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# Hydraulic Rams For Off-Stream Livestock Watering

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The benefits of off-stream watering are numerous. Watering livestock away from the water source can improve water quality, animal health, animal productivity, pasture utilization and manure distribution. As both pasture management techniques and pressure to protect the environment intensify, producers are being forced to look for new and better ways to water their livestock.

Recent cattle grazing studies show that off-stream watering significantly reduces stream bank erosion and lowers the amount of nutrients, sediment, and fecal bacteria entering the water source. In fact, many scientists feel that off-stream watering is a cost effective alternative to stream bank fencing.

For maximum production and pasture utilization, animals need plenty of water. By providing animals with easy access to water, off-stream watering helps insure that water is not a limiting factor to animal weight gains. These additional water sources also open up pasture management options, like rotational grazing, which can increase pasture carrying capacity and/or enhance forage utilization.

From the standpoint of animal health, some diseases are spread by animals coming into contact with urine and/or feces discharged from infected animals. Also, studies have shown that the incidence of foot rot and mastitis are greater among cattle herds that are allowed to enter wet, muddy areas. Off-stream watering helps solve these problems, by allowing producers to remove cattle from many of the areas that harbor disease organisms.

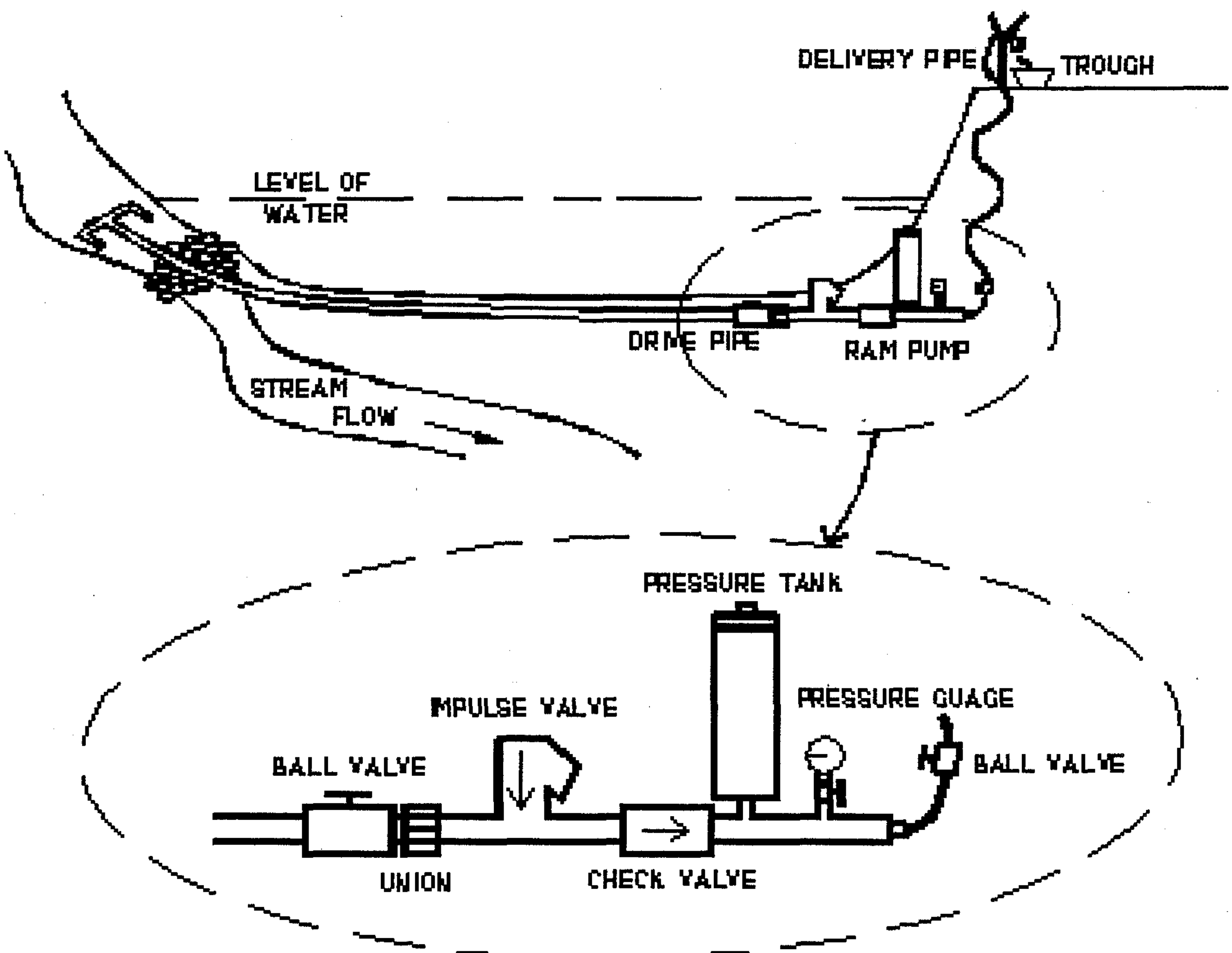


Figure 1. Hydraulic Ram Installation

Were it not for the initial cost of setting up watering systems, escalating energy costs, and limited access to electricity, off-stream watering would probably be far more widespread than it is today. The hydraulic ram pump overcomes many of these obstacles. It is a motorless, low flow rate pump that uses flowing water as an energy source to operate the pump. Hydraulic rams are ideal for use where small quantities of water are required, such as for livestock watering.

## PRINCIPLE OF OPERATION

A hydraulic ram uses the kinetic energy of falling water to pump water. The mechanics of the hydraulic ram are pictured (Figure 1) and described below. Water from a spring, creek, artesian well, or stream flows down the drive pipe and out through the impulse valve until its velocity is sufficient to close the valve. The sudden closing of the impulse valve forces a moving column of water to pass through a check valve and into the pressure tank. The momentum of the flowing water compresses the tank's air-bladder until the pressure of the trapped air is so great that the bladder begins to rebound, pushing water back down and out of the pressure tank. Water flowing out of the pressure tank forces the one way check valve to close which diverts all water flow through the delivery pipe to its destination. The closing of the check valve also creates a slight vacuum, which permits the impulse valve to reopen, and the pumping cycle begins again.

