WATER OPERATION AND MAINTENANCE

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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.

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and Maintenance Technical Services
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Cover photograph:

Sugar Pine Dam, Auburn-Folsom South Unit of the American River Division, Central Valley Project, California. The dam, completed in 1983, is located in Placer County on North Shirttail Canyon Creek. Water storage is provided for municipal and industrial purposes, some irrigation, fish and wildlife, and recreation.

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INTRODUCTION

A successful education program allows utilization of new ideas developed by others and a means to inform personnel of new technology and developments. See articles on pages 1 and 6.

A well flowmeter is a great tool for managing irrigation to avoid applying more water than is necessary. The article beginning on page 11 describes Nebraska's growing trend toward the use of well flowmeters.

Hints to keep cool when driving in heat. See page 16.

WATER SYSTEMS MANAGEMENT WORKSHOP[1]

Recognizing the need to keep employees abreast of new techniques and developments, a Water Systems Management Workshop was initiated in 1961 by the Bureau of Reclamation, Water Operation and Maintenance Branch, located at the E&R Center in Denver, Colorado. By popular demand, this 1-week workshop has become an annual seminar of supervisors, managers, watermasters, and others responsible or associated with the operation and maintenance of water systems. It is held when field activities are generally at a minimum for the convenience of operating personnel.

The objectives of the workshop are geared toward presenting up-to-date information which can be applied to the daily problems encountered in operating and maintaining water systems, for self-improvement, and for an interchange of experiences, ideas, and solutions to problems. The number of new ideas and methods which have been passed along at these workshops can only be estimated.

Leaders who are well qualified in their particular field are in charge of each session. They give a brief summary of the material to be covered and the remaining time is spent discussing and exchanging information by all participants in the session. Participants are requested to come prepared to discuss experiences and procedures they have found to be advantageous on their respective jobs.

All participants are provided with a set of session notes covering the basic subject matter of the various sessions. Essentially, the notes serve as the workshop textbook and are mailed to all participants about 3 weeks before the workshop.

Certain manuals published by the Bureau are used as references and are made available for purchase during the workshop. They include the Concrete Manual, Earth Manual, Paint Manual, Water Measurement Manual, Design of Small Canal Structures, Drainage Manual, and Ground Water Manual.

Attendance at the workshop is restricted to approximately 120 persons. Each participant attends 24 sessions which are limited to approximately 25 participants to permit open discussion. Every effort is made to present information which can be applied directly to daily problems encountered in operating and maintaining water systems. A summary description of each session follows:

Project Organization Management. – This session includes the relations of manager and board as a team and their functioning together with respect to each other's rights and responsibilities and the principles of maintaining favorable relations among management, employees, and water users. The development of operating rules to guide board, manager, and employees is covered.

Water Systems Automation and Management, Part 1. – This general subject includes consideration of the problems related to managing project water, beginning at the source of supply, and bringing the water through the main canals, laterals, and conduits to the water users. The overall water operations management program is outlined, and the increasing importance of accurate water measurement, remote and automatic control, and irrigation scheduling is introduced. The responsibility of the board in establishing operating rules and in determining amounts of water to be allocated in shortage years

[1] Article compiled by Jill A. Davidson, Water O&M Branch, Bureau of Reclamation, Denver, Colorado.

are viewed. Certain records must be kept of water deliveries and flows, and the upkeep of these records and their place in the operation are covered.

Water Systems Automation and Management, Part 2. – A variety of control methods are available for upgrading an irrigation system with the potential of improving service to water users, increasing efficiency of operations, and reducing costs. These methods vary from isolated control of a simple gate structure to the operation of all project control facilities from a central location with modern digital computer process control equipment. Operating objectives and schemes for controlling water delivered through conveyance systems are discussed. Basic information on available control systems and devices to accomplish the desired operation is included in this session.

Water Systems Automation and Management, Part 3. – The subject of this presentation is a computer-supported program called WMC (Water Management and Conservation). The objective of the WMC program is to improve project operations for effective utilization of irrigation water. The program integrates on-farm water management with the operations of the distribution system to achieve total water management. The operational aspects of day-to-day scheduling of irrigations are illustrated. The current approaches for system scheduling and the various input requirements and resultant output are covered. Illustrations of how the data are collected through the WMC program for water accounting are presented.

Water Systems Automation and Management, Part 4. – The WMC session (part 3 above) discusses the use of computers in water management. This session provides information on the application of minicomputers in an irrigation district environment. One role of the minicomputer is to assist with management of irrigation water, both at the field level and throughout the distribution system. Additional uses discussed will relate to water accounting, water billing, records management, payroll, and other district operations that can be automated. Advice on both hardware and software requirements is provided, and the economic feasibility of minicomputer usage is discussed.

