Irrigation Training Toolbox
Irrigation Water Management Plan

Irrigation Water Management Plan

National Employee Development Center
Natural Resources Conservation Service
Fort Worth, Texas
October 1996

FOUR PARTS OF A PLAN

1. Narrative
2. Plan Sheet
3. Design Sheet
4. Supporting Documentation

NARRATIVE

1. SETS DOWN BASIC SYSTEM INFORMATION
2. SUMMARIZES THE DESIGN
3. SETS DOWN MANAGEMENT INFORMATION
4. DISCUSSES IRRIGATION WATER MANAGEMENT
   - A. IRRIGATION SCHEDULING
   - B. SOIL MOISTURE MONITORING

IRRIGATION DEVELOPMENT PLAN

Irrigator..............Example
Legal Description......SW of 11-23-37
County.................Blackdirt
Date...................
Planner................

This plan is for an irrigation system that consists of well #1 pumping water at the rate of 600 gpm, a 40 acre flood field and a 32 acre sprinkled field.

The well supplies water to both fields with 8 inch PVC underground pipe. The flood field has gated pipe to deliver water to the furrows, a ditch at the lower end to direct water to a tailwater pit, and a return line to return the water to the top of the field to be used again. The field had been leveled to a 0.2 percent grade. The sprinkled field is irrigated with a 660 foot long center pivot which uses spray nozzles to distribute the water onto the field.

Generally, corn is planted on field 2 and grain sorghum on field 1. However, this may be reversed some years because of weed or insect problems. Changing the crops will not change the design.

Field 1 will be irrigated by furrows with approximately 46 furrows being watered per set and 13 gallons per minute (gpm) in each furrow. Each set will be irrigated approximately 16.3 hours to apply 3.5 inches of net water. The number of furrows per set, gpm per furrow, and time of irrigation per set can be altered to match seasonal soil conditions and labor availability, but 3.5 inches of net water should be applied with each irrigation. Also, the stream size shall not exceed 26 gallons per minute. Advance time (time for water to reach the end of the furrow) should be as fast as possible to provide for uniform application of water. Runoff water will be reused on the field.

The design of field 2 requires a soil surface residue level of 4000 pounds per acre at planting time. To achieve this residue amount may require minimum tillage of the field. No-till or ridge-till will also leave high amounts of residue on the field. A residue level less than 4000 pounds may require different nozzles or a decrease in water flowing to the system. If the sprinkler package is changed to increase or decrease the wetted diameter of the nozzles the design will need to be checked.

Form KS-ENG-394 (Irrigation Water Management) shows that the well is large enough to meet the demands of the crops during the irrigation season. During the month of highest demand (July) it will take only 18 days of pumping to meet the irrigation requirements.

Irrigation Water Management

To produce maximum crop yields, plants must have ample moisture throughout the growing season. Moisture is especially important during the critical growth period of the crop. For corn this critical growth period is tasseling and silking and for grain sorghum it is the boot, bloom, and milk-dough stages. If water is limited, moisture during the critical growth periods will provide maximum yield per unit water applied. Irrigations can be applied during the vegetative period if the crop is under a moisture short situation.

The amount of moisture in the soil profile should be measured periodically to determine when and how much to irrigate. For full irrigation, the corn and grain sorghum should be irrigated when the moisture level in the soil profile has dropped to 50% of available water in the top three feet for field 1 and the top one foot for field 2. This level of soil moisture can be determined by using the feel method, tensiometers, gypsum blocks, or other methods.

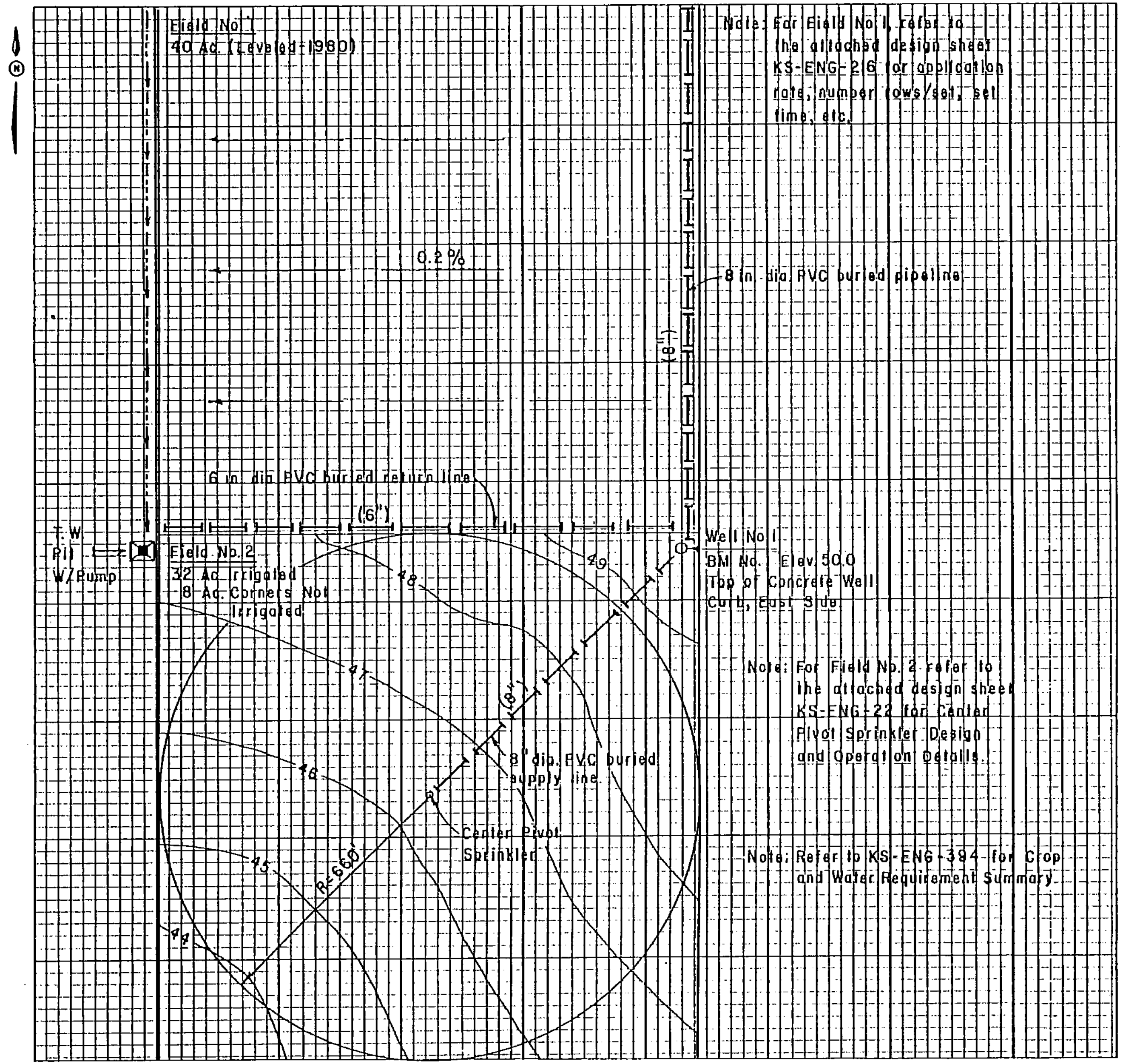
Visual observations of the system in operation during the season should be made to check for erosion in the furrows, runoff, leaks in the system and other problems.

Plan Revision

Whenever the output from the well has been determined to be significantly different from the 600 gpm assumed or the operation of the center pivot and furrow systems has changed, this water conservation plan must be reviewed and/or revised.

PLAN SHEET

1. Detailed Map of Field
2. Contour Lines to Show Slope
3. Cropping Plan
4. Soils Information
5. Sprinkler Design Information
6. Water Quality and Quantity



Note: For Field No. 1 refer to the attached design sheet KS-ENG-216 for application rate, number rows/set, set time, etc.

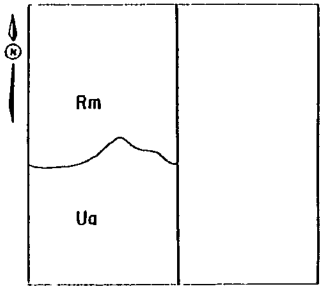
Note: For Field No. 2 refer to the attached design sheet KS-ENG-22 for Center Pivot Sprinkler Design and Operation Details.

Note: Refer to KS-ENG-394 for Crop and Water Requirement Summary.

GENERAL LAYOUT MAP
Scale: 1"= 300'

CROPPING PLAN				
FIELD No	SUMMER IRRIGATION		WINTER IRRIGATION	
	AREA-ACRES	CROP	AREA-ACRES	CROP
1	40	Sorghum		
2	32	Corn		
TOTAL ACRES	72			

Note: Attach forms KS-EN-216 (Furrow Irrigation Design And Irrigation Water Management) and KS EN-22a (Sprinkler Irrigation Operation And Evaluation) as needed.



SOILS MAP
SCALE: 1"= 1,320'

SOIL INFORMATION			
SOIL SYMBOL	SOIL SERIES	DESIGN GROUP	INTAKE FAMILY
Rm	Richfield	3	0.3
Ug	Ulysses	5	0.5

SPRINKLER DESIGN					
FIELD	INTAKE FAMILY (IN.)	DESIGN SLOPE (%)	CROP RESIDUE (LBS./AC.)	MAX ALLOW APPLIC. RATE (IN./HR.)	DESIGN APPLIC RATE (IN./HR.)
2	0.5	0.4	4,000	5.04	4.87

AVAILABLE WATER	
WELL OR PUMP No	CAPACITY G.P.M.
1	600
TOTAL DIVERSION RATE	600 G.P.M.

WATER QUALITY TEST *	
ELECTRICAL CONDUCTIVITY MILLIMHOS/CM	SOLUBLE SODIUM PERCENTAGE
(Not needed)	

* If determined needed.

IRRIGATION DEVELOPMENT PLAN

NAME Example
LEGAL

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

	Date	
Designed		Approved by
Drawn		Title
Traced		Title
Checked		Sheet No. of / Drawing No.

