Department of the Interior

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OPERATION AND MAINTENANCE EQUIPMENT AND PROCEDURES

RELEASE NO. 21

July, August and September 1957

CONTENTS

OPERATION AND MAINTENANCE

EQUIPMENT AND PROCEDURES

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INTRODUCTION

Included in this issue of the bulletin are a list of Power O&M Bulletins of interest to irrigation operators, articles on weed control, a suggestion for reducing the maintenance costs of drainage channels, a new tool for cleaning metal surfaces, and a method of repairing leaks in concrete pipe. In addition, there are two timely articles: "Control of Weeds on Ditchbanks," by F. L. Timmons, Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Laramie, Wyoming, and "Maintenance Painting" prepared by the Bureau's Paint Laboratory.

Mr. Timmons discussed weed control on ditchbanks at a meeting of the Four States Irrigation Council in Denver, Colorado, last spring. It was believed the discussion would prove of interest to all irrigators, and consequently permission to include it in the O&M Bulletin was requested of Mr. Timmons.

We have been asked to include information on maintenance painting in the bulletin for some time, and the Paint Laboratory will prepare a series of articles on the subject. The first article is devoted to an introduction and maintenance painting of woodwork. This will be followed, in subsequent releases, by articles on the maintenance painting of metalwork and other surfaces.

This bulletin, published quarterly, is circulated for the benefit of irrigation project operation and maintenance people. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. Reference to a trade name does not constitute the endorsement of a particular product, and omission of any commercially available item does not imply discrimination against any manufacturer. It is hoped that the labor-saving devices or less costly equipment developed by the resourceful water users will be a step toward commercial development of equipment for use on irrigation projects in a continued effort to reduce costs and increase operating efficiency.

For the benefit of readers who did not receive, or would like to have earlier releases of the Bulletin, back numbers of most issues are available.

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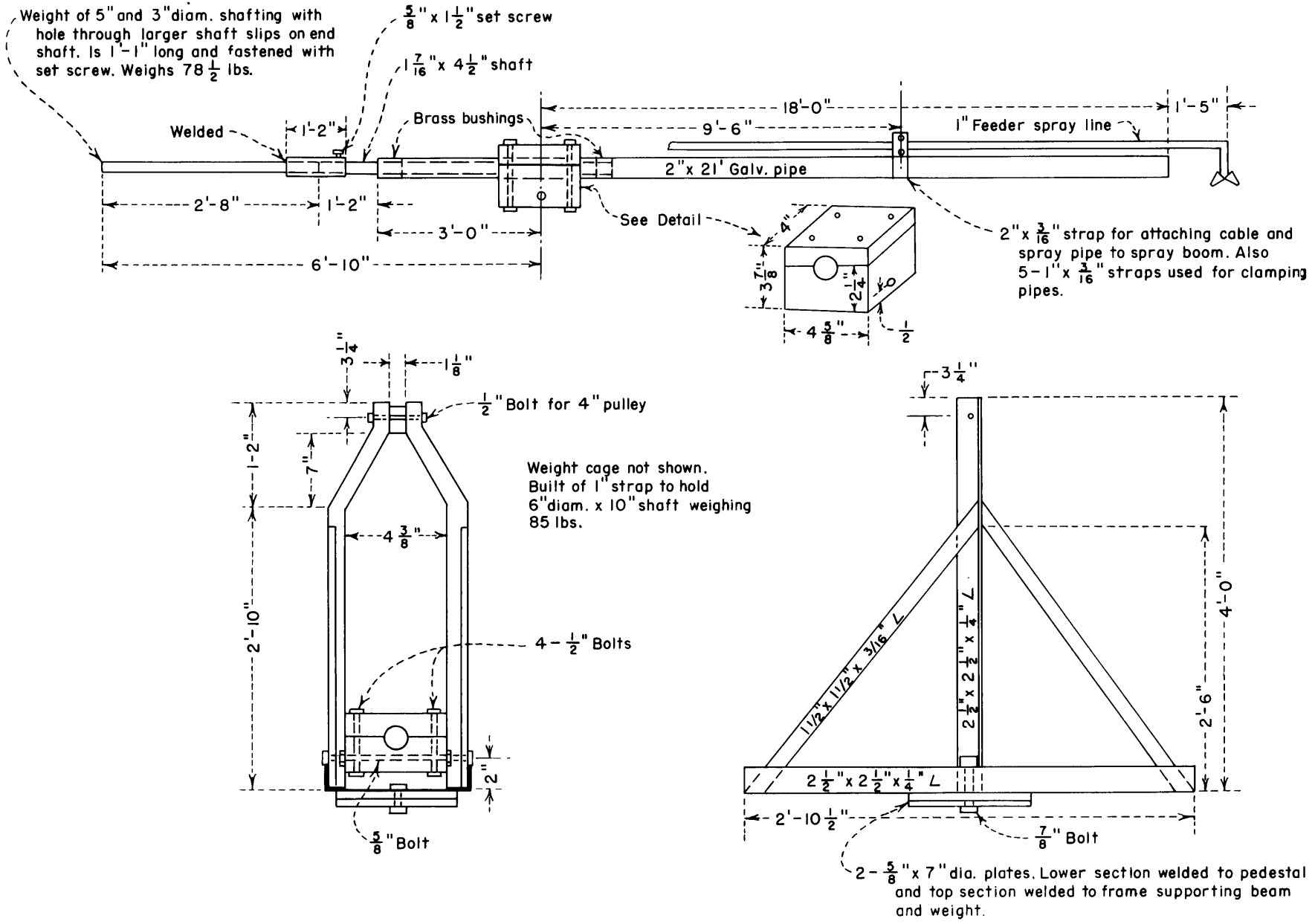
DIVISION OF IRRIGATION OPERATIONS
Commissioner's Office
Denver, Colorado

COUNTER-WEIGHTED SPRAY OR BURNER BOOM

A new counter-weighted spray or burner boom, shown on the cover of this issue of the bulletin, has been constructed and put into use on the Ysleta Branch of the Rio Grande Project, Texas-New Mexico. The boom was constructed at the suggestion of Henry C. Lange, Foreman of Equipment Operations, and William C. Brady, Chief of the Ysleta Irrigation Field Branch, to replace older type manually-operated booms similar to that shown at the bottom of this page.