Table 1. Daily Water Requirements

| Livestock (drinking) | gallons/animal/day |
|---|---|
| Milking cow | 25-45 |
| Dry cow | 12-30 |
| Calf | 6-12 |
| Beef animal | 1.5/100 lbs. weight |
| Hog | 4 |
| Horse | 10-15 |
| Sheep | 2 |
| 100 Chickens | 4-5/100 birds |
| 100 Turkeys | 18/100 birds |

## PUMP SELECTION

A ram's size must be selected to produce a required flow rate while generating enough pressure to lift the water to the desired elevation. The fall from the water supply source to the ram must be at least 2 feet and the minimum flow of water needed is roughly 1-2 gallons per minute (gpm). The relationship between pump output and water source can be expressed as:

$$Q = \frac{V \times F}{E} \times 0.60 \text{, where:}$$

Q = pumping flow rate (gpm)
F = vertical fall of the drive pipe (ft)
V = available flow through drive pipe (gpm)
E = vertical distance or eleveation that the water will be raised (ft)
0.60 = efficiency of a ram installation
** Each of these parameters is further defined below**

*Note:* The length of the delivery pipe is not considered in this equation because friction losses are normally small due to low flow rates. However, if the discharge pipe is extremely long or if the flow rate is high, friction losses in the delivery pipe will affect pump flow rates.

### Pumping Flow Rate (Q)

Before installing a ram pump, you need to have an estimate of your water requirements. Use Table 1 to determine water requirements. Multiply the number of animals that the pump will serve by the daily water requirement for that animal in order to determine a total daily water requirement in gallons. Next, divide that number by 1440 to determine desired pumping flow rate (Q) in gallons per minute.

### Measuring Available Water Flow (V)

If the flow of water from the source is small it can be measured by timing how long it takes to fill a bucket of known capacity with water from the supply source. However, for larger flows it may be necessary to use a weir or flow meter to measure available water. This measurement should be taken during the driest season of the year. Be sure that the flow (V) is calculated in gallons per minute.

### Vertical Fall (F) & Lift Elevation (E)

The fall from the supply source to the ram can be determined using a leveling instrument or by using a carpenters level securely fastened to the top of a pole (*See Figure 2*). Starting at the proposed ram sight, place the pole-level on the ground and observe where the line of sight hits. Continue in this manner until you reach the level of the source. Add the measurements together to obtain the vertical fall of the water (F) in feet.

The same procedure can be used to determine lift elevation (E). In this case, measure from the proposed ram sight up to the point of discharge.