Water Measurement, Part 1. – A discussion on basic theory and field conditions tending to reduce measurement accuracy is provided, including the effect of adverse conditions, use of the wrong device, effect on nonmaintenance and poor workmanship, effect of submergence or flooding, and others. Material is presented to aid in the selection, use, and maintenance of propeller meters, and use of flumes and weirs.

Water Measurement, Part 2. – This session is devoted to a discussion of the individual problems encountered in accurate water measurement. To further illustrate the proper techniques and procedures that should be followed, the illustrated lecture is supplemented by laboratory demonstrations and measurement exercises.

Water-Related Sediment Problems. – This session covers the many types of sediment problems encountered either at a diversion structure or throughout a water distribution system. The discussion of sediment problems also includes some fundamental relationships with river or stream channel hydraulics because bank erosion problems as well as the movement or deposition of sediment involve water, the transporting agent. Other major variables besides stream channel characteristics that are covered in evaluating the problem are sizes of sediment from clays to gravels and cobbles, changes in flow, and effect of manmade structures. Operation and maintenance problems involving sediment discussed are: (1) diversion structures and canal headworks, (2) canal and distribution systems, (3) pumping plants,

(4) stability of natural channels to convey waste flows and return flows, and (5) miscellaneous river channel or sediment problems.

Mobile Equipment Selection, Procurement, and Use. – This session is devoted to the selection of mobile equipment and its use in the operation and maintenance of water systems. The basis upon which the various types of equipment may be selected, each machine's adaptability and versatility, the various kinds of special equipment available for each type machine, and other considerations are discussed. Specifications for equipment and the procurement of equipment are considered, as well as matters related to the proper care and operation of the machines.

Mobile Equipment Efficiency and Operating Costs. – This session is devoted to the consideration of efficiency and operating costs of maintenance equipment. The matter of owning versus renting equipment is considered as are the procedures and forms for keeping reliable cost records of individual pieces of equipment. This includes mention of bookkeeping machines suitable for such work. The need for such cost records and how they should be analyzed and used are considered.

Rehabilitation of Water Conveyance Systems. – More and more water districts, particularly those whose systems were built many years ago, are replacing droplines, open chutes, troublesome reaches of laterals, and leaky channels with pipe. This is being done in many cases as part of an R&B (Rehabilitation and Betterment) program which also usually includes the replacement of other structures in the system. An example of the advantages and benefits of undertaking an R&B program is given.

Flexible Canal Linings and Concrete Joint Sealants. – Information on various lower cost canal linings and other means of reducing seepage losses from channels is the basis of this session. The session covers the various types of linings: slip-form concrete, earth, and plastic membranes, which are those most frequently used. Methods of installation and maintenance and relative costs are discussed, as well as the advantages and disadvantages of each type of lining. Included in the discussions and lecture notes is a presentation on concrete joint and crack sealing methods and materials.

Design, Installation, and Maintenance of Pipe Systems. – This session deals with the economic aspects of justifying enclosing lateral systems in pipe, the benefits to be derived, and the development of new types of pipe. Discussions include pipe installation procedures and techniques, operation and maintenance practices and problems, and various methods of repair.

Concrete Mixes and Materials. – This session covers selection of proper cement and aggregates; the use of admixtures and additives; computation and mix proportions; and the selection, testing, and use of premixed concrete in lieu of field mixing for construction and repair work involving water system structures on an operating project.

Concrete Repair and Maintenance. – Review of Bureau requirements for concrete repair is covered in this session. There is a discussion and slide presentation on repair methods, repair materials, evaluating the cause and extent of damage, and case histories on Bureau structures. Laboratory demonstrations of repair methods, including dry pack, epoxy-bonded concrete, epoxy-bonded mortar, and epoxy-pressure injection, are geared toward capabilities of an average operating organization.

Earth Construction Practices. – This subject covers general soils engineering procedures and is geared to the personnel and equipment normally available to the average operating organization. Adequacy

of foundations as to bearing capacity, stability, settlement, expansion, deterioration, and permeability are included in this session. Soil properties, as determined from classification and general description, are also covered. Field investigations and exploration and treatment of foundations to overcome deficiencies are discussed. Also included are construction of roads, embankments, linings, blankets, and filters; placement of backfill; blending of materials from borrow pits; and methods of determining the quality of the work accomplished. General description of soil properties and methods for identifying and selecting soils are discussed.

Selection of Protective Coatings. – Coatings commonly used in the protection of metalwork are covered in this session with a brief discussion of the types generally recommended for various exposures. New coating developments are summarized.