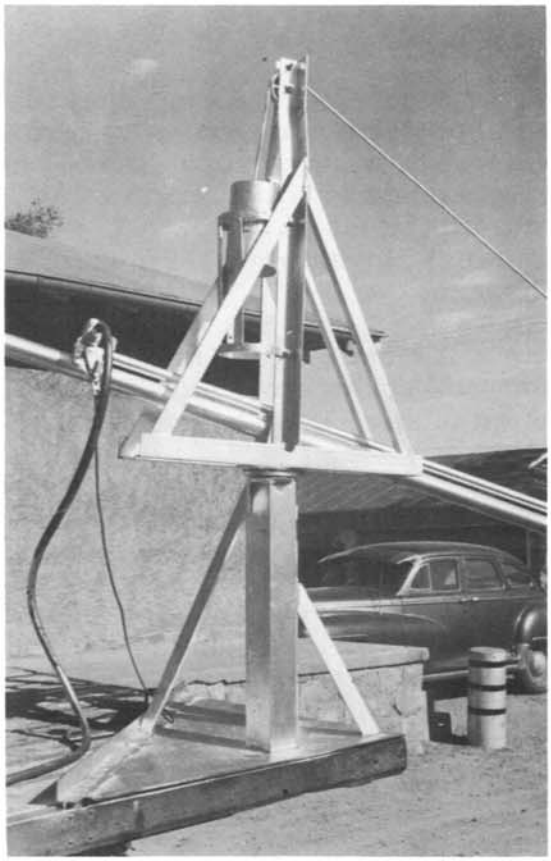
The new type counter-weighted boom, shown above, in position for operation, is considerably lighter and much less rigid in construction. It was constructed at a cost of $112.50 compared to a cost of $194 for construction of the older type boom. The new boom has required considerably less repair for the one year operated than the heavier boom and it is believed the newer design will last longer in service.



COUNTER-WEIGHTED SPRAY OR BURNER BOOM

The new boom may be constructed to any desired length. Counter-balancing is accomplished by a weight supported at the boom pedestal and attached approximately at the mid-point of the boom by cable. The boom was made of two-inch galvanized pipe with a one-inch feed line attached by means of metal straps. The valve for controlling the feed line is a single-pull quick-acting type that is controlled by a rope by the operator. The one-inch feed line can be extended four feet beyond its present length when used as a burner.

The counter-weight attached to the cable weighs 85 pounds and the weight on the end of the operating end of the boom is about 78-1/2 pounds. A schematic drawing showing the dimensions of the boom counter-weight, mounting pedestal, etc., is shown on the facing page.



The two photographs, above, show more details of the counter-weighted boom. The photograph at left is a rear view of the boom in position to travel. At right the pedestal and arrangement of the counter-weight can be seen. The method of attaching the supply line to the feed line can be seen in both of the photographs as well as the rope whicn the operator uses in opening the quick-acting valve of the feed line.

* * * * *

CONTROL OF WEEDS ON DITCHBANKS

Methods of controlling ditchbank weeds depends to a considerable extent upon the type of weed involved--whether it is a herbaceous weed or a woody plant, a broad-leaved species or a grass, a perennial or an annual, and whether it is associated with a crop or is growing in a non-crop area. With few exceptions the same weeds grow on ditchbanks as on farmland. The method of control may be similar in both situations but may be quite different for the same species of weed depending on the associated cropping conditions. Control methods are discussed in this article by F. L. Timmons, Research Agronomist, Crops Research Division, Agricultural Research Service, U. S. Department of Agriculture, Laramie, Wyoming.

Weeds Classified

Before considering methods of control, I shall discuss a classification of weeds and give a few examples of each type. Among the herbaceous weeds typical broad-leaved perennials and biennials in this region are field bindweed, bur ragweed, dogbane, hoary cress or whitetop, Canada thistle, Russian knapweed, smartweeds, bullthistle, milkweeds, and even sweet clover when it grows in areas where it is not desired such as ditchbanks.

Annual weeds commonly found on ditchbanks are sunflower, pigweed, lambsquarters, marsh elder, giant ragweed, annual smartweed, Russian thistle, kochia, and others.

Perennial grasses and sedges which commonly cause trouble on ditchbanks in the Four-State area are Johnson grass, quackgrass, ripgut grass, brome, orchard and other rank-growing grasses. Common annual weedy grasses are foxtail, barnyard grass, and stinkgrass and typical winter annuals are wild barley, wild bromegrass, and goatgrass. Barnyard grass is about the only one of the annual grasses which constitutes a problem on ditchbanks.

Among the troublesome woody plants on ditchbanks are the various species of willow, wild rose, cottonwood, and in a few areas, salt cedar.

Prevention of Weeds

Despite the recent improvements in methods of controlling weeds, prevention is still easier and much less expensive. In the realm of weed control, an ounce of prevention is certainly worth a pound of control. As a matter of fact, an ounce of effort in preventing field bindweed from getting started on the farm otten is worth a ton of control.

Many of our weed seeds have the ability to remain viable in the soil, in manure, or in water for a long period of time. Research has shown that seed of bindweed, mustard, and pigweed may remain viable in the soil for as long as 30 years even under normal cultivation and cropping

practice. These hard coated seeds also remain viable in manure and for several years in water. It can be readily seen that with weeds of this type it is particularly important that they be prevented from infesting the land in the first place if at all possible.

The seeds of hoary cress, Canada thistle, and most of the grasses do not remain viable in the soil more than 2 or 3 years. However, even with these species it is important to prevent them from producing seed, particularly in fence rows, on the irrigation ditchbanks, and in waste areas which serve as a reservoir for weed seed to infest adjacent farmland.

Use of Crop Competition in Weed Control

Crop competition, which is nature's remedy for weeds, often is not used as efficiently as it should be in controlling weeds with the least trouble and expense. Seeding of ditchbanks to adapted grass mixtures makes effective use of crop competition for control of weeds. In selecting the kinds of grass to seed on ditchbanks, some drought resistant species should be used for the area high above the waterline while the moisture-loving species should be included for the zone at and immediately above the waterline. Rank growing species should be avoided in such seed mixtures, especially on smaller canals which are not pastured. Bureau of Reclamation Operation and Maintenance Equipment and Procedures Release Nos. 3, 8, and 16 give excellent information on equipment and techniques for seeding grasses on ditchbanks.

Control of Ditchbank Weeds

Pasturing.--Probably most of you are more directly interested in the control of ditchbank weeds than of farmland weeds. Pasturing with livestock is the most effective and least expensive method for the general control of most herbaceous species and of sprouts of woody species in many situations. The effective use of pasturing requires herding or fencing. Special gates and livestock guards are necessary to provide for easy access to the ditchbank roads by vehicles while at the same time preventing the livestock from escaping from the fenced area. Pasturing goes hand in hand with ditchbank seeding as an effective weed control measure and makes it possible to utilize rank growing and high forage producing grasses on ditchbanks without interfering with the flow of water or with inspection of the ditchbanks.

Mowing.--Where pasturing cannot be utilized conveniently or economically, mowing is an effective method on nearly all types of weeds. However, mowing is rather slow and relatively expensive and requires proper shaping of the ditchbanks and ditchbank roads on each side. Also, special ditchbank mowers with heavy sickles and sections that will cut at any angle through an arc of at least 120^{o} are advantageous, if not absolutely necessary. Such mowers which will cut heavy growth including willows up to two inches in diameter are in rather extensive use in Bureau of Reclamation Region 5, and some of them may also be in use in your Region 7. One

special advantage of mowing ditchbank weeds is that it encourages low-growing grasses such as Bermuda, buffalo, and bluegrass to replace tall growing grasses and broad-leaved species.

