WATER OPERATION AND MAINTENANCE

BULLETIN NO. 124

JUNE 1983

IN THIS ISSUE

UNITED STATES DEPARTMENT OF THE INTERIOR
Bureau of Reclamation

The Water Operation and Maintenance Bulletin is published quarterly for the benefit of those operating water supply systems. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It is hoped that the reports herein concerning labor-saving devices and less costly equipment and procedures will result in improved efficiency and reduced costs of the systems for those operators adapting these ideas to their needs.

To assure proper recognition of those individuals whose suggestions are published in the bulletins, the suggestion number as well as the person's name is given. All Bureau offices are reminded to notify their Suggestions Award Committee when a suggestion is adopted.

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Division of Operation
and Maintenance Technical Services
Engineering and Research Center
P O Box 25007
Denver CO 80225

Cover photograph:

Programmable handheld calculators are a very useful tool in water operation and maintenance activities.

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WATER OPERATION AND MAINTENANCE
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INTRODUCTION

A programmable handheld calculator provides concise and immediate information whether in the field or in the office. The article beginning on page 1 details how the calculator can be used in water O&M activities.

The results of a case study of soil property changes and brine seepage through a compacted soil lining are given on page 8.

Through a regularly scheduled examination program, signs of potential problems can be recognized. An example of preventive maintenance is given on page 11.

Pipes carrying water colder than room temperature causes condensation and drips. One solution to catching the drips is given on page 14.

Applying a fine grout mix to canal and tunnel inverts has resulted in longer surface wear. See page 15.

Your safety attitudes may be dangerous to yourself and others. A very interesting article on page 16.

USE OF PROGRAMMABLE HANDHELD CALCULATORS IN WATER OPERATION AND MAINTENANCE ACTIVITIES[1]

In view of the latest state-of-the-art with respect to programmable handheld calculators, reliable, concise, and immediate information can be provided to personnel at a fraction of the cost of large-scale computers. Portability, access, and ease of use are extremely important attributes for such a device, especially for those individuals not familiar with operation of calculators and who spend a lot of their time in the field or an office setting. In addition, ease of programing makes operation of the calculator less condescending or intimidating, particularly for those who do not use calculators on a day-to-day basis. Preprogramed magnetic cards can be permanently stored and used at a later date whenever the need for using the program arises (fig. 1).

Figure 1.–Preprogramed magnetic cards used with handheld calculator.

All inputs can be prompted (calculator asks for input) in alphabetic characters so that one does not have to remember where to store number constants before running or executing a program. In essence, all prompting, data storage, and result format are programed by an operator and performed entirely by the calculator.

This project has written flood routing programs for all 10 of its dams and reservoirs and has incorporated their use in Project SOP (Standing Operating Procedures). Not only will the programs serve as a tool to aid dam tenders in making decisions and releases, this method is in full compliance with instructions given in SOP's and established operating criteria. These preprogramed cards are contained in SOP's at each site or control center for use during

[1] This article written especially for this publication by Mr. Stuart Hirai, South Platte Projects Office, Bureau of Reclamation, Loveland, Colorado.

emergency or normal operations. This will limit errors as a minimum of key strokes for input reduces opportunity for punching in wrong numbers and gives the dam tender necessary support for making decisions during a loss in communications. For example, a sample for routing floods shows just one of the many programs this project has written and uses in the calculator:

1. Magnetic card is read into calculator using a card reader (fig. 2).

Figure 2.–Magnetic card is read into calculator.

After pressing key to which data routine is previously assigned, a DATA IN message informs operator that coefficients are stored and ready to execute (fig. 3).

2. The "Prompt" asks operator for starting elevation after arriving on site (fig. 4).

3. The "Prompt" asks operator for end elevation after a specified time interval (fig. 5).

4. Provides change in storage in cubic meters (acre-feet) (fig. 6).

5. The "Prompt" asks operator for specified time interval used above in minutes (hours may also be used) when starting elevation to end elevation was reached (fig. 7).

