

# Potential Impacts of Improper Irrigation System Design<sup>1</sup>

Fedro S. Zazueta and Dorota Z. Haman<sup>2</sup>

The improper design of irrigation systems can have several consequences. These can be classified as those affecting (1) public health, (2) waste of natural resources, (3) water pollution, (4) operator safety, and (5) economic factors, including cost of irrigation, economic return from irrigation, and irrigation system life expectancy.

## Consequences of Improper Design

### Public Health

When chemicals are applied through irrigation systems, failure to properly design, install, and manage backflow prevention equipment can result in the backflow of chemicals and pollution of water supplies. Likewise, failure to properly select backflow prevention equipment could result in its failure to function properly. Both Florida law and Environmental Protection Agency regulations require that backflow prevention equipment be installed when chemicals are injected into irrigation systems.

If the irrigation water source is a municipal or other public drinking water supply, backflow of water from an irrigation system can contaminate the water supply even if chemicals are not injected. Therefore, backflow prevention devices must be installed on all irrigation systems which use these water supplies. County or municipal codes specify the types of backflow prevention devices required to prevent the possible contamination of these water supplies.

### Waste of Natural Resources

Poorly designed irrigation systems which apply water nonuniformly will waste water and chemicals applied with the water. Some areas will be over-irrigated, while others will be under-irrigated. If the system manager applies the correct average amount of water, the under-irrigated areas will suffer yield or quality reductions due to water stress, while yield or quality reductions due to leaching of water and chemicals will occur in the over-irrigated areas.

With nonuniform irrigation systems, if sufficient water is applied at each irrigation to assure that none of the crop is under-irrigated, most portions will be over-irrigated. This will increase the waste of water and chemicals. Also, the fuel required to pump excess water and to produce and inject excess chemicals will be wasted.

Even well-designed irrigation systems do not apply water with perfect uniformity. The cost of obtaining perfect uniformity is prohibitive. Rather, the optimum design requires that the value of the natural resources wasted be balanced by the increased cost of achieving a greater degree of uniformity of water application, including the increased value of agricultural products that would be required to pay for the increased irrigation system cost.

1. This document is AE73, one of a series of the Department of Agricultural and Biological Engineering, UF/IFAS Extension. Original publication date February 1989. Revised October 2011. Reviewed August 2017. Visit the EDIS website at <http://edis.ifas.ufl.edu>.

2. Fedro S. Zazueta, professor; and Dorota Z. Haman, professor, Department of Agricultural and Biological Engineering; UF/IFAS Extension, Gainesville, FL 32611.

The Institute of Food and Agricultural Sciences (IFAS) is an Equal Opportunity Institution authorized to provide research, educational information and other services only to individuals and institutions that function with non-discrimination with respect to race, creed, color, religion, age, disability, sex, sexual orientation, marital status, national origin, political opinions or affiliations. For more information on obtaining other UF/IFAS Extension publications, contact your county's UF/IFAS Extension office.

U.S. Department of Agriculture, UF/IFAS Extension Service, University of Florida, IFAS, Florida A & M University Cooperative Extension Program, and Boards of County Commissioners Cooperating. Nick T. Place, dean for UF/IFAS Extension.

## Water Pollution

Excess applications of water and the resulting leaching of chemicals can result in the pollution of surface or ground-water supplies. In Florida, leaching can readily occur through the typical sandy soils. Water pollution can occur both as a result of inefficient applications of chemicals and from leaching.

It is often difficult to determine the economic and environmental effects of water pollution because it is difficult to measure, and because the impacts of various pollutants on the environment are often unknown. It is also impossible to completely eliminate the potential for water pollution because chemicals are required in the root zones and on the foliage of plants. However, the potential for water pollution can be minimized.

Leaching and water pollution can be minimized by proper irrigation system design and management, because a well-designed and well-managed irrigation system can properly apply only the required amounts of water and chemicals. Chemigation systems, irrigation systems which are designed for chemical applications by injection with the irrigation water, have great potential for reducing water pollution from irrigated lands. Chemigation systems can reduce water pollution by allowing prescription chemical applications to be made. If chemicals are applied frequently and only in amounts required by the irrigated crop, excessive amounts will never be present or subject to leaching losses.

## Operator Safety

The safety of the operator and others in the area can be affected by the improper design of an irrigation system. Electrical circuits must be properly designed and installed to avoid shock hazards in a wet environment. Power units and drive units must also be properly sized, mounted, aligned, and shielded to assure safe long-term operation. Chemical injection systems must be properly designed and installed to avoid operator contact with chemicals.

To ensure that systems will function safely, irrigation system components must be properly pressure-rated. Pressure relief valves and other safety equipment must be installed where required. All components must be installed according to specifications.

## Cost of Irrigation

To minimize the cost of irrigation, the designer must consider the total cost, which is the sum of the annual fixed and operating costs. Irrigation system cost is directly

affected by the quality of design. In general, well-designed systems have greater initial costs than poorly-designed systems. This occurs because larger components, including larger pipe sizes, are required to minimize pressure losses and achieve uniform water application. However, operating costs of well-designed systems will usually be lower. Pumping, labor, and other operating costs will usually need to be increased to compensate for under-designed irrigation systems. These factors will almost always make the total annual irrigation system cost greater for a poorly-designed irrigation system as compared to a well-designed system.

An irrigation system designer must consider existing production practices, availability of labor and the convenience of the irrigator in each design. Proper consideration of these factors will help to minimize costs by the specification of irrigation systems which are readily-managed within a given production system and which use existing labor efficiently.

## Economic Return From Irrigation

Poor irrigation system design can result in the construction of irrigation systems that cannot provide the necessary soil-water-nutrient environment for optimum crop growth. This will result in reduced yields, reduced quality, or higher costs per unit of production when compared to well-designed irrigation systems.

## System Life Expectancy

The life expectancy of a poorly-designed irrigation system may be much shorter than that of a well-designed system. As examples, the use of components that are not adequately pressure-rated, that are not resistant to chemicals being injected, or that are not otherwise properly installed or matched to the system, can result in early system failures.

Improper designs and installations or the failure to exercise proper caution in management can result in destructive “water hammer” forces which can damage pipes and other components. Also, neglecting to consider strengths of materials of pipes and other components can result in their failures due to overburden pressures from burial, especially under roadways.

Improper selection of filtration or other water treatment equipment can result in clogging and failure of trickle irrigation systems. Likewise, the failure to consider the user’s ability to manage and maintain filtration and water treatment equipment can result in irrigation system failure.

The selection of components that are not designed for use under field conditions can result in early component failure due to deterioration by solar radiation or premature weathering. The improper installation of components such as exposure of PVC pipe to solar radiation or the burial of uncoated aluminum pipe will result in their early deterioration.

## Summary

There are many possible consequences of the improper design of irrigation systems. These were classified and discussed as factors relating to (1) public health if backflow prevention systems are not properly designed or installed, (2) waste of natural resources including water, chemicals, and the energy required for pumping if systems are not properly designed and thus water cannot be applied uniformly, (3) pollution of water supplies if poor system design results in nonuniform water and chemical applications and leaching of chemicals to the water supplies, (4) operator safety if components are not properly selected and installed, (5) cost of irrigation if total annual fixed and operating costs are not considered, (6) economic return from irrigation if a poorly designed irrigation system cannot provide the crop's water requirements, (7) and system life expectancy if components are not properly selected and installed for the operating conditions expected for each individual system. To avoid problems with poorly-designed systems, all of these factors must be considered when irrigation systems are designed.