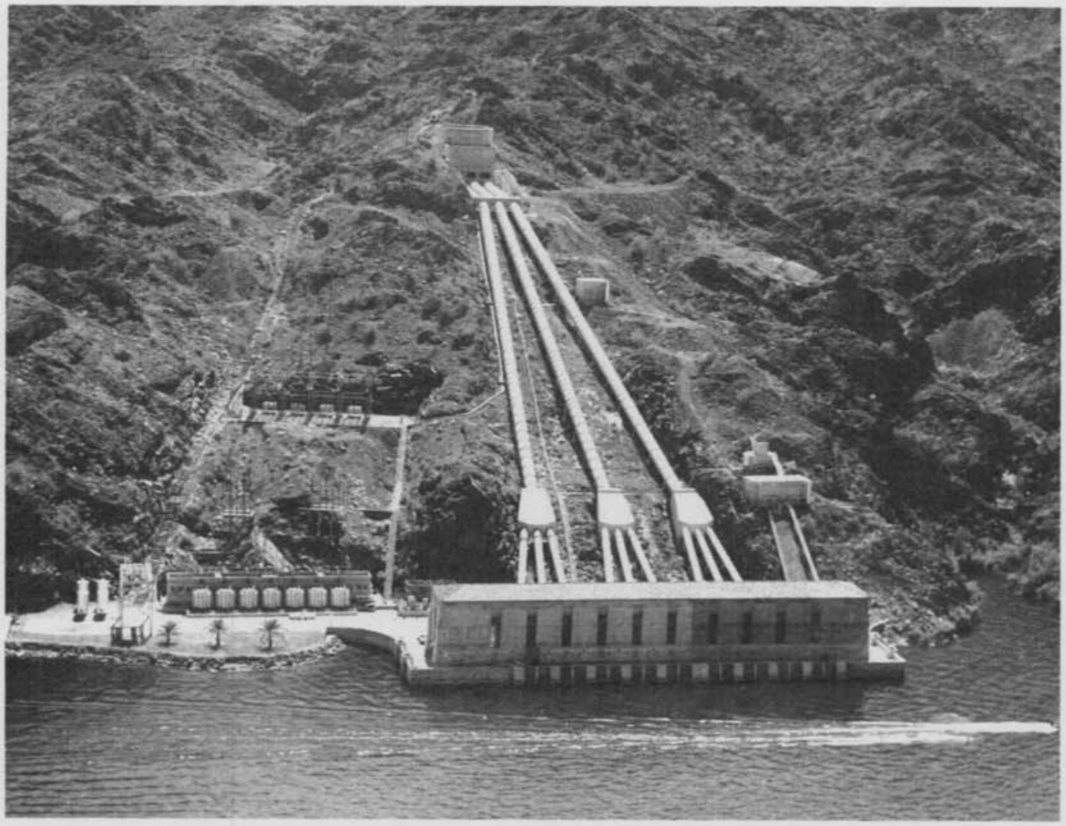
WATER OPERATION AND MAINTENANCE

BULLETIN NO. 95

MARCH 1976



IN THIS ISSUE

IRRIGATION PIPE AND AUTOMATION
HORIZONTAL DRAINS CAN PREVENT LANDSLIDES
WHAT TO DO WITH USED OIL
CLEANING DITCHES WITH MOBILE CRANE
CONTROLLING AQUATIC WEEDS
CONDUCTIVE PROPERTIES OF SYNTHETIC ROPE CAN BE A HAZARD
SCREEN SAVES FISH

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF RECLAMATION

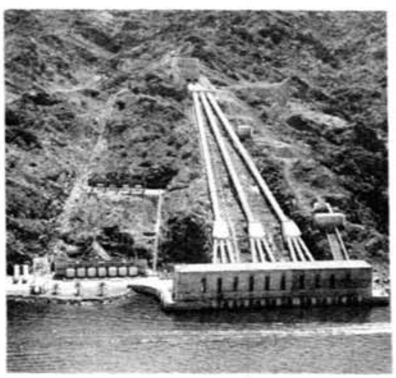
The Water Operation and Maintenance Bulletin is published quarterly for the benefit of those operating water-supply systems. Its principal purpose is to serve as a medium of exchanging operation and maintenance information. It is hoped that the reports herein concerning laborsaving devices and less costly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

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

Any information combined in this bulletin regarding commercial products may not be used for advertisement or promotional purposes and is not to be construed as an endorsement of any product by the Bureau of Reclamation.

* * * * *

Division of Water Operation
and Maintenance
Engineering and Research Center
Denver, Colorado 80225



COVER PHOTOGRAPH:

This is the Whitsett Intake Pumping Plant on Lake Havasu; it is the beginning of the Colorado River Aqueduct, 2 miles upstream from Parker Dam. The 242-mile-long aqueduct delivers water to the densely populated areas of southern California.

UNITED STATES DEPARTMENT OF THE INTERIOR
Thomas S. Kleppe
Secretary of the Interior

BUREAU OF RECLAMATION
Gilbert G. Stamm
Commissioner

WATER OPERATION AND MAINTENANCE
BULLETIN NO. 95

March 1976

INTRODUCTION

Saving water and labor for irrigation systems is the intention of the three separate research project studies described in the first article on page 1.

On natural or excavated slopes, in areas of high ground water, the danger of landslides is always present. A unique horizontal drill machine used by the Bureau solved the problem as described in the article on page 5.

Shown on page 8 are some of the techniques a leading tractor company and its dealers are using in a very beneficial oil conservation program.

"Cleaning Ditches with Mobile Crane" is the title of the article on page 12. The Huntley Irrigation District in Montana describes maintenance equipment selected to obtain maximum efficiency from their system.

The article on page 14, by a prominent weed scientist, gives an extensive view on the best methods to use for the control of aquatic weeds.

A safety article on page 20 describes how the conductive properties of synthetic rope can be most dangerous when being used near electrical powerlines.

In the article on page 21, the employees at Shawnee State Park in Pennsylvania found that by installing an inexpensive fish screen they could improve on the control of the water level at the park's lake without killing the fish.

