presentation made for the National Park Service, San Antonio Missions National Historical Park, San Antonio, Texas, in January 1983. At that time, the author was District Ranger on the Sandia Ranger District in New Mexico, where a highly successful volunteer program was developed and managed.

Designing, implementing, and managing a volunteer worker program requires the dedication of people and resources. Because people and resources are often in short supply, it is critical that a volunteer program be results oriented. Properly handled, such a program can have a significant effect on an agency's ability to accomplish its mission. To accomplish the mission efficiently and effectively, program managers must learn to maximize results.

WHAT ARE RESULTS?

Before reviewing ways to maximize results, it is important to understand what results are. There are two main groups of results that must be considered in a volunteer program: those that benefit the sponsoring agency, and those that benefit the volunteers.

In the first group, the most obvious benefit is that work is performed, tasks are accomplished, things are fixed. It is in this area that the dollar value of the program can be calculated.

Paid staff in the organization will come to know and appreciate the users of the public lands who volunteer. This contact between the agency and the "working user" helps to manage public lands with more of the taxpayers' desires in mind. Volunteers can be the source of hundreds of new ideas and innovative ways to get the job accomplished. A

successful program can help ease strained relationships that may exist between the agency and the community. Another benefit to the agency is that such programs can teach ethics and conservation to the users of the public lands who volunteer; that is, these programs provide a special opportunity to teach an important group of people how to properly use natural resources.

Training in ethics and conservation also benefits the volunteer, and therefore this aspect of volunteer programs falls within both groups of results. Most people appreciate receiving training in these areas because it helps them to appreciate resources and helps them to enjoy their outdoor activities more.

Another result that benefits volunteers is that they are able to influence management more directly. The volunteers are in a position where they can talk freely and informally with the people who are directly responsible for the management of an area. Their ideas are more readily accepted, and they have an opportunity to give more timely comments.

Volunteers also benefit directly from the work they do. Most often, people volunteer to work on projects in which they have the greatest interest. They work to maintain facilities to higher standards than an agency otherwise could afford or justify, and they help offset the cost of maintenance, which may help keep user fees lower.

The greatest benefit to volunteers is that their individual reasons for volunteering are rewarded. One agency identified 49 separate reasons why people volunteered their time and talent. Each reason may be recognized and rewarded. Volunteers want their human needs to be recognized; they need to be rewarded. If a program is handled properly, the volunteers will gain personal satisfaction from their efforts, and their reward becomes "pay" for dedicated help. Less tangible are the benefits to volunteers in terms of improved physical and mental health.

SIX WAYS to MAXIMIZE RESULTS

1. <u>Ensure that the work volunteers are going to do will, without question, help accomplish the agency's mission</u>. Time and funds are too limited to allow

for any work activity that does not help accomplish the mission.

2. Make plans and set priorities. In any organization there is more work to do than will get done. Decide which jobs are the most important, and make plans for their accomplishment.

   In a volunteer program, there will be many differences in the skills and desires of the people who want to help. As people come and go, there may be sudden changes in the skills available. Because of this, keep project plans and priorities somewhat flexible. This flexibility will permit a proper response to the changes that will naturally occur. Recruit, select, and assign volunteers based on the priority work. Treat volunteers as employees and make work assignments. Remember to consider the desires of the volunteer.

   Prepare a "wish list" of possible projects on which volunteers could work. Include how much will be required, what equipment will be needed, how much training will be required, to whom the volunteer will report, amount of support costs, and priority of the project. Keep the list close for easy reference, and build a volunteer program on it.

   Finally, follow up on your plans. A volunteer project is not complete until the manager knows that it is finished. Were quality standards met? Were any problems encountered that could be avoided the next time? Knowing these things will help improve performance. Improving performance is a part of maximizing results.

3. Select and assign volunteers with productivity in mind. Volunteers, like paid employees, must be productive. There are two parts to productivity, and they are equally important. One part is capability. A person must have the talent to do a job. The volunteer must have the tools, the equipment, and the supplies necessary to carry out the task. The second part of productivity is willingness. A volunteer must have the desire to do a job. The volunteer must be agreeable to performing the task. Willingness is something that comes with the person.

   Both factors are critical to productivity. A volunteer can have all the talent desired; but

without willingness, the person will not be productive. On the other hand, a volunteer can have the strongest desire; but if talent, ability, skill, or resources are absent, the person cannot be productive. It is easier to correct deficiencies in capability. In a willing worker, an investment in training to create skill will be rewarded. But this is not the case where willingness is absent. Changing a person's desires and their inner reasons for being uninterested and unwilling is practically impossible. Attempting such changes will be unproductive.

