COMMUNITY-TYPE Sprinkler Irrigation Systems

One river plant in Washington lifts water over 650 ft to a 2,000,000-gal reservoir to be delivered by pipelines to 4,450 acres of land. Relift plants raise the water an additional 108 ft to small reservoirs

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IN areas where most users apply water by sprinkler irrigation, considerable study has been given to determining the most efficient method of providing water for groups of sprinkler systems. This has resulted in many developments in the design and installation of community-type sprinkler systems. A community-type sprinkler system may be defined as a multiple-farm sprinkler irrigation development having a common water supply system.

There have been many community-type sprinkler irrigation systems installed in the United States in the past several years, due in part to the emphasis given the sprinkler method of applying irrigation water in recent years. Another reason is that sprinkler systems fit into the pattern of mechanization which is having a great influence on today's agriculture. Irrigation systems being designed today must give careful attention to keeping ever-increasing labor costs to a minimum. The community-type sprinkler system does this because it is adaptable to many forms of automation.

A community-type sprinkler system may deliver water under adequate pressure for sprinkler irrigation through closed pipes, or water may be delivered in open ditches to an area for the individual farm sprinkler systems. Sizes of these systems vary from a very small acreage to a hundred thousand or more acres.

Some of the earlier community-type systems were developed in the Pacific Northwest by private irrigation districts in the 1940s. Several older irrigation district systems were rehabilitated in the early 1950s and changed from a conventional gravity, surface irrigation system to a community-type sprinkler system. The U.S. Bureau of Reclamation has designed and placed in operation a number of these sprinkler systems and has plans for many more. They presently have The Dalles project under construction in north central Oregon. Water for this project will be pumped from the Columbia River into a closed-pipe distribution system and delivered at sprinkler pressure to approximately 5400 acres of farm sprinkler systems. Water must be lifted over 1200 ft above the river for some of this land. The Soil Conservation Service also has developed plans for community-type sprinkler systems under their watershed planning program. Several extensive developments of community-type sprinkler systems have been made by private investors along the Snake River in Idaho in recent years. It appears that more and more of these systems will come into use as we continue to develop our land and water resources.

Types of Systems

Few community-type sprinkler irrigation systems are alike because of the varying conditions for which they have been designed and installed. Some of the system differences are caused by the source, location and amount of available water; soil type and topography, climatic conditions, cropping patterns and the desires of the people. Community types of agricultural sprinkler-irrigation systems may be classified in accordance with their method of water delivery to the individual farm: (1) A closed-pipe system providing adequate sprinkler pressure at each water-delivery point. (2) Open pipe, canal, or waterway system delivering water to each ownership where it is pumped into a farm sprinkler distribution system.

Closed-Pipe System

The most common community-type system in the Pacific Northwest is the completely closed-pipe system where water is delivered under adequate pressure to each farm or ownership. This system has numerous advantages over the open-canal systems. The buried pipelines allow all land areas to be used for cultivation and cropping, whereas in the open-canal system land is removed from agricultural use by canals, laterals, spoil banks and borrow pits. Division of land ownerships by above-ground waterways is also prevented. This allows for more efficient farming operations and the maximum use of mechanization. Wasteways are not required as in the case of open canal systems since all water not used is retained in the pipes or regulating reservoirs. Drainage facilities for the project lands can generally be reduced or partially eliminated because water application to the land can be controlled so that crop needs and moisture-holding capacity of the soil are not exceeded. The water requirement for a project with a closed-pipe system is generally less since canal and open-ditch losses are eliminated and excess water resulting from changing demands is not wasted. Deep percolation losses also can be held to a minimum. The aquatic moss problem in the open canals and ditches is avoided when using pipelines to convey the water.

This type of system is comprised of a pumping plant at the water source, one or more booster pumps, a mainline to regulating reservoirs and lateral pipelines extending throughout the project area with turnouts to each ownership or water-delivery area. Automatic controls located in the reservoir regulate the operation of the pumps to maintain water in the reservoir at all times. The pumping plant contains various sizes of pumping units so that the highest economic efficiency can be obtained with the anticipated fluctuating demand for water. An economic engineering study must be made to determine the best reservoir capacity in relation to the

Report No. E-205 approved for publication by the ASAE Soil and Water Division. Copies may be obtained by requesting Report No. E-205 from ASAE, 420 Main St., St. Joseph, Mich., 49085, at 50¢ each (or ASAE Member Coupon).

