Department of the Interior, Bureau of Reclamation

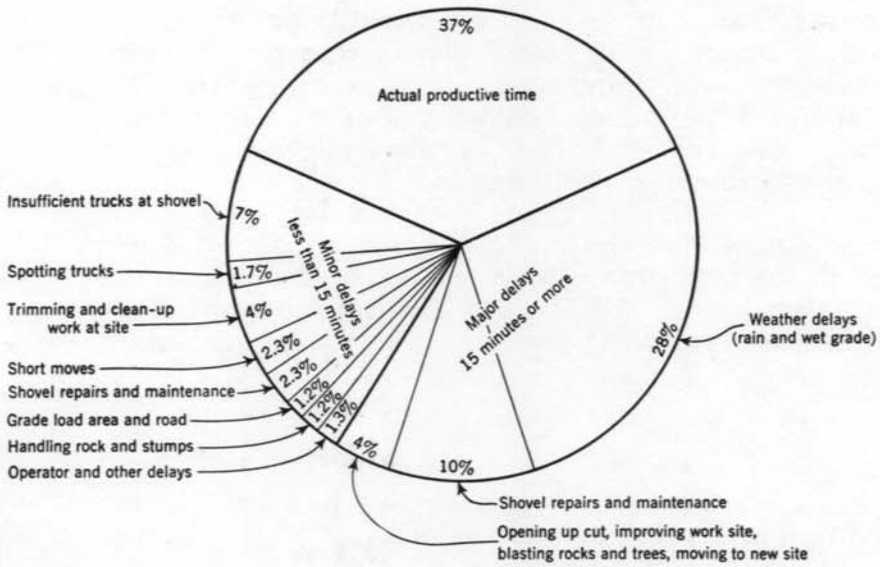
# IRRIGATION OPERATION AND MAINTENANCE

## BULLETIN NO. 52

**April, May, June 1965**








**How Much Digging Does Your Excavator Do?**

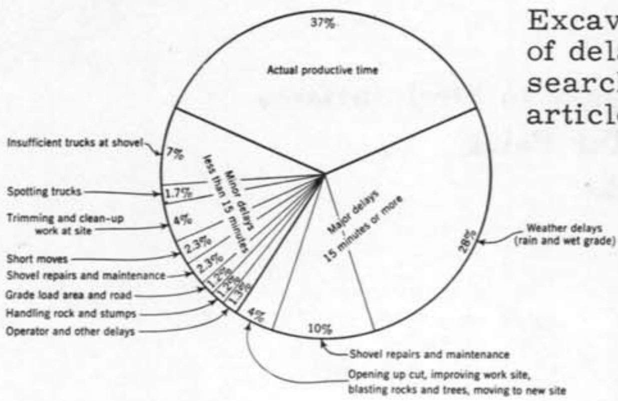
**In This Issue:**

The Irrigation Operation and Maintenance bulletin is published quarterly, for the benefit of irrigation project people. 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, developed by resourceful project people, will result in improved efficiency and reduced costs on the systems of 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.

* * * * *

Division of Irrigation Operations
Office of Chief Engineer
Denver, Colorado




Excavator production and the extent of delays, based on the Highway Research Board data, is shown; see article starting on page 1.

# IRRIGATION OPERATION AND MAINTENANCE
Bulletin No. 52

April, May, June 1965

## INTRODUCTION

At the Irrigation Operators' Workshops held in the Denver Office of the Chief Engineer of the Bureau of Reclamation, there has been an interest shown in the need for information concerning the selection of power excavating equipment for operation and maintenance on our irrigation projects. Mr. E. O. Martinson, President of the Koehring-Waterous Ltd. prepared such an article some years ago and more recently has brought his data up to date in a McGraw-Hill publication. Although aimed primarily at the construction industry and published initially in 1954, we believe the article will be of interest. It is presented in this issue of the Bulletin, beginning on page 1.

The use of liquid anhydrous ammonia ($NH_3$) fertilizer to successfully seal cracks in concrete pipelines on the Chowchilla Water District irrigation system in California is described in an article by H. V. Eastman, Secretary-Manager of the District beginning on page 11, under the title, "Miracles Do Happen."

The construction of an inexpensive storage shed using wood-pole construction will be found beginning on page 16.

The operating characteristics of constant-head-orifice turnouts are discussed in an article by E. Gordon Kruse, Agricultural Research Service, United States Department of Agriculture, who was asked to study the operating characteristics of such devices on one of the Bureau's projects. The article begins on page 18.

A request for information on the subject has led to our republishing an article on a suggested method of filling animal burrows in canal banks, page 25. This article originally appeared in Bulletin No. 1 published in 1952, but that Bulletin is now out of print and is not to be reprinted.

A supplemental report concerning the field experience with prestressed concrete bridges, which is a followup on an article published in Bulletin No. 48, is presented on page 27.

Several short reviews of laboratory reports also are being included in this issue of the Bulletin. One is concerned with the control of submersed water weeds, a second with crop tolerances to herbicides, and a third with the bonding of VR-3, VR-6, and coal-tar epoxy paint to steel surfaces previously coated with CA-50 paint.

# POWER CRANE AND SHOVEL SELECTION1/
by E. O. Martinson

The information on excavator performance here presented in chart form is intended as an aid in the selection of the proper size and type of excavators, which in the commercial range are usually available in 3/8, 1/2, 3/4, 1, 1-1/4, 1-1/2, 2 and 2-1/2 cu. yd. capacities. The capacity rating is the size of the shovel dipper normally handled by the machine. Intermediate sizes such as 5/8, 1-3/4 and 3 cu. yd. are occasionally used, and there are a number of sizes above the commercial range. For the most part the data will apply to excavating operations but they can also be used on other classes of work.

Excavators can be mounted either on crawlers, self-propelled rubber-tired mountings, or rubber-tired trucks having separate engines for traction. Crawler-mounted machines are better suited to excavating applications, whereas rubber-tired machines are used principally for lift-crane work, except possibly in the 3/8 cu. yd. size, where most of the machines are rubber-tire mounted and are used for excavating. Since most of the machines used for excavating in the commercial range are crawler mounted, the data here presented are for that type of machine.

Three principal types of attachments are available for excavators--shovel, backhoe, and crane boom. The crane boom in turn is used for excavating by means of dragline buckets or clamshell buckets and for other miscellaneous lifting purposes such as for steel erection and for the handling of concrete buckets, pile-drivers, lifting magnets, breaker balls, and the like.

The first consideration in selecting an excavator is possibly the price. Both price and weight seem to follow a fairly straight-line relationship for the various sizes of machines in the commercial range. Freight is part of the capital cost. It varies of course according to the distance from the factory.

The second factor in the selection of an excavator is its work capacity. There are three items of work capacity to be considered--range,

1/Reproduced from an article, "Power Cranes and Shovels," Civil Engineering, December 1954 and from "Handbook of Heavy Construction," Chapter 2; both by E. O. Martinson, President, Koehring-Waterous Ltd., Brantford, Ontario, Canada; the first used by permission of the Editor and the second by permission of McGraw-Hill Book Company; Copyright 1959 by the McGraw-Hill Book Company, Inc. The article "Power Cranes and Shovels," Civil Engineering in turn is based on the paper presented by Mr. Martinson at the ASCE Annual Convention, before the Construction Division session devoted to "The Use of Construction Equipment--Choice, Capacities, Economy."

lifting capacity, and hourly digging capacity. Range includes reach, lifting height, or digging depth. For lift cranes the lifting height is an important factor and may of itself determine which size of crane must be used regardless of cost. In shovel operation, the reach and lifting range are not so important as perhaps the dipper size, hourly capacity, and digging power. In backhoe work the digging depth and reach may be important factors, especially in pipeline trenching.

## Digging Ranges

Shovel digging ranges and the digging force at toothpoint are shown in Figure 1 below. The same information for hoes is shown visually in Figure 2 on the following page. Digging depth would be the most important information needed about the hoe. The relative boom and arm lengths, the lowest practical digging depth and height at discharge, may be visually compared.