Ensuring productivity is not enough; guard against nonproductivity. There are three basic ways people can be nonproductive. First, nonproductive work is that which does not contribute to accomplishing the agency mission. Second, nonproductive work is any activity where the value of the work is less than the cost of doing it. Third, people can be nonproductive by doing poor quality work.

Nonproductivity hurts in several ways. Nonproductive work requires excessive followup, and the time a supervisor spends in followup can be costly. Volunteers must be able to work independently. Nonproductive work also requires too much corrective action. Volunteers must be able to do jobs to specified standards so that corrections are not required. Finally, nonproductive work results in the loss of managerial time, which hurts other programs. In this way, nonproductive work becomes counterproductive. Not only is the task not done (nonproductivity), the time spent in dealing with it actually hurts completely unrelated tasks or projects (counterproductivity).

In dealing with productivity, the supervisor of the volunteers has four interrelated tasks to perform. First, establish what acceptable productivity is for the job. Have a good idea of this when plans are made. Second, use managerial tools and skills to maintain productivity at the acceptable level. Third, improve productivity. Do this by considering and implementing employee and volunteer suggestions. Keep up with developments in the technical fields. Be creative and innovative. Fourth, measure productivity. Measuring productivity is a prerequisite to establishing, maintaining, and improving productivity. In other words, the units of measurement are the terms you use to do the other three tasks.

4. Properly supervise your volunteers. The details of proper supervision of people are beyond the scope of this article, but is important to remember that both employees and volunteers require supervision. Poor supervision will destroy any program. This is especially true in a volunteer program because volunteers do not have to put up with bad supervision.

   Four points deserve emphasis. The most important supervisory act is to ensure that volunteers are properly "paid." Volunteers come not with a need for money, but with a desire to have human needs satisfied. Proper "pay" for a volunteer is what is given to satisfy the human needs of the volunteer. A supervisor must identify the reason the person is volunteering, and then fill the need. Filling the need is "paying" the volunteer.

   Be aware of and recognize good work. Do this with both employees and volunteers, but it is particularly important in a volunteer program. Recognition is a basic human need, and recognizing the good work of volunteers will help maximize results. Recognition is given through comments to the volunteer, the presentation of certificates, and by the preparation of news releases to make good work and outstanding service a matter of public knowledge.

   Identify, discuss, and correct poor performance. Volunteers especially want to do things correctly and almost always welcome opinions. Take action as soon as problems start to develop, and discuss the situation. When all else fails, take the final step. When a person refuses to be productive, is unable to be productive, or is unable to contribute to the agency's mission, it is the supervisor's job either to reassign or to terminate the services of the volunteer. This must be done to ensure that results are maximized.

5. Recognize the effect that a supervisor can have on the results of a volunteer program. There are six essential steps toward being a better manager.

   First, work hard at managing the program. Make it succeed! Set an example for others to follow. Put forth an honest effort with a strong desire to do the job right. Guarantee effort, not results. A strong effort almost always yields a good result.

Second, be enthusiastic about volunteers and their work. Keep up a positive and encouraging attitude. A good, supportive attitude will help maximize the results of your program.

Third, treat your volunteers as equal, valued members of the staff. Volunteers treated as equals will respond and produce as equals. Volunteers treated as less than equals and those whose service is not valued simply leave--or worse, they stay and become counterproductive.

Fourth, watch for problems between management and volunteers. Look for opportunities to modify behavior or management style so that the mission can be accomplished. Make these adjustments in relationships with each individual volunteer.

Fifth, delegate work. Delegating improves productivity and effectiveness. When work is delegated to volunteers, it is a signal that they are trusted and that their contribution is valuable. The result in the volunteer is a feeling of belonging to the group. The result in the agency is increased productivity.

Sixth, read about other volunteer programs and management techniques, but recognize that a volunteer program must be specifically designed and adapted to a specific location, to a local situation, to a unique group of employees, to a certain boss, to an existing program, and, especially, to individual volunteers.

6. Accept and pay the costs of the program. There are two kinds of program costs. The first cost is the one measured in dollars, and it includes supplies, travel, equipment, tort claims, uniforms, and office facilities. The second cost is the one measured in time. Be prepared to spend the time necessary for planning, management, supervision, and recognition.