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This article is reprinted from AGRICULTURAL ENGINEERING (vol. 45, no. 10, pp. 548-550, 565, October 1964), the Journal of the American Society of Agricultural Engineers, St. Joseph, Michigan

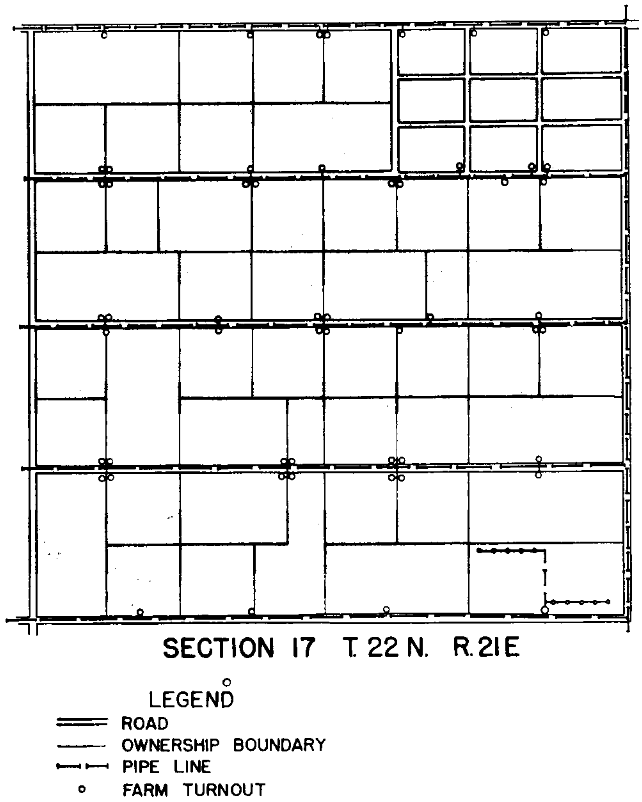

Fig. 1 Typical water distribution systems with closed-pipe pressure delivery

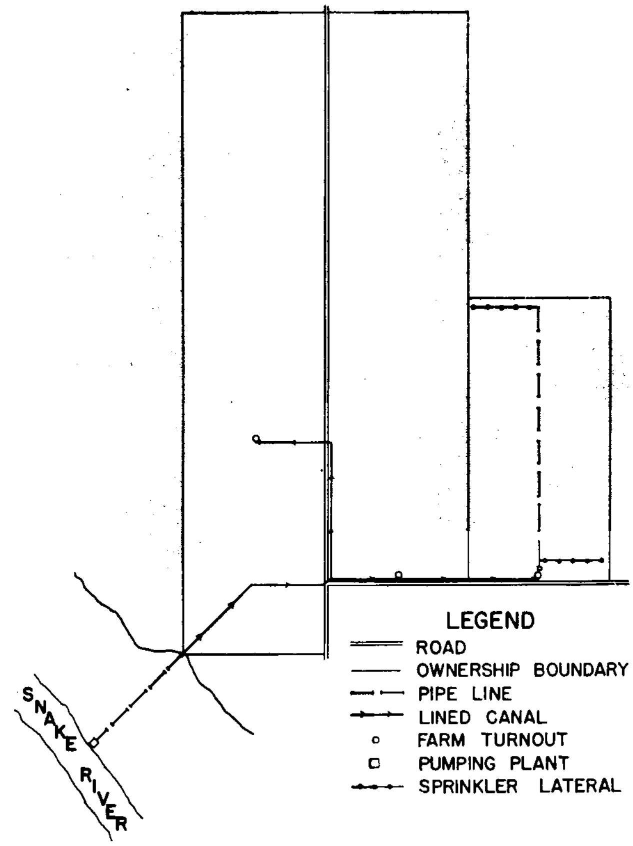

Fig. 2 Community-type sprinkler system with open-canal delivery

pumping equipment. Amount of water delivered to each user is measured with water meters installed at each turnout. Additional water meters are installed at various locations in the main and lateral pipelines to check on the system operation. In some projects booster pumps are installed in a few lateral pipelines to provide adequate pressure where the main regulating reservoir is not at a high enough elevation to provide sprinkler pressure.

The plan of operation of the East Wenatchee unit of Chief Joseph Dam project in Washington is for the river pumping plant to divert water from the Columbia River and lift it approximately 81 ft to the booster pumping plant. The latter pumping plant lifts the water approximately 652 ft to a 2,000,000-gal regulating reservoir. The water from this regulating reservoir is delivered by pipelines to approximately 4,460 acres of land. One relift pumping plant raises the water an additional 108 ft to a 150,000-gal regulating reservoir and a second relift plant raises the water 108 ft to another 75,000-gal reservoir. Each of these reservoirs serves a small distribution area.