Preparation and Application of Protective Coatings. – This session is devoted to a discussion of the fundamentals behind the specified methods for surface preparation and preparing, applying, and curing paint. Visual aids are used in presenting these ideas. Participants are invited to describe their coating experiences and problems of general interest to the benefit of all.

Cathodic Protection of Surfaces. – The fundamental principles of preventing corrosion by cathodic protection are introduced and discussed in this session. Basic engineering methods commonly employed are described. Free use is made of slides to illustrate the procedures and specific applications. Examples of successful field installations are given and individual problems are discussed.

Vegetation Management and Pest Control, Part 1. – The control of land and aquatic weeds receives primary attention in this session. The information presented emphasizes identification of the weed problems, Federal regulations pertaining to pest control, selection of methods (chemical, mechanical, or biological) for control, procurement of proper chemical, rate of chemical application, equipment for application of the control method, and followup on applications. Emphasis is placed upon the practical considerations of how to control weeds and manage desirable vegetation on water systems. Demonstrations and visual aids are used extensively.

Vegetation Management and Pest Control, Part 2. – This session is a continuation of part 1 and includes discussions on (1) equipment and its selection for specific purposes that meet project needs, (2) biological growth problems associated with closed conduit systems to acquaint those contemplating use of these systems, and (3) weed and pest control studies underway in the E&R Center laboratories.

Drainage of Irrigated Lands, Parts 1 and 2. – Nearly every irrigation system operator sooner or later encounters the problem of seeped lands. In this course, two consecutive sessions are devoted to this topic in an effort to acquaint the operators with some of the basic principles involved. Symptoms of the problem are discussed, including rising ground water, waterlogging, salinization, soil deterioration, crop response, and natural indicators. When the symptoms are found to be present, the next step is to find the cause of the problem which might be: canal and lateral losses, too much irrigation, not enough irrigation, quality of water, inadequate natural drainage, piezometric pressures, or subsurface stratigraphic situations. The next steps to be taken concern getting data on ground water, salt, irrigation and cropping practices, channel losses, permeability of soils, and stratification. The design and construction of the drainage system follow. This includes outlets, layout of the system, spacing and depth of drains, open ditch or buried pipe drains, materials, gravel envelopes and filters, manholes, and capacity (discharge) of pumped drainage wells.

Pump and Motor Maintenance. – While not all projects have pumping problems, the use of pumps is becoming more important and widespread yearly. This session covers basic pump, motor, and switchyard maintenance. The operation and maintenance problems or troubles commonly encountered with pumps and motors, the need for periodic maintenance and inspection, pump troubleshooting, and repair or replacement of parts are discussed.

In addition to the above, there is an assembly of general interest and a tour of the laboratory facilities at the Engineering and Research Center.

The workshop has proven to be very popular and is filled to capacity each year, indicating a desire by individual projects, water districts, and those individuals involved in different phases of water systems operation to keep abreast of the challenges of the changing times. The workshop is unable to accommodate all the individuals who apply for attendance. Attendance is arranged only through the Bureau's seven regional offices.

The Water Systems Management Workshop, as well as group training sessions or small workshops established among irrigation districts (see following article) or individual projects, is a tool that can be utilized to spread the message of the importance of a sound management and maintenance program for our water systems.

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SOLANO IRRIGATION DISTRICT TRAINING[2]

Every year prior to the water season, the Solano Irrigation District in Vacaville, California, holds a 3-day "Personnel Refresher Course" and a 5-day "Water Tender's School." About a month before the courses, local farmers and district personnel are notified by letter of the dates and locations.

The 3- and 5-day courses cover basically the same topics. However, the 3-day course consists of short presentations of topics, while the 5-day course contains detailed demonstrations and discussions.

The first day of the "Personnel Refresher Course" is devoted to general district information such as personnel rules, safety, payroll, safe driving, etc. The second and third days are for water tenders and water operations personnel.

The first day of the "Water Tender's School" consists of general information on personnel, payroll, and Department rules. The remainder of the week covers technical demonstrations, plus a 6-hour safe-driving class.

Material presented at both courses consists of:

1. Presentation of personnel rules, grievance procedures, and fringe benefits.

2. Summary of new procedures.

3. Timekeeping and payroll rules.

4. Introduction to water delivery and terminology, including Department rules.

5. Onsite visits to main canals and headworks and water measurement stations. In addition, the 5-day school includes an example of water measurements of larger canals.

6. Onsite visits to smaller canals and water measurement stations. The 5-day school includes demonstrations of measurement of water and coordination of farm drainage.

7. Farm practices and questions to the farmer.

8. Safe-driving class. In the 3-day course, this session is 1 hour and 15 minutes; in the 5-day school, it is approximately 6 hours long.