An ENCOURAGEMENT

A successful program produces results that contribute to the development of both the agency and the volunteer. Because resources are limited, it is imperative that program managers understand what results are, where results can be produced, and how to gain the most results from the lowest investment in resources and effort. It is management's responsibility to create and utilize successful programs. Given a fair chance with continued doses of

encouragement, volunteer programs can provide a significant resource base of talent. And this new talent can greatly improve an agency's ability to protect and manage natural resources.

Geometronics Update: Forest Service Past, Present, and Future Azimuths

Terry W. Gossard
Chief Geometronics Engineer
Washington Office

BACKGROUND

Technology transfer has been identified as an emphasis item and received special consideration during development of the Washington Office Engineering (WO-E) plan of work and objectives for FY 1985. Improving awareness of Geometronics products and services was also identified as an action item at the February 1984 National Geometronics Leaders Meeting. One of the methods recommended for increasing Geometronics visibility was to publish periodic, informal newsletters documenting significant Geometronics accomplishments and items of general interest. An important criterion established was that such information reach a broad spectrum of Forest Service employees to promote further dialogue and information exchange. After looking at several alternatives, we have selected Engineering Field Notes as the vehicle most likely to satisfy this criterion.

This initial effort will outline the roles and responsibilities of Geometronics units and refresh readers' memories as to the major programs and potential areas where Geometronics products and services can support resource management programs. Future items will document successes (and failures) for specific Geometronics-related development and operational programs. Field articles will be an integral part of our awareness and technology transfer effort. Readers are encouraged to submit Geometronics-related articles for publication.

WHAT IS GEOMETRONICS?

Most readers with 15 or more years of Forest Service experience probably remember the Surveys and Maps units which were assigned to each Regional Office Engineering Staff. Regional mapping, aerial photography coordination, and control survey work were typical activities supported by these units. The WO had a large production unit called the Photogrammetric

Service Center (PSC) which cooperated with the U.S. Department of the Interior (USDI)-Geological Survey (GS) and produced standard 7.5-minute quadrangles over National Forest System lands. In addition, PSC produced large-scale topographic maps to support Forest project work--primarily roads and trails. Rapid changes in technology during the late 1960's, and deemphasis of the USDI-GS cooperative program, changed the focus of the Surveys and Maps function from one of traditional mapping to that of a broader graphics mission. The emergence of the computer was instrumental in bringing about this change in program emphasis.

Geometronics--"measuring the Earth"--was the term selected to describe the expanded role of the Surveys and Maps units and the name was formally adopted in 1970. Remote Sensing, Automated Cartography, Digital Terrain Analysis, Orthophotos, and Geographic Information Systems have been added to the more traditional terminology of cartography, photogrammetry, and aerial photography to describe applications supported by Geometronics units. Control surveys, once a primary function of Surveys and Maps, have for the most part been delegated to the Forests. This change in program emphasis resulted in major organizational changes to support this new direction.

ORGANIZATION & TYPICAL PRODUCTS

WO-Geometronics (WOG). WO-Geometronics continues to perform the national policy and standards role but now concentrates on development of new systems or processes to support multidisciplinary graphics needs. The previous staff of more than 40 employees devoted to traditional topographic mapping has been restructured to 13 employees whose primary efforts are directed at computer enhancement of photogrammetric and cartographic processes. The Digital Terrain Information System (DTIS II), Topographic Analysis System (TOPAS), and Resource Information Display System (RIDS) are several examples of operational, computer-related graphics systems developed by WOG. Current activities include development of an interactive digitizing and edit system for LOT 7 hardware; development of the General Terrain Manipulation System (GTMS) to facilitate collection, handling, and formatting of digital terrain data; procurement of a commercial, state-of-the-art analytical aerotriangulation system; development of an aerial photography utility guide to assist in planning aerial photography

acquisitions to obtain maximum benefits from specified photography; and support to the national effort to evaluate FS Geographic Information System requirements. During the annual call for development proposals to support graphics needs, readers are encouraged to work through Regional Geometronics units in submitting proposals for future development.

Geometronics Service Center (GCS). Standards for Forest Service Base Series maps were developed in 1972. It was determined, through a comprehensive administrative study, that production of these standard products could most effectively be managed at a central site. GSC was established in Salt Lake City in 1975 and staffed with Regional cooperation; production in the new facility got underway in 1977. The staff currently has 108 positions with production directed at Primary and Secondary Base Series (PBS and SBS) Mapping, and Orthophoto quandrangles. FY 1984 production targets are 1,380 PBS maps, 37 SBS maps, and 765 Orthophoto quads. Regions and GSC annually develop work programs to balance production support to the Regions. Automated cartographic techniques are being increasingly integrated into the production cycle with development support provided by WOG. Some project work support for the Regions may be available, as scheduling permits, on a reimbursable basis.