Burning.--Burning of ditchbank weeds with oil, butane or propane burners is an effective although a rather expensive method that is used extensively in the Southwest where it probably is better adapted than in the Four-State area. However, we have found burning to be a rather promising method in our experiments in eastern Wyoming, and I believe there are many situations in this area in which burning could be used to advantage. Experiments have shown that burning every 6 to 8 weeks usually will give adequate control of most annual weeds while burning every 3 to 4 weeks is required for elimination of perennial weeds. Farmers often make the mistake of trying to burn all of the green vegetation the first time over. A more economical and even more effective method is to sear the vegetation just enough to kill the top growth the first time over and then burn the ditchbank clean several days later where necessary to remove growth obstructing the flow of water.

Chemical Control of Ditchbank Weeds

2, 4-D.--Chemical control of weeds on ditchbanks usually is somewhat more expensive than pasturing but may be less expensive than mowing or burning in many situations. For herbaceous broad-leaved species 2, 4-D is the least expensive and most effective treatment in most situations. On annual weeds and susceptible perennials applications of 1 to 2 lb/A at an early growth stage will give satisfactory results while even lighter rates are effective on some species, particularly when they are in the seedling stage. Usually it is necessary to spray 2 or 3 times each year in order to maintain adequate control. On ditchbanks adjacent to fields with sensitive crops such as sugar beets, beans, or alfalfa, the amine or low volatile ester forms of 2, 4-D should be used rather than the relatively high volatile butyl, ethyl and isopropyl esters. Regardless of which type of 2, 4-D is used it is important to avoid drift of the spray on to sensitive crops. Spraying on ditchbanks should be done only when the wind is blowing away from such sensitive crops or when there is not enough wind to cause drift.

For hard to kill perennials such as smartweed and Russian knapweed it is usually necessary to use a low volatile ester of 2, 4-D at 3 to 4 lb/A and repeat once or twice each year, as necessary, to maintain control and perhaps even eventually eliminate the weed.

The amount of water used in applying 2, 4-D on ditchbanks may vary from 20 to 100 or more gallons per acre depending upon the type of spraying equipment available. Volumes of spray lower than 20 gallons per acre increase the hazard that the finer spray particles may be drifted by wind onto nearby sensitive crops.

Dalapon. --For control of perennial weedy grasses and sedges, dalapon at 15 to 20 lb/A in 40 or more gallons of water per acre applied at an early growth stage and repeated as necessary one or more times each season has given satisfactory control of most species in experimental trials. After the perennial grass species have been eliminated by dalapon, a mixture of dalapon at only 5 or 6 lb/A and 2, 4-D at 1 to 2 pounds will give adequate control of both broad-leaved weeds and annual grasses.

ATA. --3-amino-1, 2, 4-triazole at 8 to 12 lb/A applied at an early growth stage and repeated as necessary once or twice each season is about as effective as dalapon on most grass species and considerably more effective on the sedges, particularly ripgut grass. Amino triazole has the added advantage of being effective on broad-leaved weeds as well although it is considerably more expensive than dalapon at the rates required.

Oils. --Dinitro-fortified fuel oil containing 3 pints of oil soluble 4, 6-dinitro ortho secondary butylphenol (DNBP) to 100 gallons of furnace oil or diesel oil applied at the rate of 80 to 120 gallons per acre usually gives satisfactory control of both weedy grasses and broad-leaved species. The DNBP-fortified oil treatments will need to be made every 3 to 6 weeks during the first season depending on the rate of regrowth, but in subsequent seasons applications every 6 to 8 weeks may be sufficient. The cost of the DNBP-fortified oil treatment is similar to that of the dalapon treatment for perennial grasses but considerably more than the combination of dalapon and 2, 4-D for annual weeds.

Soil Sterilants. --Soil sterilant herbicides can be used to good advantage for controlling ditchbank weeds where leaving the banks bare causes no erosion problem. Diuron or monuron at 40 to 50 lb/A, sodium chlorate at 800 to 1300 lb/A (5 to 8 lb/sq rd), borates and borate mixtures with chlorate, 2, 4-D, or a urea herbicide at 8 to 12 lb/sq rd, or erbon at 80 to 120 lb/A usually will give adequate control of most perennial ditchbank weeds above the waterline and in ditches used only intermittently for irrigation. However, none of these treatments has proved effective at or below the waterline in canals which carry water continuously. In Utah, we found that diuron or monuron at the extremely high rates of 80 to 100 lb/A applied in the fall after water had been turned out of the canal or in early spring several weeks before the water was turned in did give complete or nearly complete eradication of rank grasses such as reed canary grass and quackgrass. However, we had considerable trouble during the next two or three seasons with the bare ditchbank sloughing into the canal. All of the soil sterilant treatments are quite expensive, ranging from $0.80 to more than $1.50 per square rod or $130 to $240 per acre.

Most of the soil sterilant herbicides may be applied as a spray or broadcast as dry material. When they are applied as a spray the volume of water necessary may vary from 40 to as much as 500 or more gallons per acre depending upon the rate and solubility in water.

Annual Grasses. --The control of annual grasses on ditchbanks can be obtained with the same chemical treatments as for perennials except that only one-fourth to one-half the rates of each herbicide are necessary.

Willows and Cottonwood. --Spraying with 2, 4-D is the most effective and most economical treatment of the willows along ditchbanks. Foliage sprays with 1 to 2 pounds of 2, 4-D per acre in 100 to 150 gallons of water applied by ground rig or in 5 to 10 gallons per acre of water applied by airplane or helicopter are recommended. For complete elimination of willows or cottonwood it usually is necessary to repeat the spray treatment once or twice a year for two or three years. Occasionally it is more convenient to treat willows or cottonwood with dormant 2, 4-D sprays particularly where the infestation is scattered or the trees are quite large. For dormant sprays a 2, 4-D ester at 2 to 4 percent in oil applied as a basal spray to the lower 18 to 24 inches of the trees or in frills or cups of large trees gives good results.

Other Woody Plants. --Ordinarily 2, 4-D is not effective in controlling wild rose, osage orange, or salt cedar. For these species foliage sprays of 2, 4, 5-T or 50-50 mixtures of 2, 4-D and 2, 4, 5-T to 3 lb/A applied at the full leaf stage in the spring and again to regrowth in early fall usually give satisfactory top kill. For complete elimination of these species retreatments over a period of several years usually are necessary. Frequently, dormant applications of 2, 4, 5-T at 4 percent in oil as a basal spray on young trees or in frills or cups in larger trees are more effective than foliage sprays.