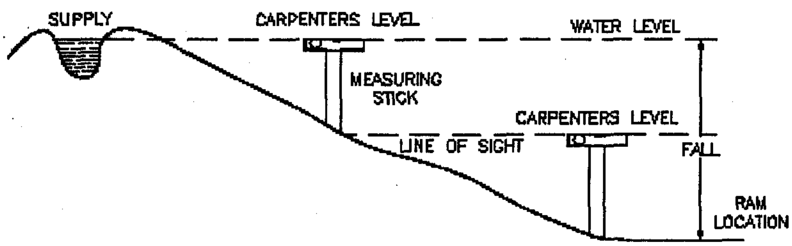


Figure 2. Determining Vertical Fall (F) and Lift Elevation (E) Using a Carpenter's Level

## INSTALLATION & CONFIGURATION

### Matching Rams to Available Water Flow

Hydraulic rams come in drive pipe sizes from 3/4" to 8" diameters, delivery pipe sizes from ½" to 4" inch diameters, and drive water requirements of $^3/_4$ to 400 gpm. Table 2 can be used as a guide in matching new pump size to available water flow.

### Foundation

The ram should be bolted or securely fastened to a very stable and level foundation.

### Source

The water source should be screened to prevent trash from entering the drive pipe and clogging the ram.

### Drive Pipe

The drive pipe is probably the most important part of a ram installation. It carries the water from the source to the ram and contains the pressure surge.

- Should be galvanized steel or at least schedule 40 PVC
- Should be as straight as possible. Minimize bends and avoid elbows.

Table 2. Hydraulic Ram Specifications

| Drive Pipe Diameter (inches) | Delivery Pipe Diameter (inches) | Min. Intake (gpm) | Max. Intake (gpm) |
|---|---|---|---|
| ¾ | ½ | ¾ | 2 |
| 1 | ½ | 1½ | 6 |
| 1¼ | ½ | 2 | 10 |
| 1½ | ¾ | 2½ | 15 |
| 2 | 1 | 3 | 33 |
| 2½ | 1¼ | 12 | 45 |
| 3 | 1½ | 20 | 75 |
| 4 | 2 | 30 | 150 |
| 6 | 3 | 75 | 400 |
| 8 | 4 | 400 | 800 |

- Should be at least one size larger than delivery pipe
- Should be watertight and rigidly anchored
- The upper end of the drive pipe should be installed at least one foot under water in order to avoid whirlpools from forming and sucking air into the drive pipe

### Determining Drive Pipe Length

Recommendations for drive pipe length are based on empirical data from systematic experiments. Calvert (1958) found that the output and stability of a ram installation depend on the ratio of drive pipe length (L) to diameter (D). He found that hydraulic rams will work satisfactorily if L/D is between 150 and 1000.

For example, to determine the minimum length of a drive pipe that has a 1½ inch diameter: L/D = 150, so D x 150 = L, or 1½" x 150 = 225" (18.75'). To calculate the maximum length for this same drive pipe: L/D = 1000, so D x 1000 = L, or 1½" x 1000 = 1500" (125').

When drive pipe length falls outside of this range both performance and stability are impaired. Increasing the drive pipe length within this range produces no change in waste or output, but it does lower the beat frequency (fewer beats per minute.) Practical aspects such as valve wear, fatigue of pipe fittings, and the amount of noise generated all favor a low beat frequency, and hence a longer drive pipe than the minimum necessary for good performance.

### Supply Pipe and Stand Pipe

If you have to go downstream for a great distance in order to obtain adequate vertical fall, a stand pipe and a supply pipe will need to be installed between the water source and the drive pipe with a tee joint *(see Figure 3)*. The supply pipe and stand pipe will not be exposed to as much stress as the drive pipe. Therefore, the strength of the materials used in their construction is not as critical. It is not imperative that these pipes run on a straight incline. However, it is essential that they be sized to carry more water than the ram can use, so that air is not sucked into the drive pipe.

### Supply Pipe

- Can be made from any material that will stand up to the pressure exerted by the water source
- Must be at least one size larger than the drive pipe
- Should run on a straight incline where possible
- The top of the supply pipe should be installed with a screen that is at least one foot under water

### Stand Pipe

- Can be made from any material that will stand up to the pressure exerted by the water source
- Must be at least two sizes larger than the supply pipe
- The top of the stand pipe should be at least a few inches above the level of the water at the source of supply

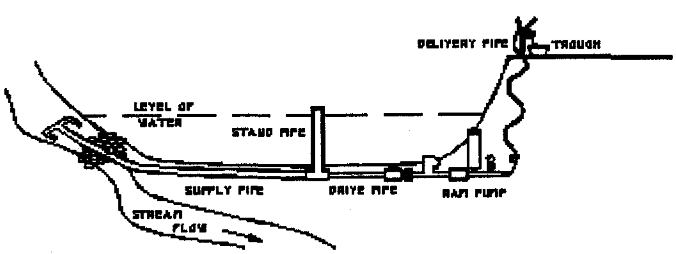


Figure 3. Hydraulic Ram With a Distant Supply

### Delivery Pipe

- Can be made from any material that will stand up to the pressure of the water leading to the watering trough.
- Avoid right angled elbows wherever possible.
- To avoid excessive pressure losses due to friction, make sure that the diameter of the delivery pipe is large enough so that the velocity of the water running through it does not exceed 5 feet per second.

