

Flow Meter Use on Dairies

Larry Schwankl

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Thanks to Noelia Silva and UC Cooperative Extension - Tulare County for hosting today's meeting.

Powerpoint Presentations with Narration

- **Units and Measures of Irrigation Water**
- **What is Irrigation Efficiency**
- **What is Irrigation Uniformity**
- **Measuring Applied Irrigation Water**
- **How Much Water Should Be Applied?**
- **Tailwater Return Systems**
- **Basics of Surface Irrigation**
- **I'm Applying Too Much Water, What Can I Do?**
- **Why Do I Need To Be a Good Water Manager?**

Measuring Irrigation Water Flow Rates



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- Why do I need to know my flow rates?



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- Why do I need to know my flow rates?
 - The requirement is that you are to apply no more Nitrogen than 1.4 times the Nitrogen removed in the crop.
- How do you do this?

Flow Meter Use on Dairies

- How is this done?
 - Take water quality samples to get the nitrogen content (ppm or mg/l)



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 - Want the N calculations in lbs. of N per acre
 - For well water: $\text{NO}_3\text{-N} \times 2.73 = \text{lbs. N per ac-ft of water}$

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 - For manure water: a little more complicated because of nitrogen in ammonium and organic forms.

<http://www.cdqa.org/binder.asp>

“Calculating Nutrient Application from Liquid Manure Irrigations”



The screenshot shows the website for the California Dairy Quality Assurance Program. The header includes the logo for the California Dairy Quality Assurance Program, the tagline "Compliance Through Education", and contact information: 1-866-66CDQAP, 1-866-662-3727, and info@CDQA.org. A "powered by Google" logo is also present. The main content area features a navigation menu with links for Home, About Us, Reports, Contacts, Q&A, Publications, and Press Room. Below the menu, the page title is "WDR General Order Reference Binder Materials". The content is organized into a numbered list:

1. Regulatory Summary/Updates Timelines
 1. Are You Eligible...(June 29 RB5 Mailing-Attachment A)
 2. Where to Begin? (June 29 RB5 Mailing-Attachment B)
 3. Special Activity Dates to Remember

Flow Meter Use on Dairies

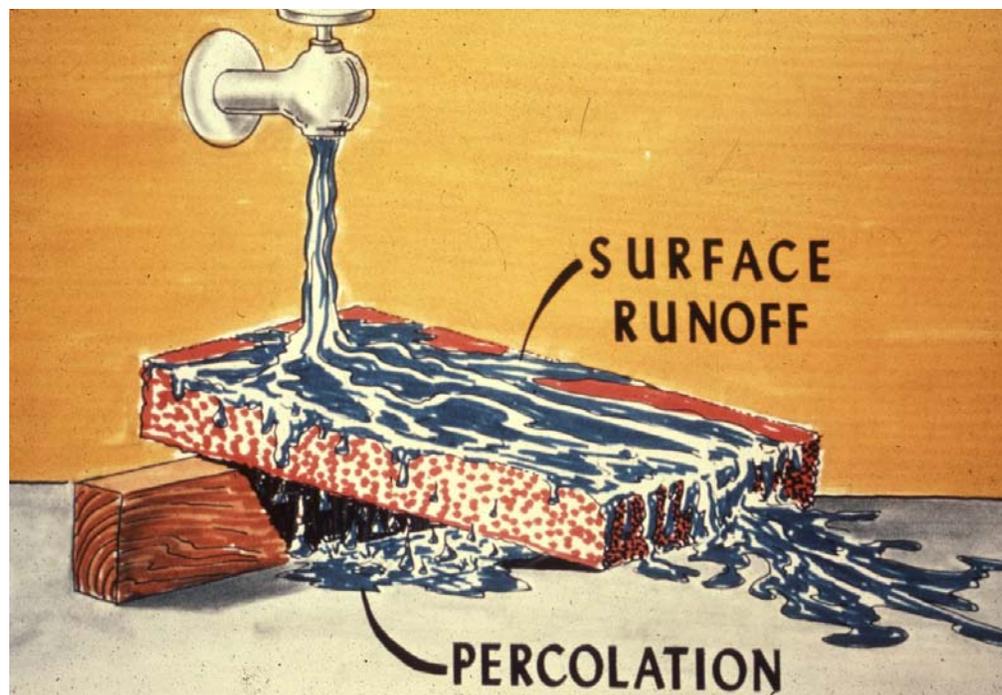
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 - You HAVE to know the VOLUME of water applied to make the “Applied N” calculation