LEGEND	EXISTING	PLANNED
Irrigation Well	●	○
Bench Mark	X^{BM}	SAME
Farm Boundary	———	SAME
Field Boundary	— — —	SAME
Fence	—x——x—	—/——/—
Bench	BENCH	BENCH

LEGEND	EXISTING	PLANNED
Direction Of Irrigation	——→	SAME
Field Number	②	SAME
Private Road	=======	SAME
Public Road	═╪═	SAME
Tailwater Recovery Pit	▣	☐
Dam, Stockwater, Irrigation, Etc.		

LEGEND	EXISTING	PLANNED
Terrace	—T→—T—	--T-→--T--
Diversion	—D→—D—	--D--→--D--
Outlets And Waterways		SAME
Drain Or Pick Up Ditch	···→···→	SAME
Buried Pipeline (Irrigation)		
Surface Or Gated Pipe	—O——O—	--O---O--

LEGEND	EXISTING	PLANNED
Railroad	++++++++	SAME
Buried Utility: O-Oil, G-Gas, T-Tel, W-Water, E-Elec.	—●—( )—●—	—O—( )—O—
Bridge	══)(══	===)(===

3/84

U.S. Government Printing Office 1984 — 766-057

DESIGN SHEETS

1. Sprinkler
    - A. Field and Crop Information
    - B. Equipment Information
    - C. Maximum Allowance Application Rate
    - D. Design Application Rate
    - E. Other Information

2. Furrow
    - A. Field and Crop Information
    - B. Length of Run
    - C. Furrow Stream Size
    - D. Set Time
    - E. Other Information

USDA
SCS

KS-ENG-22
Rev. 3/79

CENTER PIVOT SPRINKLER
DESIGN OR OPERATION EVALUATION

Owner Example Field Office Blackdirt

Legal Descr. SW 1/4 11-23-37 Plan No. ______

Note: Design data from Part 5 of the Kansas Irrigation Guide.

Soil Ulysses Intake family 0.5 Design group 5

Crop Corn Residue 4000 lbs.; Land slope 0.4 %

Water supply 600 gpm; Pipe dia. 6 in.; Line length, L 660 ft.

Distance from pivot to outer drive wheel, D 650 ft.

End gun used (corners) (continuous) [✓ not used]; Q_g — gpm

Number and size of nozzles on outer 100 ft. of line —, 3/8" x —"

Travel speed, T.S. 2.2 ft./min. (at the outside drive wheel)

Area irrigated by line L 32 ac. (Table 5.6); Efficiency 75 %

Pivot pressure, P_p 25 p.s.i.; Q at the pivot, Q_p 600 gpm

Pressure loss in line, P_L 5 p.s.i. (Table 5.8); Pressure at end of line = $P_p - P_L$ = 25 - 5 = 20 p.s.i.; Water supply 600gpm ÷ area irrigated 32 ac. = 18.75 gpm/ac. - actual.

Minimum gross irrigation requirement (continuous application) - Tables 5.3, 5.3a, 5.4, 5.4a = 4.6 gpm/ac. Note: actual gpm/ac. must equal or exceed this. If short, reduce acres or increase water supply.

From Table 5.6, percent of total gpm delivered to outer 100 foot of line = 28.5 % x total gpm 600 = 171 ÷ no. of nozzles in outer 100 ft. 10 = 17.1 * gpm/nozzle, Q_n. from Table 5.7, a 3/8 " nozzle, Q = 18 gpm, and a — " nozzle, Q = — gpm

Total for both nozzles = 18 * gpm, Q_s.

* Total for nozzle(s) Q_s should equal or exceed gpm, Q_n.

(Continued on page 2)

Wetted diameter, W.D. of larger nozzle = 35 ft. (Table 5.7)

Travel distance, T.D. = 6.28 x distance from pivot to outer wheel, D, 650 ft. = 4082 ft. Revolution time, R.T. = T.D. 4082 ft. ÷ (T.S. 2.2 ft./min. x 60) = 30.9 hrs.

Gross application, G.A. $= \frac{Q}{450} \times \frac{R.T.}{A.} = \frac{600}{450} \times \frac{30.9}{32} = 1.29$ in.

Net application = G.A. 1.29 in. x efficiency 75 % = 0.97 in.

Maximum allowable application rate for specified intake group, slope, and residue = 5.04 *in./hr. (Table [✓ 5.2] or 5.2a)

Actual applic. rate $= (G.A. \div \frac{W.D.}{T.S.}) \times 60 = (1.29 \div \frac{35}{2.2})\ 60 = 4.87$ in./hr.

Note: Application rate must not exceed the maximum allowable rate.

System [✓ is] or is not operating within acceptable limits (circle one).

Comments or Recommendations: ______________________________

____

____

** The system is designed and being operated to meet the objectives of sound irrigation water management. Yes ____ No ____

Acres of irrigation water management. ________

Evaluation by ____________________ Date ____________

Title ____________________

Note: Tables referred to are listed in the Kansas Irrigation Guide.

* 1.5"/hr. (4000# residue) x 0.7 = 1.05"/hr. adjusted rate
** Complete if operation evaluation is being made.

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USDA-SCS         CENTER PIVOT IRRIGATION SYSTEM        Trial Form
                                                       KS-ENG-22b

Irrigator: Example                    Land Slope (%):         0.4 %
Legal Description: SW 1/4 11-23-37    Soil:                Ulysses
County:  Blackdirt                    Intake Family:          0.5
Plan #:  1                            Design Group:             5
                                      Degrees of Rotation:    360(degrees)
*******************ALTERNATIVE #1****************************************
Crop:    Corn                             Residue (lb):      4000(lb/ac)
Center Pivot System Flowrate (gpm):                           600(gpm)
Center Pivot System Wetted Radius, L (ft):                    665(ft)
Distance from Pivot to Outer Drive Wheel (ft): . . . .        650(ft)
Wetted Diameter of Largest Lateral Nozzle, WD (ft):            35(ft)
Desired Net Application   (in):                              1.00(in)
Theoretical Efficiency (%) (from Table 5.1):                  75%
Gross Application (in): . . . . . . . . . . . . . . .        1.33(in)
Area Irrigated by Line L, (ac): . . .                        31.9(ac)
Time to Irrigate Entire Area Once, (days)                     1.3(days)
Actual Gross Irrigation Available    (gpm/ac):               18.8(gpm/ac)
Minimum Gross Irrigation Requirement (gpm/ac):                4.6(gpm/ac)
         Ks. Irrig. Guide Table 5.3, 5.3a, 5.4, 5.4a
Percent of Min. Gross Irrig. Requirement (should > 100%)     409%
Maximum Allowable Application Rate (in/hr):                  5.04(in/hr)
         Ks. Irrig. Guide Table 5.2, 5.2a
Actual Application Rate (in/hr): . . . . . . . . . . .       4.85(in/hr)
Ratio {(Actual Applic. Rate)/(Maximum Allowable Rate)}         96%
         (Above ratio should be <= 100%)
Minimum Allowable Wetted Diameter of Outer Nozzles             34(ft)
         to achieve Max. Allow. Applic. Rate
Travel Speed of Outer Drive Wheel (ft/min)                   2.12(ft/min)

Version:       1.5        Planned by:________________     Date:_________

Dev. Date:   SEP 91       Checked by:________________     Date:_________
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USDA
SCS

DESIGN SHEET FOR SURFACE IRRIGATION SYSTEMS

KS-ENG-216
REV. 3/79

Page 1 of 2

Farmer Example
Field Office Blackdirt

Legal Descr. SW 1/4 11-23-37
Plan No.

Available Water 600 g.p.m. - c.f.s.

Design from Part 4 or 6 of the Kansas Irrigation Guide.

Furrow or Corrugation

Field No.	1	
Area - acres	40	
Soils	Richfield	
Irrig. Design Group	3	
Intake family	0.3	
Crop	Sorghum	
Net moist. replaced (in.)	3.5	
Design slope (%)	0.2	
Length of run (ft.)	1300	
Furrow Spacing (in.)	30	
Max. stream (gpm)	26	
Unit stream (gpm/100')	1.0	
Furrow stream (gpm) Initial	13	
Cutback	—	
Reuse	13	
No. rows/set Initial	46	
Cutback	—	
Gross water used (in.)	4.1	
Field eff. (%)	85	
Time to reach end of row (hrs.) *	3.25	
Time required (hrs.)	16.3	

* Not to exceed 20 % of total time/set-hrs.

Border or Basin

Field No.		
Area - acres		
Soils		
Irrig. Design Group		
Intake family		
Crop		
Net moist. replaced (in.)		
Design slope (%)		
Length of run (ft.)		
Border width (ft.)		
Unit stream (cfs/100')		
cfs/ft. width (Q/w)=(Lxq)		
Border stream (cfs)(gpm)		
Flow depth d (ft.)		
Border ht. (ft.)=d+0.2		
No. Borders per set		
Field eff. (%)		
Avg. time/set (hrs.)**		

$$\text{**}\quad \text{Time/set (hrs.)} = \frac{0.23 \times \text{net application (in.)}}{\text{eff.}(\%) \times \text{unit stream } q(\text{cfs})}$$

Designed by ______ Date ______

Approved by ______ Date ______

Note: Record irrigation water management documentation notes on back after Irrigation System has been applied and is in operation.

SUPPORTING DOCUMENTATION

1. NET IRRIGATION WATER REQUIREMENTS
2. IRRIGATION PLANNING WORKSHEET
3. APPLICATION TO APPROPRIATE WATER

USDA
SCS

KS-ENG-394
Rev. 2/82

Operator: Example

Address: ____

Location: Blackdirt

IRRIGATION WATER MANAGEMENT

CROPS AND WATER REQUIREMENT SUMMARY FOR WATER YEAR 92

Well Discharge or Water Delivery 600 g.p.m.