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AURAND CLEANING TOOL

The tool shown in the photograph below has proved to be very useful in cleaning metal surfaces for painting at Shasta Dam and Powerplant. It is very good for removing all kinds of hard paints, rust, scale, etc.

The tool consists of two drums on which are mounted hard steel cutting wheels, similar to grinding wheel dressing cutters. As the drums rotate at high speed, the cutters which fit loosely on their respective shafts, are brought into contact with the surface to be cleaned by centrifugal force. The tool is supplied commercially with either pneumatic or electric power.

Additional information regarding the cleaning tool may be obtained from the Chief, Shasta Operations Field Branch, Bureau of Reclamation, Redding, California.

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PREVENTING STRUCTURE WASHOUTS

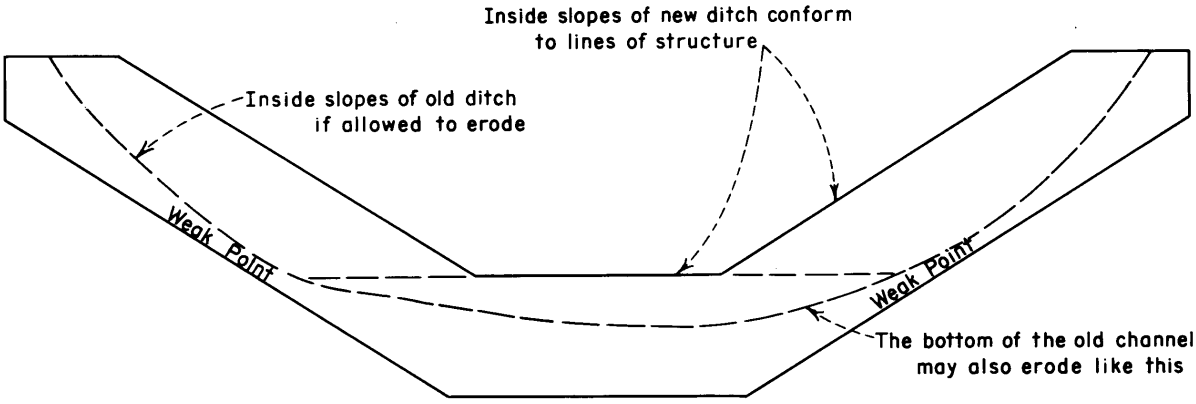
One of the most troublesome maintenance problems confronting many of our operating projects is that of keeping structures from washing out around the upstream headwalls. This has happened to the weir drop structure shown at left. Of course, when the water starts around the headwall, the whole structure will likely be lost if the leak is not stopped promptly. The break shown was discovered early enough so that the structure was not lost.

To meet the threat of structure washouts, the various project operators have devised means to prevent the washouts from occurring or to stop the leaks before they develop into serious breaks. We propose to mention some of the measures employed by these operators with the hope that readers of this publication may benefit by the experience of others.

We find that there are a number of causes contributing to the occurrence of washouts around cutoff walls such as: The natural erosion and reshaping of the channel section to develop points of weakness at cutoffs; the burrowing of animals of various sorts; frost heaving of the structure; shrinkage of the drying foundation material away from the structure; and inadequacy of the cutoff as originally constructed. The last named cause might be attributed to improper design or to the failure of construction engineers to exercise good judgement in adapting the optional dimensions given to the specific conditions encountered at the site. Our designers are now requiring deeper cutoffs than have been used heretofore, but, in any case, we have our washouts starting around the cutoffs of our older structures.

In order to appreciate some of the factors contributing to washouts, let us take a look at what changes may take place in the shape of the channel immediately upstream from the structure if the earth section is permitted to follow the course of nature. The figure, shown on the following page, of an ordinary small structure cutoff, shows that the inside channel lines originally conform to the inside concrete lines of the cutoff. However, as time goes on the ditch widens and changes from trapezoidal to U-shaped and where velocities are high the bottom is likely to scour. This results in the face of the cutoff becoming more and more exposed and points of weakness develop where the surface of the earth channel approaches the sloping bottom of the cutoff. To make things worse, burrowing animals choose these points for their digging operations with the well known results.

While the condition depicted by the sketch may not be typical of all old ditches, it is typical of a great many that have not been maintained as well as they might have been. Suppose that a gravel blanket had been



SMALL STRUCTURE CUTOFF

placed around the wetted perimeter of the ditch section when the structure was built. In all probability, the banks would not have eroded and the weak points would not have developed and we would have a safe structure. By the same token, a structure which has deteriorated to the condition shown could be made safe by a similar treatment, namely, a substantial blanket of gravel to restore the ditch to something like its original lines. Furthermore, it would probably prove to be a good investment for any project, having gravel available, to place a blanket at the upstream end of every canal or lateral structure in their system.

It has been found that a gravel blanket 4 to 6 inches thick placed around the wetted perimeter from the cutoff upstream about 6 feet gives very good protection. Erosion is prevented and the smaller burrowing animals do not like to dig in gravel. There is a difference of opinion among O&M men as to the amount of gravel to be used in such a location, but the amount mentioned should be considered to be a minimum. For larger structures, the blanket should be thicker and extend farther upstream, coarser materials being used for higher velocities and greater depths of water. The type of gravel most likely to give good service should be fairly well graded, or at least it should contain a reasonable amount of fines or dirt, and, preferably, a little clay.

When washouts occur, such as the one shown, it is the practice of many of our O&M people to extend the bottom of the cutoff down from the sloping portion so that it is square across the bottom. Gravelly material is then used for backfilling to complete the job.

By way of meeting emergencies of this nature, one project keeps two dump trucks loaded with gravel, during the period of heaviest water demand, ready to rush to any threatened point on the system. Another project keeps a flat bed truck loaded with light sheet steel piling, sand bags, shovels, and gravel ready to proceed immediately to any place on the system where a break is threatening. Of course, the practice of going over the whole system carefully each spring, before turning the water in, and repairing any structures that look weak is very common among experienced operators, but it is easy to miss an animal burrow or other weak point. In that case we must be prepared to cope with the breaks when they occur.

Another project that has a rather short supply of gravel uses another means of thwarting the burrowing animals. As shown in the photograph below, short reaches of gunite lining are placed upstream from the drop structures. In locations where the drops are located within a few feet of the turnout outlets, as is the case in the photograph, the two structures are connected with the gunite lining. (Incidentally, if you want accurate water measurement, don't locate the staff gage as close to the weir as shown.)

Some of our new ditches, in their first year or two of operation, gave a lot of trouble through structure washouts, but these are usually not due to development of weak spots through changes in the canal section. They are more generally due to settlement of the backfill as it becomes wet or to shrinking of foundation materials as they dry out, or to similar causes.