IRRIGATION PIPE AND AUTOMATION[1]

The Snake River Conservation Research Center at Kimberly, Idaho, is "responsible for research on current regional agricultural problems associated with managing soil and water resources and on basic soil and water management principles," says Dr. Marvin E. Jensen, director. "Most research projects are problem-oriented and 'multidisciplinary'."

When visiting the center in September, we were impressed with the number of projects and the type of studies that can lead relatively quickly to practical application. Among them were three that seem particularly apropos at this time since they involve ways to save both water and labor. All make use of automated systems, either surface or buried.

Automatic Surface Irrigation

Gated pipe is one of the most promising ways of distributing water to furrows in an automated system, says agricultural engineer Allan S. Humpherys. He and his coworkers have developed an automated surface system which is simpler and probably will be less expensive to build commercially than some other automated systems.

It requires automated valves and control systems, explains Humpherys, with the valves designed so that they can be opened and closed by a small stream of water taken from the irrigation pipeline just ahead of the valves. "As a result, there is no need to have wires, or air and water lines running from a central source to control the valves. Thus, except in special situations, we do not have to bring another energy source into the field to operate them."

It simplifies the control, also, explains Humpherys. He uses a time control unit powered by flashlight batteries at each valve to "tell" the valve when to open and close.

A valve is closed by water which flows through a small tube from the upstream side of the valve to a bladder inside the valve body. When this specially designed, modified tire innertube or bladder is inflated with water, it closes the valve by expanding to fill or seal the flow area. When the timer control unit drains water from the bladder onto the ground, the bladder is deflated and the valve opens. Water in the pipeline then flattens the bladder and flows out the opposite end of the valve body into the gated pipe for distribution to the furrows to be irrigated.

The timer control unit has a small d-c electric motor powered by two D-cell flashlight batteries. The motor operates a small inexpensive

---

[1] Printed by special permission of the editor, Mr. Ron Ross, from the November/December 1974 issue of Irrigation Age.

three-way pilot valve to direct water either into or out of the bladder. Humpherys says one pair of batteries will last an entire irrigation season. He is testing two types of timers for the timer control unit. One is a 24-hour mechanical timer while the other is an electronic timer being developed at the research center.

System Adapted for Cutback Streams

In addition to reducing labor, the valves can be used to obtain cutback furrow streams. Cutback flows require relatively large furrow streams until water reaches the end of the field and then the stream size is decreased to reduce runoff and soil erosion.

In the test this year with a cutback system, a research field was divided into two sides. Half the field was irrigated with a full stream for about 1-1/2 hours, then the other half was irrigated for 1-1/2 hours to get the furrow wet completely through the field. Then the entire field was irrigated at one-half normal stream size.

In field tests last year, the irrigation efficiency achieved by irrigating corn with cutback streams was about 70 percent. The valves are being tested in other systems with the aim of reducing labor, soil erosion, and water use, says Humpherys.

Buried Multiset Systems

Besides Humpherys, soil scientist W. W. Rasmussen and agricultural engineers J. A. Bondurant and R. V. Worstell are trying a new system called the multiset irrigation system to conserve both water and soil.

An automated "buried multiset" irrigation system is being developed by the researchers to reduce the labor involved in moving surface pipe distribution laterals, he continues. With this system, the field irrigation run is divided into several subruns by buried pipe laterals placed at intervals down the field. Water added at intervals along the furrow results in the same effect as if the field were divided into several shorter furrow segments. Since the water needs to advance a shorter distance from each outlet, the entire length of run, and hence the field, is wet more uniformly and in less time. The system is well adapted for making light, frequent water applications.

The experimental site where the system was tested in 1973 was divided into four subruns, each 165 feet long. Pipe laterals were buried below plow depth so that regular farming operations could be performed in the fields without having to move pipe. Water was supplied to the individual furrows through open, uniformly spaced nozzles on the buried lateral. When water was turned into the lateral, it jetted from the nozzles and washed a pathway up through the soil into the furrow.

Nozzles in the test system were short, 3/8-inch-diameter tubes attached to the buried plastic pipe lateral. The nozzles were large enough so that when canal water was used, only a minimum amount of screening was necessary to prevent plugging.

The automatic valves developed at the research center were used to control the flow of water to each lateral. These valves turned the water on and off at the right time and in the selected order as the irrigation progressed down the field from one subrun to the next. The valves can be controlled by timeclocks, soil moisture sensors, programed controllers, or a combination of these units.

In the automated multiset system tested, a tensiometer was used to determine when irrigation was needed. When the soil water decreased to a predetermined level, the first automatic valve was activated to start irrigation in the first subrun. Water was distributed to each furrow in the set through the nozzles on the buried pipe. Irrigation water then flowed to the end of the subrun, where the next lateral was located, with some overlap onto the next set. The valve on the first lateral then closed, and the valve on the next lateral opened. Thus, irrigation proceeded stepwise from one lateral to the next. Laterals can be controlled in either a downslope or upslope direction. A commercial, programed time-sequencing controller was used to control the valves in the experimental field test.

A crop of beans was irrigated about twice a week during the peak water use period. Water was in the furrows for about 1.5 to 2 hours each time which was long enough to replace the moisture used between irrigations. With light, frequent irrigations, the furrows remained moist so that water advanced rapidly throughout the subrun length to give a relatively uniform application. Since the silt loam soil was kept moist, the added water quickly distributed throughout the root zone and a very uniform, high soil water level was maintained throughout the season.

Some of the benefits of this new system include:

1. Reduced soil erosion because smaller stream sizes are used in each furrow.

2. Reduced runoff because of the short period of water application and infiltration into the subruns at the lower end of the field.

3. Reduced deep percolation losses due to short runs and more accurate water distribution.

4. Reduced labor requirements. Once the system is installed, very little labor is required except for maintenance and periodic observations.

5. Less water is required because with reduced runoff and deep percolation there is less waste.

6. Reduced energy requirements. Many systems could be operated as gravity systems where land slope is adequate or where a low-pressure pipeline supplies the water. Other systems might require a pump to supply water at 3 to 5 pounds per square inch pressure, but this would require much less energy than the 50 to 100 lb/in^2 required for a sprinkler system.