Conservation Plan No: 31

Blackdirt County SCS No: ____

Date: ____

CROP		* Net Monthly Water Requirement- Acre Inches Per Acre											
		JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
Alfalfa Corn	15.4					0.6	3.5	6.3	5.0				
Sorghum Sugar Beets	13.3						0.6	5.6	5.2	1.9			
Soybeans Wheat													
Grass													

FIELD NO.	ACRES	CROP	Net Monthly Water Requirement — Acre Inches Per Crop											
			JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
			Area for Crops Receiving Full or Selected Irrigation During the Summer											
1	40	Sorghum												
2	32	Corn					24	140	252	200				
								19	179	166	61			
SUB-TOTAL							24	159	431	366	61			
			Area for Crops Receiving Pre-irrigation and/or Fall & Winter Irrigation											
SUB-TOTAL														
GRAND TOTAL							24	159	431	366	61			
Pumping Hours (75% Eff.)							24	159	431	366	61			

Pumping Hours = $\frac{450 \times \text{Total Acre Inches}}{\text{gpm} \times \text{Eff. (Decimal)}}$

* Net Monthly Water Require...ant Acre Inches Per Acre (From Part 2 Irrigation Guide 80% Chance)

Pumping 18 days in July

86.75 ac·ft
pumped

PEAK PERIOD CONSUMPTIVE USE RATE - Inches Per Day											
CROP	Net Irrigation Application					CROP	Net Irrigation Application				
	1"	2"	3"	4"	5"		1"	2"	3"	4"	5"
Alfalfa, Corn	0.34	0.32	0.31	0.30	0.29	Grass	0.32	0.30	0.29	0.28	0.27
Sorghum	0.31	0.29	0.28	0.27	0.26	Small Grain	0.23	0.22	0.21	0.20	0.20
Sugar Beets, Beans	0.29	0.28	0.27	0.26	0.25						

KS-ENG-41
1/90

IRRIGATION PLANNING WORKSHEET

NAME: Example

BY: ______

LEGAL DESCRIPTION: SW ¼ 11-23-37

DATE: ______

COUNTY: Blackdirt

RESOURCE DATA

PLAN MAP: Attach sketch map or copy of aerial photo. Indicate field numbers and boundaries; the direction North; and existing wells, pipelines, utilities, etc. Indicate planned structures if appropriate.

TOPOGRAPHY: Attach photocopy of USGS map or other topographic map.

SOILS: Attach photocopy of soils map(s) and complete table below:

SOIL SYMBOL	SOIL SERIES	DESIGN GROUP	INTAKE FAMILY
Rm	Richfield	3	0.3
Ua	Ulysses	5	0.5

FLOODPLAIN HAZARD: YES ______ NO ✓ (Mark yes if damage from scour or sediment occurs once every 10 yrs. or more often.)

WATER QUANTITY AND QUALITY: Complete table; mark capacity estimates with an *:

SOURCE NUMBER	CAPACITY (GPM)	SOURCE TYPE	WATER QUALITY		
			O.K.	UNKNOWN	TEST REQUIRED
1	600	Well	✓		
TOTAL AVAILABLE	600				

CROPPING SEQUENCE: Complete the following table:

TRACT/ FIELD NO.	AREA ACRES	CROP SEQUENCE OR ROTATION	IRRIGATION GOAL	
			FULL	LIMITED
1	40	Sorghum	✓	
2	32	Corn	✓	

List Tracts/Fields requiring FSA Compliance Plans: ______

GRAVITY (FURROW OR BORDER) SYSTEM DATA

The following data applies to field no. 1

TYPE OF SYSTEM: Tailwater Reuse ✓ Surge ____ Cutback ____ Other ____

PRACTICES PLANNED OR APPLIED: Land Leveling ✓ Pipeline ✓ Tailwater Pit ✓ Drainage System ✓

ESTIMATED SYSTEM EFFICIENCY: 75 %

WATER APPLICATION PER IRRIGATION: 3 to 4 Inches Gross / [✓ Net] (circle one)

FURROW SPACING: 30 Inches BORDER WIDTH: — Feet

LENGTH OF RUN: 1300 Feet NO. OF ROWS/BORDERS PER SET: 20 - 30 (if known)

SPRINKLER SYSTEM DATA

The following data applies to field no. 2

ESTIMATED CROP RESIDUE LEVEL: 4000 Pounds/Acre

WATER APPLICATION PER IRRIGATION: 1 Inches Gross / [✓ Net] (circle one)

PRESSURE AT SOURCE: 25 PSI TOTAL SYSTEM Q: 600 GPM

LATERAL PIPE DIAMETER: 6" Inches

NOZZLE DATA: Type: Spray Size: 3/8"

Pressure: 20 PSI Q: 18 GPM Wetted Diameter: 35 Ft.

CENTER PIVOT SYSTEM:

TOTAL WETTED LENGTH: 665 Ft. DISTANCE FROM PIVOT TO OUTER WHEEL: 650 Ft.

TRAVEL SPEED: — Feet/Min. OR REVOLUTION TIME: 32 Hours

END GUN: CORNERS ONLY, CONTINUOUS, [✓ NOT USED] (circle one) END GUN Q: — GPM

TRAVELLING GUN SYSTEM:

TRAVEL SPEED: ____ Feet/Minute WETTED SECTOR: ____ Degrees

TOWPATH SPACING: ____ Feet

PERIODIC MOVE SYSTEM: (Side-Roll, Solid-Set, Hand-Moved and Towed Systems)

TOTAL LATERAL LENGTH: ____ Feet LATERAL SPACING: ____ Feet

NOZZLE SPACING ON LATERAL: ____ Feet

OUTLINE FOR WRITING IRRIGATION DEVELOPMENT PLANS

1. The person writing the IDP and/or obtaining the information from the irrigator should have a general knowledge of irrigation. This is to ask the necessary questions concerning what the irrigator has been doing or plans to do to irrigate his field.

2. Gather the information from the irrigator or other places. This is done with help from the KS-ENG-41. Need slope information from USGS maps (sprinklers) or field surveys (furrows). Obtain an aerial photo showing field and well or pump locations. Use a soil survey to obtain the soils information. Ask the irrigator how he irrigates or plans to irrigate the field, get as much information as possible.

3. First fill out the KS-ENG-440B or equivalent. Draw sketch of field and related areas. Draw soils map and fill out soils information. Fill out cropping plan and other information. Sprinkler design will be filled out after the KS-ENG-22 is completed (for sprinkler), this is not filled out for flood systems.

4. Fill out design sheets KS-ENG-22 for sprinklers and KS-ENG-216 for flood systems.

5. Optional: KS-ENG-394, Crops and Water Requirement Summary.

6. Write a narrative to summarize the Irrigation Development Plan and ~~instruct the irrigator on what he needs to do to meet the plan.~~

set down what was agreed on by the planner and irrigator.

WRITING IRRIGATION WATER CONSERVATION PLANS

Harold R. Blume
Soil Conservation Service
760 South Broadway
Salina, Kansas 67401

The Soil Conservation Service (SCS) has been assisting farmers and ranchers with their conservation needs for over 55 years. Irrigation practices constitute just a portion of the many practices SCS plans and designs. Assistance for irrigators includes designing and laying out irrigation pipelines, tailwater recovery pits, and land leveling; designing sprinkler, surface, and trickle systems; and planning irrigation systems (irrigation water conservation plans).

The initial emphasis of SCS irrigation work was on furrow irrigation systems. Irrigation water conservation plans outlined the system operation. The SCS also designed the practices contained in these plans.

In 1989 the State of Kansas started requiring irrigation water conservation plans for all new permits to use water for irrigation and for a few other situations. The SCS has provided assistance in developing some of these plans.

The following outlines general information that should appear in most SCS plans. Not all planners and designers may think alike on the format and content of the plans, but there are certain guidelines on content set down by the Division of Water Resources and the Kansas Water Office that should be followed. More detailed information on these guidelines can be obtained from the two agencies.

FORMAT AND CONTENT OF A SCS DEVELOPED PLAN

1 A plan consists of four basic parts: the narrative, a plan sheet, design sheets, and supporting documentation. The length of each of these items will depend upon the complexity of the irrigation system being planned.

Narrative

2 The narrative is the first part of the plan. It summarizes the design as agreed to by the irrigator and the planner. The basic parameters of the system are spelled out: whether it's a furrow-irrigated or sprinkler-irrigated field; size and location of the field; number of wells or pumps and their size; and other pertinent items. Besides the physical requirements of the system, it also states the tillage and other management requirements needed to achieve the desired irrigation efficiencies.

Writing an IDP is no different than writing a conservation plan.

Other information in the narrative would cover irrigation water management. Irrigation water management is the practice of managing the water to achieve the largest return for the amount of water used while maintaining acceptable system efficiencies. Two parts of irrigation water management are irrigation scheduling and soil moisture monitoring. Irrigation scheduling is the act of scheduling the irrigations at times when they will do the most good. Soil moisture monitoring is measuring the amount of moisture in the root zone. This measurement is necessary because it is difficult to know when and how much to irrigate if the amount of water in the plants root zone is unknown. Irrigation water management should be discussed with the irrigator. The planner should discuss

3 & 4

Plan Sheet

5 The plan sheet provides more detailed information about the field. A detailed map of the field is shown with location of roads, farmsteads, wells, pipelines, tailwater pits, direction of irrigation for a furrow field, etc. Also, contour lines showing the elevation and slope of the field are superimposed over the drawing of the field itself. The contour lines for sprinkler irrigated fields may be on 5 or 10 foot intervals. For furrow fields, the contours need to be on 1 foot intervals or information is provided that shows the field has been leveled to an acceptable uniform grade.

Other information that can be placed on the plan sheet would include: 1) the cropping plan, which shows what crops will be grown and how many acres of each; 2) soils information, with names of the soils occurring on the field and their irrigation design group and intake family; 3) the design information for any sprinkler used; and 4) information on the water source, capacity (gallons per minute) of the source, and any water quality concerns.

6 & 7

Design Sheets

8 Different design sheets are used depending on the type of irrigation system used. The designs are based on information in the SCS Kansas Irrigation Guide and other SCS irrigation references.

For sprinkler systems, information from the plan sheet and information on the physical properties of the system itself (length of system, flowrate, size and location of sprinkler nozzles, etc.) are used to design a new sprinkler system or to verify the design of an existing system. SCS would determine: the maximum allowable and the design application rates of the nozzles; application efficiency of the system; required wetted diameter of the largest nozzle; time to irrigate the field; and the amount of water applied.