6. Provides inflow entering reservoir at specified time interval (fig. 8).

7. The "Prompt" asks if any outflow from reservoir is being released (fig. 9).

8. Final "Prompt" provides total average inflow entering reservoir during specified time interval (fig. 10).

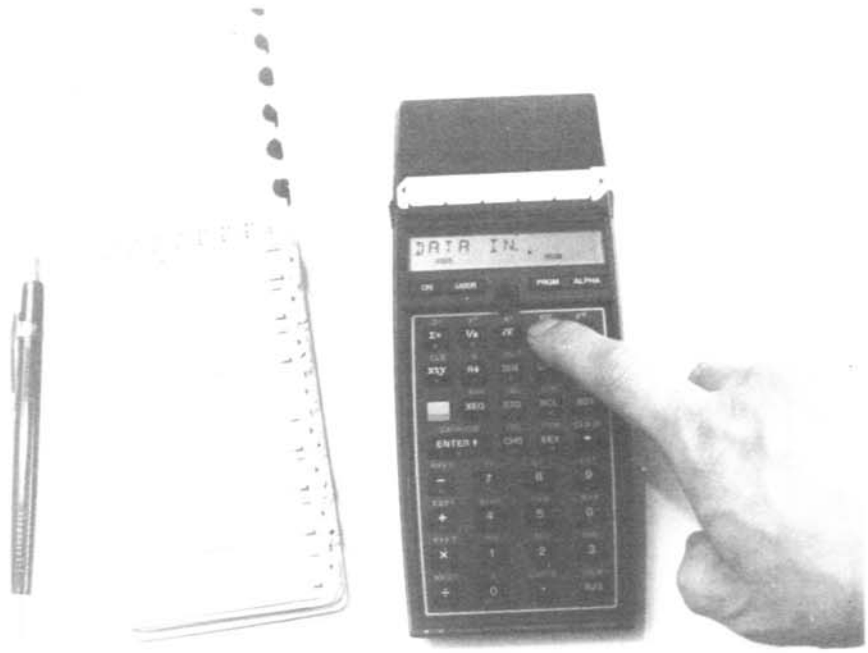

Figure 3.–DATA IN message shown on calculator.

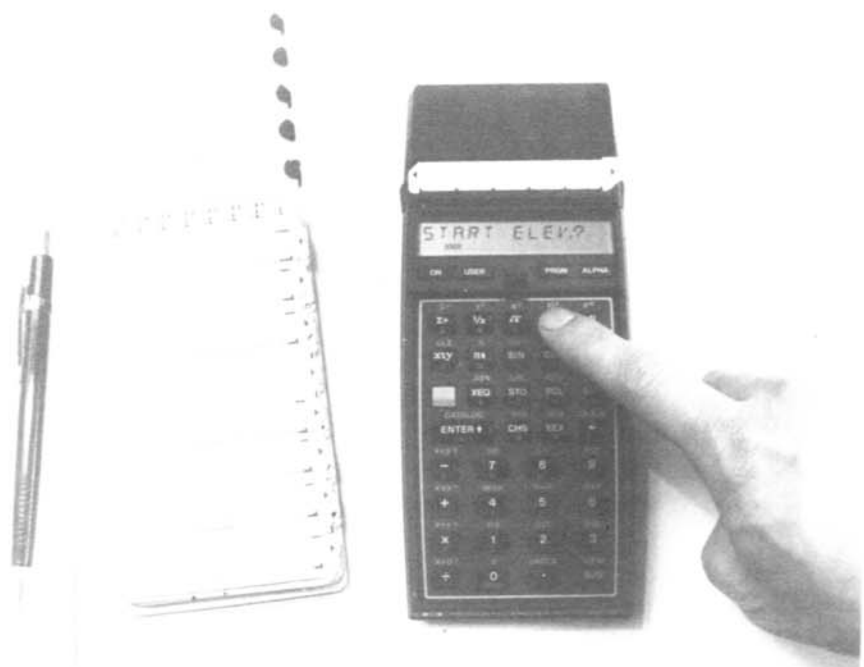

Figure 4.–"Start" elevation.

Figure 5.–"End" elevation.

Figure 6.–"Acre-feet"

Figure 7.–"Time interval" in minutes.

Figure 8.–"Inflow" entering reservoir at specified time interval.

Figure 9.–"Outflow" from reservoir.

Figure 10.–Final prompt provides total average "inflow" entering reservoir.

9. If one needs to go through the process again, merely press another assigned key and program starts at beginning (step 2). This action totalizes change in storage automatically for later reference.