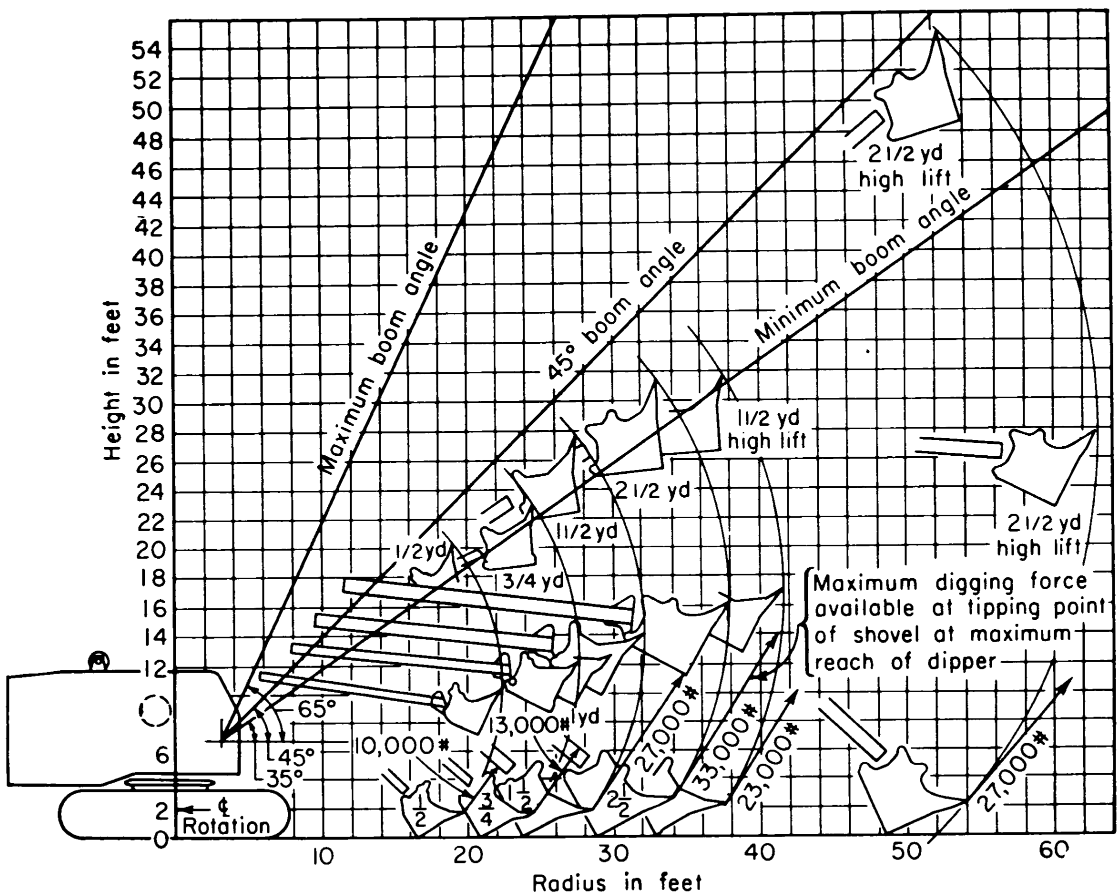
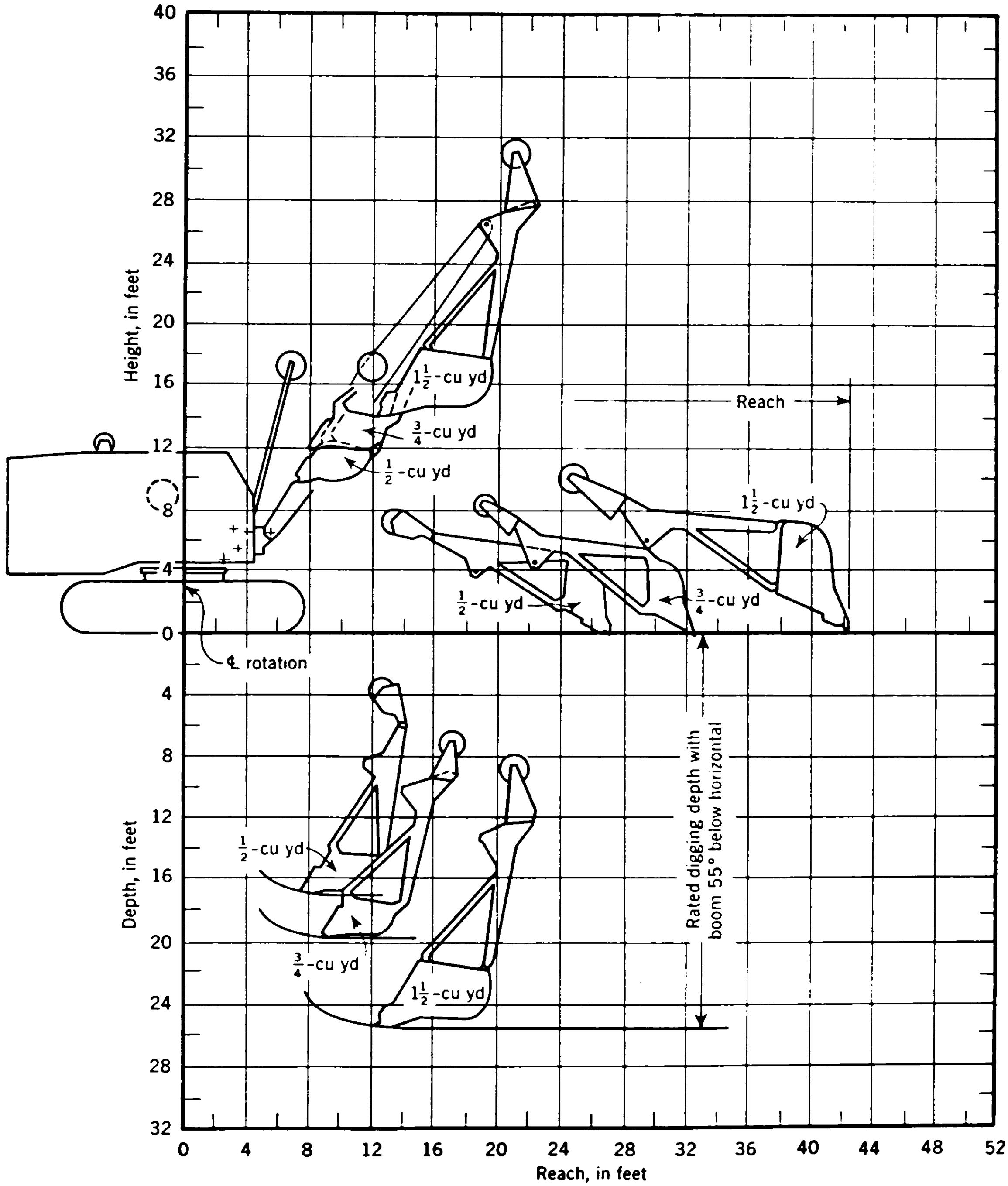



Figure 1



Height, in feet
Depth, in feet
Reach, in feet
1½-cu yd
¾-cu yd
½-cu yd
Reach
℄ rotation
Rated digging depth with boom 55° below horizontal


Figure 2

The crane-boom range diagram, Figure 3, on the following page, gives considerably more information than the usual range diagram found in the manufacturer's bulletin. It plots the standard crane-boom lengths for each of seven different sizes of machines normally available and recommended by the manufacturer. The shortest length of boom indicated is the basic boom length, which is fairly well standardized among the various manufacturers. For example, the base boom for a 1 cu. yd. machine is shown to be 40 ft. long, while the base boom for a 2-1/2 cu. yd. is 60 ft. Crane-boom extensions are available in 5-, 10-, 15- and 20-ft. lengths to make up boom lengths in the steps shown up to the maximum usually recommended for crawler-mounted machines. Jib extensions are available for use on lift-crane booms. The jibs are adjustable in angular position for reaching over parapets or for extending the lifting height of the boom. However, they are suitable for light lifts only. The maximum jib length recommended in most manufacturers' bulletins is plotted as the top point on the boom diagram for each size.

This range diagram also shows the usual range of boom working angles for draglines and clamshells. Within the dragline portion of the chart, another set of recommended boom lengths is given which is more limited in range. For draglines it is not practicable to use the longer boom lengths available for lift-crane work because the bucket capacity would be reduced too much. Thus on a 2-1/2-cu. yd. dragline, boom lengths of 60, 70, 80, 90 and rarely 100 ft. might be used whereas for lift-crane work a 120-ft. boom with a 30-ft. jib extension could be permitted.

Then, in addition to the various recommended and available boom lengths, the reach and height above the ground for any boom can be determined as well as the approximate angle of the boom for that position. This part of the chart is useful for determining clearance height or lifting height.

## Lifting Capacity

The second item in the work capacity of a machine is its lifting capacity. Another combination chart, Figure 4, on page 6, consists of curves of approximate lifting capacity for seven sizes of machines. These curves are only approximate because the lifting capacity varies considerably among the various makes of machines depending upon the length of crawler and the counterweights, and the manufacturer's literature should be consulted for more accurate data. This chart is most useful as a comparison of the relative lifting capacities between sizes. The chart gives the lifting capacity for various distances from the center line of rotation of the machine. The safe lifting capacity is three-quarters of the actual tipping load. Therefore a crawler machine on a hard, firm surface will actually lift up to one-third more than this chart indicates.

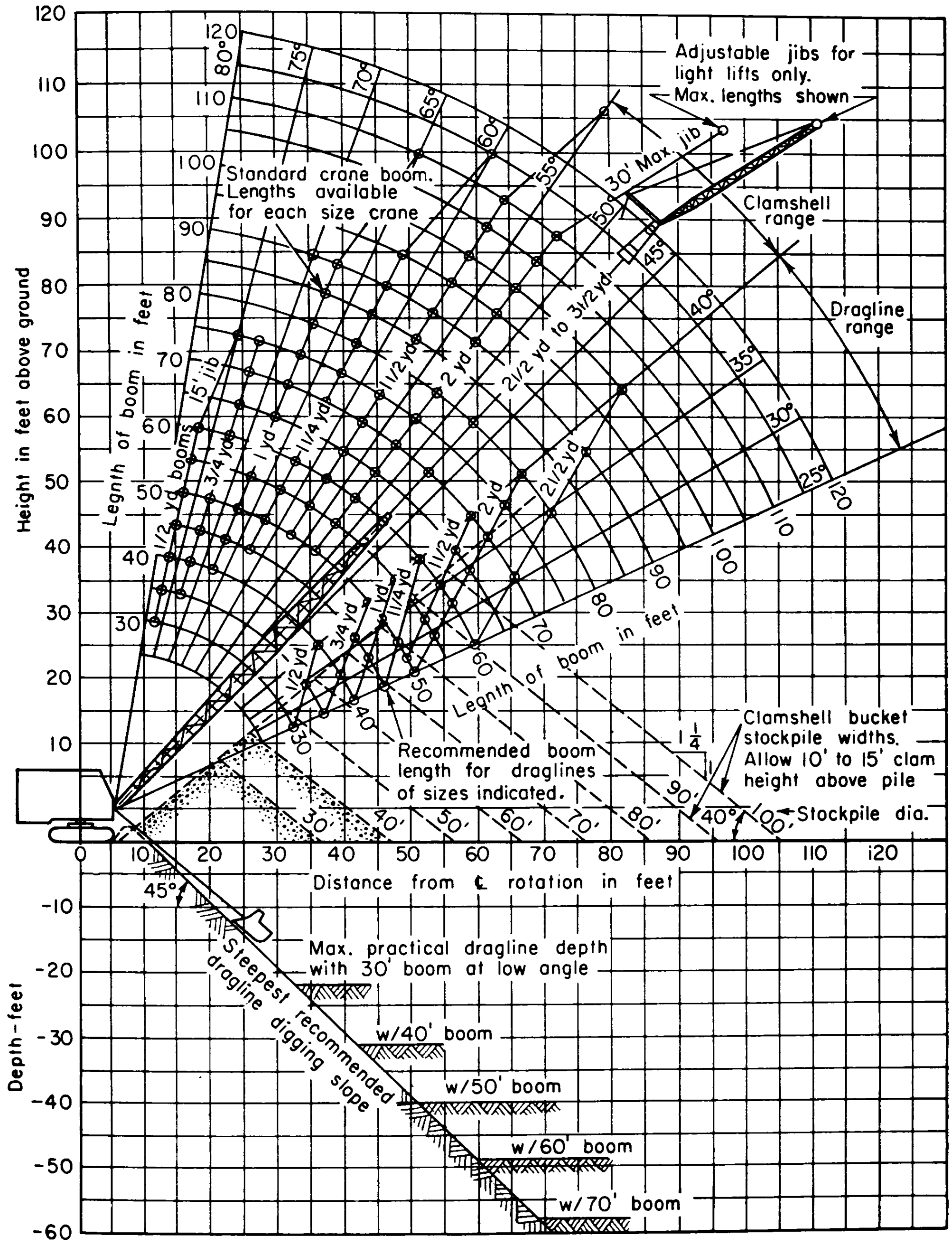

Adjustable jibs for light lifts only. Max. lengths shown
30' Max. jib
Clamshell range
Dragline range
Standard crane boom. Lengths available for each size crane
Length of boom in feet
15' jib
1/2 yd booms
3/4 yd
1 yd
1 1/4 yd
1 1/2 yd
2 yd
2 1/2 yd to 3 1/2 yd
2 1/2 yd
Recommended boom length for draglines of sizes indicated.
Clamshell bucket stockpile widths. Allow 10' to 15' clam height above pile
Stockpile dia.
Height in feet above ground
Distance from ℄ rotation in feet
Depth-feet
Max. practical dragline depth with 30' boom at low angle
w/40' boom
w/50' boom
w/60' boom
w/70' boom
Steepest recommended dragline digging slope
45°

