

**ENGINEERING
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Field **Notes**

Underwater Repair of Bridge Footing

Stabilization of the Foundation for Bridge Footing

Washington Office News



FOREST SERVICE

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FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
Washington, D.C. 20013

UNDERWATER REPAIR OF BRIDGE FOOTING

Lyle Lallum
Structural Engineer

Duane Yager
Structural Engineer

Region 1

The Bungalow Bridge spans the North Fork of the Clearwater River in northern Idaho. It is located approximately 75 air miles (121 km) west of Missoula, Montana, on the Clearwater National Forest which is managed through the Supervisor's Office at Orofino, Idaho.

The bridge consists of a 39-foot (11.89-meter) simple span and a 80.5-foot, 112-foot, and 80-foot (24.5, 34.1, and 23.4 meter) three-span continuous unit. The superstructure is composed of a concrete deck 28 feet (8.5 meters) wide, supported by constant-depth riveted steel plate girders on the continuous unit, and by steel wide-flange beams on the simple span. The substructure is composed of two-column concrete end bents founded on spread footings, and piers consisting of solid reinforced concrete shafts with reinforced concrete footing resting on plain concrete seals.

Pier No. 2 is located between the 80.5-foot (24.5 meter) and 112-foot (34.1 meter) continuous spans. The reinforced concrete pier shaft is 22.5 feet (6.9 meters) high x 28 feet (8.5 meters) x 3.5 feet (1.1 meters), and rests on 9 x 32 x 4 foot (2.7 x 9.8 x 1.2 meter) reinforced footing sitting on a 9 x 35 x 5 foot (2.7 x 10.7 x 1.5 meter) plain concrete seal. At this site, the river flows in a westerly direction, with normal water depth of approximately 5 to 12 feet (1.5 to 3.7 meters) along the respective southern and northern edges of the footing seal.

Visual observation by Forest Service Engineering personnel during the summer of 1974 indicated the possibility of scour problems around Pier No. 2 of the bridge. Scour around and under pier footings has long been a worldwide problem for engineers. In this case, the Region 1 Transportation Structures Group was contacted, Engineering personnel with scuba diving gear were sent to inspect the footing, and severe scour was noted under the footing seal.

The underwater inspection revealed scour depths of 2 to 2.5 feet (0.61 to 0.76 meters) along the eastern end of the plain concrete seal. Along most of the 35-foot (10.7 meter) length, the northern edge of the seal had scour which varied from 2 to 3 feet (0.61 to 0.91 meters) deep and extended as far as 5 feet (1.5 meters) under the seal. The western end was undermined from 0 to 2 feet (0 to 0.61 meters) deep. The remaining south side of the seal showed little or no scour.

Three alternatives were considered:

Repair of Pier No. 2 at an estimated cost of \$90,000;

Replacement of Pier No. 2 at an estimated cost of \$200,000; and,

Complete bridge replacement at an estimated cost of \$400,000.

The first alternative was chosen because it would result in less environmental impact, less cost, and quicker repair, even though all repair work to the pier had to be done under water, and there was more risk involved.

A contract was advertised for sandblasting and painting portions of the superstructure, as well as repairing the pier footing, and was awarded to William Cummings of Orofino, Idaho. Forest Service personnel involved were: J.M. White, Contracting Officer; Neal Flowers, Contracting Officer's Representative; and Lyle Lallum, Inspector.

The section of the contract for footing repair called for construction of access dikes, and a cofferdam with a perimeter from 3 to 5 feet (0.91 to 1.52 meters) outside the perimeter of the existing seal. The contractor was then required to pump the loose material from within the boundaries of the cofferdam to bedrock, and fill in that space with concrete to an elevation even with the top of the existing seal. Because of the fisheries in the river, stream turbidity at a point 150 feet downstream from the construction site was limited to an increase of 20 Jackson Turbidity Units*, and the work had to be performed between July 15 and September 15, 1976.

In lieu of a cofferdam, the contractor proposed to perform the pier repair work through an alternate solution employing bagged grout, which he called "bagpipe groutainer forms"; that proposal was accepted. The work was to be performed by a subcontractor, Turzillo Corporation, whose main office is in Brecksville, Ohio.

This method of repair, though unknown to Region 1 engineering personnel, had been used successfully by the subcontractor on similar contracts in the Midwest and Canada. The bagpipe groutainer forms are bags cut and sewn from a roll of cotton-like fabric at the site. A small hole is left in one end of each bag, where a nozzle is inserted to fill it with grout. The bags are placed in layers and filled with grout to form a wall, in much the same way that a mason uses stones to form a wall.

**Standard Methods for the Examination of Water and Wastewater, joint publication of the American Public Health Association, the American Water Works Association, and the Water Pollution Control Federation. Latest edition.*

The proposed method required two divers for underwater work, and a "dryland" crew consisting of two diver helpers and three laborers, plus a foreman and a superintendent. A barge was used to store the divers' equipment and as a work platform for the divers' helpers (fig. 1). The work consisted of:

Excavation of loose material from around and under the footing;

Placement of the bagged grout; and

The pumping of the cavity under the footing seal full of grout.