9. Maintenance procedures.

10. M&I water or plant operations.

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[2] Information for this article was provided by Gordon Johnston, retired, Solano Irrigation District, Vacaville, California. Compiled by Jill Davidson.

11. Pump maintenance.

12. Introduction to safety programs, purchasing procedures, vandalism, and security.

13. Radio communications.

14. Weed control.

15. Water measuring devices. This portion of the 3-day course is presented by representatives from private industry. The 5-day school covers actual practices of water measurement.

16. Water reporting.

17. Introduction to the Special Services Department.

A tour of the office, yard, and supervisors' areas; demonstrations of the IMS (Irrigation Management Services) program and the ground-water study; and computer operations are included only in the 5-day school.

Topics on auto maintenance responsibilities, rules and regulations for farmers, general regulations for employees, introduction to Special Services Department, and meter maintenance are presented in the 3-day course.

The Solano Irrigation District has many water users who only speak Spanish; therefore, the ditchriders carry a sheet listing conversational Spanish/English phrases to aid them in communicating with water users (see following page).

The District requires that all employees attend the courses at least once and every other year thereafter. This provides the employee with an opportunity to keep abreast of changes, to understand the operation of the water district, to relate their experiences, and to ask any questions.

A questionnaire on the courses is distributed the last day of class to everyone from the manager down to the trainee. Items on the questionnaire are summarized and questions answered as soon as possible and are distributed to next year's course leaders for their consideration.

CONVERSATIONAL SPANISH FOR WATER TENDERS

What time would you like the water?	¿ A qué hora quieres la agua?
I would like the water at 8:00 in the morning (afternoon,evening).	Quiero la agua a las ocho de la mañana (de la tarde, de la noche).
At what gate would you like the water?	¿ En qué compuerta quieres la agua?
I want the water at gate No. 6.	Quiero la agua en la compuerta número seis (6).
How much water do you want?	¿ Cuánta agua quieres?
I want 3 feet. I want 2-1/2 feet.	Quiero tres (3) pies. Quiero dos y media (2-1/2) pies.
Are you ready for the water now?	¿ Está listo para la agua ahora?
Yes, I am ready. No, I am not ready.	Si, estoy listo. No, no estoy listo.
When will you be ready?	¿ Cuándo va a estar listo?
I will be ready in 2 hours.	Estaré listo en dos (2) horas.
What time is the water going to be here?	¿ A qué hora viene la agua?
The water will be late. It will be here in 2 hours.	La agua va a venir tarde. La agua va a estar aquí en dos (2) horas.
Do not open the gate. I will start the water.	No abras la compuerta. Voy a empezar la agua.
Do not start the pump; I will start it.	No empieces la pompa, yo voy a empezarla.
Is the water OK?	¿ Está bien la agua?
Yes, the water is OK. There is not enough water.	Si, la agua esta bien. No hay bastante agua.
There is too much water.	Hay demasiado agua.
I have the water early, do you want it?	Tengo la agua temprano. ¿ La quieres?
I have extra water. Can you use it?	Yo tengo agua de más. ¿ La puedes usar?

CONVERSATIONAL SPANISH FOR WATER TENDERS—Continued

At what time would you like the water shut off?	¿ A qué hora quieres cerrar la agua?
Shut off the water at 8:00 in the morning (afternoon, evening).	Quiero cerrar la agua a las ocho de la mañana (de la tarde, de la noche).
Where is your boss?	¿ Donde está su jefe.
I don't know.	No sé.
He is over there.	Está alli.

CONVERSATIONAL PHRASES

How are you?	¿ Como está usted?
I'm fine, thank you.	Estoy bien gracias.
How is it going?	¿ Como va?
Everything is alright.	Todo está bien.
What's happening?	¿ Qué pasa?
Not much.	No mucho.
What is your name?	¿ Como se llama?
My name is _____ .	Me llamo _____ .
Where do you live?	¿ Donde vive usted?
I live in Vacaville.	Yo vivo in Vacaville.
What time is it?	¿ Qué hora es?
It is 8 o'clock in the morning.	Son las ocho de la mañana.
It is 2 o'clock in the afternoon.	Son las dos de la tarde.
What is your telephone number?	¿ Cual es su número de telefono?
My telephone number is _____ .	Mi número de telefono es _____ .

NUMBERS

1 – uno
2 – dos
3 – tres
4 – cuatro
5 – cinco
6 – seis
7 – siete
8 – ocho
9 – nueve
10 – diez

11 – once
12 – doce
13 – trece
14 – catorce
15 – quince
16 – diez y seis
17 – diez y siete
18 – diez y ocho
19 – diez y nueve
20 – veinte

30 – treinta
40 – cuarenta
50 – cincuenta
60 – sesenta
70 – setenta
80 – ochenta
90 – noventa
100 – cien
1/2 – un media
1/4 – un cuarta

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FLOWMETER'S VALUE OVERLOOKED BY MANY[3]

By Don McCabe

"Proponents say meters save costs and water by documenting what you pump; accuracy hinges on right installation."