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 - If we apply more water than can be held in the crop's root zone, we get drainage (deep percolation).
 - If there is nitrate present in the soil, the drainage water will leach nitrate from the root zone.
 - Bad for groundwater
 - Nitrogen no longer available for crop use = Under-fertilization

Flow Meter Use on Dairies

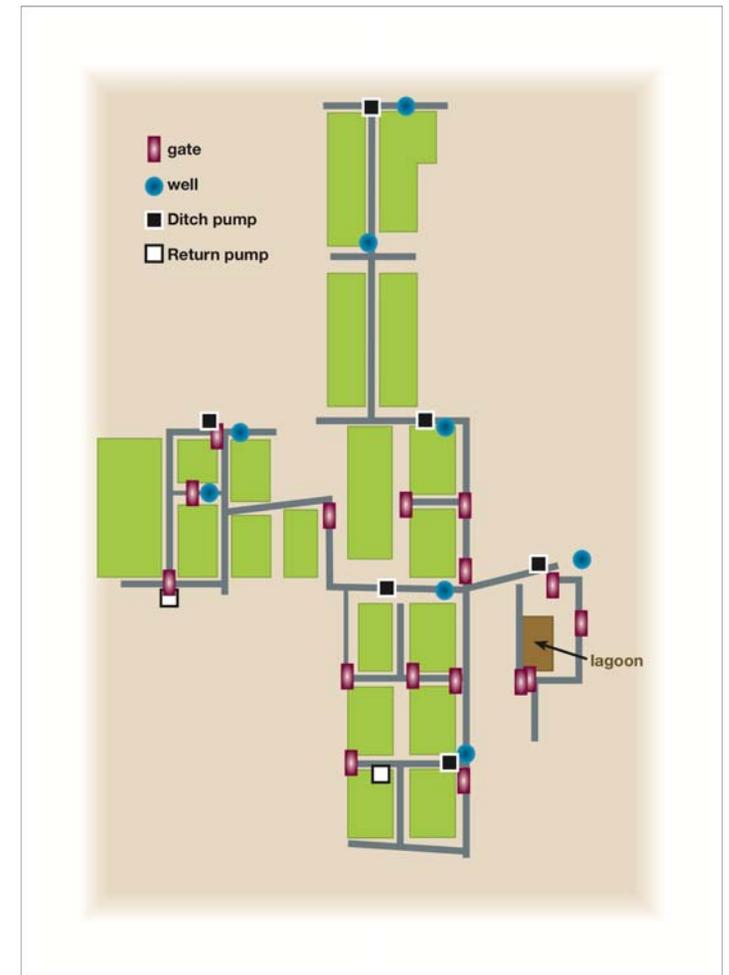
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Flow Meter Use on Dairies