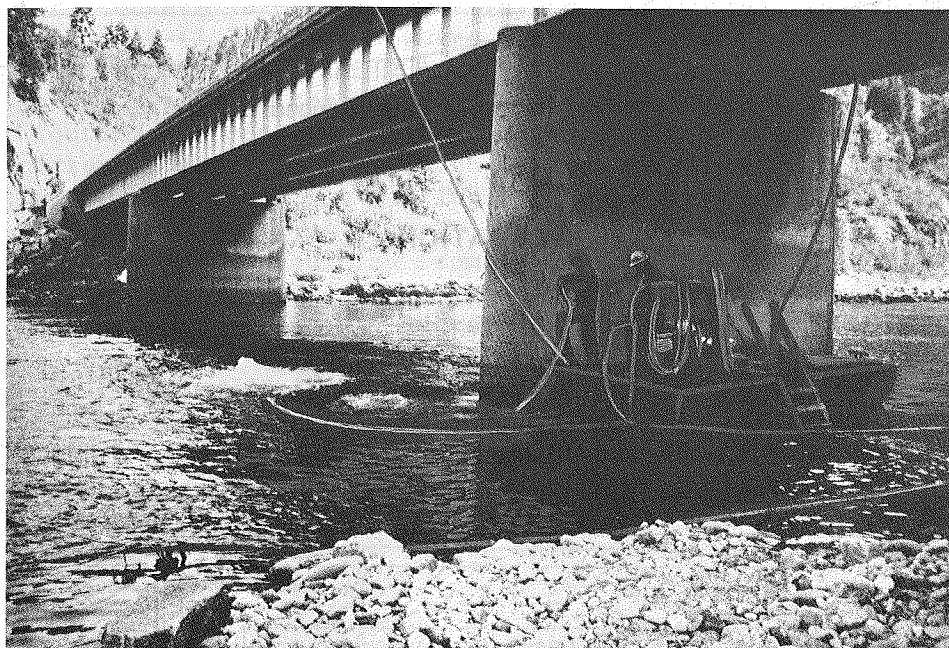
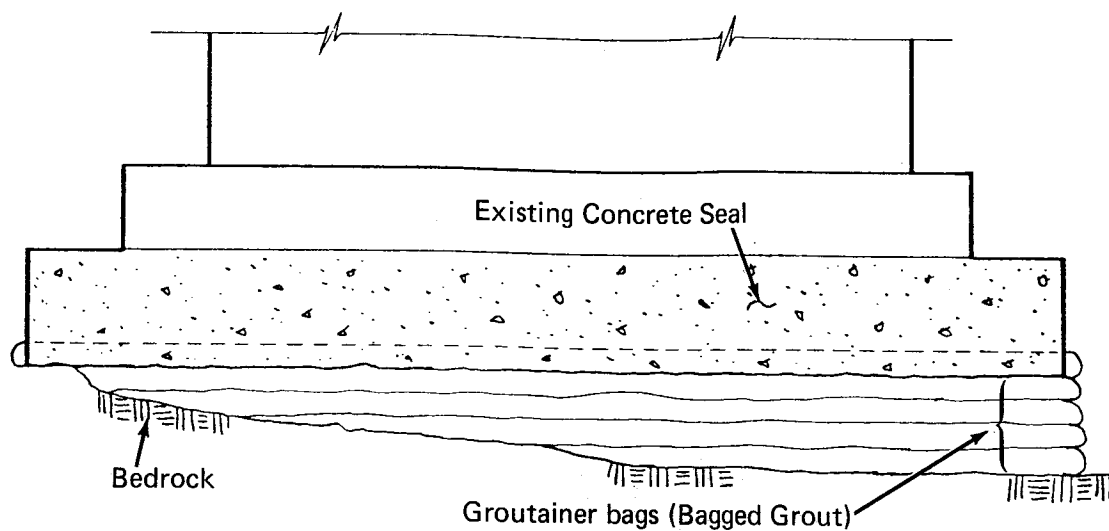
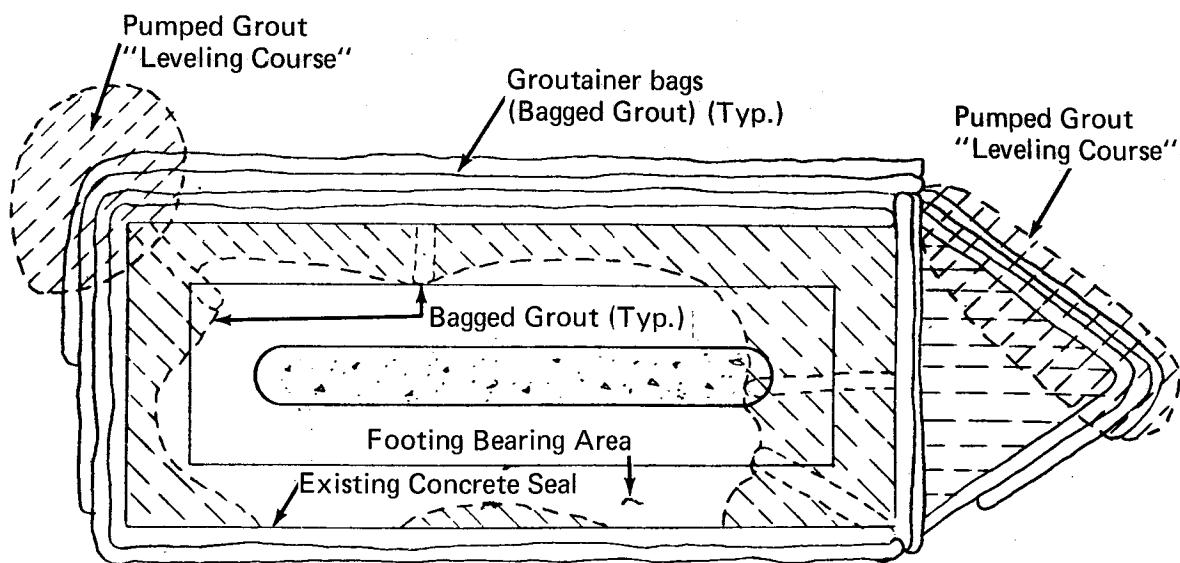


Figure 1. Barge used as work platform for divers.

The excavating consisted of removing all loose material from the streambed in the area under the footing seal and within the proposed perimeter of the bagged grout (fig. 2). Material up to 6 inches (15 cm) in diameter was removed by using "airlifts" handled by the divers. Airlifts are metal tubes varying from 4 to 10 inches (10 to 25 cm) in diameter that move material by compressed air forced through them, creating a suction at the bottom. The clear granular nature of the material involved made it possible to deposit this material in the riverbed without exceeding the contract turbidity requirements. Material larger than 6 inches (15 cm) was either moved by hand or by a backhoe operating from the bridge deck. The backhoe



ELEVATION



PLAN

Figure 2. Plan for excavation.

used cables attached to the boom to pull log debris away from the footing area.

The groutainer bags were placed on the bedrock and filled with grout. Depending on the roughness of the bedrock surface, bag lengths varied from 3 to 20 feet (0.9 to 5.1 meters). A horizontal plane was formed by the bottom layer of bags, upon which more layers of groutainer bags could be readily placed. In areas where scour depths were the largest, it was necessary to place three groutainer bags side by side on the bedrock in order to establish a base wide enough for the gravity wall form. Succeeding layers were stepped in, until only one bag was required when the top of the wall was reached. The bottom layer of groutainer bags was doweled 18 inches (45.7 cm) into bedrock with #6 reinforcing bar dowels at 2 feet (0.61 meter) centers. The second and third layers were doweled at 3 feet (0.91 meter) centers into next lower layers. Additional layers were doweled at 4 feet (1.2 meter) centers into next lower layer.

In addition to repairing the scour area under the existing seal, a nose on the pier footing was constructed that began at the corners of the existing seal and extended about 12 feet (3.66 meters) upstream from the seal, to reduce flow turbulence in the footing area during future high-water periods.

The size of the cavity resulting from the excavation caused concern about the possibility of the pier shifting or collapsing due to excessive loss of bearing area under the footing. Therefore, it was decided to divide the cavity into six parts. Each part was excavated, a bag wall built, and the bags and cavity pumped full of grout before proceeding to the next part (fig. 3), as each layer of bags was completed. The top layer of bags was placed so as to form a lip between the wall and existing concrete sill. Pipes were inserted into the silled cavity through the wall before the last layer of bags was placed. The pipes were used to allow the trapped water to escape as the cavity, formed by the wall and bottom of existing sill, was filled with grout (fig. 4).