Figure 3

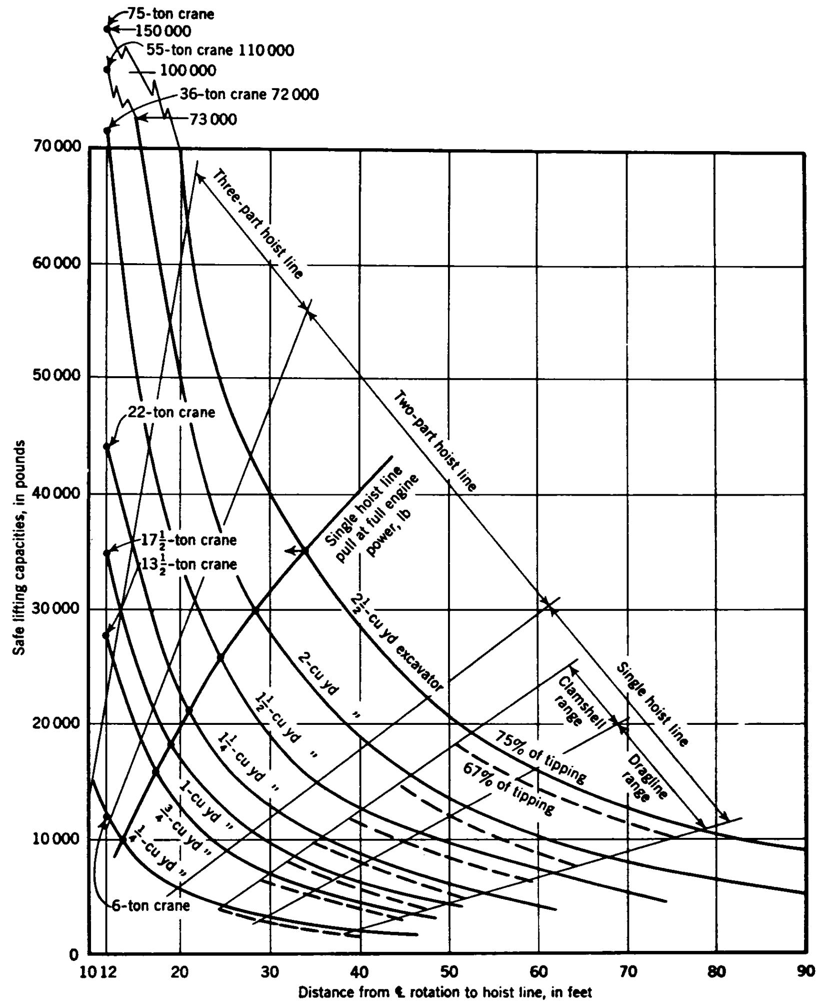



Figure 4

Some manufacturers recommend that for clamshell and dragline digging, 67 percent, or two-thirds of the tipping load, be used for determining the weight of the loaded bucket, and the dashed line plots this capacity in the clamshell and dragline range.

The safe lifting capacity of the machine at a 12-ft. radius might be generally considered to be the rated lifting capacity of the machine in tons when equipped as a crane. Thus, the 3/4-cu. yd. excavator of this chart might be classed as a 13-1/2-ton crane, and the 1-1/2-cu. yd. excavator could be classed as a 36-ton crane. These tonnage ratings will again depend on the length of the crawlers, the size of the counterweights, and the weight of the machine.

The lifting-capacity chart also shows the maximum hoist-line pull available at full engine horsepower for each of the seven sizes shown. The recommended line pull used in hoisting or lifting work is less than the maximum available line pull in order to provide spare power for accelerating the load or for swinging the machine. Also, the safety factor of the cable at full engine power is not adequate for steady lifting. The chart shows the safe lifting range for a single hoist line and the range where a two-part, three-part, or four-part hoist line would be recommended. More than four parts of line should be provided for the heavier lifts on the larger machines.

By using Figures 3 and 4 in combination, it is a simple matter to determine the weight of the loaded clamshell bucket or the weight of the loaded dragline bucket that can be used for any size of machine and any desired working radius or boom length. It is only necessary to know the weight of the loaded bucket in order to determine the size of bucket that might be used. Dragline bucket weights are shown in Figure 5 and clamshell bucket weights in Figure 6.

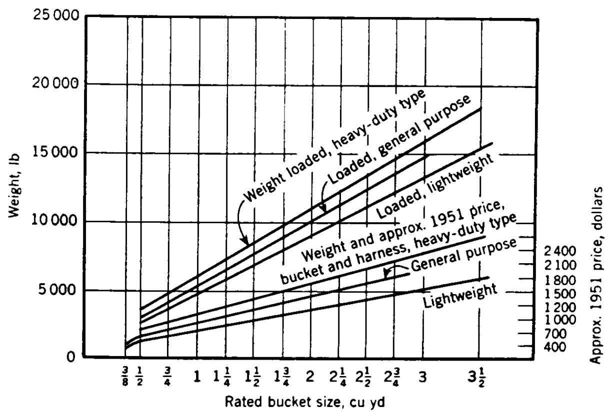



Figure 5

In Figure 5 at left, operating weights of dragline buckets are shown, assuming that buckets are loaded to rated capacity with earth or gravel weighing 100 lb per cu. ft. or 2,700 lb per cu. yd.

Figure 6 at the lower left shows operating weights of clamshell buckets, assuming that buckets are loaded to rated capacity with earth or gravel weighing 100 lb per cu. ft. or 2,700 lb per cu. yd.

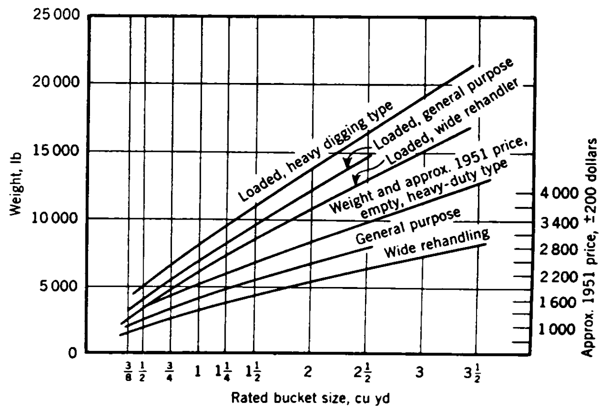



Figure 6

These charts make it evident that the shortest possible boom should always be used to obtain the greatest lifting and digging capacity. Another reason for using short booms is that the energy absorbed and the resulting heating of the swinging clutches varies as the square of the radius of the load. The operator may have to reduce his swinging speed when handling a loaded bucket out at the maximum radius to prevent the swing clutches from becoming overheated.

## Digging Capacity

The third item included under the subject of work capacity is the digging capacity in cubic yards per hour. The hoist and digging line speeds and the swing speeds for each size of excavator are quite uniform among the various manufacturers, with hoist speeds in the vicinity of 160 to 180 fpm, shovel-dipper hoisting speeds of 75 to 85 fpm, and dragline digging speeds of 125 to 150 fpm. Swing speeds range from around 5 rpm on the small machines to 2-1/4 rpm on the large machines of the commercial range.

The excavator-cycle elements are based on the excavator speeds and the distances required for filling the bucket or dipper. The minimum cycle times are shown in Figure 7 below. It is assumed that hoisting is continued during the swing cycle, and the swing cycle is started slightly before the bucket is filled. The approximate hoisting distances during the loaded swing cycle are shown on the curve for the total cycle times. The time to accelerate and decelerate the swing is greater for draglines and clamshells because of the much greater inertia caused by their long booms and heavy counterweights. The cycle elements are based on shovels dumping into vehicles, draglines to embankments and clamshells from stock piles to bins or other piles.

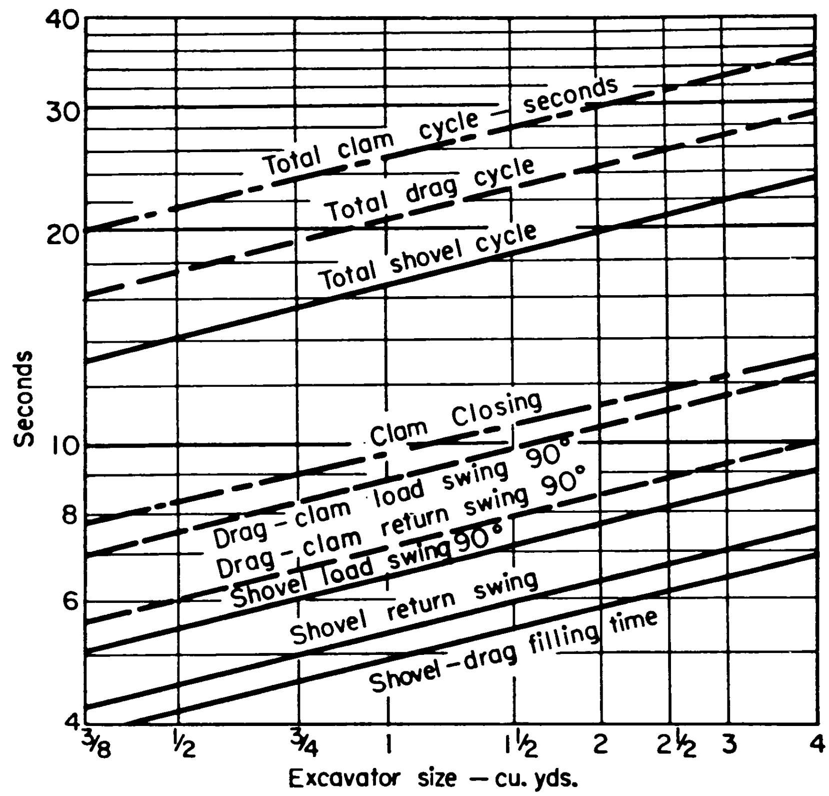



Figure 7

The estimated hourly output in cubic yards per hour for shovels, draglines, and clamshells is shown in Figure 8 below. In actual practice the maximum theoretical output must be modified by various efficiency factors to determine the average output. The primary scale of Figure 8 is for 100 per cent efficiency, and modified scales are shown for other operating efficiencies.