The designers recognize these problems which face operators and they are doing something about it. It was customary on older drawings to stipulate a minimum depth of cutoff wall, which would be adequate under good conditions, with the expectation that the construction engineers would extend the cutoffs down deeper if unfavorable materials were encountered. It appears, however, that in many instances no consideration was given by the construction people to deepening the cutoffs below the minimum and this resulted in inadequate structures in many cases. In the newer designs, the cutoffs have been deepened beyond the old minimum dimension, and where the design data indicates that the foundation material is unfavorable other steps are taken to assure adequate cutoffs. Such steps may be the squaring up of the bottom of the cutoff, or the steepening of the bottom

slopes to reduce the missing corner area, or gravel blankets upstream from the structures may be specified.

We are probably safe in saying that future cutoffs will give less trouble than the old ones, but we still have to live with the old ones and it is our hope that the ideas expressed here will be of some use to operators in doing that.

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COOPERATION IN WEED CONTROL

Region 6 of the Bureau of Reclamation in the annual report of the weed control program in that region discusses the commendable cooperative weed control efforts of the States, Counties, Irrigation Districts and Water Users on the Belle Fourche Project in South Dakota and the Sun River Project in Montana. On the Belle Fourche Project, the irrigation district performs the weed control work on the project delivery system and drains; whereas, the County, State and the landowners have weed-control measures of their own, using mostly tractor-mounted spraying equipment. Weed-control chemicals, in addition, are made available to the landowners and water users by the irrigation district at cost.

The Greenfields Irrigation District on the Sun River Project goes one step farther. Chemicals for use on ditch and drain rights-of-way on the water users' farms are furnished the water users in that district without charge. During the past year, 1,240 gallons of 2,4-D was furnished the water users at a material cost to the district of $2,666.00. Actually, however, with the water users doing the spraying, money was saved by the district. On the basis of a district labor cost of $3.90 per gallon for application of the chemicals, the water user contribution in the form of labor would have been about $4,836. Teton County furnished the water users with four 100-gallon spray units mounted on two-wheel trailers and these and one unit furnished by the irrigation district were loaned to any water user who wished to cooperate. For annual and perennial weed control the Greenfields Irrigation District sold to the farmer at $2.35 per gallon, 1,016 gallons of 2,4-D. On the whole, this part of the weed control program has been most effective.

There are distinct advantages in providing chemicals at no cost to the water users for the control of weeds on ditch and drain rights-of-way, in the opinion of Region 6 and the region also feels that much can be accomplished by selling the chemicals to the water users at cost for their own use. Such a practice brings about a better understanding of the weed control problem by the water users, encourages their cooperation, and in most instances, it is believed, will probably result in a saving to the water users in lower district maintenance costs. On both the projects cited, the regional office reports that the conscientious and determined water users have made progress in the control and eradication of annual and perennial weeds.

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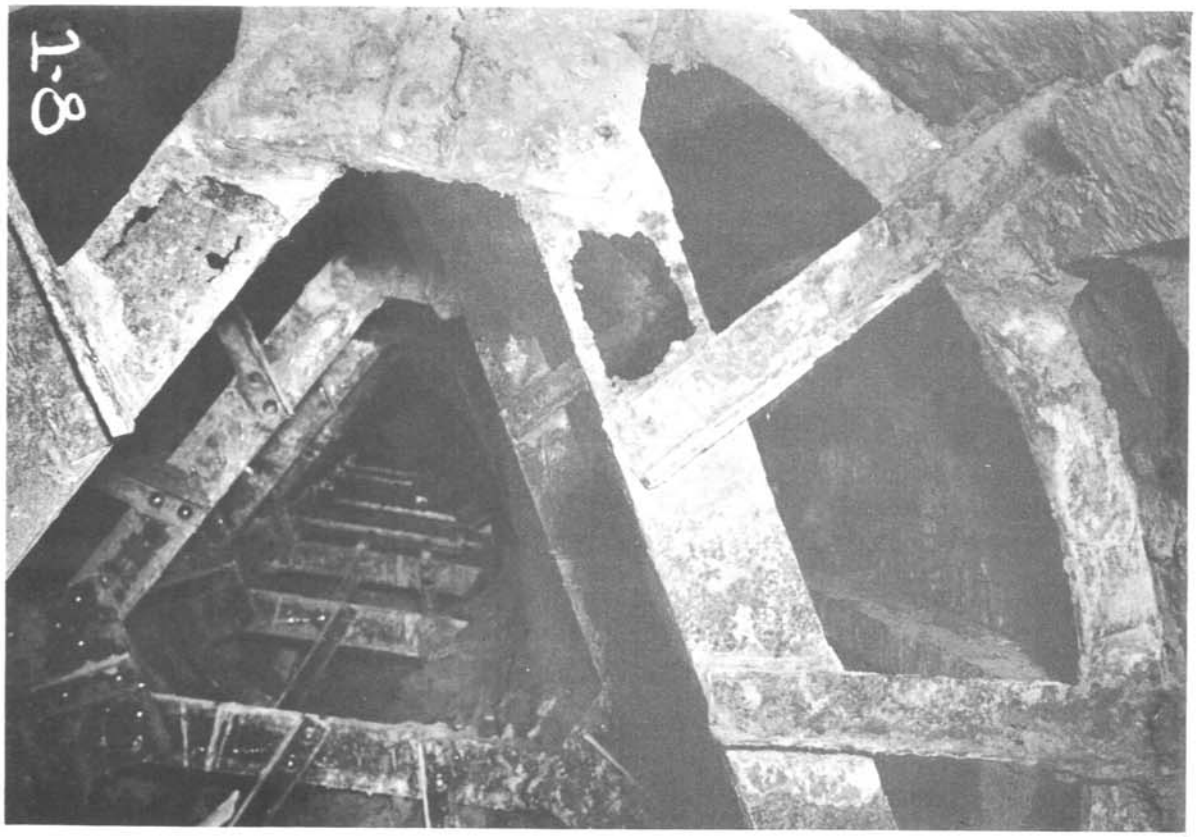
MAINTENANCE PAINTING

Six billion dollars a year! That's the price tag on corrosion of metalwork in the United States according to recognized authorities. It means that an amount nearly equal to one tenth of the federal budget is spent just in maintaining or replacing metalwork exposed to corrosive environments. The cost of combating corrosion is not a small item on irrigation projects; however, the cost of protecting against exposure is in most instances less costly than replacement of facilities. An example of the corrosive action on metalwork is well illustrated in the photograph below.



Continuous operation of a powerplant necessitated uninterrupted diversion into canal headworks. The roller gate shown, therefore, was held continuously in a submerged or partially submerged position. Operation in this manner during the past 23 years had afforded only limited periods for examination or maintenance and repair of the gate and other under-water surfaces of the structure. Damage and deterioration from erosion, freezing, thawing, debris accumulation, silt deposition, rusting and other causes has therefore been accumulative. The three-sixteenth inch thick metal plates are rusted through, seven-sixteenth inch thick metal has been reduced to five-sixteenth inch, and many of the channels are either rusted through or so weakened that much of the interior metal framework must now be replaced.