The grout was composed of cement, sand, and an additive called "*Interaid*" which acted as a pumping lubricant. The grout was mixed by an air-operated mixer in 6 cubic-foot (0.17 cubic meter) batches (absolute volume) and pumped through 1-1/2-inch (3.8 cm) diameter hoses to the footing area. (fig. 5). The mix design consisted of 3 bags Type II cement, 7 cu. ft. (0.2 cubic meter) of sand, 2 pounds 10 ounces (1.2 kg) of *Interaid*, and 16 gallons (60.6 liters) of water. Test cubes taken from the grout consistently showed compressive strengths in excess of 3,500 psi (24,131 kilopascals) for 7-day and 7,000 psi (48,263 kilopascals) for 28-day tests.

The total contract time involved in the footing repair was 25 working days. Engineering personnel engaged in this project agreed that it was a practical and efficient method of repairing scoured footings. A cost savings of about 7 percent of the original contract price for the footing repair portion of the contract was realized by using this method. It is thought

that a further savings could have been realized, had the designers known about this procedure prior to writing and advertising the contract. There was only one bid received on this project, from a local contractor not experienced in this type of work. The actual underwater work was subcontracted.



Figure 3. One layer of grout bags and grout was pumped into this portion of the area under the footing.

The advantages of using the groutainer method in lieu of a cofferdam were as follows.

The condition of the foundation could be checked by divers during all of the repair operation.

There was less environmental damage caused by sedimentation.

The method was more economical.

The scour area could be repaired in parts, reducing the possibility of the pier shifting.

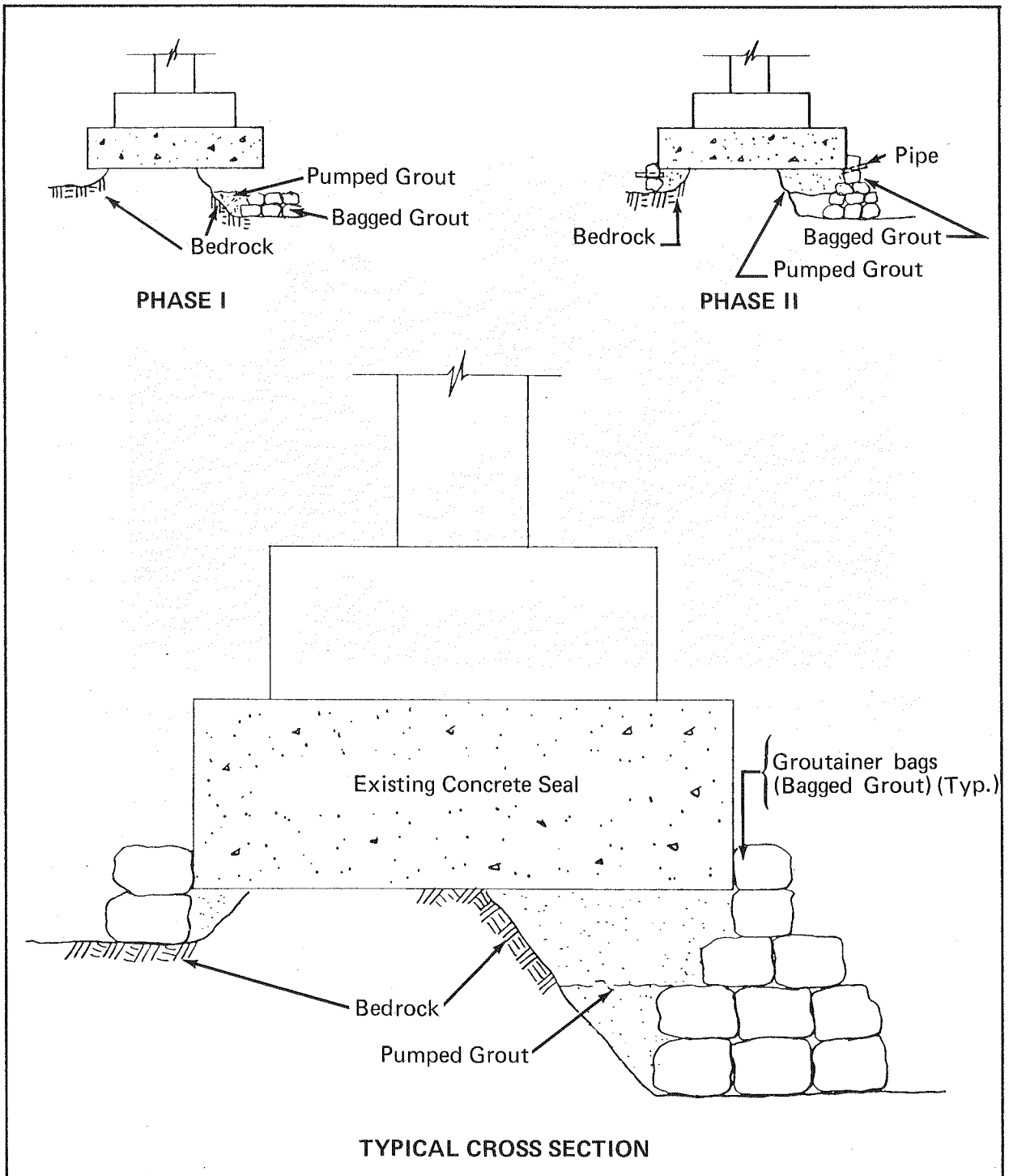


Figure 4. Placement of bags to form a lip between the wall and existing concrete sill.

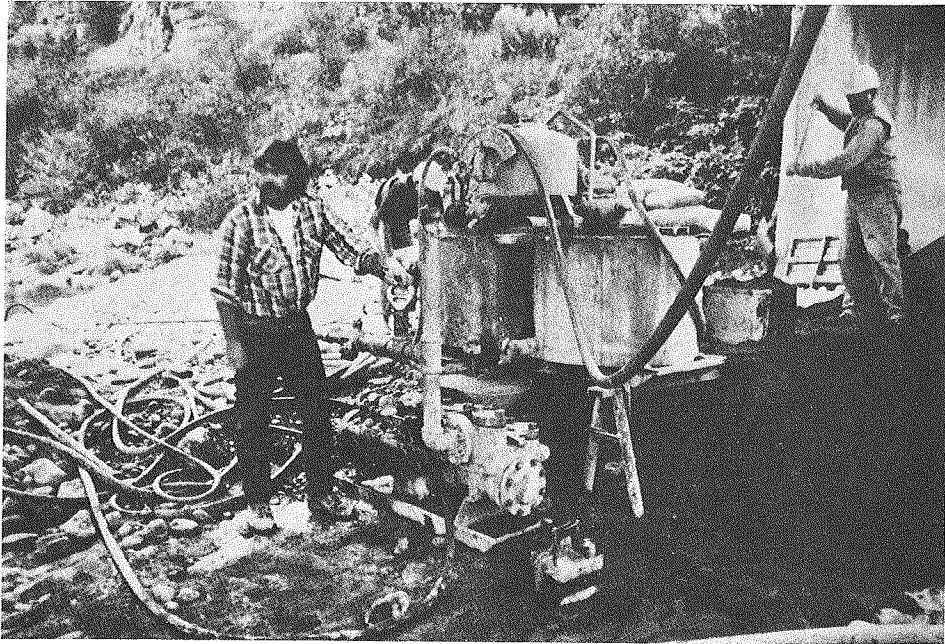


Figure 5. Grout mixers and pump operated by an air compressor.