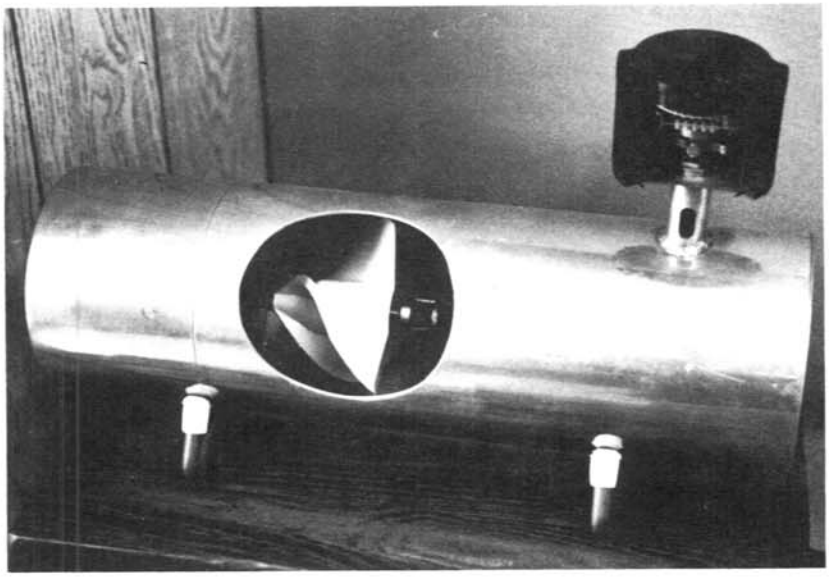

Figure 1. Cutaway shows the propeller unit of a meter that is already installed in a pipe section. The diameter of the propeller is usually 50 to 80 percent of the pipe diameter.

To Jerry Miller of Davenport, the well flowmeter was a shock.

After installing one 3 years ago on a well in a 150-acre (60.7-ha) cornfield irrigated by gated-pipe, Miller found out how much water he was actually pumping. It wasn't good news.

In order to keep the entire field adequately watered from one well, Miller ran the pump practically around the clock, to the point where he believes he was pumping nearly twice as much water as the crop required. "Water is worth much more than that," he now says.

He alleviated the problem, and saved water in the process, by drilling another well to take the load off the first one. And he's also bought "several more meters" for other wells (fig. 1).

Miller is an example of a growing trend in Nebraska toward the use of well flowmeters to measure the amount of water pumped. Yet, Les Sheffield, University of Nebraska Agricultural Economist and

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[3] Reprinted by special permission from Don McCabe, Associate Editor, Nebraska Farmer, from March 19, 1983 issue.

Irrigation Specialist, thinks only slightly more than 10 percent of the 70,000 irrigation pumps in the state have flowmeters. And most of those in the 10 percent group are in the three ground-water control areas – Upper Republican, Little Blue, and Upper Big Blue NRD's (Nebraska Reclamation District) – or in the many voluntary irrigation scheduling programs across the state.

Perhaps no one piece of irrigation equipment raises the eyebrows of Nebraska irrigators more than the flowmeter. Why the apparent reluctance to use them?

Cost and Accuracy

It apparently stems from the cost of meters (from $350 to $500 each) and from concerns over their accuracy. There can be a sizable investment in meters, depending on the number of wells. Also, there are irrigators who think a flowmeter is the first step toward a state tax on ground water.

The Upper Republican NRD, which requires meters in its 3-year-old mandatory allocation plan, has had to seek court action to stop at least two irrigators from pumping until they get meters. Officials of the Little Blue NRD, which officially begins ground-water allocation in 1985, have encountered some reluctance to meters. The NRD this year and in 1984, in the voluntary allocation phase, is offering irrigators several additional acre-inches of water to start out with in 1985 if they install meters now.

To at least two Nebraskans, the flowmeter is an indispensable tool for managing irrigation to avoid applying more water – and incurring more cost – than is necessary.

They are George Woolsey (fig. 2) and Mark Nannen (fig. 3), who both oversee popular scheduling programs where meters are used. And you don't have to be in a control area, where meters are usually required, or a scheduling program, to draw these benefits.

Figure 2. George Woolsey, Clay County Extension Agent, who oversees the county's decade-old irrigation scheduling program.

Figure 3. Mark Nannen is Manager of the Blue River Association of Ground-Water Conservation Districts, which has an effective scheduling program.