This particular calculator provides great flexibility in that a user's library contains programs written for a wide variety of subjects, thus providing ample software for users of the calculator at approximately $6 (minimum) per subject.

Peripheral devices and accessories are also available and include:

1. Card reader.

2. Optical wand.

3. Printer plotter.

4. Digital cassette drive (130 k).

5. Application modules.

6. Rechargeable batteries, charger, etc.

Overall capacity can be added as operator becomes familiar and comfortable with operation of the calculator and peripheral devices. The author, at least for now, has opted for the CV model with card reader to provide a personal library of programs used for and during O&M activities in and out of an office setting.

For further questions regarding this type of calculator, make your inquiries to Zenas Blevins, Chief, Water and Land Operations Division, or the author at the South Platte River Project Office, P O Box 449, Loveland CO 80539.

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WHAT HAPPENED TO THE SOIL LINING IN THE SALTPOND?[2]

What could possibly be of interest to the Bureau at the bottom of an old abandoned brine evaporation pond under 1 to 3 meters (3 to 10 ft) of rock salt near Carlsbad Caverns in New Mexico? The answer is a compacted soil lining. Information was needed on how effectively the lining had performed over the last 19 years in preventing seepage of brine from the pond. In this case, most of the dissolved salts in the brine consisted of saturated sodium chloride.

Linings are needed to reduce seepage and to prevent the pollution of underground water supplies from evaporation ponds and are envisioned for use in salt-gradient solar ponds. The solar pond is a possible new way of producing energy. The sun shining on a properly managed saltpond generates heat which can be converted to other forms of energy. However, a low-cost, low-permeability lining of heat-resistant material is needed to increase the cost effectiveness of the solar pond. From experience to date, where suitable clayey soils are available at or near a pond site, a compacted soil lining is likely to be the least expensive type of lining for this purpose. However, there was no information available on the effects of high concentrations of dissolved salt on seepage through compacted soil linings over a long period of time. The brine pond in New Mexico provided an opportunity to perform a case study of soil-property changes and brine seepage through a compacted soil lining.

The lining in New Mexico is in the bottom of a natural depression (closed basin). The pond (now known as Anderson Lake) was part of a salinity alleviation experiment to reduce brine seepage from an aquifer which was polluting the Pecos River at Malaga Bend. The Bureau, the USGS (U.S. Geological Survey), and the Pecos River Commission all cooperated in the salinity alleviation project. The E&R Center performed laboratory tests on soils from the pond site in 1962, and the lining was then constructed under Bureau contract. The pond was operated from 1963 to 1976, when it was abandoned because it became filled with salt deposit and was no longer reducing pollution in the river.

After the first year of pond operation, the brine level was maintained above the soil-lined area and pond seepage increased. At present, rainfall and seepage are causing the brine level to fluctuate above and below the lined area (fig. 11). Recent measurements, when the brine level was within the lined area, showed that the seepage rate was very low (about 0.4 millimeter (0.015 in) per day). This is about one-tenth of the seepage rate as calculated by the USGS during the first year of pond operation, and the initial seepage rate was lower than most recorded data for any type of lining on a canal or pond. This is in spite of an unconventional method of lining construction which consisted of (1) scarifying the soil in place to a 0.5-meter (20-in) depth, (2) adding brine to the soil, and (3) surface compacting with a vibratory roller.