- Which flows do you need to measure?
 - Manure water flows
 - Freshwater flows

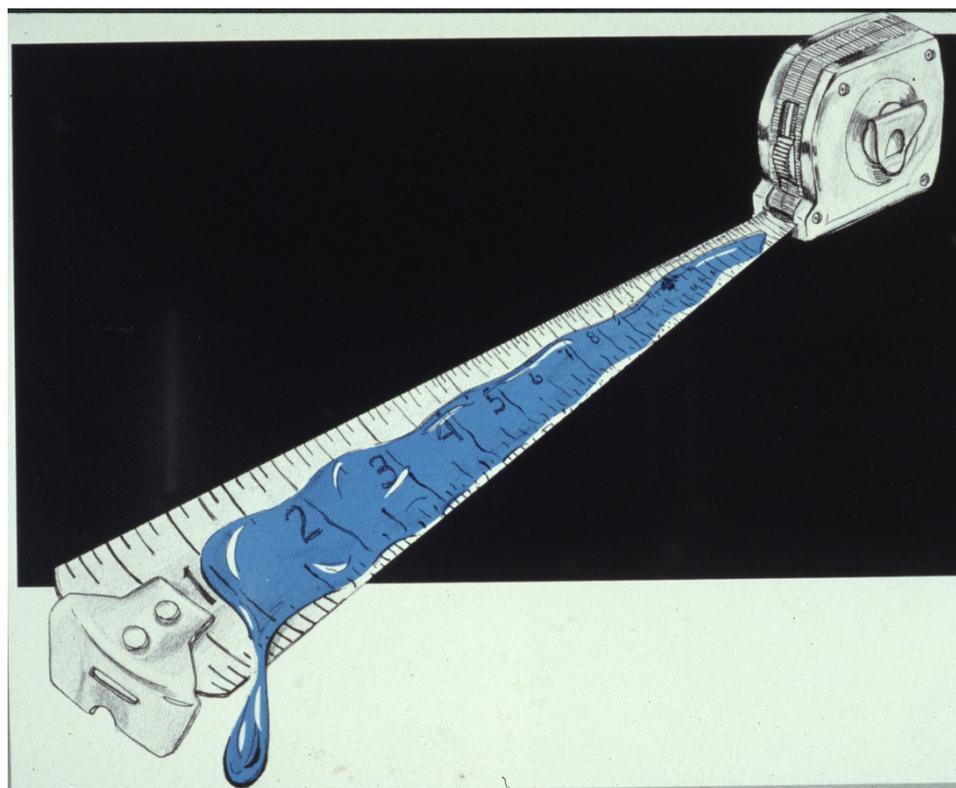
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Schwankl Water Management Rule of Thumb

If it's hard to do, it probably won't get done.

If it's easy to do, it might get done.



Flow Meter Use on Dairies

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 - What kind of flow meter?
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 - Electromagnetic meter (Magmeter) – nothing to clog up



Flow Meter Use on Dairies

RESEARCH ARTICLE

Flow meters tested on dairy lagoon water

Larry Schwankl
Alison Eagle
Carol Frate
Ben Nydam



Accurate flow-rate measurements are needed to more efficiently manage nutrients in water from dairy manure ponds, which is later applied during irrigation. Commonly used in agriculture, the propeller meter often becomes entangled with weeds and twine from a dairy manure pond, making it difficult to obtain readings.

As California's dairy industry continues to grow, manure management has become an increasingly important issue for dairy producers, government regulators and the public living in close proximity to dairies. Dairies are increasingly required to prepare nutrient management plans and comply with regulations concerning their manure management practices. A common dairy practice in California is to house the cows in free stall barns with water flush systems to remove the manure. The manure flush water, high in nutrients such as nitrogen and phosphorus, is collected in holding ponds until it can be combined with freshwater and applied to cropland during irrigation. Being able to quantify the amount of manure water applied is critical to good nutrient management of crops. The high trash and debris content of manure water has precluded the use of most flow meters commonly used in agriculture, such as the propeller meter. A field test of electromagnetic flow meters and a Doppler flow meter determined that both were accurate, dependable and appropriate for measuring manure-water flow rates. Their drawbacks are price (\$3,000 to \$4,000) and the need for electrical power for permanent flow-meter installations.

There are approximately 2,200 dairies in California, with more than 1.4 million cows. The largest concentration of dairies is in Southern California (Riverside and San Bernardino counties) and in the San Joaquin Valley (Tulare County north to San Joaquin County). Dairy size is continually increasing, resulting in ever-larger volumes of manure that must be managed. Many dairies use a free stall barn system that is flushed with water to remove manure and collect it in a holding pond. Other dairy water (such as holding pen/milking parlor water or storm-water runoff) that comes in contact with manure is also collected and stored in the manure pond. The manure-pond water, which is rich in nutrients, is mixed with freshwater and applied to agricultural fields during irrigation. The objective is to apply the nutrients in agronomically appropriate amounts and, in doing so, manage the amount of nitrogen and phosphorus that might eventually pollute groundwater.

Successful nutrient management of dairy manure-pond water applied to fields requires knowing both the flow rate from the pond and the nutrient content of the pond water. Pond water must be sampled to determine nutrient concentrations. Sampling is most easily

done at the pond's discharge pipe, either with a sampling valve inserted into the pipe or as the water enters a stand-pipe prior to being mixed with freshwater and sent to the fields for irrigation. Water quality may vary by season and by pond depth, so sampling should be done appropriately to characterize the manure water.