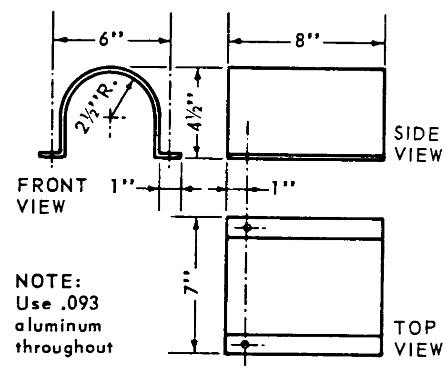
* * * * *

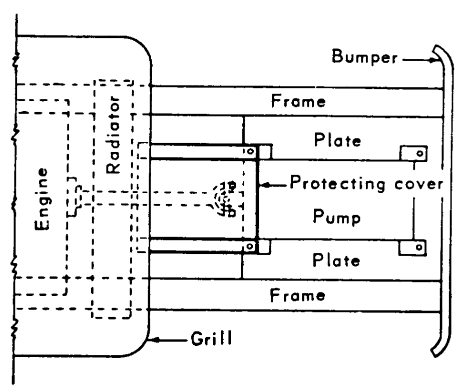
SHIELD PUMP SHAFT

(Reprinted from the November/December 1975 issue of GRIST, a publication by the National Conference on State Parks, Wash. D.C.)

Grant E. Mullin, Jr., a Mechanic with the National Capital Parks suggests that an aluminum shield be placed between the radiator and bumper to protect the hydraulic pump shaft and universal joint in the front of the truck. The shield is a simple piece of aluminum, 0.093 thick and about 8 inches wide.

For his suggestion, Mr. Mullin was awarded a $50 incentive award.





Diagram

HORIZONTAL DRAINS CAN PREVENT LANDSLIDES[1]

One of the most troublesome maintenance problems in areas of high ground water is the failure of natural or excavated slopes. Water seeping into soil behind the slope lubricates the particles which cause the soil mass to lose its strength and gravity acts to move the soil downhill. One of the best ways to solve this problem is to install horizontal drains in the slope to lower the ground water level.

In 1973, the Bureau of Reclamation, Engineering and Research Center, Denver, Colorado, purchased for Bureau-wide use a drill with a special system for installing horizontal drains. The drill is called an Aardvark, named after the "large burrowing African mammal." Figure 1 shows an Aardvark at work. The extra-wide crawler-type tracks make the 20-ton machine suitable for traveling on soft ground. It has rollover protection for the operator when the machine is traveling. Drill rods are coupled and uncoupled by hydraulic wrenches which is an important safety feature over the use of hand wrenches for this purpose. Figure 2 shows a three-man crew adding a 10-foot section of rod during drilling. The photograph was taken before the hydraulic

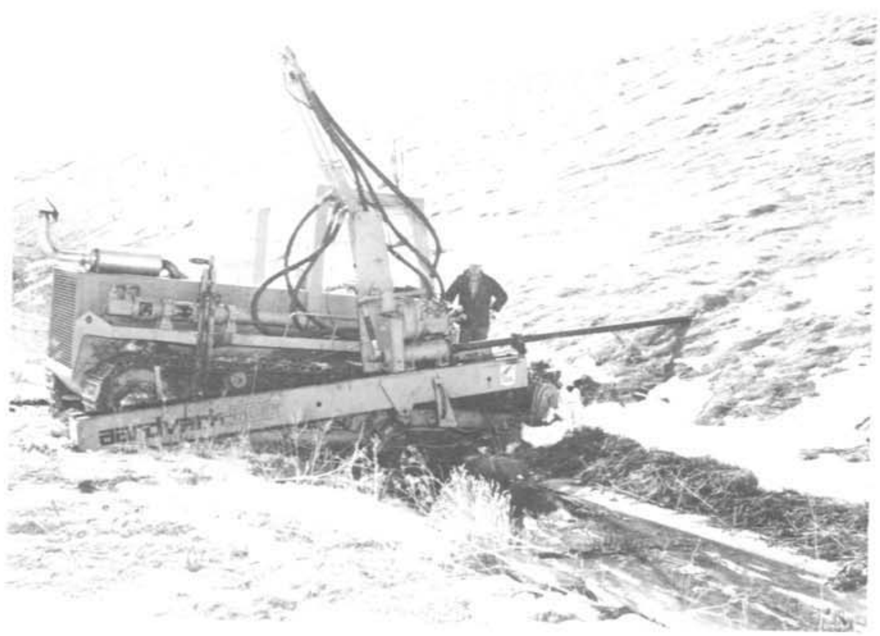


Figure 1

---

[1] Written especially for this publication by C. W. Jones, Head, Special Investigations and Research Section, Division of General Research, Earth Sciences Branch, Engineering and Research Center, Denver, Colorado

Figure 2

wrenches were installed. Men in the Upper Missouri, Lower Colorado, and Mid-Pacific Regions have been trained to install drains using the Aardvark.

Holes are normally 100 to 500 feet long and up to about 1,000 feet of drain can be installed in a day. After each hole is drilled, the drill rod rotation is reversed to drop off the disposable bit. The slotted 1-1/2-inch drain pipe is slid into place through the larger diameter drill rod, which is then removed. Usually, three or four holes are drilled in a fan-shaped pattern with the drain pipe converging to a single collector pipe. Even low rates of continuous water flow from such drains will significantly lower the water level and increase slope stability. Figure 3 shows two drains in operation. Notice the wet rocky soil; this was in a landslide area on the side of a mountain near Vail Pass, Colorado, where a new highway is being constructed.

Except for short periods, the Aardvark has been in continual use since its purchase with much of the time being spent on the McClusky Canal of the Missouri-Souris Project in North Dakota. There, drains installed through its use have been very successful in preventing large landslides

Figure 3

in the recently excavated canal. It has also been used to stabilize a roadway cut near Scoggins Dam on the Tualatin Project, Oregon. In addition, the Aardvark has been used on several jobs to assist other Government agencies where the Bureau's help was appropriate. It has been suggested for use in lowering the phreatic waterline in downstream areas of several earth dams; and in fact, a similar machine was used for this purpose on Merritt Dam in Nebraska before the Bureau machine was purchased.