Twenty-three years of service is considerable, but there is little doubt that the metal would have served for many more years with proper protection by suitable paints.

O&M forces are charged with maintaining the continuing effectiveness of protective coatings throughout the life of structures to assure the uninterrupted flow of water and power. The purpose of a series of articles prepared by the Bureau's Paint Laboratory, of which this is the first, is to provide information and to suggest procedures for the accomplishment of an organized and standardized paint maintenance program that should result in reduced maintenance. These articles will touch upon the types of attack to which various coatings are vulnerable, criteria for ascertaining the extent of coating deterioration, and the most effective repair procedures. The articles will attempt to cover all important problems in Bureau paint work, with this first article devoted to an introduction and the maintenance painting of woodwork. From time to time, comments on measures taken to solve specific problems by field forces will be presented. Accordingly, reports from the field are encouraged so that all may benefit from the experience of others. Questions or comments directed to the Paint Laboratory concerning these articles, or to the Division of Irrigation Operations, on painting or any other maintenance problems are invited.

Exposure considerations largely dictate the selection of the original coating. The original cost of protective and decorative coatings used on Bureau of Reclamation structures ranges from $0.12 to $1.00 a square foot. The coating materials and application methods required in Bureau specifications are believed to be consistent with best practice elsewhere, and the most favorable from a long-term economic viewpoint. Nevertheless, it must be remembered that paint coatings, though continuously being improved, are still relative thin films generally containing organic matter, and as such are vulnerable to one or more of nature's destructive forces. If deterioration is allowed to proceed until the effectiveness of the protective coating is lost, considerable expense will be incurred by replacement of the existing coating, or corrosion of the base material can result in a financial loss far greater than the cost of providing paint protection. In order to prevent such loss, it is necessary that the coatings be inspected and maintained at regular intervals so that destruction of the coating and base material will be held to a minimum.

Many firms in private industry have recognized the importance of reducing corrosion, and, by supporting a fully inclusive system for recording the performance of protective coatings, they hope to obtain maximum service and economy. The ever increasing extent of maintenance painting and the cost of performing it would seem to make such a practice worth while by Bureau and Water User's O&M forces. Such a record would provide much needed information, result in painting economy, and serve as a first step in standardizing maintenance procedures. The problems of inspection and maintenance are usually complicated by the fact that most forms of coating deterioration are very gradual and not readily apparent in the early phases. Thus, it is desirable to establish an inspection

schedule with a system for recording the degree and rate of deterioration in order to anticipate scheduling of work at the time when it will be needed. On the other hand, damage to a coating from impact, abrasion, or unusual temperature conditions may occur quite rapidly. In both circumstances regular inspection and records can be instrumental in greatly extending the life of the existing coatings and thus in cutting down on the cost per square foot per year for protection.

To accomplish an integrated paint maintenance program capable of achieving maximum results over long periods, it would be well to make the scheduling of repair work the chief responsibility of one individual on the project. This individual preferably should have had experience in the application of different paint materials. His initial work should be to conduct a "paint survey" of all painted items in his area. The data so obtained should be as complete as possible regarding the past history and present condition of each coating and could be compiled in a card file for easy reference. Provision should be made for the inspection of surfaces which usually are inaccessible by reason of their submergence during normal operation. The maintenance painting in succeeding years should be planned in consultation with and under the direction of the responsible individual, and procedures and coatings should be chosen in the light of the records maintained for the purpose. When the time for complete rehabilitation of the coating arrives it may be decided that a more durable coating will provide greater economy over a long period or possibly that a cheaper one will serve satisfactorily in the particular location. In the performance of maintenance painting and repainting work, it should be the responsibility of the individual designated to see that good practices are followed in order to assure that the optimum quality of application is obtained. Cost data on the work should constitute a part of the record which will become an increasingly valuable source of valid information on the overall cost of particular coatings and paint protection in general.

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MAINTENANCE PAINTING OF WOODWORK

Painting of woodwork on Bureau projects occupies a position of secondary importance to that of painting metalwork by reason of the smaller area and the expense involved and the consequences of paint failure. Nevertheless, regular inspection and maintenance of woodwork coatings are required to preserve the base material and to maintain a pleasing appearance. Dwellings, office buildings, and warehouses for the bulk of painted wooden surfaces and some problems likely to occur in maintaining the paints should be considered.

The maintenance of coatings for wood can be divided for discussion into three general categories according to the exposure:

(1) Interior Woodwork
(2) Exterior Woodwork
(3) Immersed or Buried Wood

Interior Woodwork

Interior woodwork when properly coated with paint and varnish should remain in good condition for many years inasmuch as the exposure usually precludes effects of sunlight, rain, and extreme temperature changes. Coating deterioration is very slow and aging changes are not readily apparent. Physical damage to the original coating is the main reason for repainting interior woodwork and this usually results from erosion due to repeated washings, scratching, and chipping resulting from impacts. Over many years too frequent repainting will result in excessive buildup of material in which chips and cracks are difficult to conceal in a repaint job. When this happens all of the old coatings must be removed before repainting can provide fully satisfactory appearance and service. This expensive and laborious task should be delayed as long as possible by repainting only when necessary.

An inspection schedule should be established, based on the amount of use and the quality of appearance desired in the particular area. For example, paint on wood in an office open to the public and in daily use should be inspected more often than a little-used hallway open only to personnel of the organization.

A knowledge of the material originally used on the surface is helpful in selecting materials for repainting because, as a general rule, best results will be obtained if the paint is basically the same as the original. The original paint can often be determined by reference to the construction specifications and with few exceptions will be found to conform to one of the Federal Specifications. Suitable paints for interior woodwork are discussed on pages 23-26 of the Bureau's Paint Manual.

Experience has been that small quantities of specifications materials sometimes are difficult to procure. However, the various General Services Administration warehouses carry stocks of paints conforming to Federal Specifications. Bureau installations may purchase such tested GSA paints which will give assurance of obtaining quality. Where this is not possible or feasible, good quality stock paints in small quantities may be procured from reputable paint companies.

Details of surface preparation and repainting of interior woodwork are discussed in the Paint Manual on pages 42 to 44.

Exterior Woodwork

Deterioration of coatings in exterior exposure is much more rapid than that of coatings on interior woodwork mainly because of greater effect of sunlight, moisture, and temperature changes. Therefore, inspection of such surfaces should be scheduled at more frequent intervals. Yearly inspection should be arranged for all areas directly exposed to weather. Inspection of areas that are somewhat protected (such as covered porches) should be every 2 years although in many cases yearly inspection may be convenient in conjunction with inspection of the other surfaces.

The pitfall of too frequent repainting and the resultant cracking and peeling of excessively thick coatings should be avoided. In this connection, it should be noted that on a building the degree of deterioration and the rate of chalking of painted surfaces is dependent upon the direction each of the surfaces is facing. As a rule, the surfaces facing north will require painting less often than surfaces facing south (east and west are usually intermediate) and these surfaces can be separately maintained and have separate "Coating Service Record" cards. This can result in substantial savings in maintenance costs as well as to act against a heavy paint buildup on the surfaces facing north.