Regional Geometronics Groups. The establishment of GSC significantly changed the role of Regional Geometronics Groups. Although these units, with Forest support, are still an integral part of the Base Series Mapping program, most of the traditional drafting workload has been transferred to GSC. This has generally reduced the size of the Regional units and has also redirected their mission towards more direct support of Regional project graphics needs. Digitizing and mapping support for Forest Plans, digital and conventional photogrammetric support for facilities location and design, integration of remote sensing techniques to support resource management, and construction of special graphics products have, for the most part, become the focus of these units. Field personnel should take advantage of the capabilities of these units to support their mapping and other graphics requirements needed to support Forest management.

SUMMARY & FUTURE ARTICLES

Hopefully, the above material has refreshed readers' memories or exposed those unfamiliar with Geometronics to the purpose and typical services provided

by GSC and National and Regional Geometronics units. The advent of the computer and other technology has dramatically changed the processes available to support Forest Service graphics requirements. The Geometronics mission and organization have changed to reflect expanded capabilities now available. In future issues of Engineering Field Notes, we will publish articles to illustrate both developmental and operational programs which demonstrate these expanded services. Two articles have already been identified and they are:

(1) Examples of the Use of Close-Range Photogrammetry to Support Unique Mapping Requirements.

(2) Evaluation of Radar and Laser Profiling to Map Terrain in Dense Canopy Environments.

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Lining Deteriorated Culvert Pipes on the Jones Valley Road

Robert McCrea
District Engineer
Shasta-Trinity National Forests
Region 5

INTRODUCTION

The need to replace culvert pipe as a result of chemical degradation is not a common problem, but could be in the forseeable future. Should this evolve as a common occurrence, the cost to the Government will be substantial if conventional replacement is used. Common practice is to excavate, remove and replace the damaged pipe, backfill, and compact. Of the activities that take place, excavation and backfilling can be the most costly. Generally, this depends upon the amount of material that is removed. Another problem associated with the removal of a damaged pipe is being able to duplicate the well-consolidated condition of the embankment and the surfacing associated with the original installation. This is particularly true with asphalt surfaces. In 1982, the Shasta Lake District on the Shasta-Trinity National Forests evaluated and implemented the alternative of lining existing degraded pipes with pipes manufactured of polyethylene.

PROJECT EVALUATION

In fiscal year 1982, the Shasta Lake Ranger District was faced with the problem of replacing 17 pipes that were located along a 2-mile section of a paved arterial road. This needed to be done before reconstruction on the traveled way. The pipes varied in size between 18 inches and 36 inches in diameter. All pipes were installed in 1968 and were bedded in natural stream courses that run water seasonally. Nearly all the pipes had degraded to the point where the inverts were nonexistent (see figure 1). Degradation was attributed to a weak solution of hydrogen sulfide resulting from water chemically reacting with a high concentration of iron pyrites.

This situation raised concerns regarding the cost of replacing the existing pipes and replacing them with pipes constructed of a material that would resist attack by the hydrogen sulfide. The high cost of

excavation was also a concern because the average depth of fill at centerline was 25 feet.

In search of alternative materials that would be nonreactive, we found that pipes manufactured from polyethylene would solve the problem of future chemical degradation. Lining the old pipe was identified as a possible alternative to eliminate the high cost of excavation. Although we knew that the polyethylene pipe would solve the degradation problem, we were not sure of the problems we might encounter by trying to line the existing pipes. Unsure of the viability, we proceeded to analyze this alternative. We addressed the following:

(1) How much would the insert affect the flow characteristics?

(2) If the old pipe eventually failed, how could we ensure uniform load transfer from the old pipe to the new pipe?

(3) Was there truly a cost savings associated with this alternative?

(4) How difficult would it be to handle, maneuver, and insert polyethylene as a liner?

We addressed our initial concern of flow characteristics by analyzing each of the various size pipes. Using the U.S. Geological Survey method, which was found to be the most reliable, we determined that all the 18-inch pipes except one could be replaced by 12-inch diameter pipes. With inlet control, we found that the headwater increased by about 2 times the original value. We did not feel that the additional headwater was excessive since the majority of the fills had available head capacity in excess of 12 feet. All the fills were well consolidated, eliminating any chance of piping. The remaining pipes were analyzed to determine allowable size reduction. Our analysis showed that by increasing the head at each location we were able to reduce the end area. There was no logging activity tributary to the project area; therefore, the effect of logging slash was not a factor. In most cases, we found that pipe size could be reduced enough to allow for sleeving. The one 18-inch pipe at 42+71 was found to be smaller than required to drain the tributary area.