Woolsey, Clay County Extension Agent, has conducted a voluntary scheduling program for the past 12 years. This program now offers irrigators $100 toward the price of a meter and free irrigation scheduling for 1 year as an incentive to get meters installed.

Nannen operates the Blue River Association of the Ground-water Conservation District's scheduling program in York, Seward, Fillmore, and Hamilton Counties.

Both say that savings incurred by using a meter outweigh the meter's cost, and that improper installation, which we'll get into later, has more to do with an inaccurate meter than the product itself.

Essentially, the flowmeter is both a management and diagnostic tool.

As a management tool, "a meter is the only way to figure out what you're pumping, for each irrigation and for the entire season," says Woolsey. "We measure the hours on a tractor and about everything else in agriculture. Why not water applications?"

Woolsey uses this example: "If your soil has a moisture deficit of 1-1/4 inches (30 mm) and you want to leave 1/4 inch (6 mm) for rain, you have to know that your system will actually put on 1 inch (25 mm)."

The savings in fuel from pumping only what you need is enough to pay for the meter, he points out.

In Woolsey's voluntary program, the more than 100 participants are required to have meters in order to join.

Diagnostic Tool

As a diagnostic tool, a meter helps you determine the efficiency of your pumping plant and detects problems in both the well and pump. "Your well efficiency could be down to, say, 750 gallons per minute (gpm) (47 L) instead of the 1000 gpm (63 L) you expected, and you wouldn't even know it without a meter," Nannen says. "Some irrigators tell me, after using meters, 'I thought I was pumping more than I actually am.'"

A drop in the well output is not that noticeable without a meter or well pump test. And even with a pump test, says Dean Eisenhauer, University of Nebraska South Central Station Irrigation Specialist, a well's yield can change as the water level fluctuates within a season. "Only the meter can tell you this," he says.

Knowing that the gallonage is down may necessitate a pump adjustment, or a change in the length of the run or number of rows watered in a gated-pipe operation.

Nannen, like Woolsey, agrees meters have opened irrigators' eyes to the more traditional problem of overwatering. Some gated-pipe irrigators simply run the well for "so many hours" as a way to figure water applications. In one case, he says, an irrigator found out by using a meter he was applying as much as 10 inches (250 mm) of water per acre in one application to a 100-acre (40.5-ha) field.

Practically all meters in use today in the state are propeller meters. The propeller rotates on a horizontal axle, registering the volume of water flowing through the section of pipe that houses the meter. Most also register rate of flow, usually in gallons per minute (liters) (fig. 4).

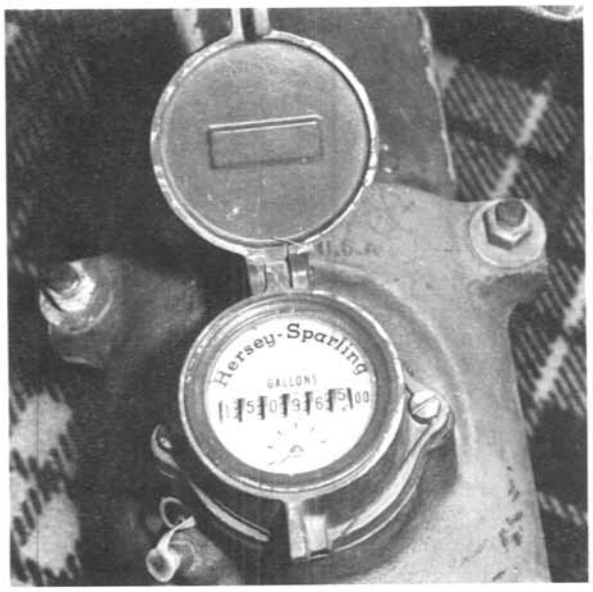

Figure 4. Meter face with a smaller sweep hand which can be timed to measure the flow rate.