STABILIZATION OF THE FOUNDATION FOR BRIDGE FOOTING

*Duane Yager
Structural Engineer
Region 1*

The Sun River Bridge is a three-span prestress concrete girder bridge located 24 miles (39 km) west of Augusta, Montana. The bridge was built in 1965 after a major flood in the area. The original footing was placed 8 feet (2.4 m) below the ground line.

In the spring of 1975, before high water, the footing of Pier No. 1 was found to be partially undermined. Emergency repairs were made to protect the footing during spring runoff, but a near record runoff occurred in June. The riprap placed around the footing was eroded, with scouring beneath the footing. The pier settled about 1 inch (2.5 cm) on the upstream end and over 2 inches (5 cm) on the downstream end. This differential settlement caused cracks in the columns, bearing assembly breakage, and a corner of the cap to break off. The amount of movement could not be tolerated in a bridge designed as a simple span structure.

The objective was to stabilize the pier in its existing position, and to repair the bearing assemblies, columns, and cap. Based on previous experience with grouting, it was decided to stabilize the pier by pumping grout into the native foundation material, forming a consolidated mass 20 feet wide by 39 feet long by 10 feet deep (6.1 x 11.9 x 3.0 meters), and enlarging the existing concrete footing.

A contract for the repairs was awarded to Lee Turzello Contracting Co., and work began on December 15. The area is subject to severe winter weather conditions: temperatures can vary between 50°F. (10°C) to -35°F (-37°C) in 24 hours, and 50 mph (80 kmh) winds are not uncommon. Enclosures (Fig. 1) were built to protect the workers, and this precaution was justified, as all the conditions described occurred during conduct of the work.

The first operation was to drive 3/4-inch (1.9 cm) steel pipes vertically at about 3 feet (0.91 m) outside of the existing footings. The pipes were placed on 4-foot (1.2 m) centers, and were driven 3 to 5 feet (0.91 to 1.52 m) into the native material. Grout was pumped through these pipes until it surfaced (see Figures 2, 3, and 4). This procedure sealed the top area. A star drill was used to core through the grout, and steel casing was driven in the holes. The steel pipes were then driven inside the

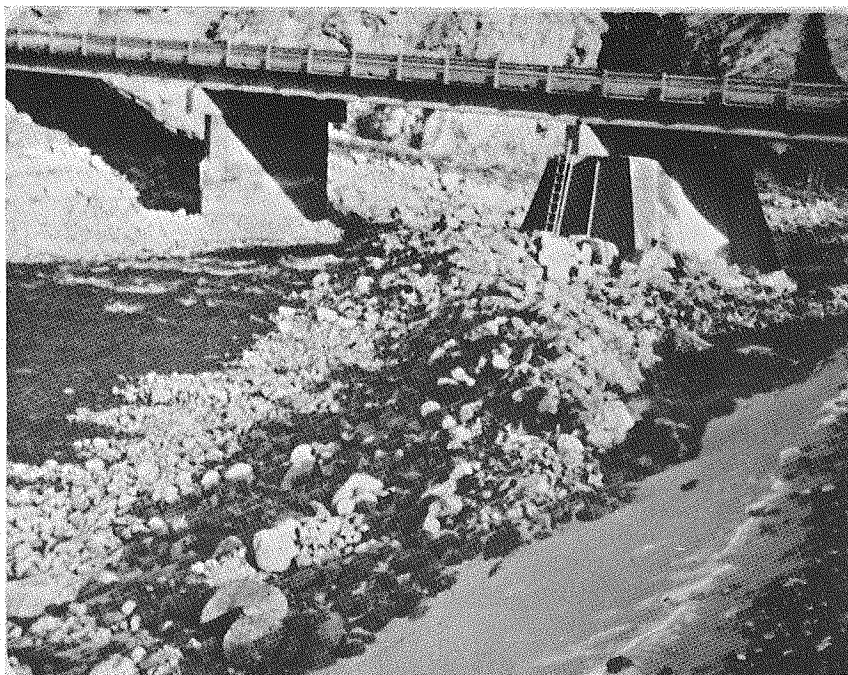


Figure 1. Enclosure built for men to work.

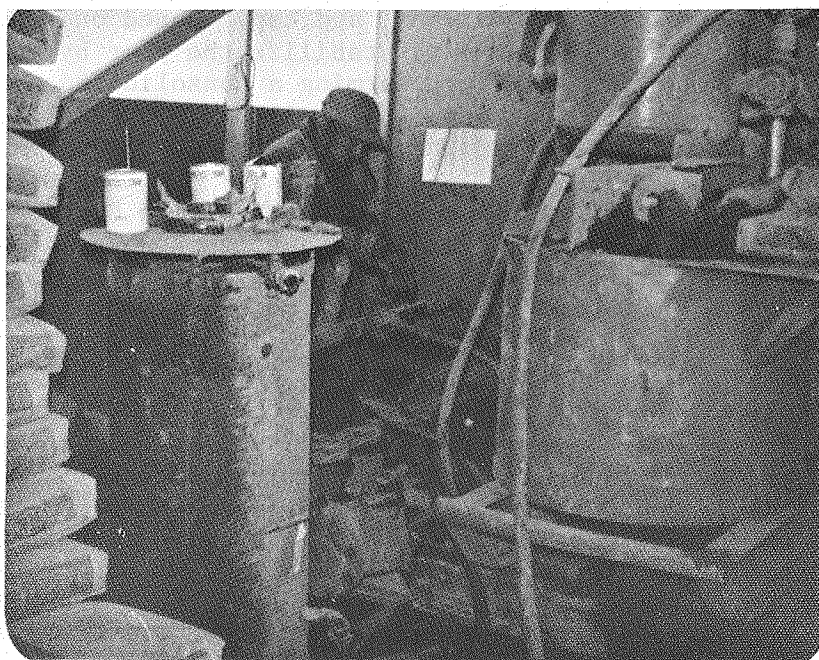


Figure 2. Grout pump and water heater.