In February 1976 the Aardvark was scheduled to be used on the Central Arizona Project for about 3 months to obtain horizontal cores in the rock abutments of Buttes Dam. This is the first use of the drill for coring and it will be somewhat of an experiment, particularly as to the length of core obtainable. One of the main reasons for purchasing the drill was for research and development of horizontal drains and sampling methods, and a variety of unusual applications for the drill will be considered.

The cost of drain installation will vary with the soil conditions and ease of drilling. An analysis prepared by the Missouri-Souris Project showed a cost of $2.37 per foot for about 10,000 feet of drains.

Bureau offices having a need for the Aardvark, should contact the Chief, Division of General Research, E&R Center, Bureau of Reclamation, code 1500, Denver Federal Center, Denver, Colorado 80225. Judging from the previous demand for the drill, it may be necessary to schedule projects several months in advance.

* * * * *

WHAT TO DO WITH USED OIL[1]

Used oil can be disposed profitably without offending ecologists. Some used oils can be mixed with engine fuels, but there are some hazards. Other oils are welcomed by reprocessors.

Concern for the environment has produced laws preventing the dumping of oil on the land and in the sea in most areas of the world. Energy shortages make it necessary to examine more ways to obtain maximum use of the oil available. So, for two reasons - protection of the environment and conservation of resources - new uses for used oil may become a way of life for the future.

A leading tractor company and its dealers have taken an active part in developing ways to reuse oil. Here are some of the ways they are using in oil conservation programs:

a. Process used oil through a re-refiner.

This process is most beneficial to large fleets and permanent installations. Storage tank size and pickup or delivery would be arranged with the individual re-refining company.

b. Dispose of oil through local waste oil service.

This necessitates a contract with a waste-oil pickup service. Waste services and agreements vary. The size of storage tank, placement of the tank at the jobsite, valve size, and frequency of pickup need to be arranged. A large volume (1,000 gallons or more) is usually required for pickup.

Another possibility is a contact with a Government agency that maintains secondary roads. Waste oil can be used for road oiling to control dust. Some Government agencies will not use waste oil for this purpose. Ideally, road oil should have some asphaltic binder to minimize runoff and pooling of the oil in low spots.

c. Burn used oil mixed with furnace oil in oil-fired boilers.

This procedure is most applicable to facilities near asphalt plants, steam cleaners, or oil-fired furnaces. Consult a furnace service agency for recommendations regarding this practice.

WARNING - never burn any used oil containing gasoline in a furnace. An explosion can occur in the burner. Only used diesel crankcase oil can be mixed with diesel fuel.

---

[1] Printed by special permission of the editor from the January 1975 issue of Roads & Streets.

d. Mix used crankcase and hydraulic oil with diesel fuel.

Mixing used crankcase and hydraulic oil with the fuel used in diesel engines is not common. The used crankcase and hydraulic oil available on the average job will be less than 2 percent of the fuel requirements. To get maximum use of this 2 percent, the used oil must be handled without contaminating it. This is a nearly insurmountable task for the average heavy equipment owner. The current recommendation on fuel tank caps, "Buy Clean Fuel - Keep It Clean," is still good advice.

Fleet owners must balance the risks involved in mixing used crankcase oil and hydraulic oil with the fuel used in an engine. These risks include: the possibility of fuel system problems caused by used oil that did not mix with fuel, premature plugging of fuel filters, and introduction of water or contaminants into fuel tanks.

There are several limitations to this process that should be pointed out. These limitations are:

1. Only used diesel crankcase oil or hydraulic oil can be mixed with diesel fuel. Used gasoline engine oil is heavily contaminated with lead and must not be used. Used oil from transmissions or gear compartments is heavily contaminated.

2. Ambient temperatures present mixing problems. At temperatures under 32° F (0° C), special heating equipment will be required. A fuel mix of less than 1 percent is recommended where fuel filters are subject to plugging from the waxing of cold diesel fuel.

3. An oil and fuel mixture cannot be used if exhaust valve deposits have been a problem. This problem will be most prevalent on a naturally aspirated engine operating at altitudes above 3,000 feet.

4. The life of the fuel filter will be shortened. Anticipate 750- to 1,000-hour intervals between filter changes. Fuel filters will have a black sludge-like coating when changed. This comes from the fuel soot in the used oil.

5. Do not drain into just any open container and then pour the used oil into a diesel fuel tank. There is no such thing as a clean open container. Rapid fuel filter plugging will occur.

Once the fuel and oil are well mixed, the oil will not settle. Some fuel soot from the used oil may settle, but this will collect on the fuel filters. Prefiltering and settling of used oil reduces the problem of filter plugging.

Power will usually increase very slightly because of the higher heat value of the used oil-fuel mixture.

Handling Procedures

The success of the oil-fuel mixture process depends, to some extent, on where it is used and how it is handled. New uses for used oil may become a way of life for the future. Following are suggested handling procedures for specific types of engine installations:

Permanent Installations

--Evacuate the used oil with a dry break fast oil change system. Fast oil change attachments are available for most large machines.

--Mix a small sample of used oil and diesel fuel to 50-50 proportions. Take a hydrometer reading of the mixture.

--Place the used oil in a large tank and mix 50-50 with diesel fuel.

--Circulate the used oil and diesel fuel in the large tank with a pump having a capacity of approximately 10 gal/min. Pump the oil from the bottom of the tank and spray into the top of the tank. Circulate the oil until a sample taken from the tank has the same API hydrometer reading as the small premixed sample.

--Allow the tank to settle for approximately 48 hours after mixing. Settling will allow a large portion of any contaminants to settle to the bottom of the tank and thus extend engine fuel filter life.

--Draw off a sample from the bottom of the tank and look for water or sludge. Draw off water and sludge.