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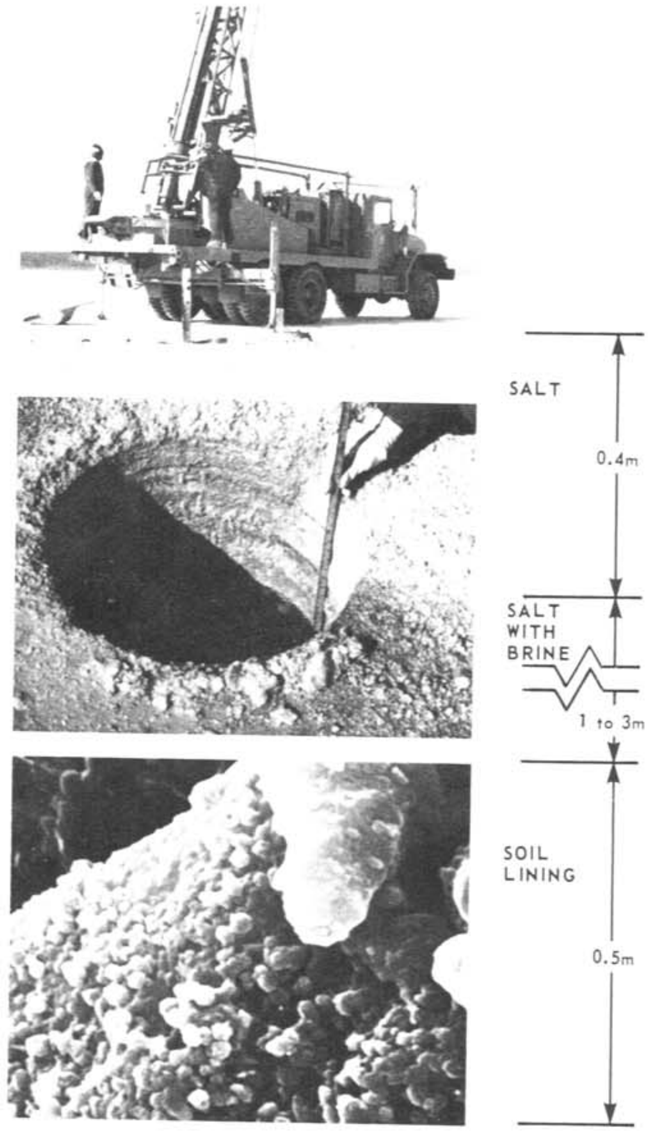
[2] Article by Chester W. Jones, Soils Engineering Specialist, Bureau of Reclamation, E&R Center, Denver, Colorado.

In March 1982, personnel from the Bureau Carlsbad Projects Office and the E&R Center drilled (fig. 12) through the accumulated salt and obtained samples of the soil lining for laboratory chemical and physical tests. Results of tests showed that the density of the soil lining had increased from that estimated at the time of lining placement. Tests and electron photomicrographs (fig. 13) also showed some salt deposited in the soil voids. Thus, the increase in density and decrease in seepage are partly explained by the deposited salt. However, it is speculated that the salt also reacted with clay in the soil and that osmosis possibly caused some consolidation. Only detailed studies of the effects of the salt on the soil can provide more complete answers.



Figures 11, 12, 13.–Carlsbad Project drillers setting up the rig on Anderson Lake to auger a 0.6-m-diameter hole through the salt and brine to the soil lining. The electron photomicrograph (courtesy of the USGS), with a magnification of 10,000 times, shows salt crystals deposited in the soil voids.

The nature of clay and chemical reactions on the clay, which influence permeability, are of concern in a saltpond. To simplify, there are different varieties of clay, each with its own peculiar properties. However, clay is essentially composed of crystalline, plate-shaped particles, primarily of hydrous aluminum silicates, about 1 or 2 micrometers long. Each particle is made up of thin sheets of basic structural units, and the particles have negative electrical charges on the faces and positive charges on the edges.

The clay particles in wet soil are surrounded by chemicals which dissociated into positive and negative ions which are more or less attached to the particles. Depending on the distribution and intensity of electrical charges, the nature and concentration of surrounding ions, and gravitational forces, the clay particles repel or attract one another. When they repel one another, the clay is in a deflocculated (dispersed) condition. When they attract one another, the clay is in a flocculated (aggregated) condition. When the particles are deflocculated, they are more or less parallel in orientation. They will slide more easily over one another and can be compacted to a higher density with lower permeability than when they are flocculated in more haphazard orientation. Sodium chloride ($NaCl$) in a water solution in soil voids will dissociate into positive ions (Na^+) and negative ions (Cl^-) which can react with clay to change the state of flocculation. The ions of some chemicals, including molecular water with H^+ and OH^- ions, may penetrate between the unit sheets of the clay particle and cause the clay to shrink or swell. If the soil is sufficiently dense, it can act as a semipermeable membrane, and the soil will be consolidated by osmosis. These reactions affect the soil permeability, which is a measure of the rate of water flow or seepage through the soil.

