C - CENTER-PIVOT IRRIGATION SYSTEM

GENERAL

The example problems in this chapter are intended to illustrate the procedure used in the design of center-pivot irrigation systems. It should be understood that these two examples cannot show all design situations or all alternatives to consider when designing a center-pivot irrigation system. Most often center-pivot irrigation systems are designed by the manufacturer and evaluated by the NRCS resource engineer. These examples illustrate a design method for supplying water to the total root zone. A common practice is to establish and manage a moisture control zone which is usually 50% of the rooting depth.

DESIGN CRITERIA

Design criteria for center-pivot irrigation systems are contained in the Alabama NRCS Conservation Practice Standard (CPS), Irrigation System, Sprinkler, Code 442, Field Office Technical Guide. All center-pivot systems must be designed in accordance with applicable requirements contained in CPS 442.

FORMULAS USED IN DESIGNING AND EVALUATING CENTER-PIVOT IRRIGATION SYSTEMS

The following formulas are used in the design and evaluation of center-pivot irrigation systems:

a. Precipitation rate from center-pivot systems.

$$I = \frac{96.3\ Qs}{D \times S_B}$$

Where:
- I = Precipitation or application rate in in/hr.
- Qs = Discharge from individual sprinkler in gpm
- D = Wetted diameter of sprinkler nozzle in feet
- S_B = Spacing of nozzles along the boom in feet

Note: 96.3 converts gpm/sqft to in/hr

b. Gross application depth in inches from individual sprinklers on a center-pivot.

$$d = \frac{Qs}{0.62 \times S_B \times v}$$

Where:
- d = Application depth in inches (gross)
- v = Velocity of rotational speed of individual sprinkler along the boom in ft/min.

c. Equations in Steps a. and b. can be combined as follows to relate terms into a sometimes useful relationship.

$$v = \frac{I \times D}{60 \times d}$$

d. Total capacity requirements based on known application depth, area, and time of application.

$$Q = \frac{453 \times A \times d}{H \times F}$$

Where:
- Q = Total system discharge capacity in GPM
- A = Acreage of the design area to be sprinkler irrigated in acres
- d = Gross depth of application in inches
- H = Number of actual operating hrs/day
- F = Number of days allowed for completion of one irrigation

The following example shows the use of the above formulas to design a center-pivot irrigation system.

EXAMPLE PROBLEM NO. 1

Given:

1. Location: Andalusia, Climatic Zone 7.
2. System: Center-pivot without end gun.
3. System efficiency: 70%
4. Crop: Corn
5. Acreage: 160 acre field.
6. Soil: (Evaluated on site).
7. Slope: Between 2 and 5 percent.

Solution:

Step 1. Refer to chapter 3 to determine the moisture extraction rooting depth. In this example, the moisture extraction depth is 36 inches.
Step 2. Determine the available water holding capacity (AWC). Assume a field evaluation is made and the weighted-average AWC for the top 36 in. is 0.052 in/in. The AWC for the rooting depth is 0.052 in/in x 36 in = 1.87 in.
Step 3. Determine the net depth of application of a management allowed deficit of 50 percent. Net application depth = 1.87 in x 0.50 = 0.94.
Step 4. Determine the maximum allowed application rate, assuming a basic soil intake rate is 3 in/hr. This is also the maximum application rate.
Step 5. Determine the irrigation frequency for the peak use period. The peak consumptive use for corn in this climate zone is found to be 0.30 in/day. The irrigation frequency is equal to the net depth of

application divided by the peak use rate. Irrigation frequency is 0.94 in / 0.30 in/day = 3.1 days.

Step 6. Determine the rate of travel at the outermost drive wheel (generally located about 50 ft from the end of the boom).