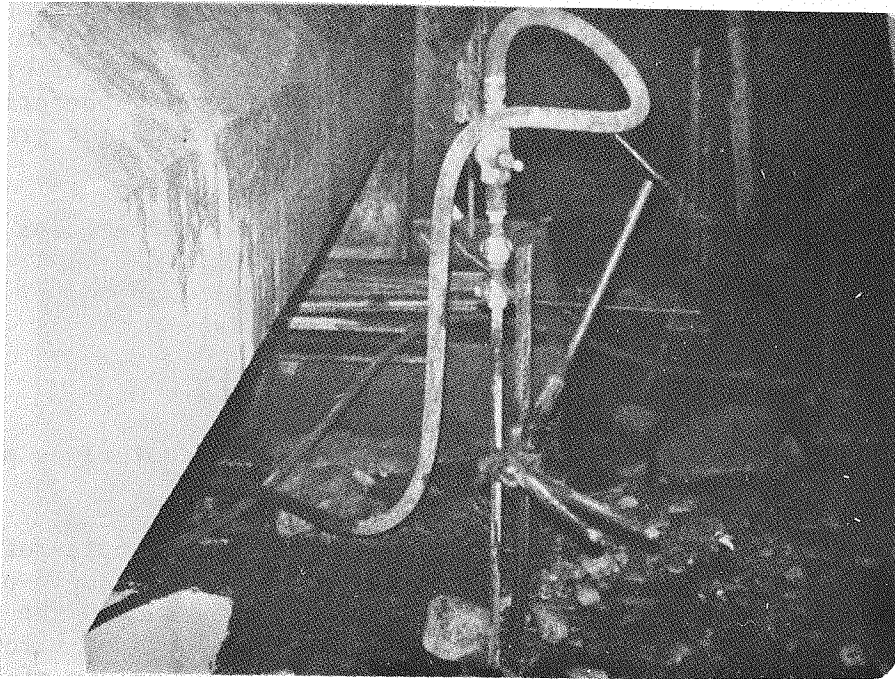


Figure 3. Pumping grout through 3/4-inch steel pipes.

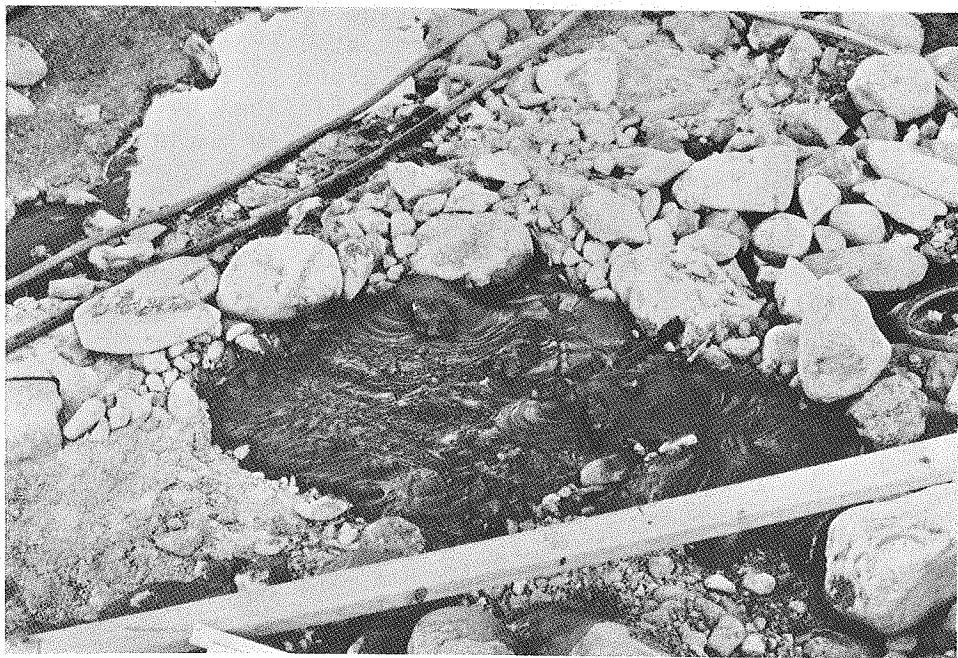


Figure 4. Grout was pumped until it came to surface.

casing to a depth of 10 feet (3.05 m) and grout was pumped to complete the consolidation of a mass 20 x 39 x 10 feet (6.1 x 11.9 x 3.0 m) in width, length, and depth. About 80 cubic yards (61.2 cubic meters) of grout were used. Special care was necessary during the final pumping operations directly under the existing footing, because a small amount of grout pressure could have raised the entire pier.

The grout mixture pumped into the native material was as follows:

- 0 to 3 cu. ft. (0-0.085 cu. meters) sand
- 1 bag *Interaid* (2 lb 5 oz) (1.05 kg)
- 2 bags cement
- 12 gallons (45.4 liters) water

The amount of sand used varied, depending on the amount of fines present in the native material.

The last step of the repairs was to encase the existing footing of the pier with concrete. The original contract specified standard cast-in-place reinforced concrete. Because of the freezing temperature and the long distance to any concrete plant, the contractor requested and was allowed to use Preplaced Aggregate Concrete (PAC) (Fig. 5). PAC consists of preplacing coarse aggregate of 1/2- to 1-1/2-inch (1.3 to 3.8 cm), as shown in Figure 6, and then pumping grout (sand-cement) into the aggregate to form concrete (Fig. 7). The compressive strength of the cylinders made from PAC ranged between 5,200 psi to 5,590 psi (35,852 to 38,541 kilopascals) at 28 days.

One problem with PAC is that the forms must be "watertight" or the grout will not fill all the voids. Pumping starts at the bottom and proceeds to the top (Fig. 8). It took 12 hours to pump grout to form 48 cubic yards (36.7 cu. meters) of PAC. The top of PAC was finished by striking the top surface similar to cast-in-place concrete. Very few voids were found when the forms were stripped.

The cost of the project was \$50,000, but the results achieved by consolidating the native material with pumped grout, and using PAC to enlarge the pier footing, will provide a satisfactory and long-lasting product (Fig. 9).