A proposed future extension of this investigation would include attempts to reduce soil permeability to a very low rate by chemico-osomotic means. If successful and if a practicable construction method can be adopted, it is possible that an effective low-cost lining for salt-ponds could result. Research on this subject is needed not only for brine ponds but is also related to soil linings for the containment of other liquid chemical wastes which are currently of widespread environmental concern.

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PREVENTIVE MAINTENANCE[3]

The extent of preventive maintenance that is economically justified in the care of an irrigation system is a subject that receives a variety of attention. What requires attention and when? We have found one of the most effective preventive maintenance efforts that can be performed is accomplished through a regularly scheduled examination program. Recognizing the signs of a potential problem and effectively evaluating the situation for appropriate action is preventive maintenance.

An example of identifying a potential problem occurred during a November 8, 1982 RO&M (Review of Operation and Maintenance) examination of the Northern Colorado Water Conservancy District facilities. A low area or slump was noticed in the backfill next to the left wall of a canal chute and stilling basin (fig. 14). The slump area was brought to the attention of district personnel and a suggestion made to excavate to determine its origin.

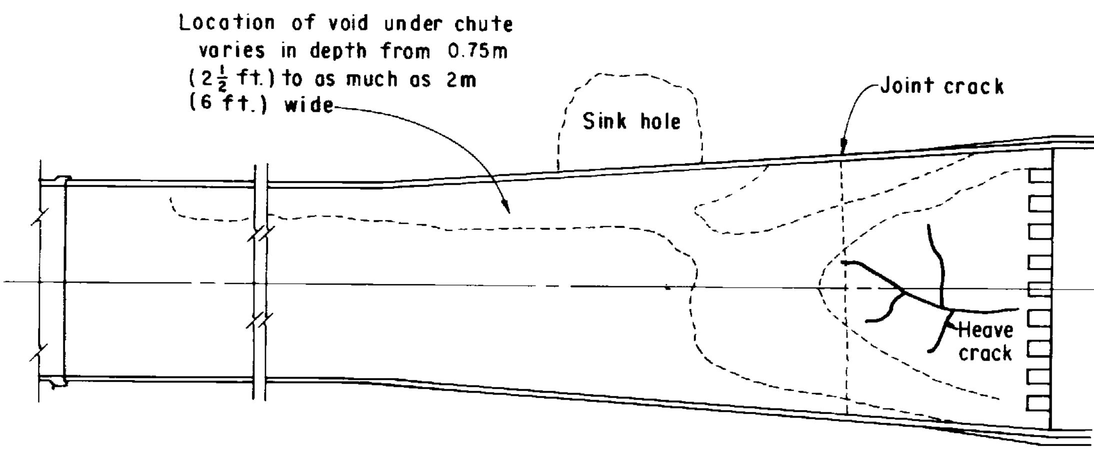

Figure 14.–Canal chute sketch.

The District started excavating and discovered a hole under the chute (fig. 15) that varied in depth from 0.75 meter (2-1/2 ft) to as much as 2 meters (6 ft) wide. Upon closer examination and by drilling several rows of 57-millimeter- (2-1/4-in-) diameter holes in the floor of the chute (fig. 16), they discovered that the erosion underneath the chute started near the top of the chute and extended all the way down to the water level in the stilling basin. Water was entering the floor through a 20-millimeter- (3/4-in-) diameter mud pocket hole and another small rectangular grade-stake hole. These two holes were in the floor and near the left wall about 4.5 meters (15 ft) upstream of where the 200-millimeter (8-in) drainpipe comes through the south wall.

The District then performed grouting operations, using a 6-1/2-bag cement mix with extra fine sand. They also used 2 percent air entrainment with another mixture called pozzolan. Both of these admixtures were used as a lubricant. The repair operation took 6.9 cubic meters (9 yd^3) of grout and 13 man-days to complete.

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[3] This article was prepared especially for the Bulletin by Zenas C. Blevins, Chief, Water and Land Division, South Platte River Projects Office, Loveland, Colorado, Bureau of Reclamation.

Figure 15.–The 2-m by 0.30-m (6-ft by 1-ft) eroded hole was found when the surface slump was excavated.