Most exterior oil paints are now formulated to be "self-cleaning" through chalking. In other words, the surface of the coating will gradually become powdery and be washed away by rain. This is actually a controlled type of deterioration and is much more to be desired than the cracking and peeling which occurred with aging of paints of earlier formulation. The self-cleaning feature of the newer paints largely limits their deterioration to the surface and allows for a gradual reduction of the film thickness so that as age embrittles and shrinks the paints there will be less tendency for cracking and peeling. Any surface deposition will wash off to a certain extent with the chalking of the paint. When additional paint is applied the old paint is "revitalized" and a flexible will-bonded film is usually restored.

Inspection records of exterior woodwork paints over a period of time may first show "chalking" then "slight checking" and "wood being exposed in thin areas." Before the latter description fits any significant fraction of the total surface it is time for application of additional paint. The inspections should also take note of any warping or cracking of the wood and, if these have occurred, suitable repairs should precede the actual painting operation. Special attention should be given to the condition of paint and wood on doors and windows since these surfaces receive physical abuse in addition to attack by the weather.

Surfaces which are coated with enamel or other nonchalking materials and are in fairly good condition at the time of repainting will require only scraping or sandpapering as surface preparation. However, if deterioration has taken the form of severe cracking and peeling, the adhesion of the old paint is probably generally poor and additional paint will soon show the same cracking. On occasions the new paint has actually aggravated the situation by lifting the old paint. Inspection reports may eventually show "cracking and peeling." Where this condition is general and severe, especially where numerous repaintings have built up excessive film thickness, the existing coating has little value and only complete removal of the old paint and repainting will give satisfactory results.

Surface preparation required before repainting is undertaken depends upon the extent and type of deterioration. For surfaces having merely thin and heavily-chalked paint, light wire brushing to remove loose material down to firm paint or wood will suffice. Of course, small areas having penetrating stains or other blemishes should receive appropriate

special attention such as seal coating with shellac. Doors and windows will often require more thorough cleaning and usually some crack filling.

Perhaps the easiest method of complete paint removal for large areas is by burning with a paint burner and scraping while the paint is still hot and soft. Remnants of brittle burned paint can be removed by scraping or wire brushing after the paint has cooled. All paint should be scraped from corners and edges such as the bottom side and ends of siding because at these places the defective paint will usually be quite thick. Precautions against fire will, of course, be required during burning.

Following the general rule, paint chosen for maintenance painting should be of the same type as originally used (unless complete removal of the old paint has been performed). If the deterioration of a chalking-type paint has not progressed too far any exposed wood can be touched-up with primary paint and then a single coat of finish paint applied at a minimum coverage rate to provide the desired appearance and protection. A two-coat application should be made if sizeable areas of wood are exposed and the old paint is generally quite thin. In this case, the first coat should be a primer type or thinned finish paint to produce greater penetration of the base. The top coat should be applied without thinning and coverage in both cases should be as specified in Federal Specifications, or by the manufacturer.

It is noted that in the painting of dwellings the greatest tendency to economize is exhibited by attempting to cover the largest possible area per gallon of paint. Within reasonable limits, superior and longer lived protection is provided by thicker coatings. It will be found that application costs far exceed material costs and thus conservatism in materials will often prove to be false economy.

Certain conditions peculiar to a particular location may be encountered which adversely affect the durability of any coating used on the exterior paint of dwellings. For example, outside paint on housing units which were located at high elevation and where low humidities and temperatures prevail during winter months was observed to deteriorate very rapidly. In this case, moisture released in the interior of the house by ordinary household operations (heating, washing, etc.) escaped the house in part by traveling into and through the siding on the exterior and condensation of moisture vapors in attics and walls contributed to continuously damp conditions in the wood. No ordinary coating can be expected to resist such exposure. To combat early deterioration of paint coatings and also to prevent other damage to the structure the fundamental cause of paint breakdown must be isolated and remedied before normal coating performance can be obtained.

Immersed or Buried Wood

Wood to be buried or in contact with water is usually treated with creosote or pentachlorophenol. With effective treatment a minimum of

25-years service can be expected. The application of such treatments on large items such as piling, transmission line poles, etc., requires special plant equipment, and general practice is to replace deteriorated wood with new, freshly treated wood rather than to attempt retreatment. A cresote preservative conforming to Federal Specifications TT-W-556b, Type II, should be used in the pressure treating of wood in contact with soil or water. Wood Preservative, TT-W-572, Type II, Composition A, is satisfactory for hand application to wood in most other exposures such as subflooring and the framing below the subflooring.

A limited maintenance program is sometimes indicated. For example, treated fence posts near parking areas can be scarred to depths that will leave untreated wood exposed to attack. Such damage should be treated with a liberally brushed-on coating of Wood Preservative. Any structural modification of treated structures resulting in exposure of untreated wood as by saw cuts should be treated in the same manner.

Coating service record cards may be kept on structures containing treated wood although the interval between inspections can be as long as 5 years except in such cases as mentioned above. These cards can be of value in predicting when replacement of the treated wood will be necessary.

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REPAIRING LEAKS IN CONCRETE PIPES

The Lindmore Irrigation District, a unit of the Central Valley Project, California, has a distribution system consisting of 123 miles of concrete gravity pipe lines with associated junction boxes, valves, standpipes, flow meters, etc., serving 26,627 acres. The system is comprised of four main laterals, two pumping plants, and moss screen structures at the head of each lateral.

Figure 1

One of the greatest and most expensive problems with concrete pipe lines is the repair of leaks in the unreinforced mortar joints, and occasionally a cracked pipe. Repairs must usually be made while the line is in use. The method of repair employed by the Lindmore Irrigation District is described in

this article prepared by William G. Meyer, Engineer, Fresno Operations Field Branch, Central Valley Project, California.

The majority of the leaks occur at the beginning of the irrigation season due to contraction when the cold water of the Friant-Kern Canal is first turned into the lines, which have warmed up during the winter. As a temporary measure when the number of leaks is too great to handle in a reasonable time, the District puts sawdust in the line. This method serves very well until repairs can be made. Some of the larger lines have rubber gasketed joints and very little trouble has been experienced with these. Prior to March 1, 1956, leaks were repaired by the contractor, who originally built the system. His method was to break a hole in the line, add a mortar ring to the inside of the crack or joint, seal the broken hole and add mortar to the outside mortar band. This did not prove satisfactory since the inside band of mortar constricted the flow somewhat, and later, leaks reoccurred. For a more permanent repair the District has in the past used lead wool, placed in the cracks with a miner's pick and covered with mortar. However, as time went by, this method also proved to be unreliable.