The calculated head was equal to the available head. This was initially a concern; however, we noted that past performance of this pipe had been adequate, and therefore we felt that the risk of failure was very low. We selected a pipe with the largest inside diameter that would fit an 18-inch pipe. In this case, we proposed to use smooth-walled, heavy-duty polyethylene pipe because we could fit a 16-inch diameter smooth-walled pipe into the 18-inch diameter pipe. A 16-inch corrugated pipe would not fit. The results showing as-built and replacement sizes for all sites are shown in table 1.

Another concern was ensuring uniform load transfer from the old pipe to the new pipe in the event the old pipe collapsed. The galvanized metal pipes had degraded to the point that we knew that at some time some of the pipes would collapse. Since there was a void between the old and new pipe, there was fear that eventual failure of embankment would crush the new pipe without a medium to transfer the load uniformly. To prevent this from happening, we proposed to fill the void with a five-sack concrete grout mix (see figure 2).

Recognizing that we had a viable alternative, we attempted to cost out both methods, fixing the variables of diameter and cross slope. Figure 3 shows the cost differential between sleeving old pipes with polyethylene pipe and conventionally digging them out and replacing them.

Figure 1.--Existing pipe with invert gone.

Figure 2.--Grouted inlet end with insert.

Table 1.--Sizes of as-built and replacement pipes (inside diameter, in inches).

Location	As-Built	Replacement	Size
42+71	18	16	smooth-wall polyethylene pipe
44+74	18	12	corrugated polyethylene pipe
49+16	18	12	corrugated polyethylene pipe
53+50	18	12	corrugated polyethylene pipe
60+45	24	18	corrugated polyethylene pipe
64+25	30	24	corrugated polyethylene pipe
68+40	18	12	corrugated polyethylene pipe
70+81	18	12	corrugated polyethylene pipe
75+25	18	12	corrugated polyethylene pipe
75+85	18	12	corrugated polyethylene pipe
79+30	24	18	corrugated polyethylene pipe
82+85	18	12	corrugated polyethylene pipe
84+90	18	12	Corban RPM
87+50	36	33	corrugated polyethylene pipe
93+00	18	12	corrugated polyethylene pipe
95+61	24	18	corrugated polyethylene pipe
100+25	24	18	corrugated polyethylene pipe

The cost comparison was made on the basis of replacing only 18-inch pipes. We found that corrugated polyethylene pipe can be used when replacement requirements do not exceed 24 inches in diameter. Larger size pipe is available in polyethylene, but not with the same configurations and gage. As a result, the cost is greater for materials. As noted earlier, the pipe at Station 42+71 required a minimum diameter of 16 inches, which was available in corrugated polyethylene pipe but would not fit the existing pipe. As a replacement, we proposed using 16-inch smooth polyethylene pipe of heavier gage. The cost of this pipe was twice the cost of corrugated polyethylene pipe or a comparable-size steel pipe. As a result, the cost of sleeving, as shown in figure 3, would adjust slightly upward and shift the break-even point to the right.

The largest pipe that required sleeving was a 36-inch diameter pipe located at 87+50. Initially we planned on using smooth polyethylene pipe. This material was not available at the time it was needed, so we elected to use Corban RPM liner pipe, which also was costly and would shift the break-even point to the right on figure 3.