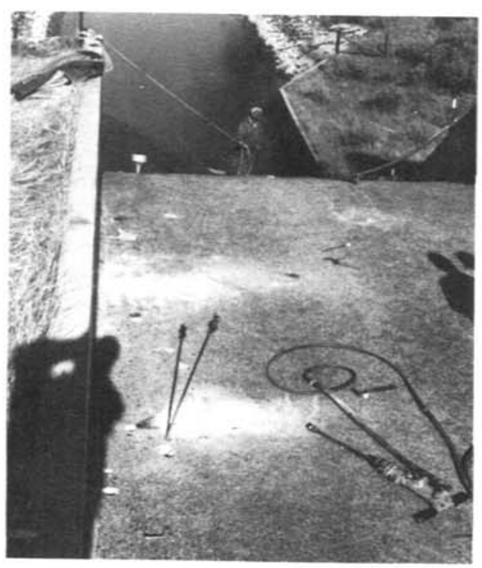

Figure 16.–View of chute and stilling pool. The two holes found in the floor can be seen where the steel rod is sticking into the floor and immediately upstream.

No lateral drains or cutoff walls were constructed under this chute, and as a result, the construction defects and seepage that got through the floor nearly destroyed the chute. The District was very appreciative to the Bureau for helping them spot this problem before it got worse.

This finding is another example of the benefits associated with RO&M examinations. Had this deterioration gone undetected for another season, the chute might have failed, costing thousands of dollars to repair and creating major crop damage.

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DRIP PAN USED TO COLLECT CONDENSATION[4]

Many pumping and power plants have trouble with condensation from big pipes carrying water colder than the room temperature.

Some plants wrap these pipes with insulation to reduce the dripping water on equipment below. Others such as this plant have elected to install a drip pan.

The drip in figure 17 is approximately 50 millimeters (2 in) deep and 150 millimeters (6 in) wide. On the left end, the collected water goes down a pipe to a drain in the floor. The drip pan is tack welded to the pipe after the pipe is installed, but before painting.

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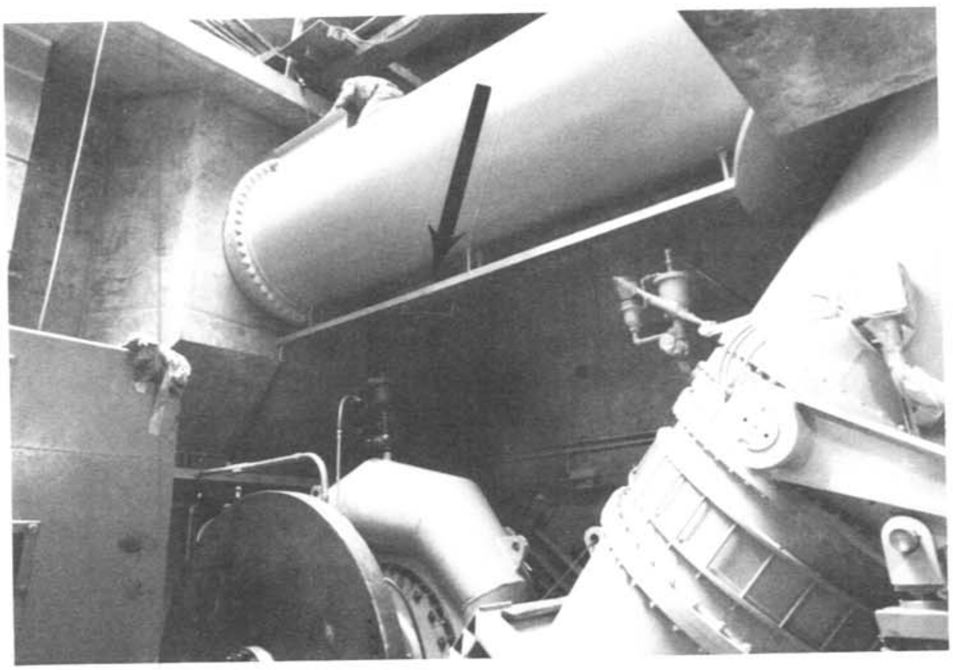

Figure 17.–Drip pan used to collect condensation.

[4] Information provided for this article by Gordon Johnston, Solano Irrigation District, California, retired.