--Using the 10-gal/min recirculation pump, pump the 50-50 mixture from the upper portion of the tank through a 10- to 3-micron filter or filters to a clean storage tank. It may be necessary to put a heater in the line before the filter to prevent rapid filter plugging.

--Only 2 to 5 percent used oil mixed with fuel can be used.

--Transfer the used oil-fuel mixture from the clean 50-50 storage tank to the fuel truck. Use a mixing valve, if one can be obtained to mix the oil-fuel mixture with clean diesel fuel. An alternative is to mix on the basis of pump volume and time of delivery. Example: A 100-gal/min pump on a diesel fuel tank would require a 5- to 10-gal/min pump on the 50-50 used oil-fuel storage tank to deliver a 2 to 5 percent used oil mixture to the tank truck if both pumps are delivering for the same time interval. If the fuel is metered, use meter reading to determine the mixture percent.

--Transfer the 2 to 5 percent used oil and fuel mixture from the fuel truck to the machines.

Individual Machines

--On machines with drain valves, install a pipe in the drain valve connection and pump the used oil directly from the crankcase into the machine fuel tank. The fuel tank must be half full of diesel fuel and the oil should be pumped through the fuel tank screen. Fill any remaining space in the fuel tank with diesel fuel. Operate the vehicle immediately for a minimum of one-half hour to mix the used oil and fuel.

--On machines without drain valves, drain the oil into a collector. This can be any clean container. Pump the oil from the collector tank through a 10-micron filter directly into a half full fuel tank of the vehicle. (Use only the oil drained from compartments of a machine in the fuel tank of that particular machine. This means that the used oil will only be burned at the normal oil change period.) Fill the remaining space in the fuel tank with diesel fuel. Then operate the vehicle immediately for a minimum of one-half hour to mix the fuel.

--With onsite fuel storage, and very small volumes of oil to dispose of, add the used oil to the storage tank. Drain the oil into a clean container and then transfer it from the container to an elevated 55-gallon drum. During the transfer process, screen the oil, preferably with a fuel tank screen. Mount the 55-gallon drum above the fuel storage tank. Install a shutoff valve and an approved primary fuel filter to a drainline from the drum. Set the shutoff valve to permit about two drops per second to pass from the drain line to the fuel tank. This will put about 2 gallons of used oil a day into the main fuel tank. This would handle about 15 gallons of used oil a week, which is enough capacity to handle four or five machines on a single-shift operation. The flow feed rate of the used oil must be used to get the correct used oil and fuel mix. Any agitation that can be provided for the fuel in the storage tank is helpful in assuring an oil-fuel mix.

* * * * *

CLEANING DITCHES WITH MOBILE CRANE[1]

A roadable excavator in Montana alternates between working as a crane to place precast irrigation structures and as a ditching machine. Equipped with a 60-inch-wide hydraulically tilting ditching bucket, the rubber-tired machine cleans accumulations of dirt and vegetation from canals ranging from 60 feet wide and 15 feet deep down to narrow laterals only 2 feet deep.

"This machine never stops," said Norman Maynard, construction manager of the Huntley Project Irrigation District near Ballantine, Montana. "For example, we recently used it to cut construction time on a 400-foot-long siphon from a week to about 12 hours."

The machine often patrols the paved roads bordering the canals while trimming. But more frequently, it works from the narrow earthen dikes along the 350-mile network of canals. On these occasions there is seldom room to use the outriggers so the operator must rely on the inherent balance of the machine to maintain its stability while digging with an extended boom. Figure 4 shows the machine working from a paved

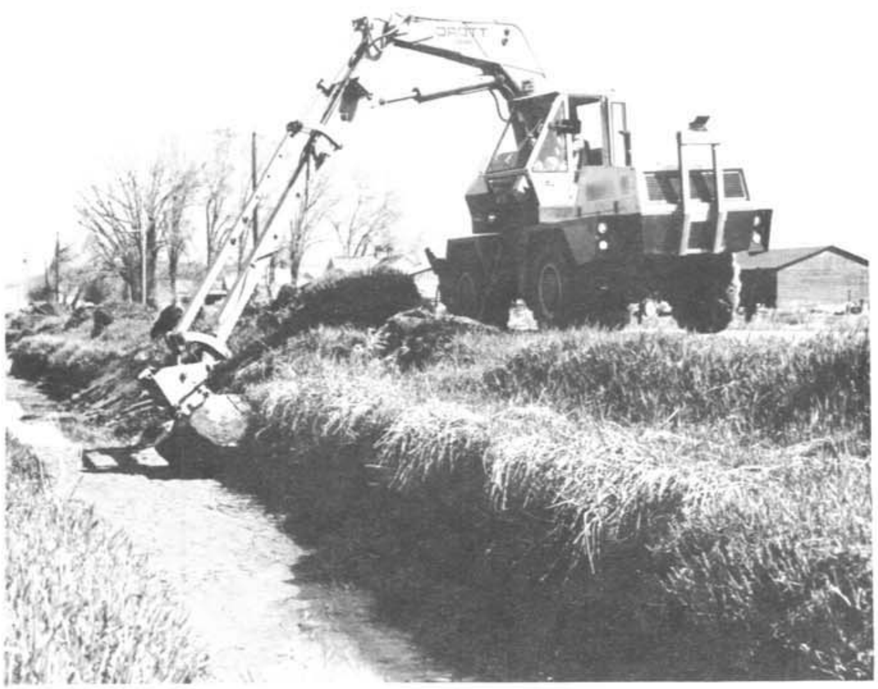


Figure 4

---

[1] Printed by special permission of the editor from the January 1975 issue of Roads & Streets.

access road. The mobile crane moves quickly from one trouble spot to another as it keeps miles of Montana irrigation canals in operation. A hydraulic tilting feature on the 60-inch-wide ditching bucket greatly increases effectiveness of this roadable excavator, as shown in figure 5. "We have so many urgent jobs to do, and the machine can do them all so well, that we expect it to jump from job to job," said Mr. Maynard.