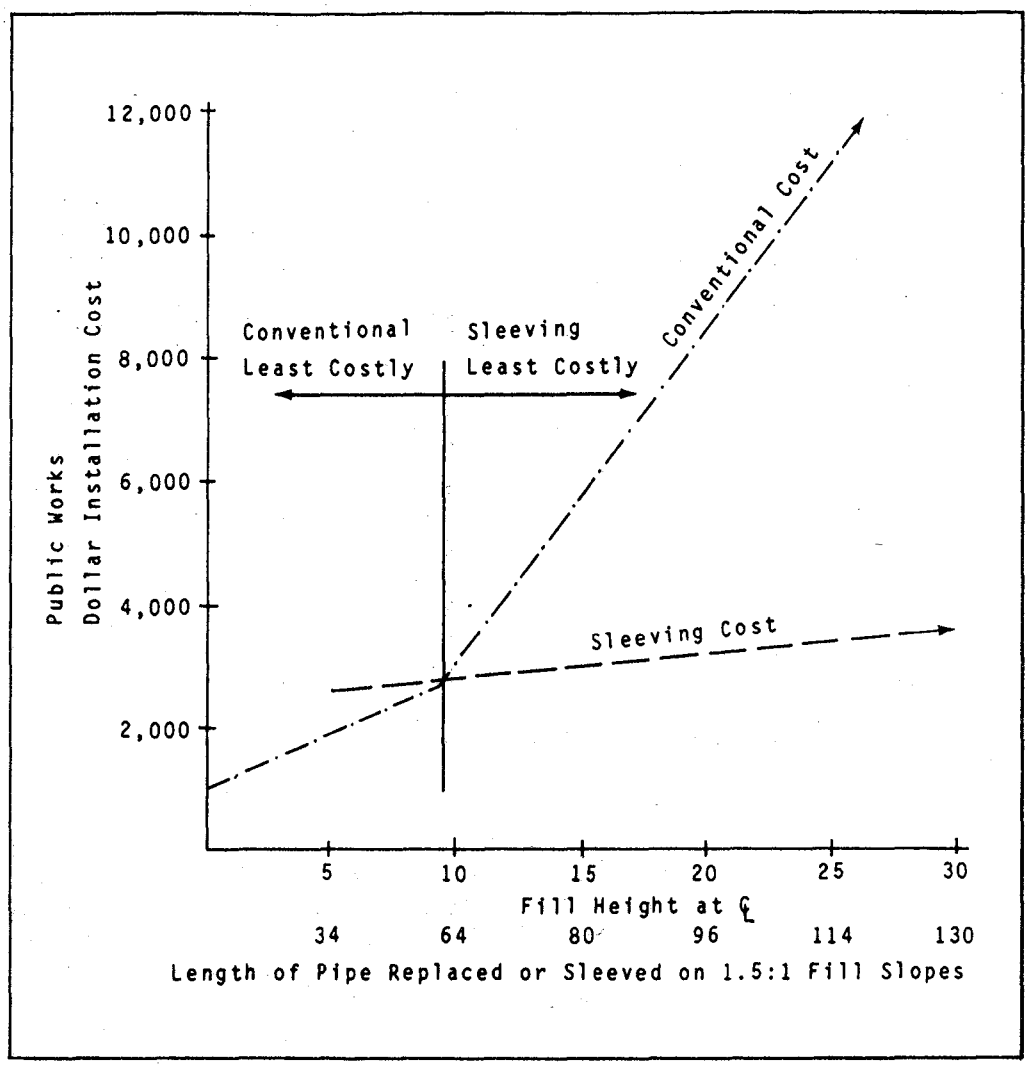

Figure 3.--Sleeving versus conventional replacement of 18-inch culvert pipe on a 30-percent slope.

We felt that our last concern with respect to handling and maneuverability could be answered only by actual application.

PROJECT IMPLEMENTATION

This project was accomplished by force account crews on the District. Since there was so little known about the procedures, we wanted the flexibility to work with various alternatives.

The 12-inch corrugated polyethylene pipe would be the best to start with because it was the easiest to handle. As shown in figure 4, the desired length was preassembled on the road grade. Sections of pipe that were joined with couplings were split longitudinally so that they could be spread and wrapped around adjoining sections of pipes. The

Figure 4.--Pipe assembled on road grade.

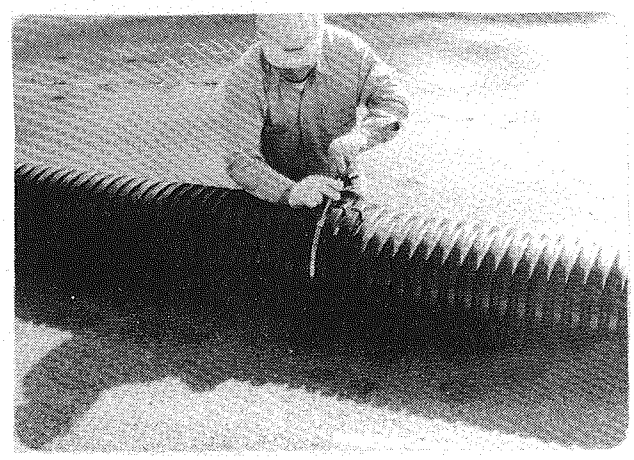

Figure 5.--Split band coupling.

coupling then was secured with expandable hose clamps (see figure 5). We were not satisfied with the coupling and replaced it with a standard screw-on coupling.