The river pumping plant has four units, two with a rating of 25.3 cfs each and two with a rating of 12.7 cfs. These pumps have an 81-ft total normal pumping head. The main booster pumping plant has four pumping units. Two of these units have ratings of 25.3 cfs each and two units have a rating of 12.7 cfs. These units have a normal total pumping head of 652 ft.

Fig. 1 shows a portion of the lateral pipeline distribution system in one 640-acre area of the project. Shown are the delivery points for many small ownerships. Pumping plants, reservoirs, the main discharge pipeline, and laterals are designed to deliver 8 gpm per acre on a simultaneous delivery basis.

Community-type sprinkler irrigation systems which deliver water under pressure to all units have been constructed and operated in a satisfactory manner without regulating reservoirs. In these systems pressure regulation is controlled by the design of the pump and pressure-control switches which shut off the pumps when the pressure becomes too high. Extreme operating care must be taken to obtain efficient operation of these systems. As a rule, the pump is not placed in operation until a number of farmers wish to irrigate. In the event only one farmer wishes to irrigate, he must delay his irrigation until others can utilize some of the water produced by the pump.

There are also a few community-type sprinkler systems in operation where the water supply is at sufficient elevation above the farm lands to produce the necessary pressure for sprinkling. Usually it is necessary to construct a storage reservoir at the higher elevation. This eliminates many of the problems associated with pumping into elevated storage or regulating tanks.

Open-Delivery System

The second type of community sprinkler irrigation system distributes the water to multiple farms at less than sprinkler operating pressure. Water from a common source is delivered to each farm through open or closed pipe, ditch, or canals. Individual farm pumps take the water delivered from the canal at the farm boundary and put it into individual farm main and lateral pipelines under adequate pressure for sprinkler irrigation.

Fig. 2 shows the layout of a 2,000-acre system in the Dry Lake area near Nampa, Ida. The water supply for this community-type sprinkler development is pumped from the Snake River. Seven pumps with a total capacity of 32 cfs lift the water 400 ft in elevation above the source and discharges it into a concrete-lined canal. The water is delivered by gravity through 2.1 miles of concrete-lined canals to three farm units. At each unit the water is delivered to pump sumps where auxiliary pumps put the water into main lines at adequate sprinkler pressure. Water is applied to the crops on the individual farms by side-roll sprinkler laterals operating from the main lines.

The pumps are automatically controlled to deliver the proper amount of water to the auxiliary pump sumps in case part or all of the farm sprinkler systems fail to operate.

Another variation in the second type of community sprinkler-irrigation system presently being planned in the Pacific Northwest provides for pumping the water supply from a river into an open canal which follows the contour of the hills surrounding the valley. Ordinary deliveries will be made from the canal through headgates into the natural drainage channels which traverse the project area. Farmers will place their individual pumping plants along the drainage channel and pump water to their farm land through their own sprinkler distribution system. This method will make use of any return flows into the drainage channel either from rainfall or irrigation and is generally economical in construction. With this layout it is difficult to determine accurately the amount of water to be diverted into each channel from day to day and considerable waste may result at the end of the channel. Losses from evaporation and use by water-loving plants are excessive in this type of system. In many cases some of the farmers do not have land adjacent to the channel and therefore do not have access to the water supply. To meet this situation, small laterals from the main canal have been designed to serve the farms not located along the channel.

Design

The design of community-type sprinkler irrigation systems include the application of recognized and established engineering standards and include many of the procedures used for designing the individual farm sprinkler system. Insofar as possible complete automation of the system with a view of reducing operating costs should not be overlooked in the design. Some of the important steps are as follows:

1 Make an inventory of available resources. This will include information on soils, topography, water supply, ownership pattern and source of power.

2 Determine the growing periods, type of crops to be grown, the seasonal consumptive irrigation requirement, the farm delivery requirements, and the peak seasonal demand.

3 Determine the depth of water to be applied at each irrigation for each crop and soil type so that farm delivery requirements and peak demand at the various points in the system can be determined.

4 Determine the best layout of mains and submains required to convey the required water to the farm turnouts.

5 Determine the required pipe size for the mains and submains for power economy.

6 Determine maximum and minimum operating conditions.

7 Design pumping plant and power unit for maximum operating efficiency within range of operating conditions with special attention given to automation.