Obtaining flow-rate measurements for manure water can be challenging. The current draft guidelines for Comprehensive Nutrient Management Plans (CNMPs), developed by the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS) and the U.S. Environmental Protection Agency, emphasize the importance of accurately measuring manure-water applications (NRCS 2003). CNMPs are required by the NRCS for cost sharing on some dairy improvements. In addition, Merced County is requiring that all of its dairies (335 in 2003) complete CNMPs by 2006 (Merced County 2003). Other Central Valley counties are also considering requiring CNMPs for dairies. In addition, revisions to federal and state water-quality regulations may mandate nutrient management plans in the near future.

Dairy operators often do not measure flow rates for their manure-pond water

Flow Meter Use on Dairies

■ How do you measure the flow rates?

- Manure water – you could use pond drop but a flow meter is the only good choice.
- What kind of flow meter?
 - Propeller flow meter
 - Electromagnetic meter (Mag meter) – nothing to clog up
 - Doppler meter – portable but not as accurate



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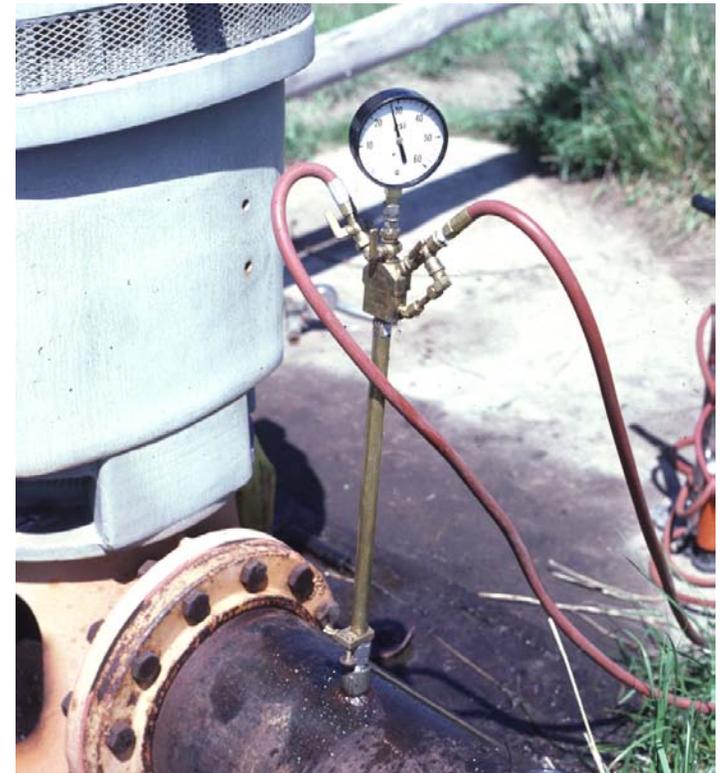
Magmeter best choice



Flow Meter Use on Dairies

■ How do you measure the flow rates?

- Manure water – you could use pond drop but a flow meter is the only good choice.
- Freshwater sources.
 - Wells – could use pump test info. but what if well flow rate is changing?
 - Dropping groundwater table, pump wear, etc.
 - Have to keep track of time of operation.



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 - What kind of flow meter? **Either a propeller meter or a magmeter will work fine**

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 - Easiest and most accurate way is to use a flow meter
 - What kind of flow meter? Either a propeller meter or a mag meter will work fine.
 - Propeller meter: nothing to clog it up, less expensive, but may require more maintenance to stay accurate.
 - Magmeter – more expensive, slightly more accurate, less maintenance.