The time for a 90° swing may approach three times the dipper loading time, as shown in the elements of Figure 8; therefore the angle of swing is important in the total operating cycle. Output shown in Figure 8 at 100 per cent efficiency is for a 90° swing with a full bucket at each pass and no lost time; hoisting time is the same as for 90° swing, with bucket loaded in traveling two or three lengths and with the easiest digging. Figures are derived from data of Figure 7. The equivalent output at other over-all operating efficiencies also is shown. The output is based on the size of the bucket. The figures are condensed from data presented by the late A. E. Holcomb, in a paper

**EXCAVATORS**

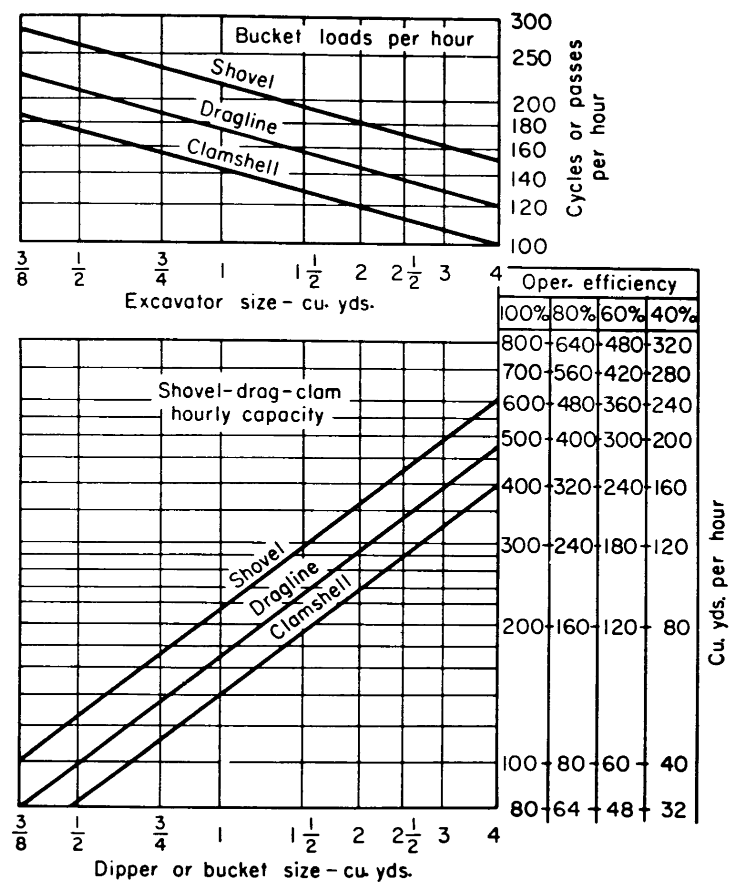



Figure 8

before the ASCE Annual Convention of 1931. These data are also contained in expanded form in publications of the Power Crane and Shovel Association. The theoretical hourly yardages must be modified for different angles of swing, higher digging faces, and types of use, whether for casting or loading trucks.

Some idea of the kinds of delay involved and the possible extent of these delays is given by Figure 9, shown below and also on the cover page. This chart is based on data presented in a bulletin of the Highway Research Board, which is a record of the average actual performance of 16 power shovels of various makes, ages, and sizes, working 10 different highway jobs. The average actual digging time in these studies was only 37 per cent of the total time. Some jobs must have been much worse than this, and others better.

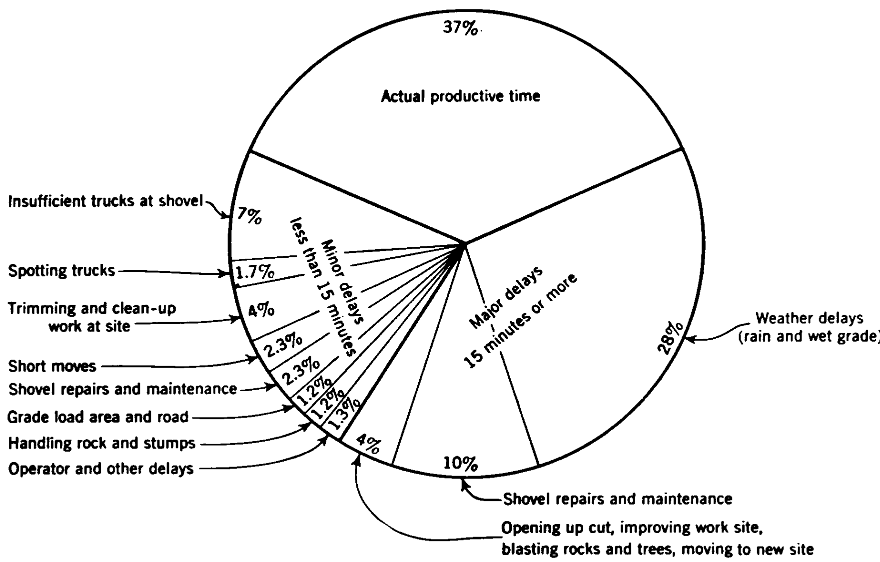



Figure 9

It can be seen that weather was the greatest single cause of delay, averaging 28 per cent of the total time. This factor may not apply in a stone-quarry operation or on a drainage canal being dug by dragline. Shovel repair and maintenance shows a time loss of 10 per cent of the total due to delays of 15 minutes or longer, plus 2.3 per cent for minor delays of less than 15 minutes, or a total of 12.3 per cent. This factor depends on the age of the machine, and a good deal on the operator. The next largest cause of delay seems to be waiting for trucks, and this factor also would not apply in certain types of operations.

Operating efficiency is further affected by the skill and integrity of the operator. He could limit his output in a number of ways so that he would not set too high a performance standard for himself. Also the operator will have a great deal to do with the amount of maintenance required to keep a machine running according to the smoothness with which he handles it. A skilled operator can prevent shocks and overloads on the machine, and can reduce cable wear and breakage.

* * * * *

## MIRACLES DO HAPPEN

(H. V. Eastman, Secretary-Manager, Chowchilla Water District, Chowchilla, California1/)

### Introduction

The Chowchilla Water District is an irrigation district of 65,000 acres, located near Fresno, California, that receives irrigation water from Millerton Lake, a reservoir created by the construction of Friant Dam on the San Joaquin River, as a part of the Central Valley Project. The District has constructed many miles of concrete pipe lines as well as canals and other facilities with funds from a Public Law 130 loan. Some of the pipe lines were used for the first time in March 1964, and immediately several hundred leaks appeared in the new lines. This was a most embarrassing, amazing and shocking occurrence. There had been very few leak problems with pipe that had been laid in earlier years, so efforts were made to get some answers.

Engineers in the Fresno office of the Bureau of Reclamation advised that the District's experience is common if the water put into the concrete lines has a temperature colder than 55 degrees F. The cold water results in line cracking and, of course, leaks. Numerous irrigation district engineers and managers provided about the same information. Several said that patching the leaks by hand or putting sawdust in the water would stop most of the leaks.

Then, what might be ascribed as a miracle, happened. Someone said there was a rumor that a large landowner had found a simple means of stopping leaks in concrete pipe lines. This owner was contacted, and he verified the report. He stated that $NH_3$, known as anhydrous ammonia, was being used to fertilize certain crops by applying it with the irrigation water through some 30-inch diameter monolithic concrete pipe lines. He had noted that his pipe lines, which had leaked very badly, stopped leaking after use of the $NH_3$. Two years later the pipe lines were still tight.

1/Adapted from a paper presented at the Irrigation Operators' Workshop, Denver, Colorado, November 11-16, 1964.

## Initial Experiment

So far as could be determined at the time, no others had used the anhydrous ammonia for leaks; however on April 1, 1964, the Chowchilla Water District started an experiment in 3 miles of 30-inch and 36-inch monolithic concrete pipe line. This line had been placed the previous year and usual practices in laying such lines had been followed. There were 171 leaks in the 3 miles of line when it was filled with water. There was no basis for determining how much $NH_3$ to use so a start was made with 80 units an hour[2/] and this was cut to 40 units after about 3 days. The chemical was delivered to the District as a liquid in pressure tanks and the amount used could be determined at all times by gauges on the tanks.

After treatment for 4 days, all but 12 of the 171 leaks had stopped completely. It was assumed that the remaining 12 leaks might require hand patching and this was done after draining the lines. Later experience indicated that these leaks also could have been cured with the $NH_3$.

The chemical used in the experiment in the first 3 miles of line cost about $300. It would have cost more than $1,000 to patch the line by hand.

## Subsequent Treatments and Field Experience

The men who were doing the initial work became confident that any normal leak could be cured with the chemical treatment, and treatment was extended to pre-cast concrete lines running from 14- to 24-inches in diameter and in monolithic lines 24- to 48-inches in size. The results were uniformly good and there were no failures. Certain pipe lines, which had persisted in leaking after continuous hand patching, were made tight with $NH_3$. Some concern was felt that the leaks might reappear due to water flow or at a time when the lines were dewatered, but no such difficulty has been experienced.

The use of $NH_3$, at Chowchilla has been in concrete pipe lines having head pressures not exceeding 14 feet, but it appears that this treatment will work equally well in pipe lines carrying higher pressures. As stated previously, the treatment was successful in monolithic type concrete pipe lines, and in pre-cast concrete pipe lines. For the benefit of those who may not be familiar with these terms, pre-cast concrete pipe is that made in lengths of 3 or 4 feet or more in a plant and hauled to the construction site where the lengths are joined with mortar or other means to make a continuous line. Millions of miles of this type of pipe are in use in California.

2/ $NH_3$ is sold by the ton. A unit of the chemical, as used in this report, weighs 1 pound.

Monolithic pipe is cast in the location where it is to be used. Construction consists of excavating a trench, usually with a rounded bottom to conform to the shape of pipe, and by the use of a special pipe forming machine that travels in the trench, a pipe is extruded into a continuous line a few feet or miles in length. The pipe forming equipment moves forward constantly, so that the pipe is generally made with a minimum of joints. The monolithic pipe is less expensive than other pipe and is used only in the larger sizes, generally from 30 to 48 inches in diameter. Thousands of miles of this pipe are in use in the San Joaquin Valley of California, and its greatest advantage is its large capacity at low construction cost.

Essentially, the addition of the anhydrous ammonia to water in a pipe line precipitates the calcium in the water as calcium carbonate. This precipitated material flows into cracks sealing them. Nothing further is done in applying the material. Some of the precipitated material will cover the entire inside of the pipe line and has filled very large as well as small cracks. The amount and type of chemicals in the water apparently has a considerable effect upon the success of the treatment. In the District's initial experiments water stored in Millerton Lake (surface water), was used at first. However, it became necessary to use water from wells because of a temporary shortage of water in the supply canal. The amount of calcium in the well water varied from well to well. Treatment with water from one well cured all leaks in 12 hours. From other wells it took as long as 3 or 4 days to stop the leaks, and no results were obtained at all using water from 2 wells.

Undoubtedly, good results can be obtained from the use of much smaller quantities of the $NH_3$ than were used in the early Chowchilla experiments. In some cases as little as 20 to 40 units of the chemical per hour will provide good results. Use of water with a higher calcium content will probably reduce the quantities of $NH_3$ necessary for obtaining a successful treatment, but further studies of the chemical reactions indicate that other chemicals in the water may have an effect upon the sealing.