Figure 5

Big Job Ahead

After more than 60 years of providing hundreds of farms with their only source of agricultural water, much of the system has deteriorated. Now the District is faced with the need to reconstruct the system and return it to peak efficiency. As a result, additional mobile units could be used to advantage.

The reconstruction task requires maintenance and construction crews to range far and fast over the entire project. Thus, the mobile unit often hits four or five widely scattered trouble spots in a day.

Irrigation season is from May through September, so the equipment used for reconstruction and maintenance is working its hardest during the cold winter months when most other area construction is at a standstill.

If further information is desired on the equipment mentioned, please write to the Huntley Project Irrigation District, Ballantine, Montana 59006.

* * * * *

CONTROLLING AQUATIC WEEDS[1]

In nature, lakes, ponds, and waterways are continually changing both physically and biologically. In the instance of static water, lakes and ponds, the aging progression is termed eutrophication.

With time, the inflowing surface water contributes mineral nutrients that enrich the water, making it more favorable for algae and higher plants. As static waters mature or eutrophy, incoming sediments and the organic residues of plant and animal life gradually fill the basin until finally the free water disappears. In the final eutrophication stage, a sedge-grass meadow occupies the filled depression.

Most smaller manmade ponds such as irrigation reservoirs and water traps are sufficiently shallow at the outset to place them in the latter half of the aging time scale. The effect of shallowness is to permit sufficient light to support plant life (photosynthesis) down to the bottom. Sufficient plant nutrients typically exist in these ponds imparted from the soil basin to support algae growth the first year of use. Where surface water drains into the pond from fertilized turf, the mineral input further enhances the growth of algae and higher plants. The presence of water fowl is yet another source of accelerated enrichment of ponds.

Where fish are maintained in a pond, the moderate population of algae and higher plants is usually quite desirable as they provide habitat for aquatic insects foraged upon by fish and escape cover for young fish. Abundant growth can, however, diminish fish productivity, create unsightly conditions, and increase down-time on irrigation systems due to plugging of pumps, screens, and sprinkler heads. Weedy aquatic plant growth also enhances the potential for mosquito production.

If one visualizes a pond or lake in cross section, it can be realized that conditions in which plants locate themselves vary widely from the moist soil above the waterline, into the shallow water of a few inches in depth, and on out into the main body of water encompassing the deeper zones.

These various zones or ecological inches change from one to the other over a relatively short distance in ponds with steep profiles, and extend for greater distances where the shoreline slope is gradual. From the point of view of maintenance, a pond profile with a steep slope has a proportionately smaller area for cattail, bulrush, and

---

[1] Presented at the Turf and Landscape Institute by W. B. McHenry, weed scientist, University of California Cooperative Extension, Davis, Calif., at the Royal Inn, Anaheim, Calif., on April 17, 1975, and reprinted here by special permission of the editor from the September/October 1975 issue of the Irrigation Journal.

other sedges and rushes to survive. A vertical drop supported by a masonry wall will eliminate the shoreline vegetation entirely and the need for weed control in that zone - if the depth is adequate at the foot of the wall.

Further out from shore, the depth of water required to exclude the true underwater aquatic plants depends primarily upon the clarity of the water, that is, the depth to which photosynthesis-supporting light energy can penetrate. Suspended colloidal soil particles, plankton algae, and dissolved coloring matter all influence water clarity and thus light penetration.

To predict the necessary depth sufficient to exclude submersed weeds at the design state of a pond is most difficult, but in clearer water a depth of from 12 to 16 feet or deeper would very often be required. Most water traps and landscape ponds are typically only a few feet deep because of soil excavation and disposal costs, personal safety, and ball retrieval.

Aquatic Weed Classification

Still viewing the visualized cross section of any given pond or reservoir, we can group aquatic vegetation according to the cross-sectional zone to which the various plants are adapted.

Emersed plants - Included here are the cattail, hardstem bulrush, umbrella sedge, and rushes. Emersed plants occupy the shoreline zone and the shallow areas out to 1 to 2 feet in depth. Cattail and bulrush may be found in even deeper water. Emersed plants typically stand erect and do not rise or fall with changes in the water level. In proper balance, scattered clumps of emersed plants enhance the aesthetic value of a pond or lake.

Cattail and bulrush (tule) are most often the common weedy forms of emersed plants. It is of utmost importance that the pond manager be able to distinguish the two distinct types in selecting herbicides for their control. The cattail has an elongated cigar-shaped flower (catkin) and quite long, narrow, sword-like leaves. The flower of bulrush is seen as a light brown, papery cluster at the very top of a roundish and seemingly leafless stem. Bulrush possesses a darker green coloration compared to cattail.

Floating plants - A few plants in this category may create weed problems on golf course ponds, notably duckweed, azolla, and water primrose. They are often seen floating among the stems of cattail and bulrush in relatively shallow water or at worst, covering an entire pond. Duckweed appears from a distance to be floating algae. Viewed closely one can see distinct flat pads about one-half to 1 inch across. During cold weather in the fall and winter it assumes a definite pink or reddish color. Azolla and duckweed are difficult plants with which to deal. On ponds subject to wind the weeds gather on the leeward side of the lake, and weed sprays only affect the top layer of plants. Diquat has been used with success in controlling duckweed where the water is relatively free of suspended soil and plankton algae (which activates the Diquat by absorption).

Water primrose often commences growth in the spring from its perennial underground root system at the shore and gradually moves out toward open water with long, floating stems. It is best controlled in the spring at and near the shore with 2,4-D low volatile ester before extensive beds of the weed develop and thus aggravate water contamination problems with the herbicide.

Submersed plants - These are the true underwater dwellers and are the most important in terms of distribution and economic problems they create in both ponds and canals. While some species may have floating surface leaves and flowering stems an inch or two above the surface, most of the stem length and leaves are submersed. Nearly all are perennial. American elodea, American pondweed, sago pondweed, curly-leaf pondweed, and coon tail are commonly seen examples of submersed species. Submersed plants likely appear in newly constructed ponds as a result of visits by wild waterfowl that have fed upon the seed at other locations.

Identification is complex and lengthy but proper species identification is important before selection of suitable herbicides.