Information on the furrow-irrigated fields is obtained from the plan sheet and the physical features of the equipment are obtained from the irrigator. On new systems, the SCS will use the above information to determine the furrow stream size, length of run, application time, and application efficiency. For an existing system, operational information provided by the irrigator and the physical system features are analyzed to determine if the furrow system is being operated efficiently.

For both types of systems described above, the design of the existing systems may have to be verified with field evaluations. For all designs, an evaluation of the system after the installation of the equipment is recommended.

9, 10, 11, &12

Supporting Documentation

13 Many different items may be placed in this part of the water conservation plan. One of the most common is the form showing estimated net irrigation water requirements of the different crops for each month during the growing season. This form determines whether the water supply is large enough to provide the total irrigation requirements of the crop, especially during the peak-use month.

Other things that may be part of the supporting documentation are additional design computations, information received from the irrigator during the design and planning processes, any field evaluations of the system, and any other information that may be important to the water conservation plan.

14, 15, &16

This is a brief overview of the content and format of irrigation water conservation plans. The actual time involved in writing a particular plan may be up to several months if the system is complex and evaluations have to be made. The planning time may be shortened with correct, timely information from the irrigator and if the irrigator can provide help in performing any field surveys and system evaluations that may be required.

LESSON PLAN HANDOUTS

IRRIGATION TERMS

Gross Irrigation Requirements (Inches) - Gross amount of water that must be available at a certain efficiency level to satisfy the moisture needs of the various crops.

Net Irrigation Requirements (Inches) - The water need of the specified crop over and above effective rainfall and the carryover soil moisture.

Farm Irrigation Efficiency (Percent) - The percent of the irrigation water at the source which actually ends up in the root zone and is available to the plant.

Water Holding Capacity (Inches) - Total amount of water that is available in the root zone of the soil profile.

Field Capacity (Inches) - Water content of the soil after the drainage rate has become small and it is an estimate of the amount of water that may be temporarily stored in the soil profile.

Permanent Wilting Point (Inches) - The soil water content below which plants growing in the soil remain wilted because there is not enough water to meet plant needs.

Available Water Capacity (Inches) - The amount of water released by the soil between field capacity and permanent wilting point that is available for crop use.

IRRIGATION
MANAGEMENT
SERIES

Originals separate - in this folder.

Soil Water Measurements:

An Aid to Irrigation Water Management

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Soil water status must be monitored for effective irrigation water management. The soil acts as a bank, storing water for use by the crop. Adequate soil water in the crop root zone provides for optimum plant growth. If the water in the soil is depleted below a given level, crop yields can be decreased.

Soil water measurement is useful in determining:

- How much water is available for crop use
- When to irrigate
- How much irrigation water to apply

Soil water measurement must be an integral part of any irrigation scheduling program. Soil water monitoring can help conserve water, conserve energy, and produce optimum crop yields.

SOIL WATER MEASUREMENT

There are several methods that can be used to measure soil water. Some are more useful to the irrigator than others. The irrigator will want a method that gives the soil water available for use by the crop. Most soil water measurement methods require calibration of some type to give available soil water.

GRAVIMETRIC SAMPLING

Samples are taken from the soil and weighed. After drying in an oven, the samples are weighed again and percent moisture, on a dry-weight basis, in the soil is calculated. The bulk density of the soil must be known to convert percent to water volume. The soil water volume at field capacity and permanent wilting point must be known to determine the percent of available water in the soil.

Gravimetric sampling is time-consuming and not very useful to most irrigators. Samples must be taken each time a measurement is needed. A day or more is required to dry the samples. The samples must be weighed accurately and must be taken from a different point in the field each time.

Gravimetric sampling is the only method that actually measures the presence of water in the soil. All other methods use some property of the soil to give a soil water measurement.

APPEARANCE AND FEEL TEST

Visual observation and feel of the soil is probably the most versatile method for irrigators to use to monitor soil water. A soil probe (Figure 1), auger, or spade is used to obtain a soil sample. Although not exact, comparing the appearance and feel of the soil with Table 1 and Figures 2, 3 and 4 can give an estimate of available soil water. Soil probing can be used as a check on other monitoring methods and is especially useful in monitoring the depth of penetration of irrigation applications and rainfalls. Sometimes other problems, like compacted soil layers, can be detected from the probing. Also, the irrigator is not tied to specific locations to monitor, but can check any location in the field as needed (although, as with gravimetric sampling, the exact same location cannot be resampled).

Soil samples for estimating water content should be taken from the active root zone. One sample should be taken from the upper quarter of the root zone and one or two more samples from lower levels. For example, with a 36-inch major root zone, sampling should probably be done at the 6- to 12-inch depth and the 24- to 30-inch depth.

Although measuring soil water by appearance and feel is not precise, with experience and judgment the irrigator should be able to estimate the level with a reasonable degree of accuracy.

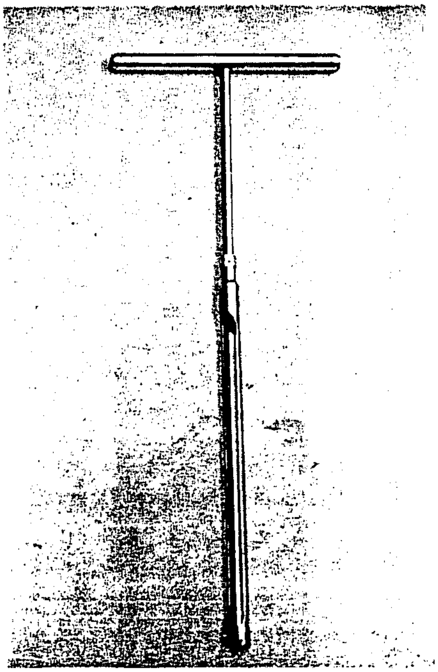


Figure 1: *Soil Probe*

TENSIOMETERS

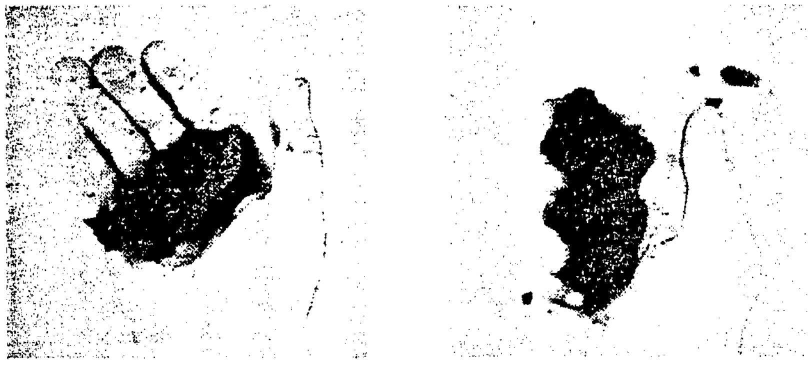
A tensiometer is a sealed, water filled tube with a vacuum gauge on the upper end and a porous ceramic tip on the lower end (Figure 5). Tensiometers are installed in a hole made with a soil probe or auger. As the soil around the tensiometer dries out, water is drawn from the tube through the ceramic tip. This creates a vacuum in the tube that can be read on the vacuum gauge. When the soil water is increased, through rainfall or irrigation, water enters the tube through the porous tip, lowering the gauge reading. The tensiometer gives a measure of soil water tension, or the force with which the water is being held by the soil, which is related to soil water content.

Tensiometers are normally available in lengths from 6 to 48 inches. The tensiometers are placed at a location where the soil water will be monitored. A station usually consists of two tensiometers of different lengths. One station should be near the upper end of the field and the other near the lower end of the first set. The stations should be placed in an area that has a similar soil, slope and plant population and are

Figure 2: MEDUIM TEXTURE-*Loams and Silt Loams*

0 to 25% Available Moisture
Crumbles easily, tends to hold together from hand pressure.

25 to 50% Available Moisture
Somewhat crumbly, will hold together in hand with pressure.



50 to 75% Available Moisture
Forms "ball" readily, will "slick" slightly with pressure.

75 to 100% Available Moisture
Forms "ball" easily, fairly friable, "slick" readily.

Table 1: INTERPRETATION CHART FOR SOIL MOISTURE

FEEL OR APPEARANCE OF SOILS

Soil Moisture Remaining	Very Light Texture	Light Texture	Medium Texture	Heavy and Very Heavy Texture
0 percent	Dry, loose, single-grained, flows through fingers.	Dry, loose, flows through fingers.	Powdery, dry, sometimes slightly crusted but easily breaks down into powdery condition.	Hard baked, cracked, sometimes has loose crumbs on surface.
50 percent or less	Still appears to be dry; will not form a ball with pressure.*	Still appears to be dry; will not form a ball.	Somewhat crumbly, but will hold together from pressure.	Somewhat pliable, will ball under pressure.
50 to 75 percent	Same as very light texture with 50 percent or less moisture.	Tends to ball under pressure but seldom will hold together.	Forms a ball, "somewhat plastic; will sometimes slick slightly with pressure."	Forms ball; will ribbon out between thumb and forefinger.
75 percent to field capacity	Tends to stick together slightly, sometimes forms a very weak ball under pressure.	Forms weak ball, breaks easily, will not slick.	Forms a ball and is very pliable; slicks readily if relatively high in clay.	Easily ribbons out between fingers; has a slick feeling.
At field capacity (100 percent)	Upon squeezing, no free water appears on soil but wet outline of ball is left on hand.	Same as very light texture.	Same as very light texture.	Same as very light texture.
Above field capacity	Free water appears when soil is bounced in hand.	Free water will be released with kneading.	Can squeeze out free water.	Puddles and freewater form on surface.

*Ball is formed by squeezing a handful of soil very firmly with fingers.

Figure 3: MODERATELY FINE TEXTURE–*Clay Loams and Silty Clay Loams*

0 to 25% Available Moisture
Crumbles readily, will hold together but "balls" with difficulty and breaks easily.