8 Prepare plans and instructions for proper layout and operation of the system.

The location of the delivery point or points on each farm or ownership should be established in consultation with the landowner, if possible, so that the plan for his individual farm distribution system will be compatible with the project distribution system. In some projects wherein an irrigation district has been organized, district officials often specify the number of acres for which a turnout will be provided, *i.e.*, one turnout for each 20, 40, 80, or 160-acre tract. Since the water does not have to be delivered to the high point of land in each tract, the pattern for a closed-line pressure distribution system conveniently lends itself to a series of parallel pipelines with sublaterals taking off at 90 degrees. This fits into the usual pattern of roads and farm ownerships. With the open-type distribution system, farm deliveries are generally made along the main canal at the most convenient place in respect to the farm lands.

Water-control gates or valves must be installed at each delivery point. It is desirable to have them at other locations in the closed-line pressure system so that small segments of the distribution system can be shut down for repair and alterations without curtailing water deliveries to the remainder of the lands.

Water-measuring devices should be installed at each farm-delivery outlet. Where water is delivered under pressure, line meters are commonly used. Deliveries from a gravity canal may be made over a weir or other conventional measuring device, if it is not satisfactory to measure the water at the pump discharge.

The type of pumping units installed in the pumping plant is determined by the source of water supply, the quantity of water to be delivered, the total dynamic head, and the source of pumping energy. Most of the pumping units in the Pacific Northwest are usually supplied with electrical energy with a few being operated by natural gas. A pumping plant located on a lake or a river is generally a simple installation. The pumping units are sized for the most economical operation considering the seasonal irrigation demand.

One or more wells often supply some community-type sprinkler systems. In some instances overhead balancing or regulating reservoirs are installed to provide adequate pressure in all parts of the distribution system and to afford a means of controlling the frequency of the pump operation. In other cases the pumps discharge directly into the main distribution system without regulating reservoirs. In the latter case the pressure is controlled at the pump by automatic pressure-regulating valves.

Installation

The installation of community-type sprinkler systems involves methods, equipment, materials, and personnel that are in common use in good construction practice. Some systems, especially where an irrigation district is involved, are installed by contract resulting from competitive bidding among contractors qualified to perform this type of work. In other cases the complete design and installation is contracted with one of the manufacturers of sprinkler-irrigation equipment who in turn subcontracts the various components to specialists in pumps, electrical, canal lining, etc.

During the installation program, it is important that a high degree of coordination be maintained between the design and installation personnel so that unusual or unforeseen changed conditions are readily recognized and plans changed accordingly.

Good workmanship and good inspection as the work progresses will result in the best obtainable system. When construction is completed, the entire system should be put through an operating test. If possible, the designers of the system and the operating personnel should participate with the construction personnel in this final test.

Operation

The principles of operation of a community-type sprinkler system are similar to those for any other irrigation system serving multiple farms. Water should be delivered to the farm turnout in the quantity and at the time the farmer needs water. Some systems deliver a continuous flow of water to the farm while others use a rotation system of deliveries to a group of farms. The successful operation of a good system requires the cooperation and good management of all the water users with the system operating personnel. If the system has been designed properly, many of its features will operate automatically with a minimum of day-to-day attention. These automatic features often prove troublesome until the initial operating problems have been worked out.

Operating personnel should be carefully selected and trained. Training should include the procedure for starting and stopping the system and service procedures for all pumps, power units, valves, electrical controls, and other equipment that make up the system.

During the irrigation season regular maintenance should be given pumping and power units according to manufacturers' recommendations. Inlet screens from surface water supplies should be inspected regularly and kept clean so that unrestricted flow of water is available at the intake structure. Periodic trips over each pipeline, canal or ditch should be made to check for leaks, malfunctioning of meters, air valves, and other controls.

At the end of the regular irrigation season after the pumps have been shut down and regulating reservoirs have been emptied, water remaining in tanks, main and lateral pipelines should be expelled through the various drains. Pump casing, pressure reducing valves, and special water-carrying piping and appurtenances should be drained. All gate valves in the system should be left in a half-open position during the winter. This will permit all water to drain and prevent damage due to freezing.

Regulation reservoirs should be cleaned and all metal work painted as weather permits during the shutdown period. A good program of preventive maintenance is the best insurance of trouble-free operation during the irrigation season.

Summary

The community-type sprinkler irrigation systems have been divided into two classes: those delivering water to the individual farm under sufficient pressure to operate a farm sprinkler system, and those delivering water by gravity or insufficient pressure to operate the farm sprinkler system. The latter type requires a booster pump to develop the necessary pressure for the farm system.

There are combinations of these two types of community systems and in some cases may be found in combination with surface-irrigation systems. These systems lend themselves well to automation and offer possibilities of reducing or keeping down labor costs in the operation of an irrigation system. Due to the growing scarcity of water and the high cost of making this water available on the land for irrigation, it appears that many more community-type sprinkler irrigation systems will be constructed in the future. • •