Diquat (Ortho Diquat Water Weed Killer) and endothall (Aquathol, Potassium Endothal) are commonly used herbicide types. In many respects their use for controlling submersed aquatics is interchangeable with one notable exception. Endothall is ineffective in controlling American elodea and Diquat is very effective. Diquat performance in controlling any species is greatly reduced by suspended soil particles (muddy or oily conditions) and heavy plankton algae growth.

Algae - Because algal plants are unique in structural form and in some of the problems they create, it is more convenient to set them aside in a separate group. Like other more complex plants these lower (less developed) plants can and do create problems and are thus referred to as weeds.

Although there are as many as eight major taxonomic groups or phyla of algae and thousands of species, in weed control one need be concerned with but two general kinds encountered in fresh water ponds and lakes. Algal forms that exist suspended in water as microscopic single-celled plants or colonies are called plankton algae (phytoplankton). Plankton types usually impart an opaque, occasionally brown color to water. A condition of intensely colored water caused by a rapid growth of plankton algae is referred to as a water bloom.

Blooms may develop following a herbicidal kill of submersed aquatics as nutrients are released (recycled) from the decomposing plants. Plankton algae, when sufficiently dense to shade the deeper water, will reduce or eliminate the higher submersed weeds. Plankton algae do not interfere with irrigation systems and typically do not create a weedy state unless aesthetic quality of the pond is reduced.

Strand Forming

The second group is the filamentous algae, colonial types that form masses of strands or filaments. They may be attached to the pond bottom or form floating mats or "scums." The filaments have sufficient tensile strength to cause accumulations that can clog screens, pumps, and sprinkler heads and interfere with angling and boating. They often form unsightly accumulations on the pond surface or along the leeward shoreline.

Both plankton and filamentous algae grow most vigorously as the water warms in the spring and summer, concurrent with the period of growing need for irrigation and increasing golf activity.

Control Methods

Emersed weeds such as cattails and bulrush can be hand pulled when they first appear and before extensive underground rhizomes - "root-stocks" - develop.

Both emersed and floating weeds lend themselves to employment of foliage-applied herbicides such as 2,4-D, dalapon, and others. Consideration must be given to the influence of herbicide use on water quality before spraying is initiated. Foliage-applied herbicides should never be used if contaminated pond water will flow onto or through adjoining property (livestock, irrigation, angling, domestic use, etc.) or into public streams. Influence of herbicide spray drift onto turf, ornamentals, or adjoining property must likewise be considered prior to spraying.

Controlling Aquatic Weeds

Before purchasing or using plant growth regulator (hormone type) herbicides such as 2,4-D or silvex, a permit must first be obtained in California from the Agricultural Commissioner in the county where the herbicide is to be applied.

Important Role

Herbicide choice and season of application play an important role in successfully controlling emersed and floating weeds. Consult recommendations to determine the best herbicide, the amount to use, and the best timing in terms of stage of growth. Always read the label on the herbicide container completely before opening it.

The simplest method of controlling submersed and algal weeds is to periodically drain the pond for a sufficient length of time to allow the unwanted vegetation to die.

Use Mowers

Aquatic weed mowers are occasionally utilized to "harvest" the undesirable submersed weeds and relieve at least the upper pond zone of excessive growth.

Aquatic herbicides for control of submersed plants in ponds and lakes include water soluble types that are dissolved in the pond water, and granular formulations of relatively low water soluble types that work at the pond bottom. Diquat (Ortho Diquat Aquatic Weed Killer) and endothall (Aquathol and Potassium Endothal) are water soluble and are applied in sufficient quantity to establish the desired concentration expressed in p/m (parts per million). These are contact herbicides and kill the weeds to the soil line. Both herbicides have a wide margin of safety for fish and other aquatic animal life. Fish kills can occur, however, from a secondary effect of herbicide use, the ensuing decomposition of dead vegetation.

Oxygen Necessary

All biological organisms in a pond of late - fish, tadpoles, insects, bacteria, fungi - require oxygen (dissolved) to live. The total oxygen need is called the biological oxygen demand or BOD. Cold water can retain more dissolved oxygen than when warm. Thus, if a heavy growth of aquatic weeds including algal forms is killed under hot summer conditions, the BOD of the water may deplete the supply of available oxygen causing fish mortality through suffocation. When in doubt, treat one-third or one-half of the pond at a time waiting 2 weeks before treating the next sector. This will allow escape water for fish instead of increasing the BOD throughout the pond.

The two registered herbicides that control plants via the pond bottom are dichlobenil (Casoron G-10) and 2,4-D (Aqua-Kleen). Neither of these compounds are registered for use in water used for irrigation, livestock watering or domestic needs. Granular 2,4-D has its principal utility in controlling the milfoil (Myriophyllum) group of submersed plants.

Universally Used

The universal herbicide for algae control - an algaecide - is copper sulfate or bluestone. If there is an average of effective concentration range it might be between 1/2 and 1-1/2 p/m. For copper to be effective it must remain dissolved for at least a few days. However, the copper combines with other dissolved constituents, particularly carbonate and bicarbonate forming an insoluble precipitant. This poses a problem in obtaining acceptable algae control in pond water containing roughly 80 p/m or higher carbonate, bicarbonate.

The presence of heavy algal blooms also appears to reduce the effectiveness of copper, probably because of insufficient dissolved (ionized) copper for a larger number of individual algal cells or colonies. Determining the concentration to use for any given pond is inexact. Local experience by trial and error is the best rule.

Have Tolerance

Most warm water fish species have a workable tolerance for copper sulfate. By contrast, trout are very sensitive and can easily be killed. Preservation of valued fish life can only be assured if an accurate water volume determination is made. Estimating how much copper sulfate to apply is to be discouraged. Repeated exposure to copper will corrode ferrous metals (steel pipe, pumps, etc.) and more particularly, aluminum.

When applying liquid herbicides to ponds for the control of submersed weeds and algae, it is recommended that spraying over the water surface be avoided. If the compounds, diluted with water, are allowed to flow by gravity into the water either from a boat or into the pond inflow during filling, spray drift contamination of the shoreline vegetation and of the applicator will be avoided.

