Tools an NRCS Field Office Could Use to Help an Irrigator

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Introduction

There are several models that engineers and conservation planners can use to help landowners make decisions on irrigation systems. In this paper I will cover the basic ones user in the Edwards Aquifer Area of South Central Texas.

Background:

The Edwards Aquifer is one of the major groundwater systems in Texas.   Today, it is the primary source of water for approximately 1.7 million people. The Edwards Aquifer is one of the world's unique groundwater resources, extending 180 miles from Brackettville in Kinney County to Kyle in Hays County, Texas. Water in the aquifer is used for household, agricultural, industrial and recreational purposes.

For years, it was thought the Edwards Aquifer was a never-ending supply of fresh drinkable water. In the 1950s, a seven-year drought drastically lowered water levels in the aquifer. In the 1980s and 1990s, droughts of shorter duration occurred, and required heavy pumping from wells. Average pumping from Edwards's wells has increased dramatically in the last five decades because of population growth and demand.

In 1940, the region was pumping 120,000 acre-feet of water, or 39 billion gallons, a year. In 1989, regional pumping reached a maximum of 542,000 acre-feet of water per year - more than 175 billion gallons.
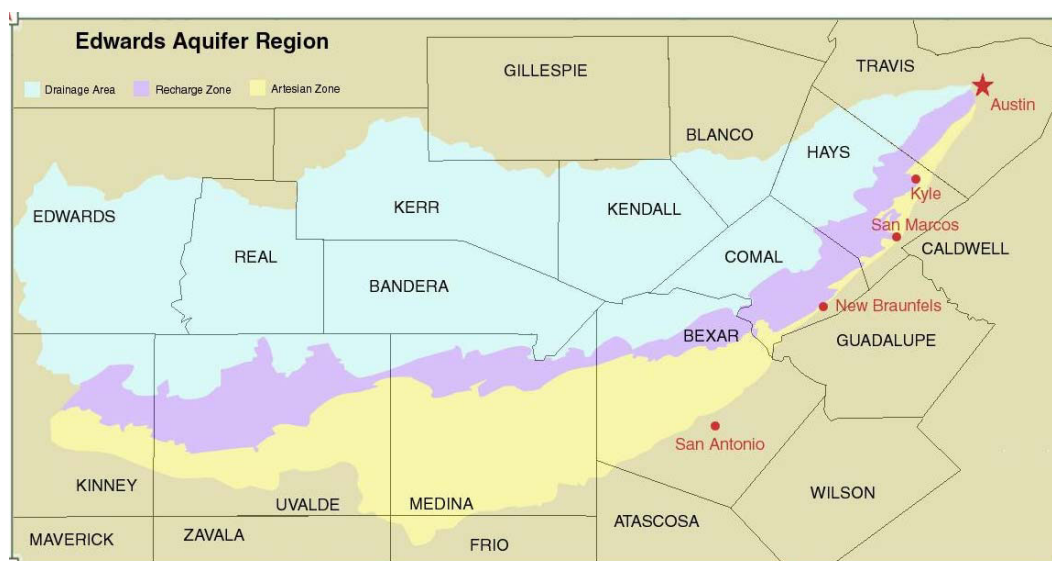

Edwards Aquifer Region

The Edwards Aquifer Authority Act was passed in 1993. However, legal challenges prevented the implementation of the Act until June 1996. One of the policies that were enacted was to limit irrigated agricultural farm land to a 2 acre/feet per acre of water allotment.

Models:

With the water limitations that have been imposed on the farmers in the area, the need for good water management decisions has also increased. The use of modeling software to help farmers make these decisions is one way of showing the differences in the water application and absorption for various crops and soil types.   The Natural Resources Conservation Service (NRCS) in Texas placed a six person team in the Edwards aquifer area to assist farmers in advancing to more efficient irrigation systems. The team is using several irrigation models to help the farmer see what their current system on a field is doing and how a change to a different system might affect their water use.

The Field:

One of the most important pieces of information NRCS can give the farmer is information on his field. One of the first steps and services NRCS can provide for the farmer, seeking ways to improve irrigation efficiency is a topo survey of the field.   With this survey NRCS can look at things like: length of run, slope of field, maximum size of system, size of field, etc.   This step can be done in any of the Civil Engineering software packages that are on the market or by hand. In the Hondo area NRCS is using an off the shelf civil engineering package called Eagle Point[1] to create our contour maps. NRCS also has the Survey Engineering Tool (SET)[2] to do this task.