It is also believed that quicker action will result if the pipe line is treated in shorter sections. Sections no more than one-half mile in length are recommended. The chemical supply tank should be moved and the $NH_3$ introduced into the pipe line at the higher ends of each new reach to be treated, rather than allow the treated water to flow from the beginning point through long reaches of pipe before getting to the reach requiring treatment.

Delivery of the chemical from the supply tanks into the pipe lines need not be a problem. It can be accomplished through short pressure hoses into standpipes or other elevated pipe connections. The pipe line being treated should be completely filled with water, and since the chemical is delivered as a liquid and is an ammonia product, care should be used in handling it. However, because of the odor, one is continually aware of its presence, should careless handling occur. Caution should, of course, be exercised in entering large pipe lines after they have been treated and dewatered.

During treatment it is necessary to have some movement of water in the lines to uniformly distribute the $NH_3$. Caution was used in our experiments when draining lines that had been treated or in permitting the farmers to use the treated water, because of the high amount of nitrogen present. Large amounts of nitrogen can damage some crops. However, most of the water from Millerton Lake was actually used on crops that needed nitrogen, and no difficulty was experienced in disposing of other water drained from the treated lines.

The question of whether the use of the anhydrous ammonia will damage the pipe lines has been asked, but chemists have given assurance that this treatment will not deteriorate the concrete in the lines to any degree. Possibly there may be some strengthening of the pipe, however, it is assumed that even though some cracks may be sealed, others may occur in new places if conditions are such that the pipe would normally be expected to crack.

Landowners within the Chowchilla Water District have been pleased with the phenomenal results achieved with the anhydrous ammonia and there is no uncertainty as to what will be done if leaks occur in the future. There are reports that others who have used $NH_3$ as fertilizer in their irrigation water had noted that their leaky pipe lines also had stopped leaking. They could not account for the reduced leakage until hearing about the Chowchilla experience. It is also understood that a large pipe company has recently adopted this method of stopping pipe leakage with anhydrous ammonia. Apparently any one with a minimum of care can use the treatment process successfully and farmers as well as irrigation districts should profit greatly.

The tremendous relief in getting away from the costly practice of hand patching or the undependable use of sawdust as a temporary cure, and having found a simple and inexpensive treatment which appears to be reliable from experience to date, must be described as a miracle.

* * * * *

## SUBMERSED WATERWEED CONTROL

The Crops Research Report ARS-34-57, October 1963, "Chemical Control of Submersed Waterweeds in Western Irrigation and Drainage Canals," is a joint report by the Agricultural Research Service, U.S. Department of Agriculture and the Bureau of Reclamation, Department of the Interior. The publication was prepared to provide canal operators and farmers with current information on the use of chemicals for control of submersed waterweeds in irrigation and drainage canals.

Recommendations are based on field and laboratory research and on observations of many field applications of aromatic solvents for more than 10 years and of acrolein for 4 years.

The report includes a discussion of chemical versus mechanical control methods as well as chemical control with aromatic solvents, acrolein, copper sulfate, and other chemicals. Included also in the report is the following summary of recommendations:

I. Control of rooted submersed weeds

1. Grade B xylene or other aromatic solvents (meeting Bureau of Reclamation specifications).

   a. Emulsifiers--certain anionic-nonionic blends at 1 to 1-1/2% of aromatic solvent by volume.
   b. Rate--10 gal./c.f.s. or 10 gal./ft of canal width, whichever is greater.
   c. Period of application--30 to 60 minutes.
   d. Time of application--when waterweeds begin impeding waterflow and before weeds reach the water surface at normal operating level.
   e. Application equipment--any sprayer that delivers a sufficient volume of chemical below the water surface at a pressure of 50 to 400 p.s.i. High pressures are best, although treatment at low pressures may be satisfactory.
   f. Distance of control--depends on density of weed growth and other factors--up to 6 miles.
   g. Application intervals--make "booster" treatments every 2.5 to 3 miles below point of initial treatment. Use 5 gal./c.f.s., if applied directly on top of treated "blanket" from initial treatment.
   h. Frequency of treatment--as needed during irrigation season, usually every 6 to 8 weeks.
   i. Precautions--use same care as in handling gasoline. Treated water not toxic to humans, farm animals, or wildlife, or irrigated crops when chemical used as recommended. Treated water highly toxic to fish and other aquatic fauna. Prevent treated water from entering fishing waters.

2. Acrolein (available from and applied only by licensed dealers).

   a. Rate--depends on density of weeds, water temperature, length of canal, and other factors--1 to 3 gal./c.f.s.
   b. Period of application--1-1/4 to 4 hours.
   c. Time of application--same as for aromatic solvents.
   d. Distance of control--depends on size of canal, density of weed growth, and other factors--5 to 20 miles.

e. Frequency of treatment--as needed during the irrigation season, usually every 6 to 8 weeks.
f. Precautions--acrolein is extremely irritating to eyes and nasal passages. Avoid contact with skin or breathing fumes. Water containing not more than 15 ppmv (parts per million by volume) is not harmful to irrigated crops and water treated according to recommendations is not dangerous to humans, farm animals, or wildlife. Treated water kills fish and other aquatic fauna. Prevent treated water from entering fishing waters.

II. Control of Algae

1. Filamentous algae, other than chara.

a. Chemical--copper sulfate.
b. Rate--1/3 to 2 lb/c.f.s.
c. Method of application--place in coarse mesh bags and hang in stream or shovel crystals into water over concrete apron.
d. Frequency of treatment--as needed during the irrigation season, usually every 10 to 14 days.
e. Distance of control--depends on density of algal growth and hardness of water--2 to 10 miles or more.

2. Chara.

a. Chemical--copper sulfate.
b. Rate--2 to 4 lb/c.f.s.
c. Method of application--same as for filamentous algae.
d. Frequency of treatment--as necessary for adequate control.

3. Precautions--wash hands thoroughly after handling crystals. Water treated as recommended not toxic to humans, farm animals, or wildlife, but may kill fish.

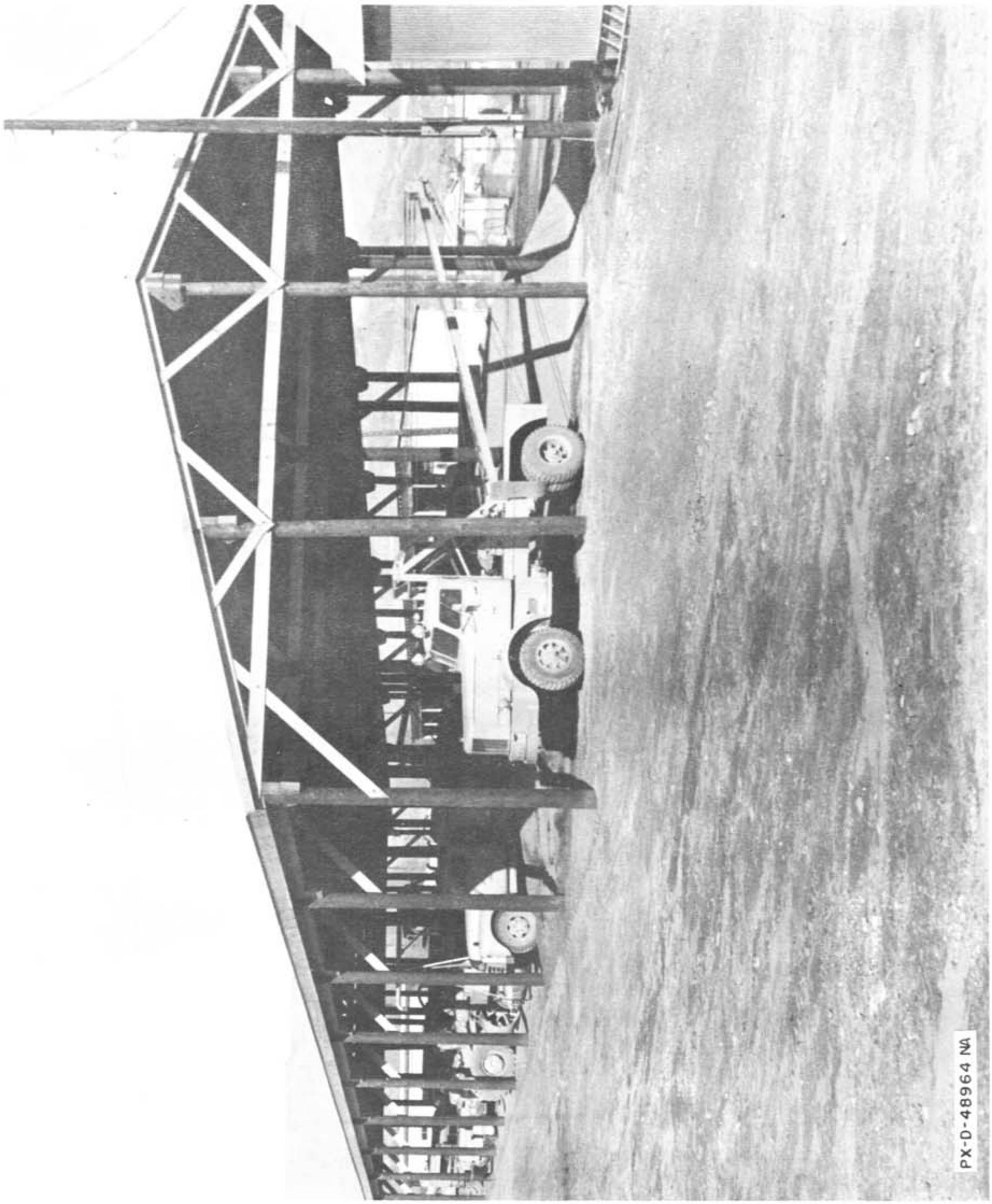
Copies of the publication probably may be obtained from local offices of the reporting agencies or are available from agency offices in Washington, D.C.

* * * * *

## STORAGE SHED FOR $1.12 PER SQUARE FOOT

(Reprinted with the Permission of the Editor of Wood Preserving News from the September 1964 issue).

Past economical construction of the first 60- by 120-foot pole-type equipment storage shed erected by Wasco County, Oregon, and general satisfaction with the job led Clifford Light, County Engineer, to


PX-D-48964 NA

declare "whenever another utility building is needed by Wasco County, it will be of the pole-type; no other kind will be considered for this purpose."

The contractor and a crew of six men completed the erection of the building in 21-1/2 days. Fifty-five 8-inch top Douglas fir poles pressure-treated with a 5 per cent pentachlorophenol solution to a minimum retention of 8 pounds per cubic foot were used. Forty-four poles were 25 feet long and 11 were 30 feet long. They were set to a depth of 6 feet and because of heavy winter snow loads in the Wasco area 12-inch concrete pads were placed under them. The roof consists of galvanized sheet metal over plywood.