* * * * *

THE ADVANTAGES OF IRRIGATION

Farmers, assured of a dependable water supply for irrigation, are freed from the hazard of dry-land-farming, where even the most drought-resistant crop can be lost in a season of short water supply. With irrigation, the farmer can grow crops in the highest demand and be assured of a profitable harvest. In these arid areas, irrigation can spell the difference between abundant production of high-quality crops and total loss. Thus, irrigation makes farming efficient, produces high intensity and quality crops and specialty foods, and adds stability to agricultural production in the West and the Nation. The irrigated areas of the Southwest produce most of the winter fruits and vegetables for the entire Nation.

Department of the Interior News

CONDUCTIVE PROPERTIES OF SYNTHETIC ROPE[1] CAN BE A HAZARD

Manmade fiber-type ropes for use in electrical operations are usually considered as nonconductive. Under this premise, they are used in Operations and Maintenance work to tie down or stabilize energized conductors or to hoist equipment from the ground to employees engaged in barehand live-line work. In construction activities they may be used as lead or sock lines during stringing operations, especially where conductors are being strung over or parallel to energized circuits.

In O&M operations, stringent inspection and use procedures are implemented and followed to ensure the integrity of the rope's dielectric properties. In construction activities, such procedures are not stringently followed, and the rope becomes contaminated with moisture or foreign particles with subsequent reduction in dielectric properties. Such contaminations can occur over long periods of use or during sudden wind or rain storms. A recent example of this latter condition occurred on a stringing operation over energized conductors. The rope was being used as a leadline to pull the sock line over energized conductors when a sudden rain and sand squall occurred. The leadline ballooned out in the strong wind and was polluted with rain and sand. As the wind suddenly died, the slack in the leadline allowed it to fall beyond the jury poles and contacted the energized line. The results of that contact was a badly damaged line.

The incident resulted in an outage only, but serious or fatal injury potential was extremely high.

Elimination of such incidents can be accomplished when stringing operations must cross energized lines through implementation and enforcement of a few basic principles:

1. Synthetic nonconductive-type lines must be considered conductive unless they are adequately protected against contamination and a stringent inspection and replacement procedure is developed and followed.

2. Utilization of dry rope nets in lieu of jury pole structures to provide additional protection against contact.

3. Provide attendant with adequate communication systems at each crossing to stop stringing operations if trouble develops.

4. Develop a stringing operation plan with explicit instructions on shutdown procedures when storms are approaching.

---

[1] Reprinted from the <u>Reclamation Safety News</u>, Second Quarter 1975.

SCREEN SAVES FISH

(Reprinted by permission from a recent issue of GRIST, a publication of the National Conference of State Parks, Washington, D.C.)

The staff at Shawnee State Park in Pennsylvania has come up with a new way to control the water level at the park's lake earthen dam without killing fish.

Several years ago, quite a few fish were killed when the dam's gates were opened. During Hurricane Agnes, the structure was damaged and the Army Corps of Engineers needed a drawdown to repair the damage. The device developed by the people at Shawnee provides a better means of retaining fish life within the impoundment after the maximum draw-down point has been reached.

An early effort to save the fish involved two sets of stoplogs which blocked the water with a piece of steel plate nailed to weigh the logs down. A diver, hired for the occasion, had to place them once they were lowered into the stoplog channel, costing the park large amounts of time and money.

A less expensive, equally effective solution was a screen system made up of a chain link fence, cut to the length of the stoplog channel. The stoplogs, pulled out to effect the drawdown, were replaced by screens of chain link fence which fitted into the slotted guides in the channel, thus offering a side-to-side barrier against passage by other than a few small fish. A sketch of this screen is shown in figure 6.

The screens are framed by 1-1/2-inch galvanized pipe on 10-foot by 65-inch panels. The fencing is tack welded all around. Diagonal bracing was made by a 3/8-inch reinforcing rod. Four 8- by 10- by

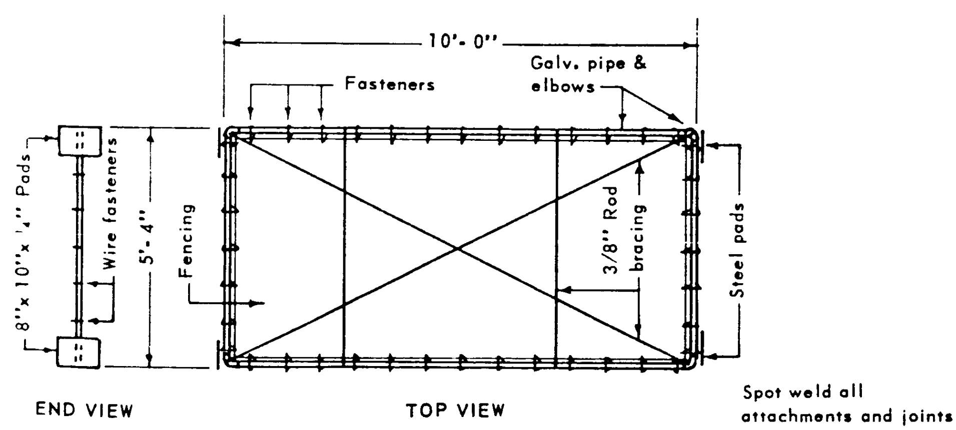


Figure 6

1/4-inch steel "pads," one to each corner of the framework, and welded at right angles to the screen, serve as guides, fitting into slots in the sidewalls of the channel and helping the screen to settle evenly to the bottom. A second screen is then fitted into the guides and settles evenly on the one below.

The screens now protect the fish against a once costly environmental error.

* * * * *

The purpose of this Bulletin is to serve as a medium of exchanging operation and maintenance information. Its success depends upon your help in obtaining and submitting new and useful O&M ideas.

Advertise your district's or project's resourcefulness by having an article published in the bulletin! So let us hear from you soon.

Prospective material should be submitted through your Bureau of Reclamation Regional office.

GPO 834-343