After joining the required number of lengths, we mounted a section of perforated polyvinylchloride (PVC) to the top of the pipe that was to act as a filling tube for the grout (see figure 6).

The pipe then was laid in the channel and attached to a harness and cable that were used to pull the insert through the old 18-inch pipe (see figures 7 and 8).

After the pipe was pulled into place, the downstream and upstream ends were grouted, leaving a 2-inch PVC nipple exposed on the upstream side for grouting (see figure 9). Unfortunately, we neglected to recognize that there was no place for the air to go once we started pumping grout. We consequently cut a hole in the uphill end of the existing pipes and let gravity do the work (see figure 10). Fortunately, there was enough slope in most cases in the pipe to allow a total fill of the void between the old pipe and new pipe. Pipes on slopes of less than 5 percent still required the fill tube; however, the pipe was filled before sealing the upstream end. After filling all the pipes with grout, the upper stream ends were grouted and sealed (see figure 11).

The smooth-walled polyethylene pipe that was installed at Station 42+71 was basically installed

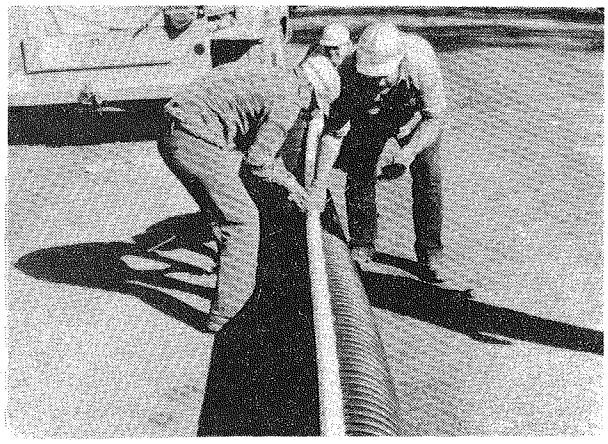

Figure 6.--Pipe with fill tube attached.

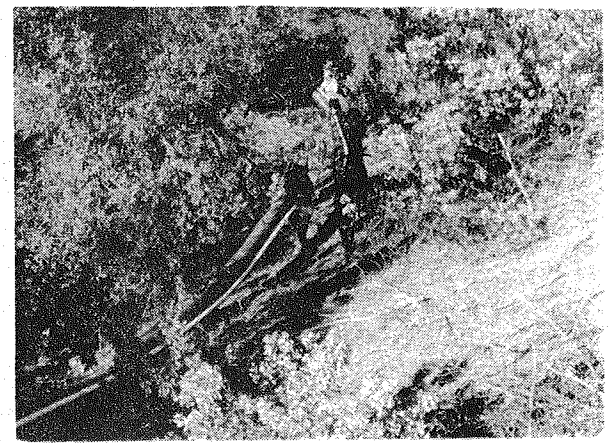

Figure 7.--Pipe layed in channel.

Figure 8.--Nylon rope harness.

Figure 9.--Fill tube (initial proposal).

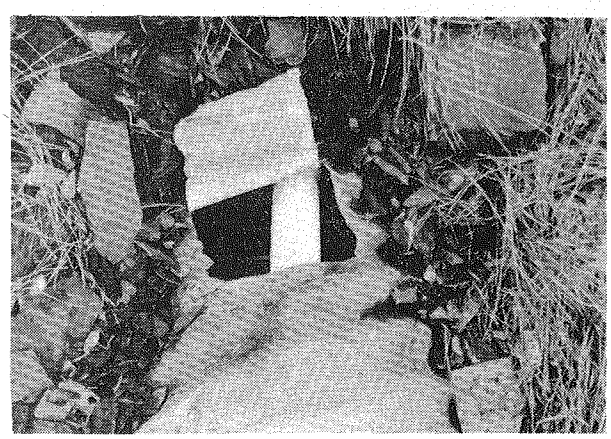

Figure 10.--Hole cut in pipe.