Because the design was economical with a total cost of only $1.12 per square foot and because the building may be expanded with ease at any time the need may arise, the design shown in the photograph on the preceding page, was chosen. The pressure-treated materials for the building and engineering assistance was provided by a West Coast company.

The American Plywood Association recently published plans for four pole-type utility buildings with clear spans of 28, 32, and 40 feet. Plywood is used for gussets, trusses and for siding and roofing.

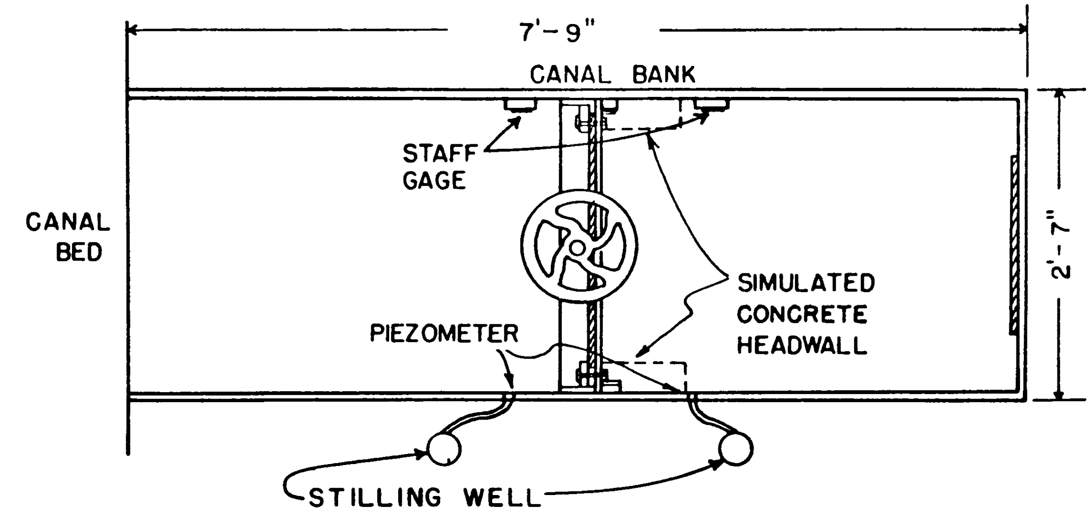
* * * * *

## THE CONSTANT-HEAD-ORIFICE TURNOUT

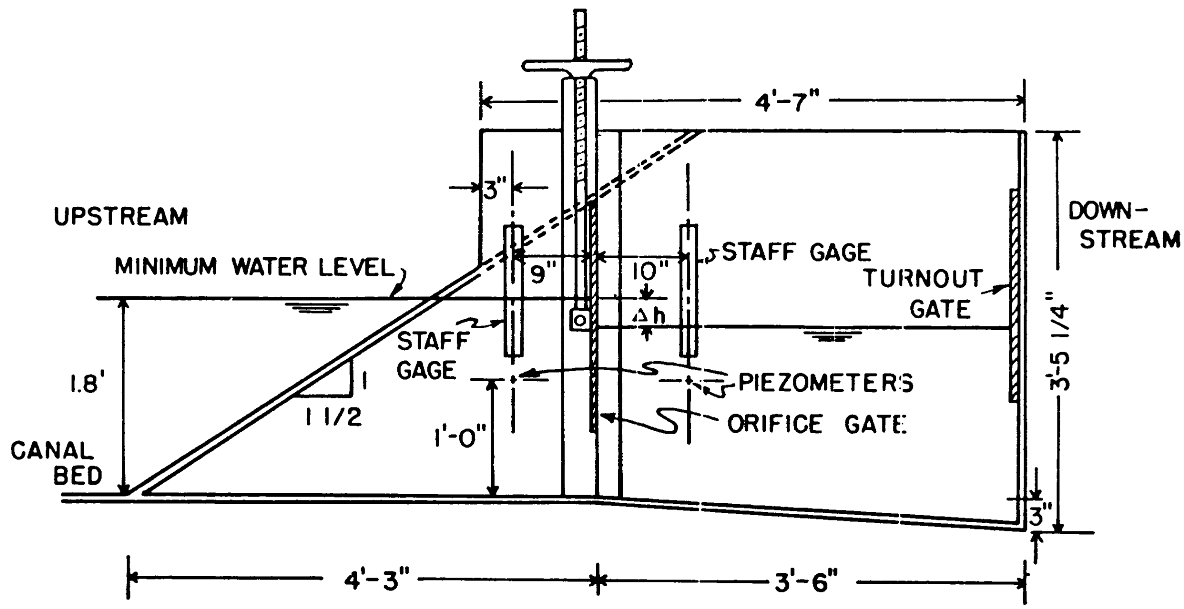
The constant-head-orifice turnout, Figure 1 on the following page, is a structure used for the control and measurement of irrigation water, and is normally used to divert water from a canal to a smaller farm lateral. The device was developed by the Bureau of Reclamation, and variations of the device are in use on many Bureau Projects.

E. Gordon Kruse, Agricultural Research Service, United States Department of Agriculture, was recently requested to study the operating characteristics of the turnouts constructed on one of the Bureau's projects. His laboratory and field studies included the effects that sediment, high canal velocities, varying downstream water levels and the plugging of the orifice gate by debris would have upon discharge. His findings were reported in the paper "The Constant-Head-Orifice Farm Turnout," published January 1965 as paper ARS-41-93, by the Agricultural Research Service, U.S. Department of Agriculture.1/

1/Copies of the paper can be obtained upon request to the Agricultural Research Service, U.S. Department of Agriculture, Beltsville, Maryland 20705.




PLAN VIEW




PROFILE VIEW

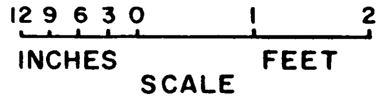



Figure 1

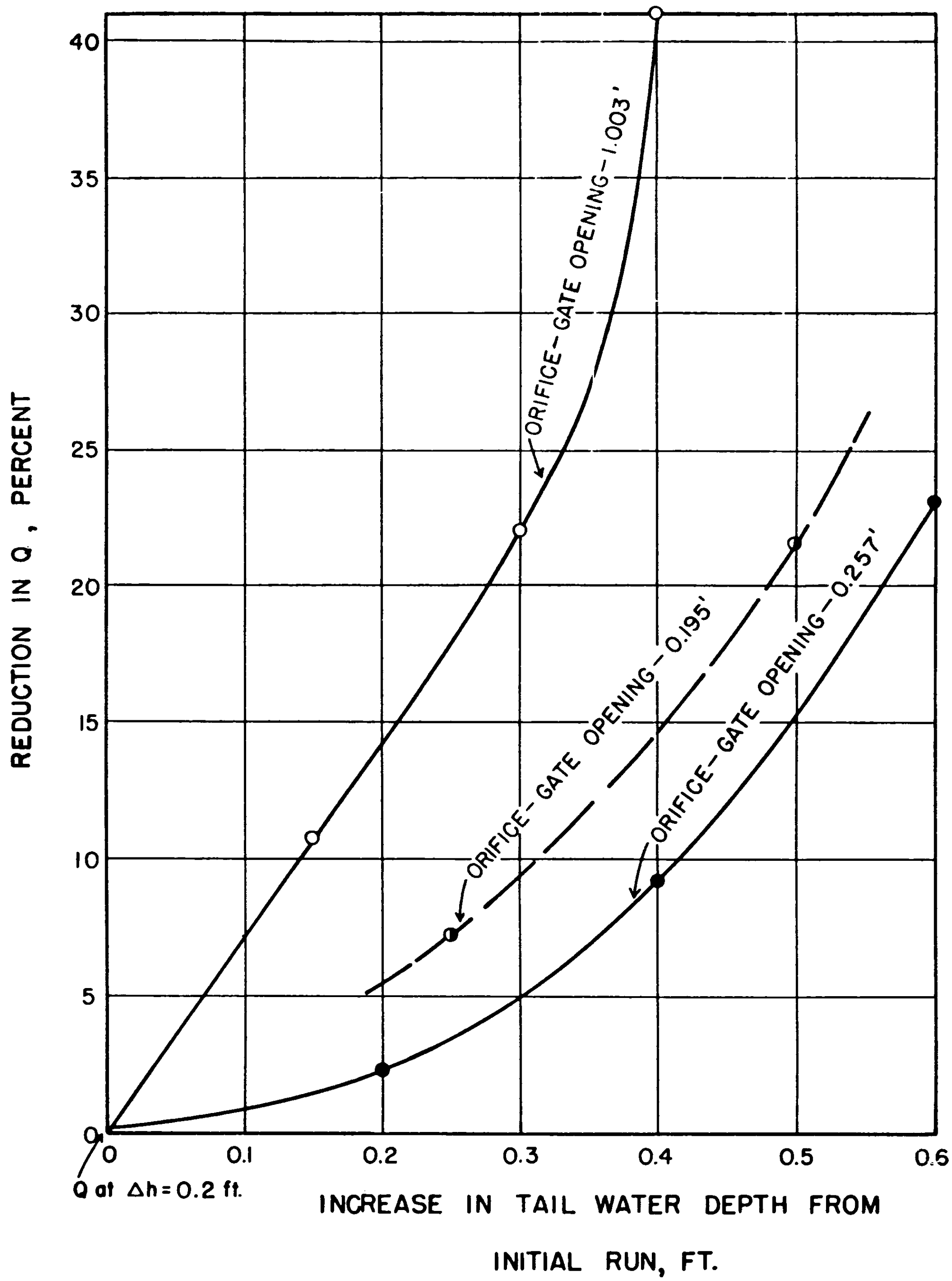
Mr. Kruse reports that the studies made show the constant-head-orifice provides reasonably accurate measurements of discharge under most operating conditions, except when obstructed with debris, or when the tail water level was raised. Under the latter conditions, discharge measurements were much less than indicated by the calibration curve.

## Effect of Tail Water Variations

The reduction in discharge from the measurement and control device upon becoming plugged with weeds and debris can be readily understood, but the amount of decrease in discharge by an increase in tail water depth is probably not fully appreciated. In each test run, after the water depth and velocity in the canal had become stable, the orifice gate was opened to the desired height and the turnout gate was adjusted to produce a 0.20-foot differential head on the orifice gate. Discharge through the structure at this setting was measured. Then another gate immediately downstream of the turnout gate was lowered to increase tail water depth on the CHO. After the flow had stabilized, the discharge was again read without the position of either the orifice or the turnout gate being changed. This procedure was repeated to give data for two or three increments of change in tail water depth.

Discharge was reduced up to 40 per cent from the initial flow conditions by increased tail water levels, Figure 2, on the following page. The discharge reduction was a result of the decreased differential head on the orifice gate caused by the increased tail water level. As the depth of tail water was increased, the canal depth upstream from the CHO was also increased to a small extent, thus producing a smaller change in the "$\Delta$ h" across the orifice gate than would occur in the field. Changes in the discharge due to tail water variations would therefore be expected to reach even greater magnitude under field conditions, where canal depths would remain more nearly constant.