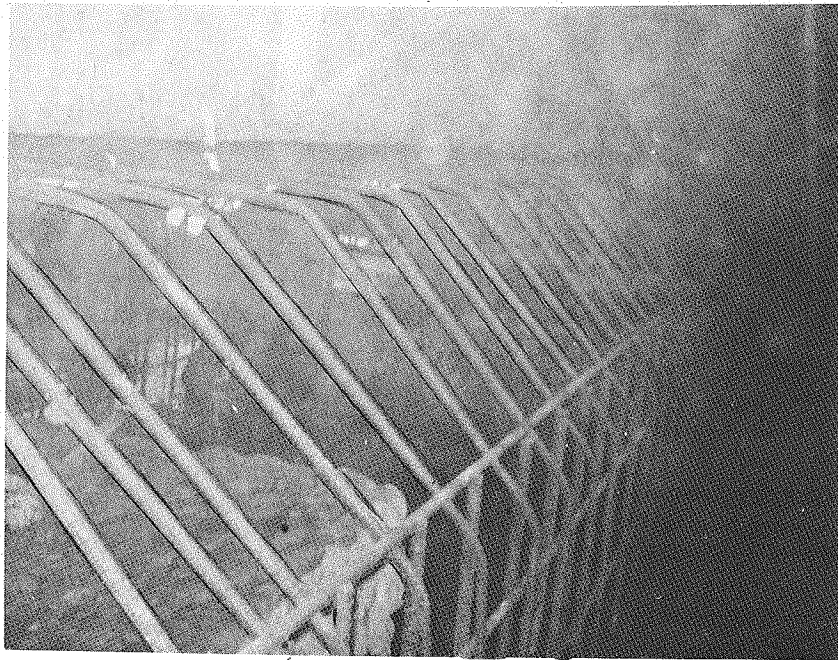


Figure 5. Reinforcing steel placed for PAC footing.

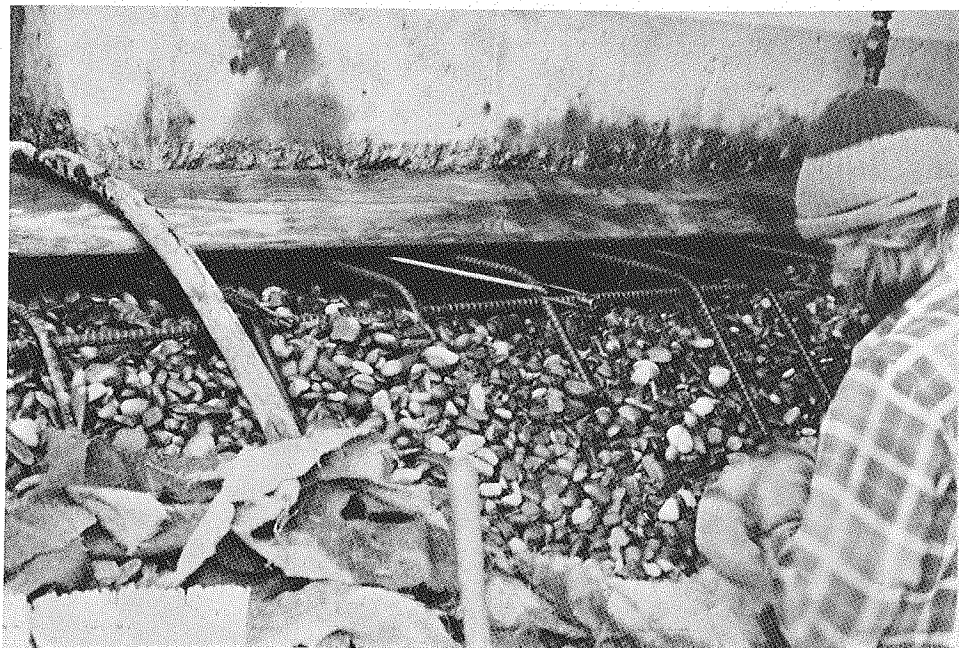


Figure 6. Placing coarse aggregate in the footing.

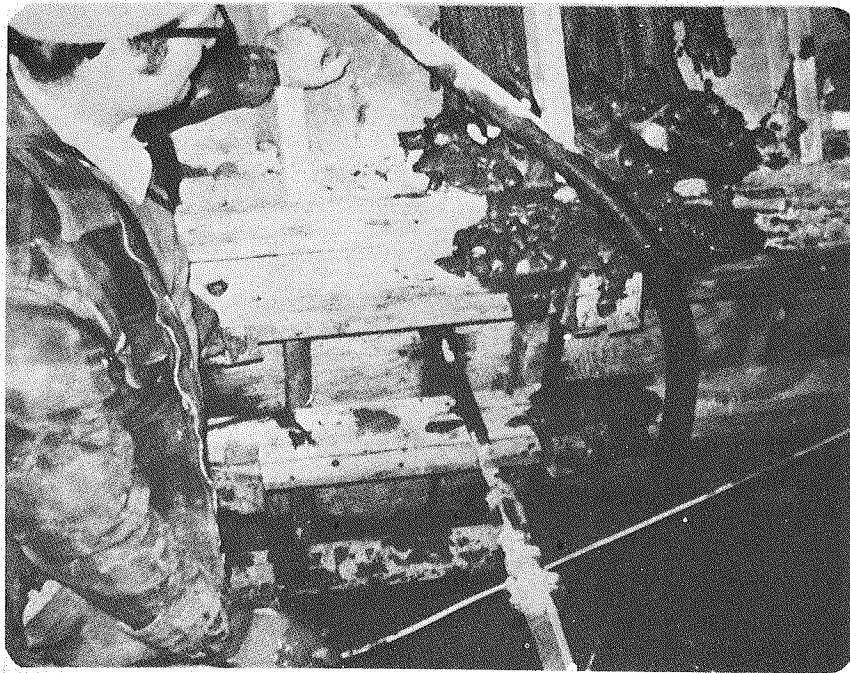


Figure 7. Pumping grout into the coarse aggregate.



Figure 8. Final pumping of grout to eliminate air pockets.



Figure 9. Finished product.

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

REGIONAL PARTICIPATION IN ED&T PROGRAM

The program development work is well underway for the FY 1979 ED&T effort. As in most years, there are more proposals than there are dollars available to fund them. This makes the final selection rather complex. A good, concise, but thorough problem definition is the first step toward selection of projects for funding. The proposals submitted by the Regions this year were outstanding in regard to problem definition. Not only were they generally well written, but there were many more proposals to be considered.

Currently, there are 10 projects being funded which are a direct result of proposals submitted by the Regions. Of course, there are many problems which went from field personnel to Centers or to the Washington Office to be included as part of the overall program. The 10 proposals referred to were submitted as a direct result of Regional ED&T effort. They were initiated at the District or Forest level and sent through the Regional ED&T Board. Through this same route a number of local or Regional problems have been identified and approved for work as Regional ED&T projects.

Regions 1, 3, 5, 8, and 9 have been particularly active in this regard in the last few years. Proposals have been solicited from the Forests and Districts. All these proposals have been reviewed at an annual Regional Board meeting, and some have ultimately been approved as Service-wide projects.

Unfortunately, all proposals, regardless of their sources, cannot be funded. However, each one that comes to the Washington Office is put into a standard format, placed in the proposal book (Blue Book), and given equal consideration. Sometimes it may take a year or two for a proposal to reach high enough priority to be included in the funded program.

We encourage all Regions to continue active participation in this program. We need to surface problems and needs of the resource managers at the field level.