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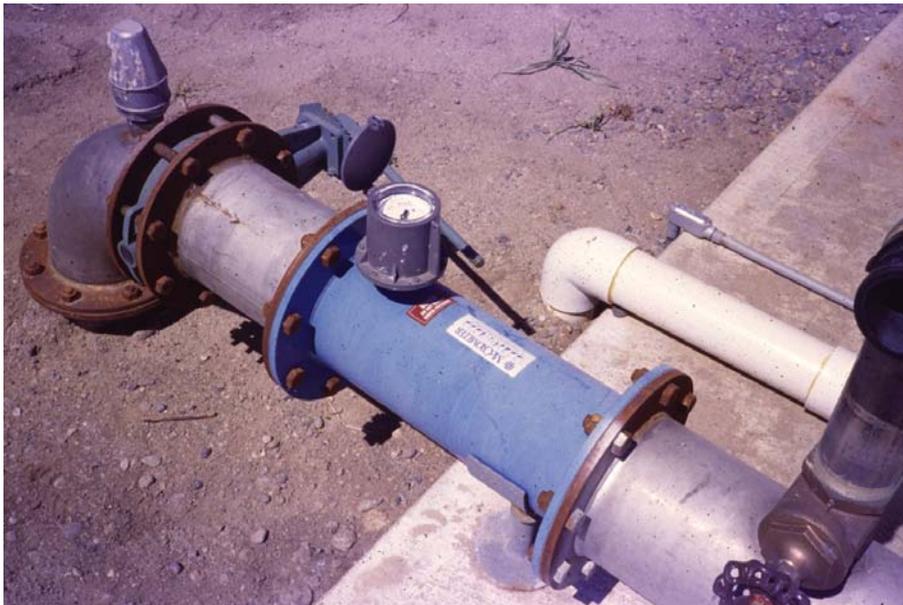


Flow Meter Use on Dairies

■ Flow Meters:

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- Most magmeters are bolted in using flanges.
- Some electromagnetic meters are partially portable – installed through a fitting in side of pipe.
- Propeller meters can be bolt-in via flanges or saddle meters.



Flow Meter Use on Dairies

- Flow Meters:
 - How are they installed?
 - Where should they be installed?

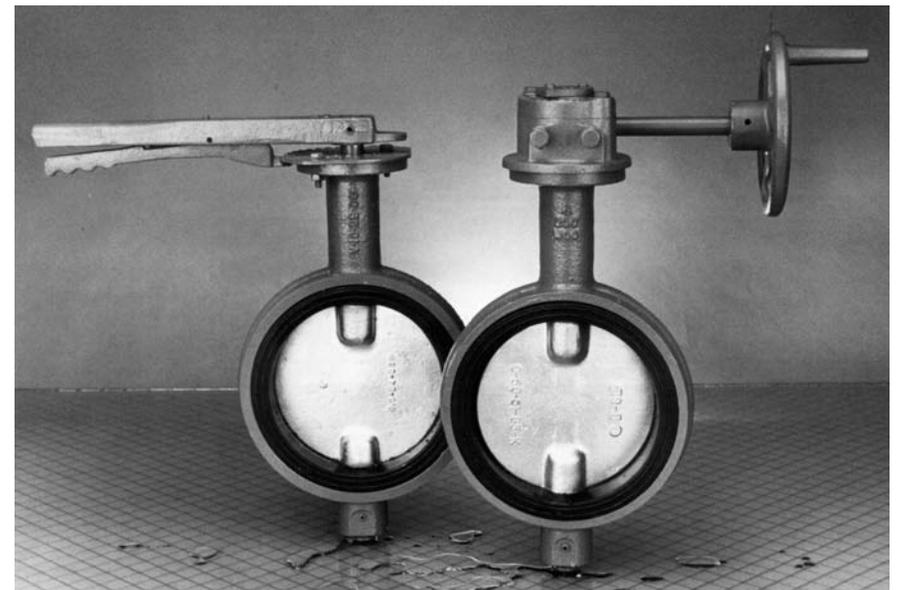
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Flow Meter Use on Dairies

- Flow Meters:
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 - Avoid installing the meter downstream of a partially open valve, elbow, and anything which disrupts the water flow path.



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Growers depend on flow meters to measure the amount of irrigation water being applied to crop. If meter readings are inaccurate, some of the precious resource may be wasted.

Water turbulence disrupts accuracy of some flow meters

Blaine R. Hanson □ Larry J. Schwankl

Flow meters were tested under a variety of conditions to determine potential errors in flow rate measurements due to excessive turbulence in the water. Results showed that propeller meters, the Hall meter and the Collins meter were not particularly sensitive to turbulence caused by elbows, while paddle-wheel meters and velocity gauges were sensitive to turbulence. Relatively large errors occurred for all meters under turbulence caused by a partially closed butterfly valve. Inserting six straightening vanes greatly reduced the error caused by partially closed valves.