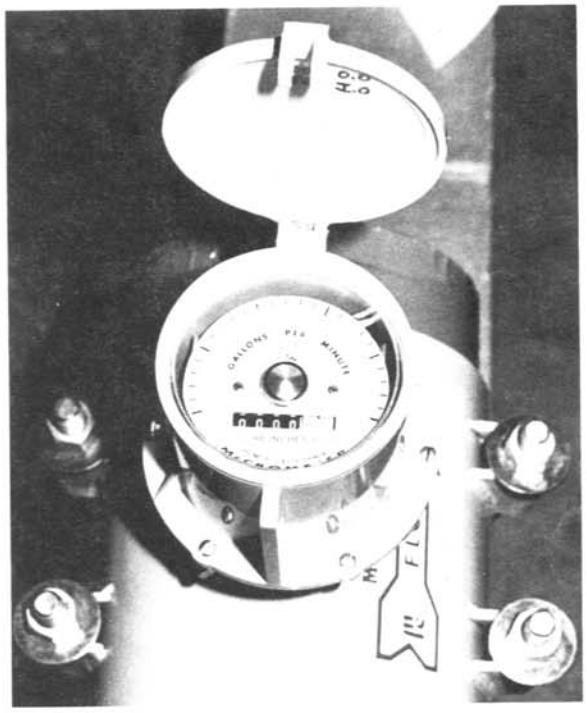

Figure 5. Meter totalizers read in gallons, acre-inches, or acre-feet. Most also have sweep hands to measure flow rate, as shown.

Most meters, but not all, have both a totalizer and a flow rate indicator. The totalizer, similar to an odometer on a car, records the accumulated volume of water pumped in either gallons, acre-feet, or acre-inches (fig. 5). A meter totalizer reading in acre-inches appears to be the most practical because the amount of water applied is usually measured in acre-inches.

The manufacturers claim, and scheduling supporters seem to agree, that meters are accurate to within plus or minus 2 to 3 percent. That's assuming they are properly installed.

Like anything mechanical, they may require servicing now and then, although there are cases where meters have maintained accurate readings for up to 10 years. By the same token, there have been problems with certain meters. Find out about the servicing and calibration available from the manufacturer when you are considering a flowmeter purchase. The Little Blue NRD plans to take care of meter servicing in its control area.

"What scares some irrigators is the flow rate reading on meters," says Greg Pope, who runs the Little Blue NRD's control area allocation program. "They see the flow rate hand fluctuating by 100 gpm (6.3 L) or more and then think the meter is in error," he says. This dial gives you a rough estimate of flow. But, he adds, it is not driven by the totalizer, the readout on which the accuracy is based.

Since the totalizer reading is usually more accurate than the meter's flow rate reading, Pope and the others interviewed recommend irrigators use the totalizer to get a more accurate reading of flow rate. This involves timing the totalizer with a stopwatch or watch.

For instance, according to Nannen, if the meter totalizer reads in gallons, time how long it takes the totalizer to register 1,000 gallons (63 L) of flow. Assuming it took 2 minutes, divide that into the 1,000 gallons (63 L) and you'll get 500 gpm (31.6 L) as the flow rate.

Installation is critical. A number of fittings for meters are available. Some propeller meters can be purchased as so-called saddle meters, which you can install yourself by either clamping it onto or welding it onto a pipe section. But make sure the meter matches the inside diameter of the pipe and place the saddle meter in the pipe section so that the propeller shaft is in the center of the pipe and alined with the pipe.

Because of potential errors here, it's a recommended practice to buy the meter already installed in a pipe section by the manufacturer. This pipe section normally comes complete with straightening vanes to reduce water turbulence.

Also, most manufacturers recommend a minimum length of unobstructed pipe equal to five times the diameter of the pipe ahead (upstream) of the propeller and an obstruction-free length of pipe equal to the pipe diameter downstream from the meter.

Mel Noffke, Manager of the McCrometer testing facility in Aurora, says the problems come when meters are placed next to a bend or elbow in a pipe.

Another point to remember is that the pipe section holding the meter must always be flowing full of water for the meter to read accurately.

Eisenhauer, at the South Central Station, recommends that irrigators remove meters in the off-season and store them indoors.

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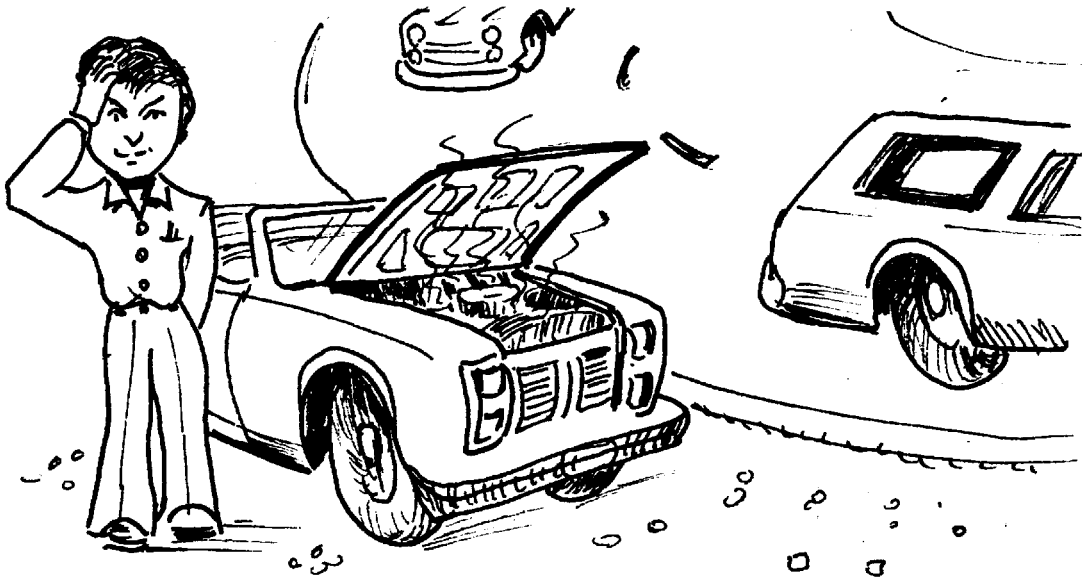
DRIVING WHEN THE HEAT'S ON[4]