Annually, the Washington Office ED&T Board meets to review activities of the Centers and program status, as well as to take up necessary business topics. In order to give this group a better perspective of the ED&T program, we met last year at the Equipment Development Center in San Dimas, California. Continuing this concept this year, we are meeting at the Center in Missoula,

Montana, April 11-13. This provides an opportunity for all attendees to visit the facilities, inspect ongoing work, and interface directly with the respective Center employees. At this meeting we will be discussing project status at each Center and reviewing on-the-ground work that is underway at MEDC.

CONSULTATION AND STANDARDS

Walter E. Furen
Assistant Director

ROADS AND SYNTHETIC FABRICS

Synthetic fabrics have become a very important material for use in road construction. A significant opportunity exists to use these fabrics because they function as an efficient filter, provide tensile strength, and compare favorably with graded aggregate filters from a cost standpoint. Substantial reductions of siltation (at a reasonable cost) may be achieved by the use of synthetic fabrics in a variety of drainage and streamside installations.

Forest Service Engineering personnel and others were recently asked these questions in an attempt to determine the state-of-the-art of fabric use on Forest Service applications:

1. How extensive is the Forest Service use of synthetic fabrics?
2. Who is doing the engineering work on Forest Service fabric projects?
3. What technical information is available on the subject?
4. What research and development work is presently underway?

The answers to these questions indicated that:

1. All regions have some experience in design and construction using synthetic fabrics.
2. Woven fabrics used for filtration in underdrains is the most common application. Many have been installed during the last 2 or 3 years.
3. Fabrics have been installed or planned for subgrade restraint on Forest projects in six Regions.
4. Fabrics have been installed or planned for material separation on Forest projects in four Regions.
5. Fabrics have been installed or planned for lagoon liners, earth strengthening, and soil retention on log bridge decks on Forest projects in four Regions.

6. The design of underdrain systems is divided between Forests and Regional Offices.
7. Regional Office materials or design sections are involved in nearly all other synthetic fabric applications.

The Federal Highway Administration (FHWA), is preparing an implementation package on the use of synthetic fabrics for highway construction. The package will contain:

1. *Highway Focus* (May 1977, Vol. 9, No. 1) FHWA publication, which is devoted entirely to synthetic fabrics.
2. *Guidelines for Use of Fabrics in Construction and Maintenance of Low-Volume Roads*, USDA, Forest Service, R-6.
3. Synthesis of nationwide fabric-related specifications presently used by several roadbuilding agencies.
4. Current information concerning the activities of the FHWA, the American Society for Testing Materials (ASTM), and the American Association of State Highway and Transportation Officials (AASHTO) relative to this subject.

The package should be distributed in early spring 1978.

The FHWA is also considering the production of an instructional movie which would portray the state-of-the-art of synthetic fabric use.

Literature Available

A substantial number of articles have been written on the subject of synthetic fabrics for road construction. A list of the pertinent ones for Forest Service Engineers is shown below:

Use of Synthetic Fabrics on Muskeg Subgrades in Road Construction, W. Vischer, USDA, Forest Service, R-10, November 1975. (22-page paper plus design examples.)

Highway Focus, US Dept Transp, FHWA, May 1977, Vol. 9, No. 1. (Eight articles on the use and specifications of synthetic fabrics.)

Guidelines for Use of Fabrics in Construction and Maintenance of Low-Volume Roads, J. Steward, R. Williamson, and J. Mohny, USDA, Forest Service, R-6, June 1977. This will also be available through U.S. Department of Transportation Implementation Division. (Comprehensive state-of-the-art and design guide.)

The Use of Fabrics in Forest Service Road Construction, A. Pelzner and J. Steward, USDA, Forest Service, October 1977. (33-page presentation for the AASHTO meeting at Atlantic City, N.J.) This paper is basically a distillation of the above "Guideline" paper. It will be published by AASHTO.

Nonwoven Fabric Is Finding Increased Use in Stabilizing Logging Roads, Ted Blackman. *Forest Industries*, November 1977, Vol. 104, No. 12. (4-page article on fabric use for subgrade restraint.)

Research and Development Work

There is extensive activity underway by road agencies, fabric manufacturers, and the academic community to answer some of the questions about fabrics. Some of these activities are:

1. FHWA has a research contract with Oregon State University to develop strength characteristics and specifications.
2. ASTM Committee D-18 and D-13 are working to develop tests and specifications for various highway uses.
3. Corps of Engineers Waterways Experiment Station is working on revised specifications.
4. Several Forest Service Regions have trail-use projects underway; some are instrumented and are being monitored.

Synthetic fabrics provide a promising new option for forest road drainage and structural problems.

Forest Service Engineers are involved in numerous and varied synthetic fabric projects and are assuming a leadership role in this new technology.

MORE ON REINFORCED EARTH

The July 1977 edition of the *Journal of the Geotechnical Engineering Division, ASCE*, carries two papers on Reinforced Earth (RE) walls. Engineers who are involved in design or construction of RE will find them informative and interesting. The references are:

Chang, Jerry C., and Raymond A. Forsyth. Design and Field Behavior of Reinforced Earth Wall. Vol. 103, No. GT7, Proc. Paper 13034, p. 677-692.

Chang, Jerry C., and Raymond A. Forsyth. Finite Element Analysis of Reinforced Earth Wall. Vol. 103, No. GT7, Proc. Paper 13035, p. 711-724.

DEVELOPMENT OF A HIGH-ALTITUDE
REMOTE-SENSING PALLET SYSTEM FOR FORESTRY APPLICATIONS

Frederick P. Weber
Manager, Forestry Applications Program

The Nationwide Forestry Applications (NFA) Program scientists at the Lyndon B. Johnson Space Center, Houston, Texas, are working with the NASA Experiment Systems Division to develop a Universal Pallet System for the WB57F, high-altitude reconnaissance aircraft (Fig. 1) for use on forestry applications studies.

During the last 18 months, the NFA Program has participated in cooperative remote sensing, technology assistance projects in Regions 1, 6, and 10 with the Methods Applications Group (FIDM, Davis, California) and the Geometronics Development Unit (E, WO). The focus of these studies has been oriented toward phototechnology development applied to timber management inventory and forest pest management problems. Our objective has been to determine the cost effectiveness of utilizing various formats of high resolution (85-120 L/mm) reconnaissance photography on select applications problems.

The remotely-sensed data collected--primarily photography--have been obtained with the Lockheed U-2 aircraft flying from the NASA-Ames Research Center at Moffett Field, Sunnyvale, California, and the General Dynamics WB57F deployed from the NASA-Johnson Space Center at Ellington AFB, Houston, Texas. Both aircraft are capable of sustained flight at 65,000 feet AMSL. The U-2 is generally restricted to carrying one remote-sensing system aloft at a time, e.g., the ITEK, KA80A optical bar, panoramic camera, or the Actron HR732 large-format camera, but not both simultaneously. This generally has caused problems in developing an objective experimental design for the phototechnology development studies.