Figure 2 – Typical Topo Survey Map

Surface Irrigation:

Since most of the existing systems in the area are flood irrigation, the team needs a good way to estimate and model the existing system. The software models that for NRCS approved use are the USDA – Agricultural Research Service (ARS) surface irrigation software developed at the Phoenix, Arizona Water Conservation Laboratory. These models include SRFR[3], BORDER[4], and BASIN[5].

Figure 4 – Output from WinSRFR

SRFR is the model used the most. It is a one dimensional mathematical model that simulates surface irrigation. It can model borders, basins or furrows. The main variable that can be changed is the length of run for the type of system being modeled. When modeling a furrow system the software can only work on a single furrow. The team will determine an average furrow length and slope to run in the software. The output that is the most useful to the team on dealing with farmer and landowner is the irrigation efficiency and the depth of application. BORDER and BASIN are specialized models to handle flood irrigation of either borders or basins. The same information can be obtained from these models to show the farmer how their system is operating and possible improvements. Some of the suggestions that can be shown with these models are: changing slope of run, length of run or surge irrigation, just to name a few.

Now ARS has combined the three software packages into a windows version. The new version is called WinSRFR[9]. It is a hydraulic analysis application that combines a simulation engine with tools for irrigation system evaluation, design, and operational analysis.
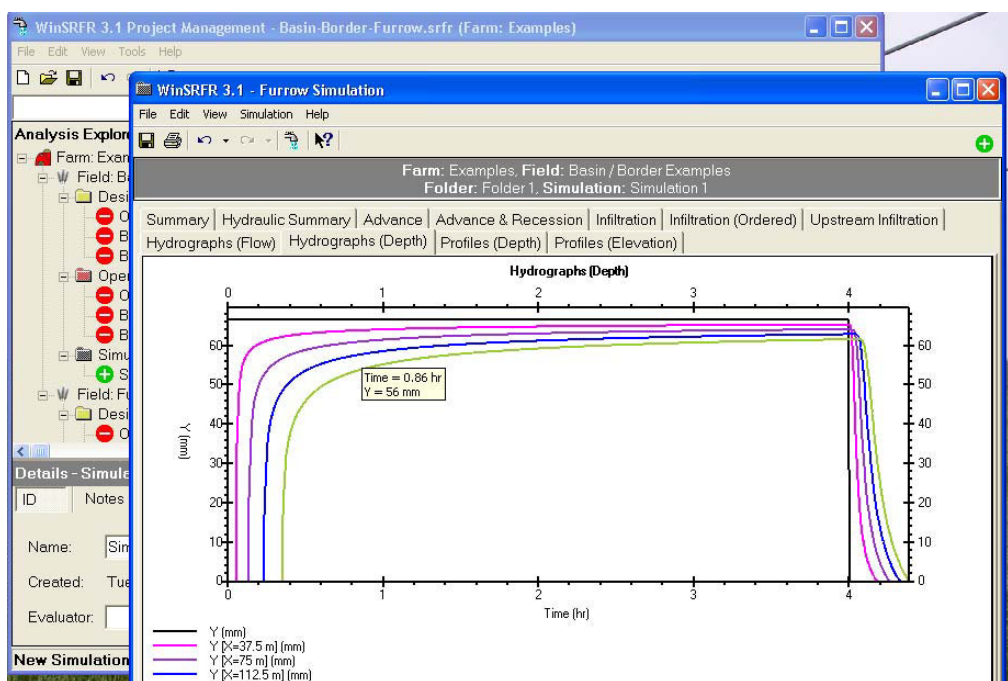

Figure 5 – Output from WinSRFR

Also, NRCS has developed a new surface irrigation model called SURFACE[10] . Surface takes inputs such as inflows, field topography, geometry of channel, infiltration characteristics and Hydrographic inputs. The hydrographic inputs include such things as an inflow hydrograph, tail water or runoff hydrograph, and advance and recession data.