System Length = 1,300 ft total
Distance to Drive Wheel = 1,300 ft - 50 ft = 1,250 ft
Length of last drive wheel's path in one revolution
= 2(Pi)r = (2) (3.14) (1,250 ft)
= 7,854 ft

$$\text{Velocity, } v = \frac{7{,}854}{3.1 \text{ days} \times 24 \text{ hr/day}} \times \frac{1 \text{ hr}}{60 \text{ min.}}$$
$$= 1.76 \text{ ft/min}$$

Step 7. Determine the sprinkler application rate (Qs) required to apply the required net depth of application. The gross application depth is the net depth of application divided by the system efficiency. The gross application depth is 0.94 in / 0.70 = 1.34 in. Using equation from Steb b. and solving for Qs, then:

$Qs = (0.62) \times (S_B) \times (d) \times (v)$

Where Qs = Sprinkler discharge in gpm
S_B = Sprinkler spacing on the boom in feet
d = Gross application depth in inches
v = Rate of travel in ft/min

Assuming S_B = 21.5 feet, then
Qs = (0.62) x (21.5) x (1.34 x (1.76)
Qs = 31.4 gpm

Step 8. Determine the minimum wetted diameter for the sprinkler by using equation in Step a. and solving for D.

$$D = \frac{96.3 \times Qs}{I \times S_B}$$

Where D = Wetted diameter in feet
Qs = Sprinkler discharge in gpm
I = Maximum allowable application rate in/hr
S_B = Spacing, feet

$$D = \frac{(96.3) \times (31.4)}{(3.0) \times (21.5)}$$

D = 46.9 feet - this is the minimum wetted diameter that can be selected for a nozzle to apply 31.4 gpm without exceeding the allowable application rate.

Step 9. Select a nozzle size from manufacturer's tables for use along last 100 feet of boom.

Operating pressure at this point on the boom should be about 60 psi. Therefore, the pressure, the minimum wetted diameter, and the required discharge are known. From manufacturer's tables, select the nozzle size of 3/8 in. at 60 psi. The flow rate is 30.6 gpm with a wetted diameter of 149 feet.

Step 10. Check the actual depth of application and application rate of this nozzle.

Application Rate, I =

$$\frac{96.3\ Qs}{D \times S_B} = \frac{(96.3) \times (30.6)}{(149) \times (21.5)} = 0.92 \text{ in/hr}$$

This is the average rate applied to a point on the ground surface as the moving lateral passes overhead. A sprinkler produces a parabolic distribution with the maximum rate directly under the sprinkler. The maximum rate is 1.5 times the average: 0.92 in/hr x 1.5 = 1.38 in/hr. This is less than 3.0 in/hr and is satisfactory.

The actual depth,

$$d = \frac{Qs}{.62 \times S_B \times v} = \frac{(30.6)}{(.62)(21.5)(1.76)} = 1.30 \text{ in}$$

This is satisfactory since Step 7 shows gross amount of 1.34 inches. Another way of checking the actual depth of application is by using equation from Step C. as follows:

$$D = \frac{I \times D}{60\ v} = \frac{(0.92) \times (149)}{(60) \times (1.76)} = 1.30 \text{ in.}$$

Another way is simply to determine the time to traverse the wetted diameter and multiply it by the application rate.

Time to traverse the wetted diameter =

$$\frac{149 \text{ ft}}{1.76 \text{ ft/min}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 1.41 \text{ hrs.}$$

Depth of Application =
1.41 hrs x 0.92 in/hr = 1.30 in.

Step 11. Determine the total irrigation system capacity. In order to get equal application of water, the last 100 feet of the circular distribution must receive 14.8 percent of the total water. For a 1,300 ft long boom, this 100 ft covers 14.8% of the total area of the circle (See Table AL6-C-1). Therefore, total capacity is determined as follows:

Qs = 30.6 gpm at 21.5 ft spacing =

$$\frac{30.6 \text{ gpm}}{21.5 \text{ ft}} = 1.42 \text{ gpm/ft}$$

$$\text{Last 100 ft will use } 1.42 \text{ gpm} \times \frac{100 \text{ ft}}{\text{ft}} - 142 \text{ gpm}$$

Qt x 14.8% = 142 gpm

$$Qt = \frac{142}{.148}$$

Qt = 960 gpm

An alternate procedure is to use Figure AL6-C-1. From Step 10, the depth (gross) of application is 1.30 inches. The maximum irrigation period is the same as the irrigation frequency from Step 5.

d/F = 1.30 / 3.1 = 0.42 and the system length is a ¼ section

Step 12. The universal soil loss equation and wind erosion formula are used to determine if the cropping system planned will hold soil losses to a tolerable amount. These items should be checked early in the system planning.