25 to 50% Available Moisture
Does not crumble, form readily, will "ball" with pressure.

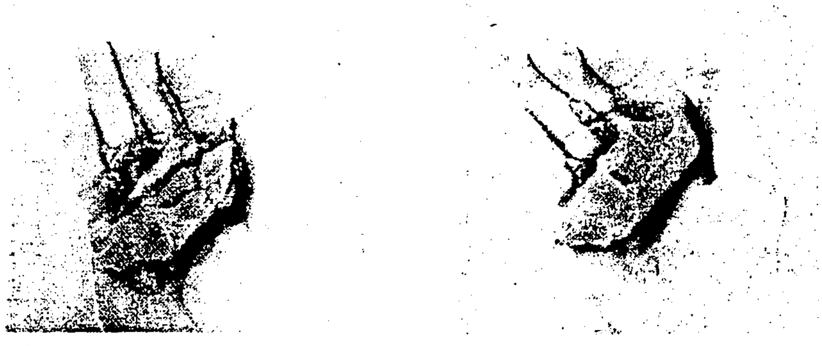
50 to 75% Available Moisture
Forms "ball" readily, will "ribbon" out between thumb and forefinger. Somewhat slick feeling.

75 to 100% Available Moisture
Easily "ribbons" out. Has "slick" feeling.

Figure 4: COARSE TEXTURE–*Sandy Loams and Loamy Sands*

0 to 25% Available Moisture
Dry, loose, flows through fingers.

25 to 50% Available Moisture
Looks dry, will not form ball with pressure.



50 to 75% Available Moisture
Will form loose ball under pressure, will not hold together even with easy handling.

75 to 100% Available Moisture
Forms weak ball, breaks easily, will not "slick."

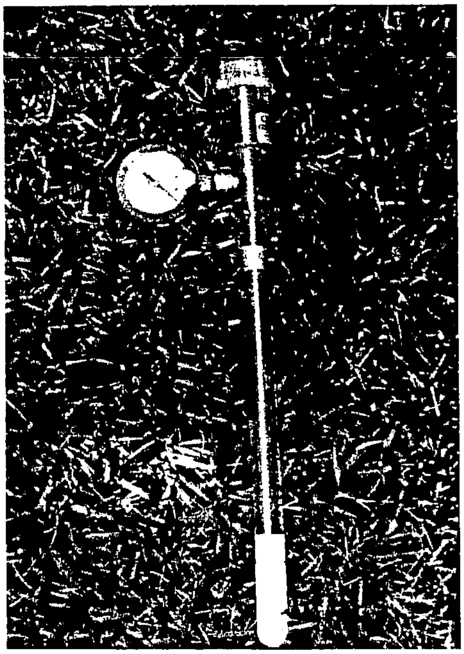


Figure 5

representative of the entire field.

The tensiometers are placed in the row and angled downward toward the furrow. The depth of installation is determined by the active root zone of the crop. This active root zone depends on the crop, stage of growth and the soil. For example, for corn on a deep soil with an active root zone of 3 feet, the recommended depths would be 12 and 24 inches.

Tensiometers are best suited for sandy soils because of the range of water tension measured. The vacuum in the tensiometer will break if the soil becomes too dry. The tensiometers must be read every few days and serviced if the fluid level drops or the vacuum is broken.

ELECTRICAL RESISTANCE BLOCKS

Electrical resistance blocks or gypsum blocks are made with gypsum around a pair of stainless steel wires or wire grids (Figure 6). These grids are attached to lead wires that can be plugged into a portable resistance meter. When the blocks are placed in the soil, the water content of the gypsum block will be nearly equal to that of the soil. The flow of electricity between the wire grids varies with water content and a reading on the resistance meter will give a measure of soil water content. For best results, the blocks should be calibrated for individual soil types to give

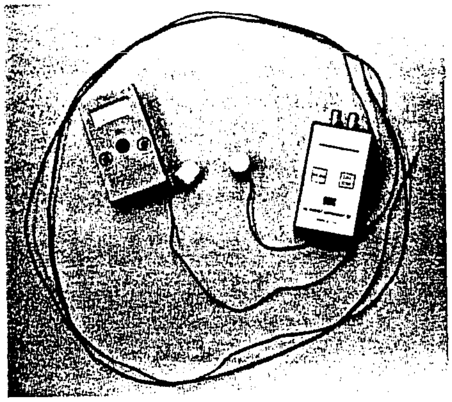


Figure 6

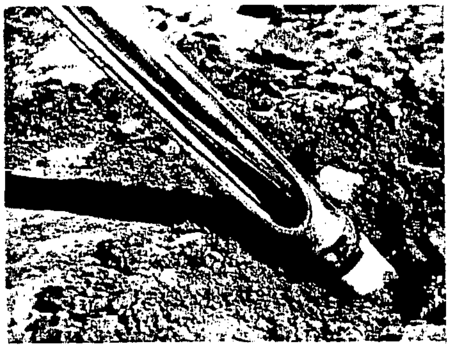


Figure 7

accurate soil water deficits.

The blocks are placed in the field similar to tensiometers. The blocks should be placed in the soil as early in the season as practical so the roots will develop around the block. The blocks are prepared for installation by subjecting them to wet-dry cycles. (Follow the manufacturer's recommendations.) A soil probe or auger is used to make a hole slightly larger in diameter than the block to the depth desired. The hole should be angled toward the furrow. The shallow blocks should be approximately under the edge of the furrow and the deep block under the furrow. Each block should be placed in a separate hole.

The last soil removed from the hole is used to make a slurry of mud in the bottom of the hole. This provides good contact between the block and the soil. The blocks are pushed into the hole with a soil probe (Figure 7). The hole should be filled with soil 3 to 4 inches at a time, tamping the soil firmly. The wire leads are brought to a single location and normally tied to a stake for easy location. The wires should be color coded or identified in some way so that the block depth is known. A differing number of knots, tied in the leads, is a good way to identify different installation depths.

Electrical resistance blocks are sensitive to a wide range of soil water conditions. Blocks are especially useful on medium and fine (clay) textured soils. The blocks are normally used for one growing season, and then are destroyed by seedbed preparation for the next crop. The meter can be used for several fields and from season to season. Blocks may not respond fast enough to soil water changes in sandy soils to be useful.

ELECTRICAL RESISTANCE PROBES

There are portable probes available that can be placed in the soil to give a water reading. Most of the probes make some type of electrical resistance measurement. One of the limitations of the probes is calibration of the probe measurements with the soil water content of a particular soil. These types of probes have not been widely used in Kansas.

NEUTRON PROBE

The neutron probe will probably not be used by individual irrigators. It is used extensively by researchers and may be used some by crop production consultants. The neutron probe is the most expensive and probably the most accurate of the soil water measuring devices available. The neutron probe uses a radioactive source that is lowered into a metal tube placed in the soil. Neutrons from the source are emitted at high velocity but are slowed by collision with hydrogen atoms on the soil. The slowed neutrons are counted by a sensor. Nearly all of the hydrogen atoms in the soil are a part of the water in the soil. Increasing the water content will increase the number of slow neutrons counted. The slow neutron count of the neutron probe is calibrated with soil water content.

The neutron probe has the advantage that the same point may be sampled as frequently as desired without disturbing the soil; the access tubes may be left in the soil for the entire season; and the measurement is a zone of substantial size which gives a better average soil water value. The procedure is time-consuming and requires special training in handling and using the equipment. The equipment is also relatively expensive.

RECORDS

A record of soil water measurements should be maintained. The soil water record, along with irrigation applications, rainfall, crop condition, stage of growth and other crop production data can help explain what takes place in a field. These records can be extremely useful in future planning and management and also help to build experience and confidence in the methods and procedures used.

SUMMARY

Soil water monitoring is necessary for effective irrigation water management. Soil water measurement can help determine (1) how much water is available in the soil for crop growth, (2) when to irrigate and (3) how much water to apply.

All soil water monitoring methods require experience and judgement. The most common method used by Kansas irrigators is the appearance and feel method, using samples collected with a soil probe. Gypsum resistance blocks and tensiometers could be useful methods as well.

Soil water records should be maintained and compared with other production data.

KSU
KANSAS STATE UNIVERSITY

COOPERATIVE EXTENSION SERVICE, MANHATTAN, KANSAS

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File: Engineering 4-3 (Irrigation) 10-89-3M

§523.00 General.

Irrigation is the efficient application of water to land areas for purposes of sustained agricultural crop production. This requires proper evaluation of the soil or land surface materials so they are compatible with the planned plantings; evaluation of water sources for quality and quantity; evaluation of the land surface topography and water delivery and distribution system layout; and operation skill levels for proper management. Irrigation increases the capability to not only produce a variety of crops, but also allows for better control of quantity and quality of the crop. It allows land susceptible to excessive erosion to be taken out of row crops and returned to permanent vegetative cover. Increases in irrigation have accentuated the need to manage the application of water, minimize erosion, use the water resources wisely, and thus maintain the quality of surface and ground water. The objectives of a resource management system, which often includes irrigation, are to achieve acceptable levels of quality for sustained use of the resources, adequately protect the environment, and provide an acceptable standard of living.

§523.01 Technical assistance.

SCS is a recognized leader in irrigation technology, especially in plant, soil, and water management. The Service helps landowners develop resource conservation systems necessary to meet the conservation needs of the land; develop technical materials and standards; train landowners, contractors, manufacturers, and others in design and use of systems compatible with soil conditions and plant needs; and assists other federal agencies and foreign governments. SCS provides landowners direct technical assistance with on-farm irrigation water management. With limited resources, priorities for furnishing technical and financial assistance must be carefully assessed.

§523.02 Irrigation guides.

Each state conservationist is responsible for preparing an irrigation guide setting forth the basic design and management criteria for all conservation irrigation methods applicable to local combinations of soils, slopes, crops, water supply, and climatic conditions. The state conservationist may assign leadership responsibility to someone on his or her staff for developing or updating the irrigation guide. Although SCS has the technical responsibility for preparing the irrigation guide, cooperation from others is desirable, such as representatives of the state university, state experiment stations, Extension Service, and Agricultural Research Service. A suggested outline for the Irrigation Guide is provided in the National Engineering Handbook, Section 15, Chapter 3, Planning Farm Irrigation Systems.