GROUT MIX APPLIED TO CANAL AND TUNNEL[5]

During a recent Review of Operation and Maintenance examination of minor structures of the Yakima-Tieton Irrigation District, the examination team noticed District personnel recoating the invert of a horseshoe bench flume with a fine concrete mix. The concrete mix is troweled to a smooth finish in order to obtain best flow characteristics. Figure 18 shows the cement grout that was placed in a portion of the canal flume in 1979. The grout is still in good condition.

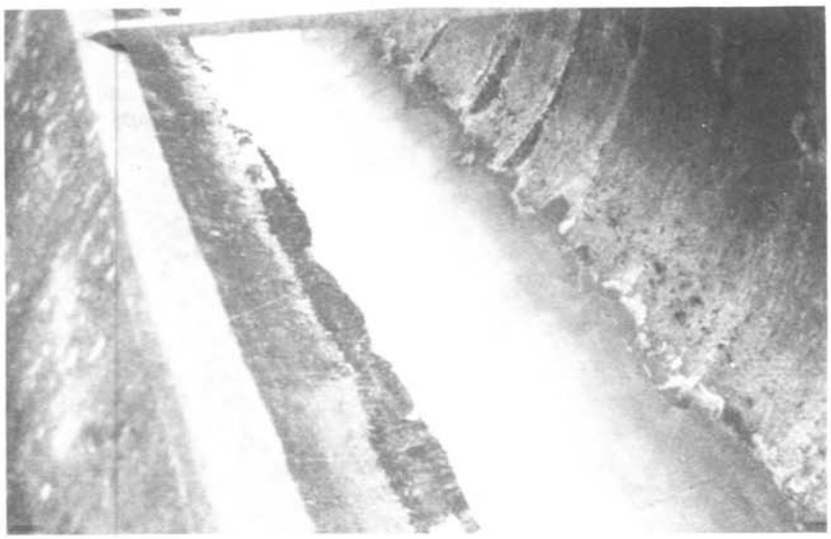

Figure 18.–Cement grout placed in a portion of the Main Canal flume in 1979.

At the North Fork Tunnel, District personnel were applying a grout mix over the tunnel invert. The material appeared to be between 12 to 25 millimeters (1/2 to 1 in) thick. This was the first time grout had been applied to the floor of the tunnel, figure 19. The District management expects the material to provide a wear surface for 20 to 25 years.

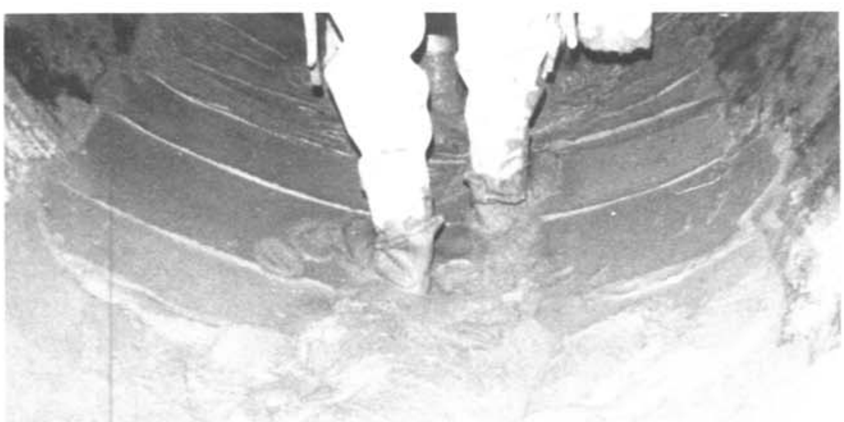

Figure 19.–Grout mix applied to floor of tunnel.

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[5] Information excerpted from Review of Operation and Maintenance examination report by Virgil Temple and Jim Gilbery, Bureau of Reclamation, Pacific Northwest Region.

HOW'S YOUR SAFETY ATTITUDE?[6]

Feelings can be strong and sometimes overwhelming. But in your day-to-day work, it's the attitudes you hold that make you work the way you do. Attitudes can be good or bad, safe or unsafe.

The unfortunate fact about unsafe attitudes at work is that those who hold them try to justify them with reasons why they are right and everyone else is wrong. It's a common human trait that most of us believe only what we want to believe—and what we want to believe is that we are right.

On the other hand, when you develop a safe attitude at work, it means you are ready to respond in an effective and safe way to your job's demands.