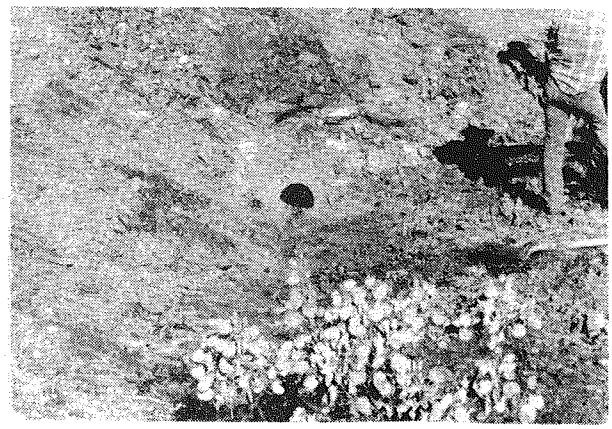

Figure 11.--Sealed entrance.

and grouted the same way except that the lengths of pipes were connected together by fusion utilizing the Phillips 24-inch fusion unit (see figures 12, 13, and 14).

At Station 87+50, a 33-inch Corban RPM pipe was installed. The procedures used were unique in that separate sections were pushed by a small tractor up the old pipe to a point where new sections could be slipped on and pushed up until the entire pipe was lined. Grout was used only to seal the ends at this site because the void between the old and new pipe was negligible and potential problems associated with load transfer were not anticipated (see figure 15).

Figure 12.--Fusion method of joining.

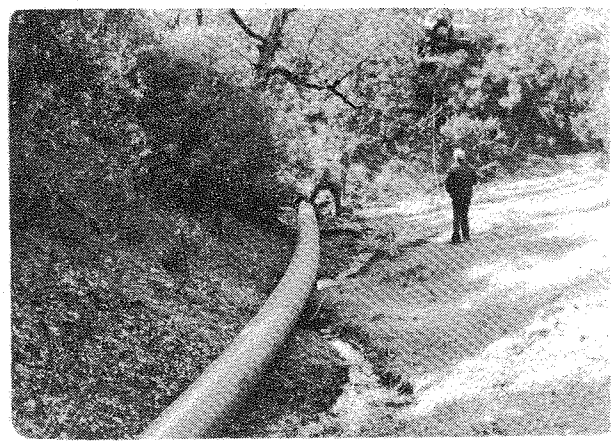

Figure 13.--Smooth-walled polyethylene pipe in channel.

Figure 14.--Pull cable attached to smooth-walled polyethlyene pipe.

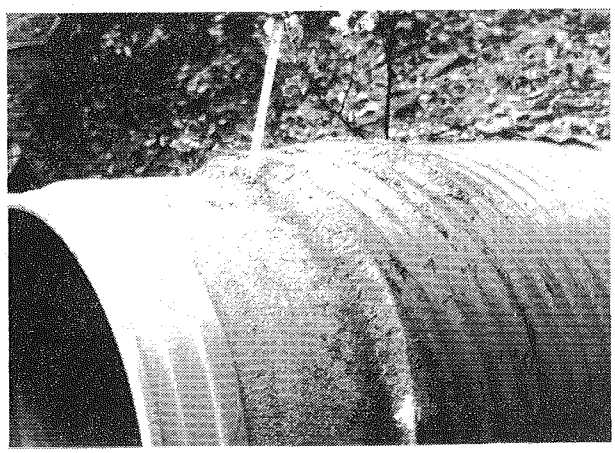

Figure 15.--Corban RPM.

SUMMARY

Lining existing culvert pipe with polyethylene pipe is a practical and low-cost alternative given the right conditions.

The condition of the existing pipe is important in that a relatively uniform cross section is required to facilitate the new pipe. This would eliminate it as a possible alternative for the majority of storm-damage projects. Our cost analysis showed that pipes buried in fills had a cost break-even point between sleeving and conventional replacement at or near 10 feet of fill at centerline for pipes up to 24 inches in diameter. For pipes with wider diameters, the break-even point would shift slightly because of the increased material cost associated with heavier gage and different type of polyethylene pipe.

A critical factor to consider is the willingness to let the headwater creep up the fill as a result of the end-area reduction. We have had two winters to observe this on the pipes we sleeved, and we have not observed any detrimental effects; however, it is important to note that the fills on this project were well consolidated and composed of granular and relatively competent material.

One advantage that was not thought of in the early stages of this project was that traffic control was not required. Had we elected to use the conventional technique, we would have been forced to shut the road down for an extended time. This would have been cause for concern in that this road serves one of the District's high-use boat ramps year round.

The obvious advantage on this project was the dollars saved. The total cost of this project was $45,000. Had we elected to accomplish this work using conventional methods, the cost would have been $210,000.

It is difficult to estimate the number of applications this alternative could have Service-wide; however, the need to replace pipes <u>will</u> become more frequent as time goes on.

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