§523.03 Assistance on irrigation projects.

SCS policy is to assist individual farmers, farmer groups, and legal entities to install irrigation practices that maximize the conservation uses of soil and water resources and minimize operation and management problems. SCS plans and designs conveyance systems that measure and control irrigation water deliveries to each water user. In irrigation land treatment projects, SCS plans and designs on-farm systems.

§523.04 Water management for salinity control.

Water management recommendations will be made that will result in control of salinity both on and off site. Some soluble salts in the soil and irrigation water are toxic to plants. Water management recommendations will consider control of salinity within the root zone and in return flows (off site). The key to soil salinity control is a net downward movement of soil water in the crop root zone. Poor internal drainage may necessitate installation of improved drainage measures.

§523.05 Irrigation training.

SCS will develop and maintain an adequately trained and informed staff which understands the principles of irrigation system design, operation and management. SCS will maintain a coordinated training program that includes a series of courses covering soil-plant-water relationships, methods of estimating evapotranspiration, methods of scheduling irrigations, system design, system evaluation and management, and the use of the latest technology and equipment. The Service also provides training and technical instructions to contractors and landowners who install and/or manage an irrigation system.

§KS523.01 Technical assistance.

(a) Kansas policy regarding technical assistance in the development of irrigated lands is as follows:

(1) Technical assistance by SCS personnel for irrigation land development shall be in accordance with the applicable Kansas standards and specifications and the criteria listed in the Kansas Irrigation Guide. Item H, Procedure Guide for Irrigation Land Development, page 1-4, Part 1, of the Kansas Irrigation Guide shall be followed for planning, design, and the establishment of irrigation systems.

(2) The feasibility for irrigation land development shall be determined by the responsible technician using the criteria listed in Item (1) above and with due consideration given to the following:

(i) Water quality has been determined to be within acceptable limits. (If a water test is needed, it will be the irrigator's responsibility to secure one.)

(ii) Water supply is adequate and dependable for the planned conservation use.

(iii) Soils are irrigable and are listed in Part 3 of the Kansas Irrigation Guide. For soils not listed in Part 3 of the guide, follow the instructions under item H.2d, Procedure Guide for Irrigation Land Development, page 1-5, Part 1, of the guide.

(iv) Topographic features lend themselves to the type of system planned with consideration given to any potential erosion, drainage, or irrigation water management problems.

② (3) Conservation planning shall be a prerequisite to furnishing technical assistance for establishing any permanent part(s) of an irrigation system. Complete irrigation system planning may be required when deemed necessary to properly install any part of a system. A complete plan should be recorded on Form KS-ENG-440A(JS) or KS-ENG-440B(JS). An irrigation plan requiring less detail may be recorded on a conservation plan map or other appropriate plan sheet.

Permanent part(s) of an irrigation system are practices such as land leveling, buried irrigation pipelines, irrigation canals and laterals, pumping plants, structures for water control, drainage mains and laterals, and tailwater recovery pits.

refer to with overhead

A complete irrigation plan of a gravity irrigation system will be done using a reliable topographic map. A topographic map ordinarily has survey shots on a maximum spacing of 330-foot (100.6-meter) with detailed shots taken between as needed. The plan will be periodically updated to show fields leveled, buried pipe and other practices installed, and dates completed.

A complete irrigation plan of a sprinkler system will be done using either a detailed topographic map or a United States Geological topographic map on a 7.5 minute scale (1:24,000) with 5-foot (1.5-meter) contour elevations.

① (b) It is Kansas SCS policy to promote irrigation water management through (1) maximum efficiency of water use, (2) minimizing soil erosion and loss of plant nutrients, and (3) controlling undesirable water loss. Proper irrigation water management should result in (1) maintaining or improving water quality and (2) optimizing the quantity of available water. The Kansas Irrigation Guide and the Kansas Technical Guide Standards provide sound criteria for irrigation design. These references shall be used for irrigation system evaluation and to assist, advise, or train irrigators to attain irrigation water management. Irrigation water management will be documented by completing applicable data sheets for the irrigated acreage.

(c) In order to promote irrigation water management, SCS personnel are to provide technical assistance to irrigators so they will have the knowledge to:

(1) Determine acceptable water quality.

(2) Know when to irrigate by determining the available soil moisture in the root zone and by knowing the peak and seasonal consumptive use rates of the crops being irrigated.

(3) Measure or compute the amount of water available for irrigating.

(4) Understand the soil characteristics and system layout so as to determine the water application rate and time needed.

(5) Adjust the system operation (delivery rate and application time) to allow for changes in soil intake rates.

(6) Control soil erosion caused by irrigation to less than "T."

(7) Apply corrective measures to prevent excessive irrigation runoff and/or percolation.

(8) Evaluate the effectiveness of the completed irrigation.

(d) Periodic evaluations of irrigation water management will be made to confirm the validity and adequacy of the technical criteria contained in the Kansas Irrigation Guide. These evaluations will be made on selected irrigation systems. The evaluations shall be under the general supervision of an engineer and coordinated through the area conservationists and the state water management specialist. Selection factors to be considered for the evaluations shall include the irrigator's desire and capability, the irrigation system design, soil characteristics, crops, water supply, and other related items.

IRRIGATION DEVELOPMENT PLAN

Irrigator..............Example
Legal Description......
County.................Wallace
Date...................9/19/91
Planner................Harold Blume

This system consists of two different wells drawing water at the rate of 1420 gpm and 1695 gpm which will be referred to as wells #1 and #2 respectively. The system currently has a towable center pivot sprinkler between fields 2 and 3. The producer is planning on another pivot to dispense with the towing between fields. The producer generally follows a wheat, corn, follow rotation. His tillage operations will consist of deep chisel in fall, light disc, plant. The pivot system(s) will be operated with 4000 lbs./ac corn residue on fields 2 and 3 and 2000 lbs./ac of wheat residue. The average slope on field 2 being 1.0% and on field 3 being 1.5%.

Use of chisel tillage operations will increase infiltration and surface storage on the center pivot field. This will be an annual operation to prevent runoff from the field and minimize the movement of water within the field.

Part of the flood ground in this plan has been leveled to meet SCS-464 land leveling specifications. All flood ground is generally .5% - 1% average slope. The producer is currently running 12 hour, 70-150 row sets. The smaller being on the longer runs (Fields 1, 5, 6). He also is using surge valves to assist with cutback on all fields.

Information in filling out the Design Sheet for Surface Irrigation Systems, KS-ENG-216, was obtained from the producer during a visit to the field. This information was used to check runoff, application efficiency, and deep percolation using equations from the Soil Conservation Service, National Engineering Handbook, Section 15, Chapter 11 (Sprinkle Irrigation). A computer program was used for these calculations. The results showed that deep percolation was minimal and that runoff could be up to 40% without cutback irrigation. Runoff will be minimized using cutback irrigation. Surge valves will be used to simulate cutback irrigation and berms will be placed at the bottom of the field to prevent any water from leaving.

There could be a tenacity with the small stream flows to have poor uniformity in water application down the field, especially on the fields with the longer runs. Soil moisture checks should be made at several places down the field on Fields 1, 5, and 6.

From Form KS-ENG-394 (Irrigation Water Management):

Frequency of irrigation for corn in July: July NIR is 6.1 inches divided by 31 days = .197 inches per day needed. 1.5 inches net irrigation divided by .197 in/day = 7.6 days.

Frequency of irrigation for wheat in May: May NIR is 4.4 inches divided by 31 days = .142 inches per day needed. 1.5 inches net irrigation divided by .142 in/day = 10.6 days.

Frequency of irrigation during peak use:
- Corn - 4.5 days.
- Wheat - 6.5 days.

The wells can meet the crop water demands for both crops.

Irrigation Scheduling

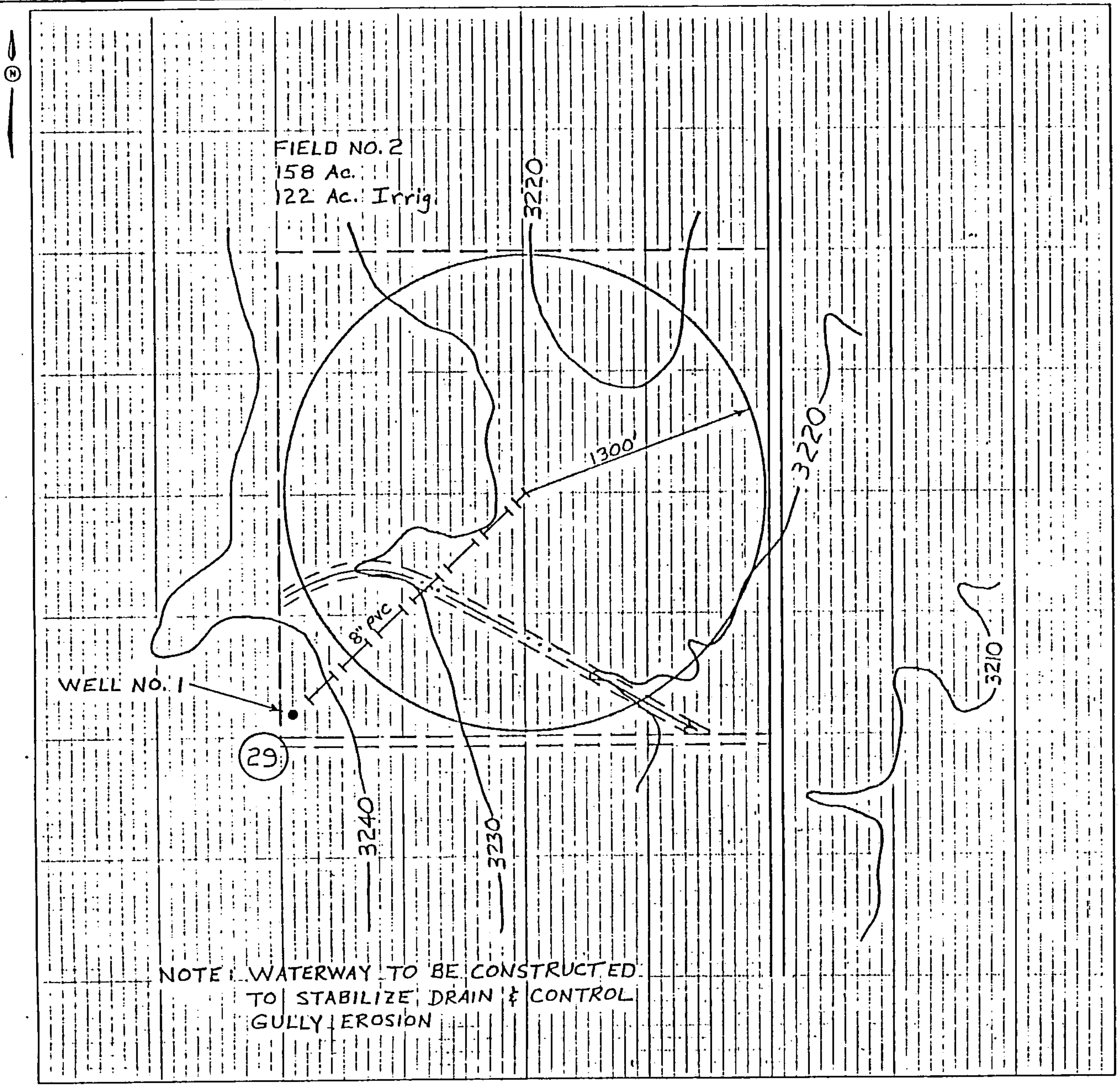
To produce maximum crop yields, plants must have ample moisture throughout the growing season. Moisture is especially important during the critical growth period of the crop. For corn this is tasseling and silking and for wheat it is boot, bloom, and early head stage. If water is limited, moisture during the critical growth periods will provide maximum yield per unit water applied. Irrigations can be applied during the vegetative period if the crop is under a moisture short situation.