Some of the outputs the program can give you to help you make decisions on the type of system being modeled include advance time, application efficiency, irrigation efficiency, distribution uniformity, and volume balance including inflow, outflow and infiltration.
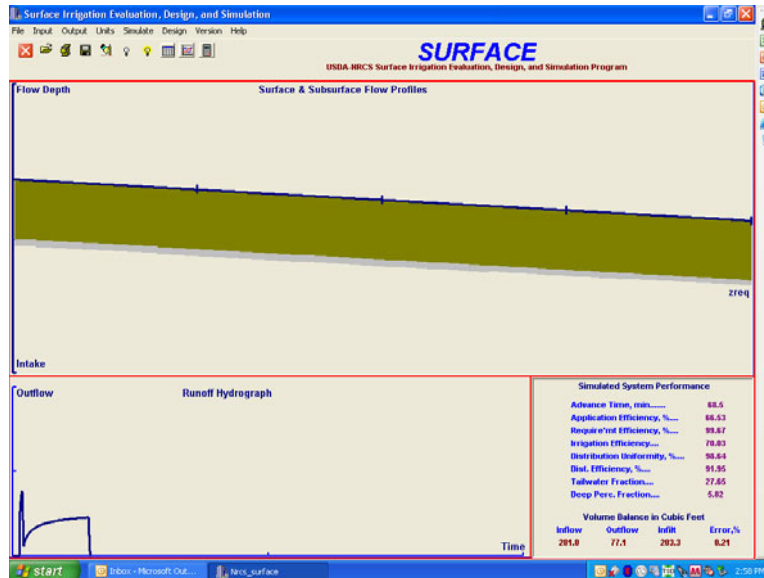
Figure 6 – Output from SURFACE SOFTWARE

Sprinkler Irrigation:

Most of the farmers and landowners in the area want to upgrade to sprinkler irrigation systems. In this particular area NRCS is promoting low pressure systems with the nozzles close to the ground.   ARS has a computer program called Center Pivot Evaluation and Design (CPED)[6] Software. With this software the proposed nozzle package can be modeled. The software will model a catch can test and report results like CU and DU. These can be used to compare the different systems.
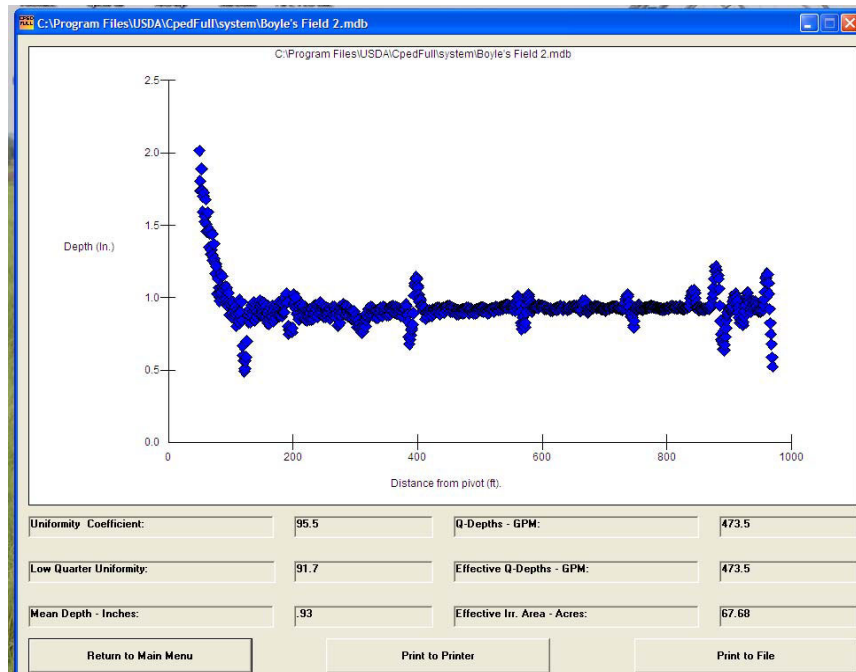
Figure 7 – Typical Output from CPED