The WB57F has a large payload for carrying experimental systems aloft. For example, various combinations of 3-foot and 6-foot pallets can be carried in the bomb bay area, up to a total length of 15 feet. Theoretically, a total gross weight pallet capability of 5,000 pounds is attainable.

The NFA Program has indicated our support to NASA in developing a high-altitude reconnaissance capability for the WB57F which can explore, concurrently, a number of technology assessment and development opportunities. Our Forest Service sensor requirements are specified as follows:

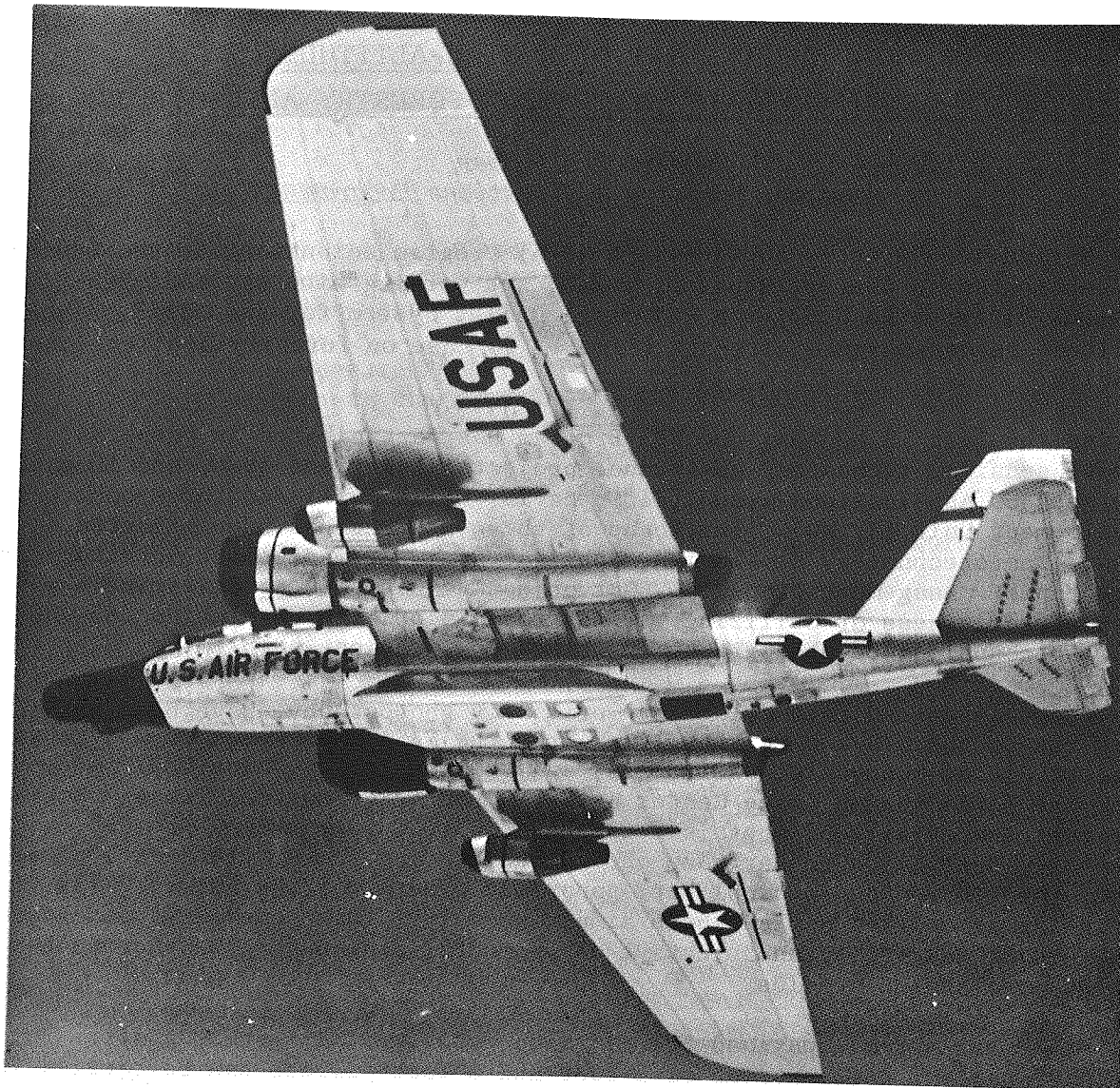


Figure 1. NASA RB57F.

Always Flown

- Panoramic Camera: 5" film format, 24-30 inch focal length lens system, 90° FOV, and 200 L/mm (or better) resolving power of T.O.C. 1.6:1 target. Some applications require stereo-convergent mode and some require stereo-mono mode.
- Frame Reconnaissance Camera: 5" x 5" frame format, 24-30 inch focal length lens system, and 150-200 L/mm (or better) resolving power of T.O.C. 1.6:1 target.

or (mission dependent)

Large Format Camera: 9" x 18" format, 24-inch focal length lens system, and 100 L/mm (or better) resolving power of T.O.C. 1.6:1 target.

- Frame Metric Camera: 9" x 9" format, 6-inch or 12-inch focal length lens system (mission dependent)
- Multispectral Camera System (AMPS): with six, high resolution camera stations on 70mm - spectrally calibrated-format. Ideally, our choice for film loading would be

CS-1, S0242

CS-2, S0131

CS-3, 2443

CS-4, 3414 no filter

CS-5, 3414 w/25A filter

CS-6, 3414 w/12 filter

Selectively Flown

- Landsat C multispectral scanner (RS18 modified)
- Landsat D multispectral scanner (NS001MS)
- Synthetic Aperture Imaging Radar (APQ 102b-modified, dual polarized X or C-band SLAR)

An example of how the WB57F forestry pallet could be applied is given in the case of the current Northern California Test Project. This NFA Program cooperative technology assistance project with R-5, MAG, and GDU deals with the assessment of drought impact on current mortality rate of trees in Northern California. While the specific technical objectives are many and varied, the overall goal is to determine the comparative efficiencies of several remote sensing approaches in a quasi-production environment for addressing several complex FIDM problems related to pest surveys, evaluations, and implementation of Pest Management action. A high priority objective is to answer questions related to the total efficiency of utilizing optical bar camera technology versus a somewhat more conventional large format camera technology. Answers obtained in the Northern California Test

Project will be considered in specifying the remote sensing technology to be applied this coming summer for statewide surveys in Montana and South Dakota.

Our current target is to have the WB57F pallet completed, with installation of the Apollo pan (OB) camera, for applications testing on the Tongass National Forest this summer. The primary mission requirement is to test imaging radar for topographic mapping on Prince of Wales Island, but we also plan to deploy the high-resolution panoramic camera, the KA96A high-resolution frame reconnaissance camera, and the Landsat C multispectral scanner.

A progress report of WB57F forestry pallet project will be given in later issues.

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 send it for publication in *Field Notes*.

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

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