The amount of moisture in the soil profile should be measured periodically to determine when and how much to irrigate. For full irrigation, the corn and wheat should be irrigated when the moisture level in the top two feet of the soil profile has dropped to 50% of a full profile. This level of soil moisture can be determined by using the feel method, tensiometers, gypsum blocks, or other methods.

Visual observations of the system in operation during the season should be made to check for erosion in the furrows, runoff, leaks in the system and other problems.

Plan Revision

Whenever the output from the wells are determined to be significantly different from the 3115 gpm assumed or the operation of the center pivots and furrow systems has changed, this water conservation plan must be revised.



GENERAL LAYOUT MAP
Scale: 1"= 660'

LEGEND	EXISTING	PLANNED
Irrigation Well	●	○
Bench Mark	X^BM	SAME
Farm Boundary	——┘	SAME
Field Boundary	— — —	SAME
Fence	—x—x—	—/—/—
Bench	BENCH	BENCH

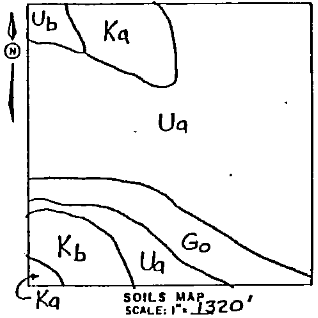
LEGEND	EXISTING	PLANNED
Direction Of Irrigation	——→	SAME
Field Number	⑥	SAME
Private Road	======	SAME
Public Road	═══	SAME
Tailwater Recovery Pit	▣	▯
Dam, Stockwater, Irrigation, Etc.		

LEGEND	EXISTING	PLANNED
Terrace	—T→—T—	--T→--T--
Diversion	—D→—D—	--D--→--D--
Outlets And Waterways	⊂≡≡≡⊃	SAME
Drain Or Pick Up Ditch	—··→—··→	SAME
Buried Pipeline (Irrigation)	⊢—⊣	⊢--⊣
Surface Or Gated Pipe	—O— —O—	--O---O--

LEGEND	EXISTING	PLANNED
Railroad	++++++++	SAME
Buried Utility: O-Oil, G-Gas, T-Tel, W-Water, E-Elec.	—●—( )—●—	—O—( )—O—
Bridge	══)(══	==)(==

CROPPING PLAN				
FIELD No.	SUMMER IRRIGATION		WINTER IRRIGATION	
	AREA-ACRES	CROP	AREA-ACRES	CROP
2	122	CORN		
TOTAL ACRES	122			

Note: Attach forms KS-EN-218 (Furrow Irrigation Design And Irrigation Water Management) and KS-EN-22a (Sprinkler Irrigation Operation And Evaluation) as needed.



SOILS MAP
SCALE: 1"= 1320'

SOIL INFORMATION			
SOIL SYMBOL	SOIL SERIES	DESIGN GROUP	INTAKE FAMILY
Go	Goshen	5	0.5
Ka, Kb	Keith	5	0.5
Ua, Ub	Ulysses	5	0.5

SPRINKLER DESIGN					
FIELD	INTAKE FAMILY (IN.)	DESIGN SLOPE (%)	CROP RESIDUE (LBS./AC.)	MAX. ALLOW APPLIC. RATE (IN./HR.)	DESIGN APPLIC. RATE (IN./HR.)
2	0.5	1	3500	1.71	1.71

AVAILABLE WATER	
WELL OR PUMP No.	CAPACITY G.P.M.
1	700
TOTAL DIVERSION RATE	700 G.P.M.

WATER QUALITY TEST *	
ELECTRICAL CONDUCTIVITY MILLIMHOS/CM	SOLUBLE SODIUM PERCENTAGE

* If determined needed.

IRRIGATION DEVELOPMENT PLAN

NAME EXAMPLE
LEGAL

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE

Designed FCM Date 12/86
Drawn
Traced
Checked

Approved by
Title

Title
Sheet No. of
Drawing No.

☆U.S. GOVERNMENT PRINTING OFFICE: 1984-766-051

USDA
SCS

KS-ENG-22
Rev. 3/79

CENTER PIVOT SPRINKLER
DESIGN OR OPERATION EVALUATION

Owner EXAMPLE Field Office ____

Legal Descr. ____ Plan No. ____

Note: Design data from Part 5 of the Kansas Irrigation Guide.

Soil Goshen Keith Ulysses Intake family 0.5 Design group 5

Crop Corn Residue 2000 lbs.; Land slope 1 %

Water supply 700 gpm; Pipe dia. 6 in.; Line length, L 1300 ft.

Distance from pivot to outer drive wheel, D 1250 ft.

End gun used (corners) (continuous) [✓ (not used)]; Q_g —— gpm

Number and size of nozzles on outer 100 ft. of line ____, ____" x ____"

4 day rev. time
Travel speed, T.S. 1.4 ft./min. (at the outside drive wheel)

Area irrigated by line L 122 ac. (Table 5.6); Efficiency 75 %

Pivot pressure, P_p ____ p.s.i.; Q at the pivot, Q_p ____ gpm

Pressure loss in line, P_L ____ p.s.i. (Table 5.8); Pressure at end of line = $P_p - P_L$ = ____ - ____ = ____ p.s.i.; Water supply 700 gpm ÷ area irrigated 122 ac. = 5.7 gpm/ac. - actual.

Minimum gross irrigation requirement (continuous application) -
50% Chance, 75% Eff.
Tables 5.3, 5.3a, 5.4, [✓ 5.4a] = 4.2 gpm/ac. Note: actual gpm/ac. must equal or exceed this. If short, reduce acres or increase water supply.

From Table 5.6, percent of total gpm delivered to outer 100 foot of line = 14.8 % x total gpm 700 = 104 ÷ no. of nozzles in outer 100 ft. ____ = ____* gpm/nozzle, Q_n. from Table 5.7, a ____" nozzle, Q = ____ gpm, and a ____" nozzle, Q = ____ gpm

Total for both nozzles = ____* gpm, Q_s.

* Total for nozzle(s) Q_s should equal or exceed gpm, Q_n.

(Continued on page 2)

Wetted diameter, W.D. of larger nozzle = 60 ft. (Table 5.7)

Travel distance, T.D. = 6.28 x distance from pivot to outer wheel, D, 1250 ft. = 7850 ft. Revolution time, R.T. = T.D. 7850 ft. ÷ (T.S. 1.4 ft./min. x 60) = 93.5 hrs. (Use 96 hrs. = 4 days)

Gross application, G.A. = $\frac{Q}{450} \times \frac{R.T.}{A.} = \frac{700}{450} \times \frac{96}{122} =$ 1.22 in.

Net application = G.A. 1.22 in. x efficiency 75 % = 0.92 in.

Maximum allowable application rate for specified intake group, slope, and residue = (1.80)(0.80) 1.44 *in./hr. (Table [✓ 5.2] or 5.2a)

Actual applic. rate = $(G.A. \div \frac{W.D.}{T.S.}) \times 60 = (1.22 \div \frac{60}{1.4})\ 60 =$ 1.71 $\frac{in.}{hr.}$

Note: Application rate must not exceed the maximum allowable rate.

System is or [✓ is not] operating within acceptable limits (circle one).

Comments or Recommendations: Raise residue level to a min. of 3500 lbs./ac. → max. allowable application rate = (1.80)(0.95) = 1.71 in/hr.

Alternative: Increase wetted dia. to 70 ft.

** The system is designed and being operated to meet the objectives of sound irrigation water management. Yes ____ No ____

Acres of irrigation water management. ________

Evaluation by FCM Date 12-88

Title ________

Note: Tables referred to are listed in the Kansas Irrigation Guide.