In a field installation, if the CHO is set at approximately the same grade as the lateral ditch being filled, the CHO may not be submerged when the gates are first opened. However, when the lateral becomes full, submergence of the CHO will result and the tail water depth will increase. Therefore, the person establishing the discharge in the CHO may need to make adjustments in the setting until flow conditions in the lateral ditch become stable.



40
35
30
25
20
15
10
5
0
REDUCTION IN Q, PERCENT
ORIFICE-GATE OPENING-1.003'
ORIFICE-GATE OPENING-0.195'
ORIFICE-GATE OPENING-0.257'
0
0.1
0.2
0.3
0.4
0.5
0.6
Q at Δh=0.2 ft.
INCREASE IN TAIL WATER DEPTH FROM
INITIAL RUN, FT.


2

Figure 2

* * * * *

# CROP TOLERANCE TO HERBICIDES

Technical Bulletin No. 1299, issued February 1964 and prepared by the Agricultural Research Service, USDA, in cooperation with the Washington, Montana, and Arizona Agricultural Experiment Stations, reviews greenhouse and field studies directed toward the "Tolerance of Certain Crops to Several Aquatic Herbicides in Irrigation Water." Research Agronomists V. F. Bruns, and R. R. Yeo, and Plant Physiologist H. F. Arle, Crops Research Division of the ARS point out in their introduction to the Bulletin that herbicides for controlling aquatic weeds have been developed and used at an increasing rate. Herbicides used for this purpose in irrigation channels, drains, ponds, or lakes may contaminate irrigation waters for croplands. Therefore, the tolerance of crops to such herbicides in irrigation water have been investigated.

It is reported in the summary and conclusions that:

"A preliminary greenhouse study on the tolerance of beans and corn to aromatic solvent No. 1 was conducted at Prosser, Washington, in 1958.

"In field experiments the tolerance of one or more crops to one or more aquatic herbicides in irrigation water was studied at Prosser, Washington (1958, 1959, 1961), Huntley, Montana (1958-59), and Phoenix, Arizona (1958-60).

"At Prosser, crops in field experiments were furrow-irrigated with certain concentrations of the chemical in the equivalent of 2 acre-inches of water during early growth.

"At Huntley, crops were furrow-irrigated with several concentrations of the chemical in the equivalent of 3 acre-inches of water after mid-season.

"At Phoenix, various concentrations of the chemical were applied in the equivalent of 4 acre-inches of water at the first or at the first and third flood irrigations of cotton.

"In Washington, young corn and beans in the greenhouse were injured slightly when the soil was wetted to field capacity with 270 to 3,000 p.p.m.v. (parts per million by volume) of aromatic solvent No. 1 in irrigation water. In the field experiments, solvent applications at 740 to 2,960 p.p.m.v. (one to four times the concentration necessary for control of submersed aquatic weeds in irrigation canals) did not reduce per-acre yields of corn or field beans.

"In Washington, acrolein at 20 p.p.m.v. killed 3 percent of the soybean plants and slightly or moderately injured the others. Corn, however, was injured only slightly. Yields of neither crop were reduced.

Acrolein at 60 and 150 p.p.m.v. severely injured the soybeans and significantly reduced the stands and yields. At 150 p.p.m.v. corn was injured severely and 3 percent of the plants were killed, but yields per acre were not reduced.

"In Montana, acrolein at 180 p.p.m.v. or fewer did not reduce the yield of sugar beets or silage corn. At 60, 120, and 180 p.p.m.v., field beans were injured in 1958, and the yields were reduced. At 60 p.p.m.v. or fewer, bean yields were not reduced in 1959, however. No acrolein residues were found in vegetative samples of beets, corn, or beans collected at harvest time in 1958.

"In Arizona, acrolein at 100 p.p.m.v. or fewer did not injure cotton appreciably nor reduce yields significantly when applied at the first or at the first and third flood irrigations. Concentrations of 160 p.p.m.v. or higher, however, severely injured the plants and significantly reduced the yields. In comparison with tests in Washington and Montana, flood-irrigated cotton was less tolerant to acrolein than furrow-irrigated corn or sugar beets but was considerably more tolerant than furrow-irrigated soybeans or field beans.

"Quaternary ammonium compounds No. 1 and No. 3, particularly at 350 p.p.m.v., somewhat reduced the vigor but not the yield of corn in Washington. Compound No. 1 at 150 and 350 p.p.m.v. killed a few soybeans and suppressed somewhat the growth of the others, but it did not reduce per-acre yields. Compound No. 3 appeared less injurious than compound No. 1. Diquat at 125, or less, p.p.m.w. (parts per million by weight) did not visibly affect the foliage of corn. The growth of field beans, however, was noticeably suppressed by Diquat even at 5 p.p.m.w. The incidence of root rot and mites interfered with the evaluation of yield differences. Additional research is needed to determine whether crops may be irrigated safely with water that contains quaternary ammonium compounds.

"Disodium salt of endothal at 25 p.p.m.w. or fewer did not visibly injure corn. Field beans, however, were severely injured and yields were reduced by even 1 p.p.m.w."

Copies of Technical Bulletin No. 1299, "Tolerance of Certain Crops to Several Aquatic Herbicides in Irrigation Water," can probably be obtained from local Agricultural Research Service offices of the United States Department of Agriculture. If not, it can be ordered from the Department of Agriculture or the Superintendent of Documents, Washington, D.C.

* * * * *

# BONDING VR-3, VR-6, AND COAL-TAR EPOXY TO STEEL SURFACES FORMERLY COATED WITH CA-50 COAL-TAR PAINT

Recent Bureau practice has been to replace failing CA-50 coal-tar paint with either VR-3 or VR-6 vinyl resin systems, or coal-tar epoxy paint, the choice of coating depending on the service, condition, and structure to be painted. However, difficulty reportedly was encountered on a field project in accomplishing effective sandblast removal of a CA-50 coating, and led to speculation as to the serviceability of various coatings subsequently applied to a surface having residual coal-tar constituents. Therefore, in a preliminary test, an attempt was made to bond VR-3 and coal-tar epoxy paints to sandblasted surfaces formerly coated with CA-50. The VR-3 adhered poorly to such a surface. The problem seemed to lie in the inability to remove, by reasonable blast cleaning, all the coal-tar residual from the steel surface.

The results led to a more intensive testing of paints which may at some time be applied to a surface formerly coated with CA-50, and to a search for means of surface preparation and/or treatment which would insure adequate adhesion and serviceability. The results of the testing and search are contained in Laboratory Report No. ChE-30, prepared by H. K. Uyeda, of the Chemical Engineering Branch, Division of Research, Office of the Chief Engineer, Bureau of Reclamation, Denver Federal Center, Denver, Colorado.

## Conclusions

Sandblasting in accordance with Bureau requirements does not remove all remnants of a CA-50 coating from a metal surface. An appreciable coal-tar residue can be detected by means of a "spot" test consisting of placing a drop of xylol on the surface. On drying, this produces a marked ring when a residue of coal tar is present.

The coal-tar residue adversely affected the adhesion of VR-3 vinyl resin paint to a sandblasted surface formerly painted with CA-50. VR-6 and coal-tar epoxy paints apparantly were not so affected.

Xylol washing of the sandblasted surface failed to improve VR-3 adhesion, and even a reblast of the xylol washed surface failed to produce acceptable VR-3 bond. Metal conditioner, MIL-M-10578B, applied to a blasted surface likewise failed to insure good bond of the VR-3, except when the surface had also been blasted intensely to white metal.

If VR-3 is to be applied to a surface previously coated with CA-50, sandblast cleaning of the surface should be thorough, and a coat of VR-6 primer should precede application of the VR-3. VR-6 and coal-tar epoxy paints present no special problems.

The conclusions reached, based upon adhesion test results, are considered reliable in that paints of demonstrated quality were used and because adhesion is the vital characteristic in question. However, the tests may not reflect long-term effects of the coal-tar residuals, and the program was therefore extended by placing the test coatings in fresh water immersion for later evaluation.

For additional details of the laboratory study, copies of the laboratory report can be obtained by writing the Chief Engineer, Bureau of Reclamation, Code 841, Denver Federal Center, Denver, Colorado.

* * * * *

## FILLING ANIMAL BURROWS IN CANAL BANKS

(Release No. 1 of our Bulletin, published in 1952, carried an article on a method used on the Belle Fourche Project in South Dakota for filling crayfish burrows in canal banks with a mixture of top soil, portland cement and water. Release No. 1 of the Bulletin is now out of print and will not be reprinted; however, we have had several requests for information on treating animal burrows in canal banks and as the information included in the former article is basic to the animal burrow problems, it is being repeated.)

While possibly only a few of our projects are troubled with crayfish to the extent found on the Belle Fourche Project, burrowing gophers and other small animals can create problems. These animals have not only damaged the banks and structures on a canal or lateral system, but property and crop damage also have resulted from flooding that has occurred as a result of weakened or damaged banks.

To fill the burrows on the Belle Fourche Project, a lean portland cement-soil grout or slurry, consisting of four parts of top soil to one part of portland cement is pumped into the burrow under 20 to 40 pounds p.s.i. pressure by the mud jack shown in Figure 1 on the following page. Water is added to the mixture until it becomes just fluid enough to flow well through the small diameter hose as shown in Figure 2, also on the following page. During filling, of course, the hose is inserted into the burrow as far as possible.

Aromatic solvent is added to the slurry as it is being mixed to kill crayfish that might be trapped in the burrow. It has been suggested that in the treatment of gopher burrows that it might be advisable to use Rosin-Amine-D Acetate as the chemical added to the slurry to kill trapped animals, since the chemical is known to repel gophers.