Picture yourself driving home under a searing sun in the middle of stop-and-go traffic when the temperature warning light flashes red or the heat gauge climbs to "hot."



Don't panic.

To cool your engine you may have to take a little heat yourself. The first thing to do is turn off the air conditioner; that will take a load off your car's cooling system. Next, turn on the heater to drain some heat away from the engine. Then put the transmission in neutral and race the engine for a moment or two. Revving the engine increases the fan speed and moves more air through the coils of your radiator.

If this doesn't work, pull off the road and stop the car. Then raise the hood and wait for the engine to cool. Engines overheat for a number of reasons, and a quick check while you're waiting might help you spot the problem.

Hot weather's hard on fan belts and hoses. And loose or broken fan belts, leaky hoses, and insufficient coolant frequently are the cause of overheating.

Some drivers think that water alone can keep a car cool. But a modern car's pressurized system needs the proper coolant – an ethylene glycol mixture – and in the proper amount. If your car has a coolant overflow tank (and most new cars do) simply look to make sure the coolant comes to the correct level. If you need to look into the radiator to check the coolant level, don't remove the radiator cap from a hot engine – the superheated coolant under pressure could scald you.

Too much heat can also cause vapor lock, which develops when heat buildup around the engine vaporizes gasoline in the gasline. Since vapor can't be pumped, the carburetor gets no fuel. Get off the road

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if you can, raise the hood, and wait five or ten minutes. To speed cooling, you can put a wet rag on the fuel pump and the fuel line to the carburetor.

Hot weather also means extra wear and tear on tires. It's important to maintain the proper pressure. Check tires when they are cold. Don't wait to check them until after you've been on the road, because you'll get a false reading. Underinflated tires are particularly hazardous in hot weather. They flex more, and the heat that results builds up pressure, which increases the chance of a blowout.

Of course, hot weather can be as rough on drivers as it is on cars. A hot, tired driver is more likely to be an accident-prone driver. One way to beat the heat is to buy an air-conditioned car – most United States drivers do. Air conditioning not only lowers temperature, but also cuts humidity and road noise.

But many car buyers have opted (for economy and energy savings) to purchase a small car without air conditioning. How can they beat the heat?

Ed Fales, author of numerous articles on driving, developed a number of tricks to stay cool. Much of his driving had been in New England, where he frequently by-passed the interstates for shady country roads.

Fales would even check the TV weather map the night before setting out on a long trip and planned his route, if he could, to drive on a cooler or overcast road.

His wife took advantage of the shade, too, by sitting behind him when the sun was pouring in the right side of the car.

Another way Fales found to keep cool was to leave several car lengths between him and the car ahead in city traffic, to avoid the heat generated by that car.

An early start in the morning puts you on the road during the coolest time of the day, and, as a bonus, traffic is lighter. Plan to get off the road – and out of the heat – early in the afternoon. This will also get westbound drivers out of the late afternoon glare as the sun begins to set.

Sunglasses will go a long way to alleviate the glare problems, but they should not be worn at dusk or after dark when they'll reduce vision.

Don't drive with paper or other light-colored objects on the dashboard that reflect sunlight onto the windshield.

It's easier to stay cool if you dress in light, loose-fitting clothing such as shorts and a short-sleeved shirt. A lot of driver discomfort comes from hot, sweaty feet. So ventilated footwear, such as snug sandals, are a cool alternative to heavy shoes.

Another problem on hot days is returning to a parked car only to sit down on a scorching seat. Of course, cloth is easier on bare flesh than vinyl. But a terrycloth towel on the seat (and over the steering wheel) can make driving away from the beach more comfortable.

Dehydration can be a big problem in a car that is not air-conditioned. The body can lose a pint of water an hour. So plan on frequent stops for a cool drink to raise your spirits as well as your body fluid level.

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

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