* 1.5"/hr. (4000# residue) x 0.7 = 1.05"/hr. adjusted rate

** Complete if operation evaluation is being made.

```
USDA-SCS          CENTER PIVOT IRRIGATION SYSTEM       Trial Form
                                                       KS-ENG-22b

Irrigator: Example                  Land Slope (%):          1 %
Legal Description: SW 1/4 11-23-37  Soil:                 Keith
County:  Blackdirt                  Intake Family:          0.5
Plan #:  T345                       Design Group:            5
                                    Degrees of Rotation:    360(degrees)
*******************ALTERNATIVE #1*************************************
Crop:    Corn                           Residue (lb):      3000(lb/ac)
Center Pivot System Flowrate (gpm):                         650(gpm)
Center Pivot System Wetted Radius, L (ft):                 1300(ft)
Distance from Pivot to Outer Drive Wheel (ft): . . . .     1290(ft)
Wetted Diameter of Largest Lateral Nozzle, WD (ft):          30(ft)
Desired Net Application   (in):                            1.00(in)
Theoretical Efficiency (%) (from Table 5.1):                75%
Gross Application (in): . . . . . . . . . . . . . .         1.33(in)
Area Irrigated by Line L, (ac): . . .                     121.9(ac)
Time to Irrigate Entire Area Once, (days)                   4.7(days)
Actual Gross Irrigation Available    (gpm/ac):              5.3(gpm/ac)
Minimum Gross Irrigation Requirement (gpm/ac):              4.6(gpm/ac)
         Ks. Irrig. Guide Table 5.3, 5.3a, 5.4, 5.4a
Percent of Min. Gross Irrig. Requirement (should > 100%)    116%
Maximum Allowable Application Rate (in/hr):                4.62(in/hr)
         Ks. Irrig. Guide Table 5.2, 5.2a
Actual Application Rate (in/hr): . . . . . . . . . . .     3.18(in/hr)
Ratio {(Actual Applic. Rate)/(Maximum Allowable Rate)}       69%
         (Above ratio should be <= 100%)
Minimum Allowable Wetted Diameter of Outer Nozzles           21(ft)
         to achieve Max. Allow. Applic. Rate
Travel Speed of Outer Drive Wheel (ft/min)                 1.19(ft/min)

Version:       1.5         Planned by:________________    Date:_________

Dev. Date:   SEP 91        Checked by:________________    Date:_________
```

II. IRRIGATION DEVELOPMENT PLAN CONTENT

A. Resource Data for Planning

1. Water quality
    - a. Primarily for salinity
    - b. May also cover nitrates, pesticides, etc.
2. Water quantity (example: well gpm)
3. Soils (see Part 3, Kansas Irrigation Guide)
4. Topography
    - a. Surface (flood/gravity) systems - grid or contour map with survey shots on maximum 330 ft. spacing
    - b. Sprinkler systems - grid/contour map or USGS topographic map (1:24,000) expanded to plan map scale
5. Flood plain data - land not recommended for development if subject to scour or deposition from flooding more frequently than once every ten years

B. IRRIGATION DEVELOPMENT PLAN

1. CONSERVATION CROPPING SEQUENCE
    - A. TYPE OF CROPS
    - B. ACRES OF EACH CROP
    - C. DETERMINATION OF MAXIMUM IRRIGATED ACRES BASED ON OBJECTIVE
        - I. FULL - USE METHOD ON PAGE 1-7 KANSAS IRRIGATION GUIDE OR FORM KS-ENG-394
        - II. SUPPLEMENTAL/LIMITED - BASED ON AVAILABLE WATER AND YIELD GOAL

2. EROSION CONTROL (AS REQUIRED)

   A. NON-EROSIVE APPLICATION RATES - MAXIMUM SLOPES STREAM SIZES, ETC.

      I. SEE PART 4, KANSAS IRRIGATION GUIDE FOR GRAVITY SYSTEMS

      II. SEE PART 5, KANSAS IRRIGATION GUIDE FOR SPRINKLER SYSTEMS

   B. MANAGEMENT PRACTICES

      I. CULTURAL - CONTOUR FARMING, CONSERVATION TILLAGE, STRIP CROPPING, ETC.

      II. MECHANICAL - FURROW-DIKING, PITTING, INTER-ROW RIPPING - FOR SPRINKLERS

   C. STRUCTURAL PRACTICES - TERRACES, WATERWAY, ETC

3. IRRIGATION DEVELOPMENT (AS REQUIRED FOR EFFICIENCY)

   A. WATER CONVEYANCE - PIPELINES, CANALS AND LATERALS, PUMPING PLANTS, WATER CONTROL STRUCTURES, ETC.

   B. GRAVITY SYSTEMS - LAND LEVELING, TAILWATER RECOVERY PITS, FIELD DRAINAGE, ETC.

   C. SPRINKLER SYSTEMS - LAND FORMING, LAND SMOOTHING, FURROWING-DIKING, PITTING, INTER-ROW RIPPING, ETC.

4. IRRIGATION WATER MANAGEMENT PRACTICES

   A. KANSAS STANDARD FOR IRRIGATION WATER MANAGEMENT - 449 AND KANSAS IRRIGATION GUIDE

   B. INCLUDE SOIL MOISTURE MONITORING, SCHEDULING, PUMPING PLANT AND IRRIGATION SYSTEM EVALUATION

   C. RECOMMENDATIONS MAY BE IN A NARRATIVE ATTACHED TO THE PLAN

CLASS PROBLEMS

How Much Water to Apply

You are checking a field of corn to determine the amount of water to apply with the next irrigation. The soil is a silt loam and has an available water holding capacity of 2.4 inches in the top foot and 2.1 inches per foot in the remainder of the profile.

On checking the soil you find the top one foot has about 25% of its available moisture remaining, the second and third foot about 50%, the fourth foot about 75%, and about 90% below the fourth foot. Irrigation efficiency is planned at 75%.

Problem: Determine the gross amount of irrigation water that should be applied to fill the top three feet of the root zone.

How Long to Irrigate a Plot

You have a well with a capacity of 900 gpm. The field is 80 acres in size. Use the gross irrigation amount from the preceding calculations.

Problem: Determine the number of hours required to irrigate the plot.

CLASS PROBLEMS

How Much Water to Apply

You are checking a field of corn to determine the amount of water to apply with the next irrigation. The soil is a silt loam and has an available water holding capacity of 2.4 inches in the top foot and 2.1 inches per foot in the remainder of the profile.

On checking the soil you find the top one foot has about 25% of its available moisture remaining, the second and third foot about 50%, the fourth foot about 75%, and about 90% below the fourth foot. Irrigation efficiency is planned at 75%.

Problem: Determine the gross amount of irrigation water that should be applied to fill the top three feet of the root zone.

Root zone: three feet

1st foot 2.4" x .75 = 1.80 inches
2nd foot 2.1" x .50 = 1.05
3rd foot 2.1" x .50 = 1.05
3.90 inches total net amount

3.90 inches/.75 = 5.20 inches gross

How Long to Irrigate a Plot

You have a well with a capacity of 900 gpm. The field is 80 acres in size. Use the gross irrigation amount from the preceding calculations.

Problem: Determine the number of hours required to irrigate the plot.

From handout: d = (Q x T)/A and T = (d x A)/Q

Q = 900 gpm / 450; Q = 2.0 cfs or 2.0 acre-inches/hr

T = (5.2 inches x 80 acres) / 2.0 acre-inches per hour

T = 208 hours or 8.7 days

IRRIGATION DEVELOPMENT PLANS

NEED AND PURPOSE OF IRRIGATION DEVELOPMENT PLANS:

A. SCS: Guide system development and operation to obtain irrigation water management and resource conservation planning.

B. State of Kansas (Water Conservation Plan Guides, KWO, 1986 and Administrative Policy No. 88-3, DWR, 1988).
   1. Confirm to state law and water plan criteria.
   2. Approved by Groundwater Management Districts - used as a tool for managing water resources in district.
   3. Guidelines based on SCS criteria.

IRRIGATION DEVELOPMENT PLAN CONTENT AND FORMAT:

I. GENERAL
   A. Refer to National Engineering Manual Part 523, 523.01 and Kansas Irrigation Guide, Part 1.
   B. Conservation planning is a prerequisite to the IDP.
   C. A complete IDP is required when needed to properly install and/or operate part or all of an irrigation system.
   D. Document IDP on forms KS-ENG-440A (large sheet) or KS-ENG-440B (small sheet). Include with rest of planning documentation in the case file.

II. IRRIGATION DEVELOPMENT PLAN CONTENT

- A. Resource Data for Planning
  - 1. Water quality
    - a. Primarily for salinity
    - b. May also cover heavy metals, etc.
  - 2. Water quantity (example: well gpm)
  - 3. Soils (see Part 3, Kansas Irrigation Guide)
  - 4. Topography
    - a. Surface (Flood/Gravity) systems - grid or contour map with survey shots on max. 330 ft. spacing
    - b. Sprinkler systems - grid/contour map or USGS topographic map (1:24,000) expanded to plan map scale
  - 5. Floodplain data - land not recommended for development if subject to scour or deposition from flooding more frequently than once every ten years
- B. Conservation/Irrigation Development Plan
  - 1. Conservation cropping sequence
    - a. Type of crops
    - b. Acres of each crop
    - c. Determination of max. irrigated acres based on objective
      - i. Full - use method on page 1-7, KIG or form KS-ENG-394
      - ii. Supplemental/limited - based on available water and yield goal
  - 2. Erosion control (as required)
    - a. Non-erosive application rates - max. slopes, stream sizes, etc.
      - i. See Part 4, Kansas Irrigation Guide for gravity systems
      - ii. See Part 5, Kansas Irrigation Guide for sprinkler systems
    - b. Management practices
      - i. Cultural - contour farming, conservation tillage, strip cropping, etc.
      - ii. Mechanical - furrow-diking, pitting, inter-row ripping - for sprinklers
    - c. Structural practices - terraces, waterways, etc.
  - 3. Irrigation development (as required for efficiency)
    - a. Water conveyance - pipelines, canals and laterals, pumping plants, water control structures
    - b. Gravity systems - land leveling, tail water recovery pits, field drainage, etc.
    - c. Sprinkler systems - land forming, land smoothing, furrow-diking, pitting, inter-row ripping
  - 4. Irrigation water management practices
    - a. Not specifically covered in Tech. Guide
    - b. Include soil moisture monitoring, scheduling, pumping plant and application system evaluation
    - c. Recommendations may be in some narrative attached to plan (no firm guidelines at this time)