* * * * *


Figure 1


Figure 2

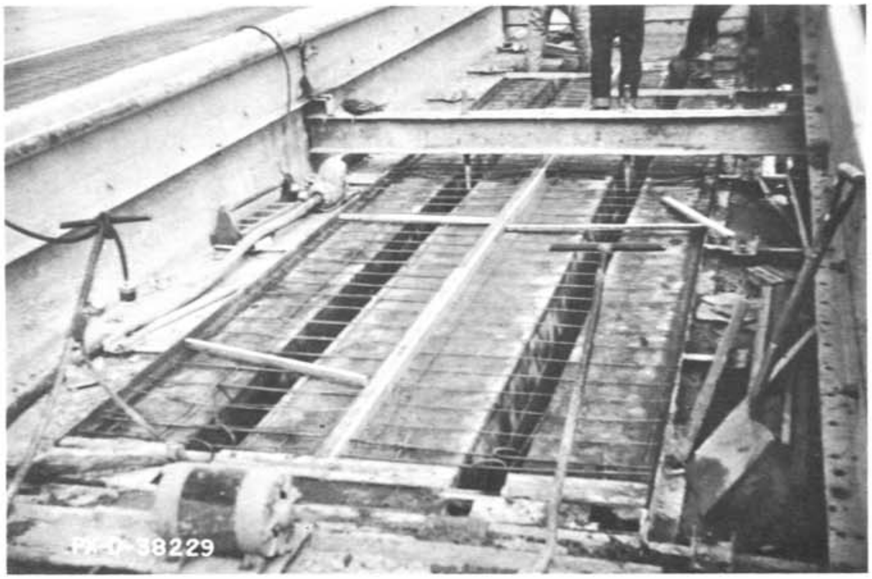
## PRESTRESSED CONCRETE BRIDGES

Release No. 48 of the Operation and Maintenance Equipment and Procedures bulletin for April, May and June 1964 included, beginning on page 25, an article concerning the use of prestressed concrete bridges on the Rio Grande Project in Texas and New Mexico. A note on the drawing accompanying the article, and also included herein on page 30 states with reference to the longitudinal section, "Steel sill plates to be anchored to abutments. Weld bearing plates of channel girders to sill plates."

Our attention has been called to field observations made of several prestressed concrete highway bridges constructed in the Denver, Colorado, area, and specifically to a problem that has developed in prefabricated units at the fixed ends of spans. As shown in Photographs No. 1 and 2 on the following page, cracks have developed in the fixed ends of the beams and extend from just inside the beam bearing toward the top and near the end of the beam. It appears that failure has been caused by the ends of the units being fixed against rotation about the bearings. Concrete creep could not take place without tension cracking the concrete as illustrated in Figure 1.

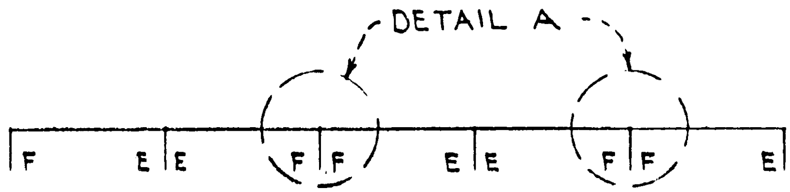
A report from the Rio Grande Project indicates that similar cracking has appeared on one of a large number of bridges examined in that vicinity. The solution to the problem appears to be to use some type of fastening which will not restrain the beams at the bearing points.

* * * * *

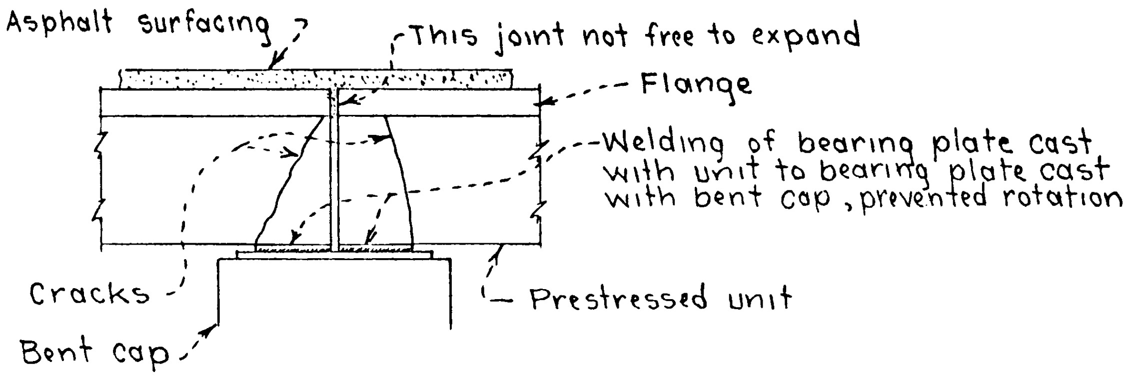



Photograph 1

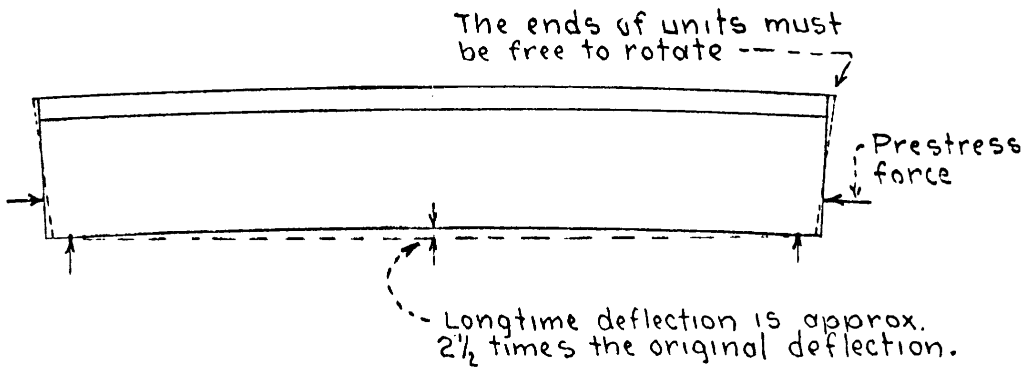
Photograph 2




LONGITUDINAL SECTION
THRU YORK STREET BRIDGE

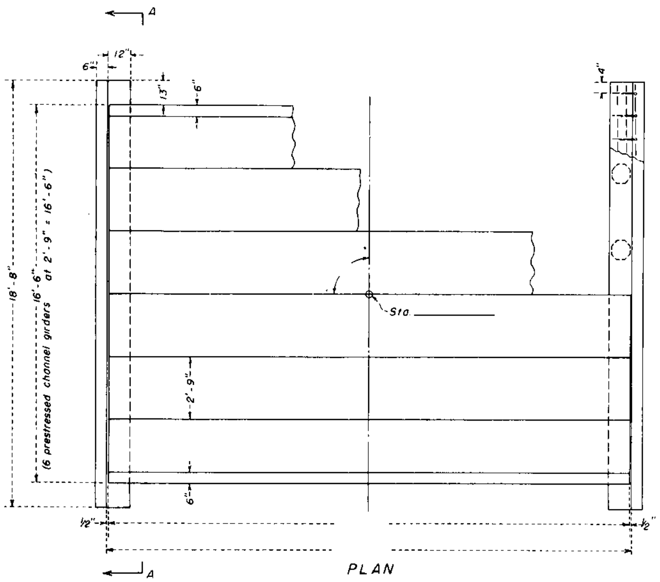



DETAIL A

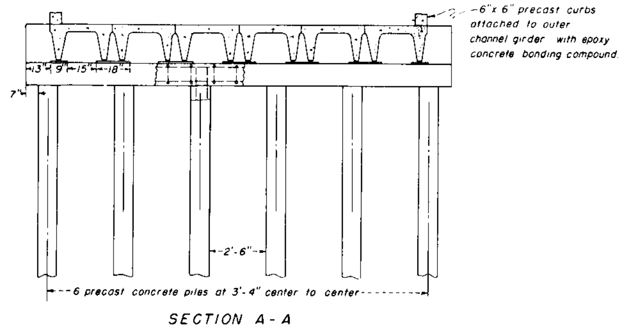



EFFECT OF CREEP IN
PRESTRESSED UNITS

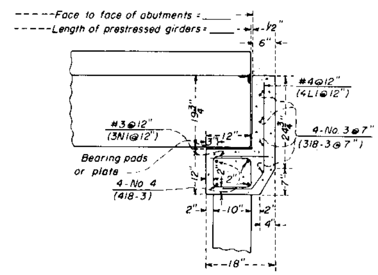
Figure 1



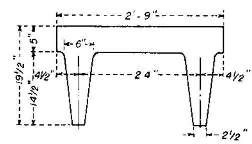

PLAN



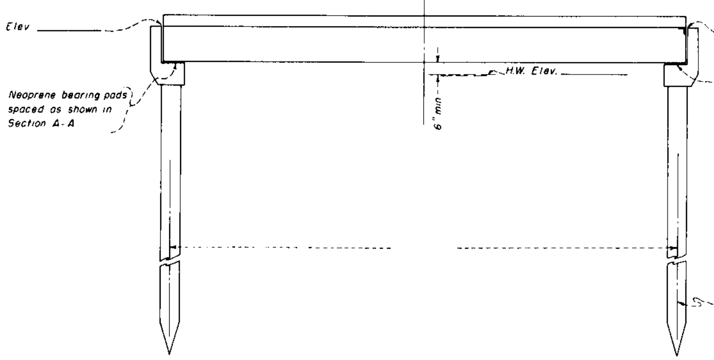

SECTION A - A




DETAIL
(Piling Cap)




END SECTION CHANNEL GIRDER




Steel sill plates to be anchored to abutments. Weld bearing plates of channel girders to sill plates.

Use fastening which does not restrain beam.

LONGITUDINAL ELEVATION

BAR LIST AND BENDING DIAGRAM
(For Two Piling Caps)

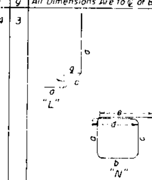
Straight Bars

| Mark | Size | Total Length | No Req'd |
|---|---|---|---|
| 318-3 | 3 | 18'-3" | 8 |
| 418-3 | 4 | 18'-3" | 8 |

Bent Bars

| Mark | Size | Total Length | No Req'd | a | b | c | d | e | f | g |
|---|---|---|---|---|---|---|---|---|---|---|
| 4L1 | 4 | 3'-0" | 38 | 8 | | 5 | 23½ | | 4 | 3 |
| 3N1 | 3 | 4'-1" | 38 | 8 | 10 | 8 | 10½ | 14½ | | |

Bending Diagrams
All Dimensions Are to ℄ of Bar




Pin Diameter for Standard Bends = 3"

Total Quantities

Superstructure
6-____ ft prestressed channel girders
____ lin. feet 6"x 6" precast concrete curbs

Piling Caps
3.1 cy concrete
113 # reinforcement, No. 3 bars
174 # reinforcement, No. 4 bars
2-¼"x 8"x 8'-6" steel bearing plate
1-½"x 8"x 9'-0" neoprene bearing pad

Piling
12-10" octagonal x ____ ft. precast concrete piling

NOTES

Unless otherwise shown, place reinforcement so that clear distance between face of concrete and nearest reinforcement is 1½" for formed surfaces.
Lap all bars 24 diameters at splices, unless otherwise shown.
Concrete design based on a compressive strength of 3,000 p.s.i.
Design is based upon H20-44 single lane loading.
Construction B.M. Elev. ____

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
RIO GRANDE PROJECT - NEW MEXICO - TEXAS

PRESTRESSED CONCRETE BRIDGE

DRAWN ____ SUBMITTED ____
TRACED ____ RECOMMENDED ____
CHECKED ____ APPROVED ____
EL PASO, TEXAS

Cost code