Of course, sometimes people like to wrap things up with a simple phrase or sentence. You've probably heard blanket statements like these many times: "People with long fingers are artistic." "People with high foreheads are smart." These statements are not necessarily true of course. But that's the way some people generalize.

How Attitudes Work

Attitudes work the same way. The ones you hold make it easy to react in a comfortable and predictable way. Your mind is already made up in advance. But an attitude does not develop in some mysterious way. Your attitude toward safety on the job is really a blend of three factors: the responses you have learned to situations at work, your habits, and your "emotional set."

Learned responses may be the result of on-the-job training or formal classroom training. Habits are formed by doing the same thing repeatedly, while you avoid contradictory behavior. Your emotional set describes how you feel about what you do.

Even if your attitude toward safety is very positive, though, it can be blocked in tense situations. In general, you may be vulnerable to any of three stages of tension at work:

1. Ordinary, day-to-day problems that only create a minimum of stress, without immediate threat to your safety – if you follow the safety procedures you've already learned.

2. Temporary emotional upsets, caused by personal conflicts or some other frustration, which create an emotional climate that is difficult for a safety attitude to survive in, unless that attitude has a lot of strength.

3. Panics that make people completely forget the safe attitudes they would otherwise be aware of.

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[6] Reprinted from "Today's Supervisor" for April 1983.

Of course, if you know in advance the safe way to respond to any contingency at work, you will be far less likely to act in a way that threatens your safety and the safety of others. Keep in mind that uncertainty leads to fear, fear leads to anxiety, and anxiety reduces the total attention that you can pay to a job. This, in turn, triggers accidents.

A Change in Attitude

Therefore, right from day one, it is vital that you consistently observe all the performance and safety standards that have been created for your protection on the job. You can't change emotions, although you can learn to recognize them and keep them under control. Attitudes, on the other hand, can be changed. Sometimes it's not easy, but it's possible if enough effort is made.

A change in attitude has to start with honest self-appraisal. You have to convince yourself that you may not be right in all circumstances. Next, you have to collect and examine different points of view and compare them with your own. You must get the facts, because an unsafe attitude is often based on incorrect information. Take the reluctance of some workers to wear hardhats when and where required. Once the facts are known about the protection afforded by hardhats, no reasonable person could argue against wearing a hardhat at the appropriate time and place. In fact, a willingness to wear a hardhat could be a lifesaving behavior.

If, on the contrary, you don't want the facts and block out the things you don't want to hear, then any decision you make is based on incomplete information. If you want to be a safe worker, the first step is to learn all you can about how accidents happen, how to prevent them, and how to survive one if it does happen.

It all boils down to this: Attitudes and emotions play a part in just about everything we do – every day. How they affect us depends on how well we can recognize emotions and control them, and whether or not our attitudes are good or bad.

When emotions run high, good judgment and ability are impaired. Those are the times when you are most vulnerable to accidents. But you can keep them in check if you recognize their destructive nature and make a conscious effort to control them.

Attitudes, once formed, are difficult to change – even by logical arguments. But they can be changed, and to do so, you must first ask yourself whether any of your safety attitudes are dangerous to yourself or others. If not, congratulations! You're right on target. Keep up the good work.

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GPO 840-180

Mission of the Bureau of Reclamation

The Bureau of Reclamation of the U.S. Department of the Interior is responsible for the development and conservation of the Nation's water resources in the Western United States.

The Bureau's original purpose "to provide for the reclamation of arid and semiarid lands in the West" today covers a wide range of interrelated functions. These include providing municipal and industrial water supplies; hydroelectric power generation; irrigation water for agriculture; water quality improvement; flood control; river navigation; river regulation and control; fish and wildlife enhancement; outdoor recreation; and research on water-related design, construction, materials, atmospheric management, and wind and solar power.

Bureau programs most frequently are the result of close cooperation with the U.S. Congress, other Federal agencies, States, local governments, academic institutions, water-user organizations, and other concerned groups.

A free pamphlet is available from the Bureau entitled "Publications for Sale." It describes some of the technical publications currently available, their cost, and how to order them. The pamphlet can be obtained upon request from the Bureau of Reclamation, Attn D-922, P O Box 25007, Denver Federal Center, Denver CO 80225-0007.