Once the sprinkler nozzle package has been checked in CPED, the next step is to review using the software CPNOZZLE[7]. This software was developed in Nebraska, and is used to estimate the amount of runoff that would be expected from the pivot system given the type of soil and the amount of residue cover in the field.   This is a good tool used to assist the producer in making irrigation water management decisions. If the model is showing high runoff, different tillage or surface storage options are analyzed and recommended to control the issue.
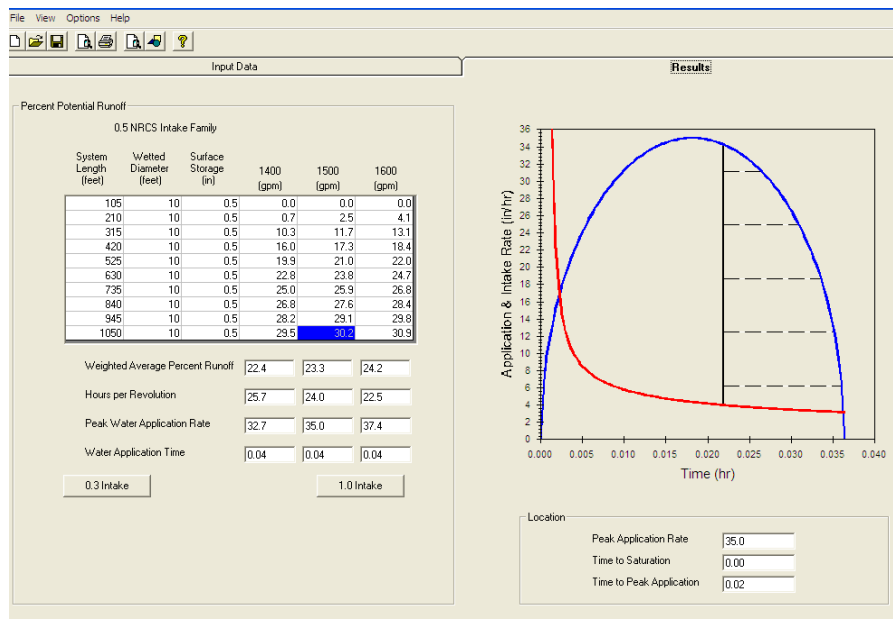
Figure 8 – Typical CPNozzle Runoff Output

Irrigation Water Management:

One of the last models NRCS will use and discuss with the landowner is Irrigation Water Requirements (IWR)[8]. This model provides an estimate of irrigation water needed by analyzing consumptive use. The software can be customized for an area by loading local weather and crop data. Some of the output information includes: Monthly estimate on net irrigation requirements for a normal and dry year, Typical ET monthly estimate, Monthly Crop ET, Graph showing water use monthly, and ET curves. The outputs can be used to help explain the water requirements of the crop to the landowner or farmer.
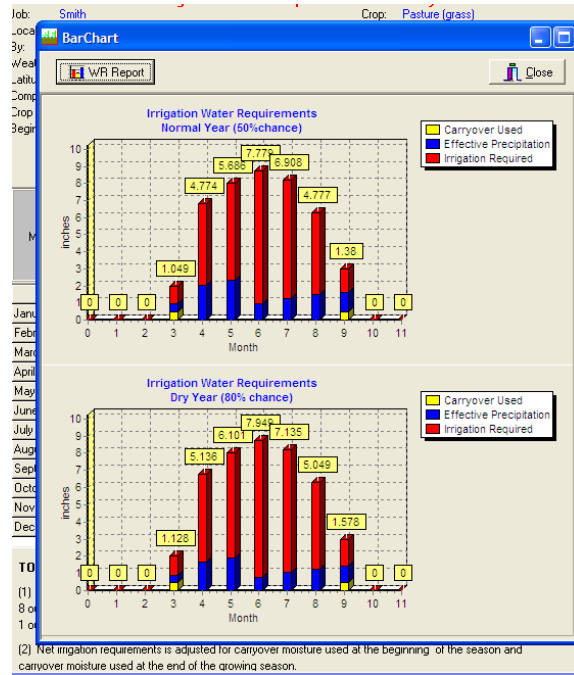

Figure 9 – Typical output from IWR on crop water use

Summary:

In closing, at present there is not just one model that can cover all the issues that water management planners might encounter.   There are several new models available and some of the ones currently being used have been updated.   Any model that helps get the point across to the landowner can be useful to an office as a planning tool. The main issues associated with the use of any of these models are whether they are being used appropriately and whether the

output provides an easy to use and effective tool top explain recommendations to the landowner.

References:

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[10] NRCS, SURFACE [Computer Software].