As water resources become more scarce and competition for them increases, using flow meters to measure the amount of irrigation water applied to a crop field is becoming more common. The flow of irrigation water in pipelines is measured with a variety of devices and is often done under less-than-ideal flow conditions, particularly where a flow measurement device is retrofitted into an existing agricultural pumping plant.

Flow meter manufacturers generally suggest installing an 8-to-10-pipe-diameter section of straight pipe (length is always relative to the diameter of the pipe) upstream of the flow meter and a 2-pipe-diameter length of straight pipe downstream. Over time,

this rule of thumb has been generally accepted without a clear understanding of its origin or the impact on flow measurement devices of upstream flow conditions. The origin of this rule of thumb is difficult to determine, but the 1935 standards of the Joint American Gas Association-American Society of Mechanical Engineers Committee on Orifice Coefficients and subsequent work seem to form the basis for it.

Pumps used for irrigation systems are rarely installed with sufficient straight pipe upstream of the flow meter. Little information appears to exist on the possible error resulting from a nonideal flow condition. This project was conducted to assess the error in flow rate measurements of flow meters used in agricultural applications under a variety of nonoptimal upstream flow conditions.

Flow rate measurement

Flow rates were measured with eight different flow meters at distances of 2-, 5-, 10- and 15-pipe-diameters downstream from a source of excessive turbulence in the water. Measurements were made in an 8-inch Sched-

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 - Avoid installing the meter downstream of a partially open valve, elbow, and anything which disrupts the water flow path.

 - Install in straight section of pipe:

 - Propeller meters: 8-10 pipe diameters of straight pipe upstream of meter. 4-5 pipe diameters of straight pipe downstream of meter.

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 - Avoid installing the meter downstream of a partially open valve, elbow, and anything which disrupts the water flow path.

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 - Propeller meters: 8-10 pipe diameters of straight pipe upstream of meter. 4-5 pipe diameters of straight pipe downstream of meter.

 - Magmeters: follow manufacturer's recommendations but straight pipe sections are usually less for magmeters than for propeller meters.

Install a sampling tap when installing the meter!

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- Other flow measurement situations:

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Estimations using Trajectory Method

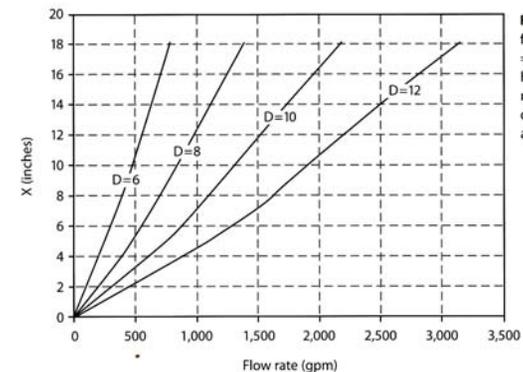
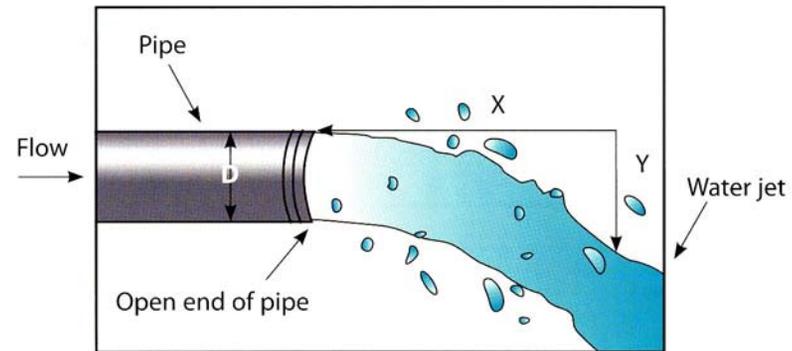


Figure 19. Flow rate chart for vertical distance (Y) = 6 inches and various horizontal distance (X) measurements for pipe diameters (D) of 6, 8, 10, and 12 inches.