$$\text{Velocity} = \frac{Q}{2.45 \times D^2} \quad \text{where:}$$

Q = pumping flow rate (gpm)
D = inside diameter of delivery pipe (in)

### Drain Tile

The total amount of vertical fall can often be greatly increased by sinking a ram pump deep into the ground and extending drainage tile to divert unused water. A frost pit or well casing can be used to bury a ram, but a drain tile is essential to carry off the waste water.

### Installation of Two or More Rams

Rams are often installed in batteries or groups if a single pump does not meet the water requirement, or if available flow in the water source varies during the year. If two or more rams are installed alongside each other, each ram must have its own drive pipe, but all of them can pump into one common delivery pipe of sufficient size to carry the water (*see Figure 4*).

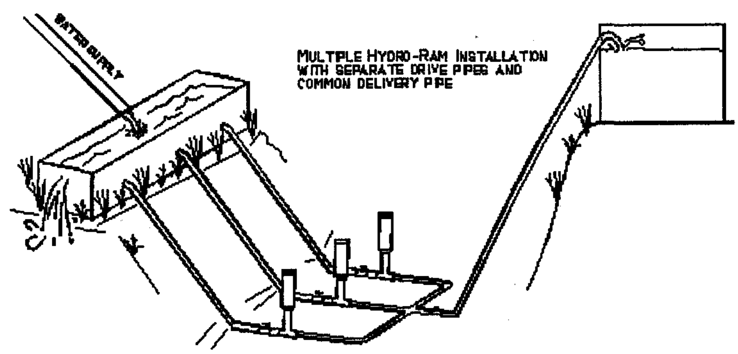


Figure 4. Installation of Hydraulic Rams in a Battery

### Installation of a Ram Behind a Dam

Water from lakes, ponds and springs can be pumped by placing a ram on the backside of a dam. The water for the ram's operation can either be piped directly through the dam, or it can be siphoned over the dam. Because the pipe in a siphon system is bent, it should be treated like a supply pipe. Therefore, a stand pipe should be installed between the siphon and the drive pipe with a tee joint (*see Figure 5*).

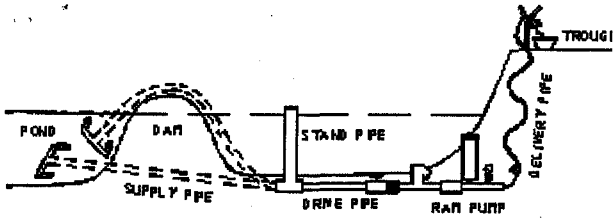


Figure 5. Installation of a Ram behind a Dam

## STARTING A RAM PUMP

- If there is a valve between the ram and the drive pipe open it
- If there is a valve between the ram and the delivery pipe it should be closed
- Push down on the impulse valve for two seconds and release. Repeat this step until the ram begins to work automatically
- When the pressure in the storage tank reaches 10 - 20 psi, the valve between the ram and the delivery pipe should be opened slowly. A gauge installed between the pressure tank and the ball valve on the delivery pipe is useful for making these pressure readings *(see Figure 1)*.

## HYDRAULIC RAM SIZING DATA SHEET

The following data sheet can either be used to help you correctly size a ram pump yourself, or you can fill it out and send it to a manufacturer, so that they will have the information needed to size it for you.

Site Characteristics:

1. Available supply of water (gpm)

______________________________

2. Vertical Fall (ft)

______________________________

(Measure the amount of vertical fall in feet from the water level of the source supply down to the level of the foundation on which the ram will rest.)

3. Distance from source of supply to ram (ft)

______________________________

4. Vertical distance or elevation that water will be raised (ft)

______________________________

5. Distance from the ram to the watering trough (ft)

______________________________

6. Total daily water requirement (gallons)

______________________________

## A PARTIAL LIST OF RAM MANUFACTURERS

B & L Associated Industries
Rt. 1, Box 118-B
Rusk TX 75785
903-743-5555

Folk Water Powered Ram Pumps, Inc.
2770 White Court, N.E.
Conyers GA 30207
770-922-4918

Rife Hydraulic Engineering Mfg. Co.
P.O. Box 367
Wilkes-Barre PA 18703
1-800-227-8511

The Ram Company
247 Llama Lane
Lowesville VA 22967
1-800-227-8511

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## ACKNOWLEDGEMENTS

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