Figure 2

Figure 3

The District has now found a much better and at the same time more durable method of repairing leaks by the use of rubber and a steel band. The sequence of operations for this method is as follows: A Diesel Fordson tractor, with hydraulic backhoe attachment, is used for the excavation, as shown

in Figure No. 1. It is necessary to remove enough material so that two men will have ample room to work under and around the line as shown in the photos. The old mortar band is chipped away with miner's picks. In so doing, the leak occasionally becomes worse, and in order to slow down the flow, lead wool is tapped into the cracks. Sometimes it is necessary to keep the hole pumped out, for which they use a diaphram type pump. The pipe is then thoroughly cleaned in preparation for the band. First, the rubber strip is centered over the crack, pulled tight around the pipe, and held in place until the steel band can be slipped over it. See Figure No. 2. Finally, the bolt on the steel band is tightened until the leak stops. (See Figure No. 3.)

Figure 4

The rubber used is unvulcanized retread rubber, commonly called "camel back," and is manufactured by the OK Rubber Welders, of Denver, Colorado. It comes in 6-inch wide by 1/2-inch thick strips in rolls varying from 50 to 60 pounds each and costs around 28-1/2 cents per pound. The rubber is cut so that it just reaches around the line after being pulled tight. The ends of the rubber strip are mitered and fastened with hog rings after stretching tight around the pipe.

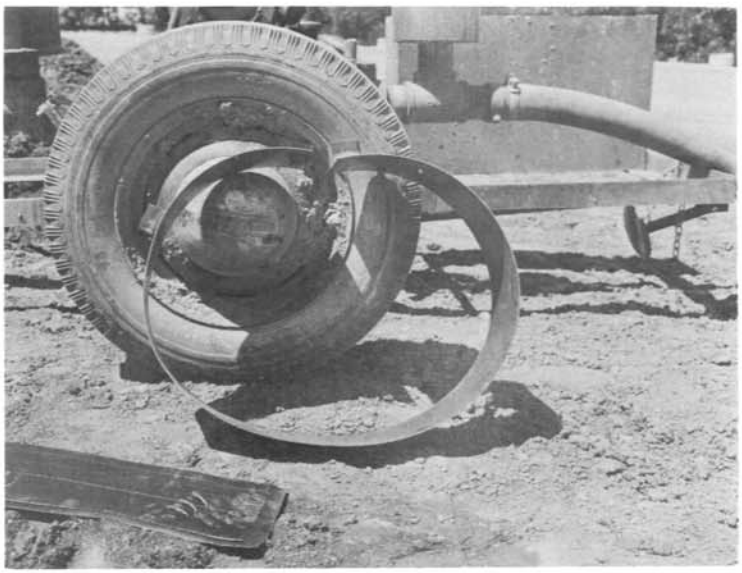

Figure 5

Regarding the steel bands, the District buys 14-gage sheets and has them cut and rolled locally, in lots of 200 bands. The tabs for the clamping bolt are made and welded in place in the District's

shop. The bands are made 6-inches wide, with a 5/8-inch by 8-inch bolt to clamp, as shown. See Figures No. 4 and 5. They use these on 12-, 15-, 18- and 21-inch pipe, and the band is made long enough so that there is 3 to 4 inches overlap in place over the rubber band. For the 21-inch pipe, the steel band is made in two halves, which of course requires two bolts. They also have a 12-inch wide steel band which is used on diagonal cracks, which could not be covered by the ordinary band. These have three clamping bolts.

Figure 6

As a safeguard against corrosion, the steel band is covered with mortar as shown in Figure No. 6. Thus far Mr. Lanning, the manager of the District, claims that only 2 in over 1,000 of these type repairs have had to be redone. The estimated cost for this type of repair is $25.00 each, which includes labor, materials, excavation, and backfill. An important advantage of this type of repair is that the line does not have to be taken out of service, and the repair can be done quickly. On an average day, three men can make 8 or 9 repairs.

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POWER O&M BULLETINS OF INTEREST TO IRRIGATION OPERATORS

The Division of Power Operations issues bulletins periodically on subjects which concern facilities under their responsibility. In reviewing the bulletins which have been issued, four were found which contain information of value to people responsible for the operation and maintenance of irrigation systems. The numbers and titles of these bulletins is given below together with a short statement of what they contain.

Bulletin No. 9 - "Keeping Motor Windings Dry." This bulletin describes the damage caused in motor windings by moisture, measures for determining the condition of the insulation in the motor and procedures for drying out the motor windings so that they are in condition for operation. Also covered are certain precautions which may be taken to prevent the accumulation of moisture inside of the motor.

Bulletin No. 12 - "Lead-Acid Storage Battery Principles." This bulletin carries a great deal of information concerning the operation and care of lead-acid storage batteries such as are provided for emergency power sources in many of our dams and powerplants. The normal operation of the battery is explained and the appearance of the cells under normal and abnormal conditions is described. Also described are various tests for determining the condition of the battery, types of chargers, methods of charging, and many other valuable information items.

Bulletin No. 23 - "Fire -- Fighting, Cause and Prevention," describes the chemistry of burning explaining the conditions leading to fires. The three classes of fires are also given together with the proper types of extinguishers, and the methods of fighting to be used on each type. The various types of fire fighting equipment and their use is covered as are the care and inspection of such equipment. Also covered is the subject of the cause and prevention of fires.

Bulletin No. 25 - "Corrosion Protection of Buried and Submerged Metals," deals with the protection of ferrous metals by cathodic methods. Both galvanic and impressed current methods are described with diagrams to illustrate the making of installations. The bulletin contains a great deal of information related to the prevention of corrosion of buried or submerged metals with an explanation of the chemistry of the action, and of certain actions which may take place to destroy unprotected metals. Covered also is an explanation of how to figure the current requirements for a given installation and other data required to complete such a design.

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These bulletins may be obtained from the Bureau of Reclamation, Attention: Code D-841, Denver Federal Center, Denver, Colorado, at a cost of 20 cents per copy for Nos. 9 and 25, 35 cents for No. 23, and 60 cents for No. 12.

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REDUCE COSTS FOR MAINTENANCE OF DRAINAGE CHANNELS

The Coachella Valley County Water District, operating the Coachella Division of the All-American Canal System, has reduced the cost of maintaining drainage and flood channels by construction of a narrower channel in the bottom of the large drain and flood channels. The pilot drainage channel is an excellent idea worth copying elsewhere.

The narrower channel has been dug in the wider flood channels to carry all drainage water and small flood flows. The practice localizes the heavy vegetative growth and permits the development of a grass covered dry bottom to develop in the main channel. Equipment can operate in the bottom of the main channel and this facilitates the control of weeds. Previously weed control had to be conducted from the higher banks of the flood channel and was not very effective.

The cost of weed control and maintenance has been reduced and a major flood can pass through the main channel unobstructed by heavy brush. It might be added that the appearance of the channel is much improved.

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