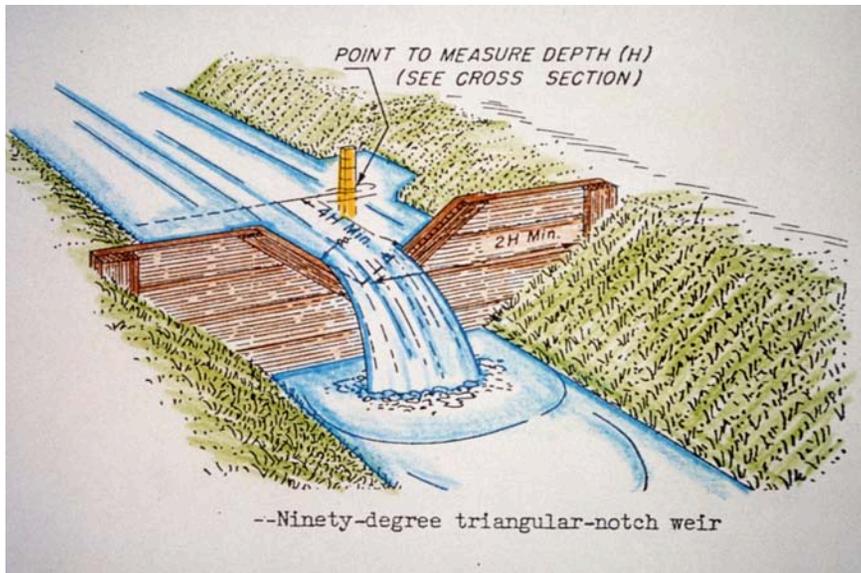
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 - Flumes – can pass debris, hard to build
 - Weirs – easier to build, traps debris
 - Siphons

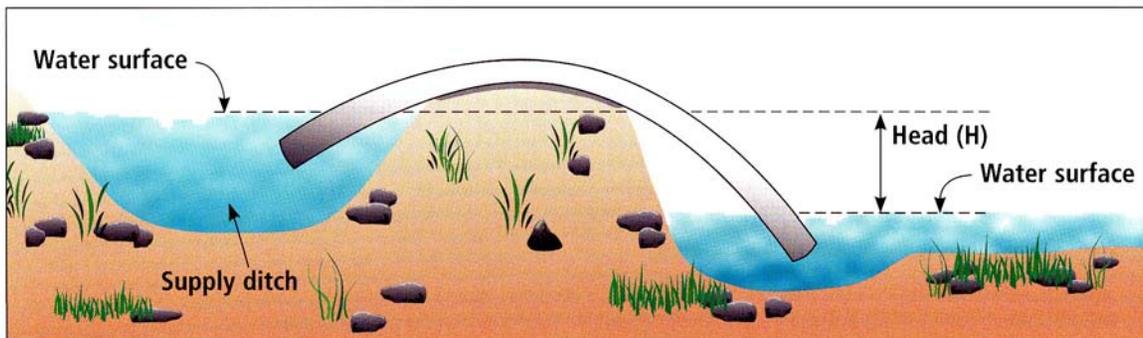
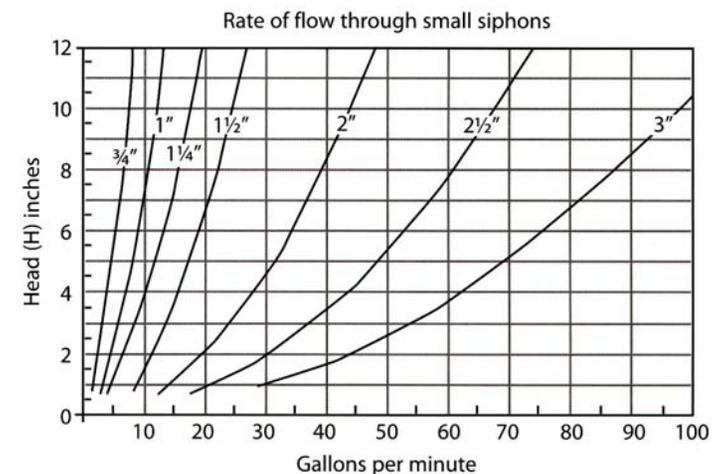


Figure 40. Measuring the head of siphons. The head is the difference between the elevation of the water surface in the ditch and the water surface in the field.



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 - Manure water application may vary
 - May give you info. on how to manage your manure water better.

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Consider getting flowmeters with data loggers

- Can always go back and check flow meter readings
- Irrigators may then only need to keep track of WHEN sets are changed

Questions???



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Powerpoint available at: <http://schwankl.uckac.edu>

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