EXAMPLE PROBLEM NO. 2

The following example illustrates a typical problem. In fact, since center-pivots are designed by the manufacturer using computers, this example would apply to most situations. The procedure involves using the "Irrigation Data Sheet - Center-Pivot Irrigation system." The NRCS technician provides the data sheet partially completed to the irrigation company. The company in turn provides pertinent design data on the form and returns it to the technician. The technician then completes the data sheet.

Given:

1. Crop and acres: 145 acres corn.
2. Soil: Field evaluated.
3. Location: Foley, AL (Baldwin Co.).
4. Well: 10 inch.
5. No existing pump.
6. Power unit to be diesel.
7. Slope: 0-3 percent.

Solution:

The item numbers mentioned in the step-by-step solution refer to the items on the "Irrigation Data Sheet - Center-Pivot Irrigation System," Exhibit AL6-C-1.

Step 1. Complete Items 1-4. These items provide pertinent data of the site.
Step 2. Complete Item 5. Make a drawing (to scale) of the field, locating trees, buildings, the well, and other features.
Step 3. Complete Item 6. Refer to chapters 3 and 4 to determine he moisture extraction rooting depths and the peak consumptive use rates. For this example, the rooting depth is 36 in. and the peak consumptive use rate is 0.30 in/day. (Note: This example is for illustration only and the values used may not be as shown in the tables.)
Step 4. Complete Item 7. Obtain the soil series from a published soil survey report or from an on-site investigation. The weighted available water capacity (AWC) is found in the field to be 0.052 in/in. The basic intake rate is found to be 3 in/hr; however, it has been estimated that the intake rate on this soil, under low application amounts, is 6 in/hr.
Step 5. Complete the following parts of Item 8.

a. AWC within the root zone is the product of the root zone moisture extraction depth (36 in.) times the AWC of the soil (0.052 in/in)
AWC = 36 in x 0.052 in/in = 1.87 in.

b. The percent depletion allowed prior to irrigation is selected to be 50 percent.

c. The net water applied per irrigation is the product of percent depletion allowed prior to irrigation (50%) times the available water within the root zone (1.87 in).
Net water applied = 0.50 x 1.87 in = 0.94.

d. The water application efficiency is determined to be 75 percent.

e. Gross water applied per irrigation is the net water applied (0.94 in) divided by the water application efficiency (0.75).
Gross water applied = 0.94 in / 0.75 = 1.25 in.

f. The irrigation interval is the net water applied (0.94 in) divided by the crop peak consumptive use (0.30 in/day).
Irrigation interval = 0.94 in / 0.30 in/day = 3.1 days.

g. The irrigation period to be used in the formula for determining Q_R is the irrigation interval 3.1 days.

h. The hours operating per day is 24 hours.

i. The quantity of water required (in gpm) is computed using the formula:

$$Q_R = \frac{453 \times \_\_\_ \text{ acres} \times \_\_\_ \text{ in gross application}}{\_\_\_\_ \text{ hrs operating/day} \times \_\_\_\_ \text{ days/irrigation}}$$

$$Q_R = \frac{453 \times 145 \text{ ac} \times 1.25 \text{ in}}{24 \text{ hrs/day} \times 3.1 \text{ days/irrigation}}$$

$$Q_R = 1{,}104 \text{ gpm}$$

The manufacturer used 1,100 gpm for the design of the system.

Step 6. The manufacturer provides the data for Item 9. This must meet the criteria previously discussed.

a. Pivot length = 1,314 ft; pivot pressure = 38 psi.
b. Spray nozzle.
c. Gross application per revolution 1.25 in.
d. Nozzle gpm and pressure along last 100 ft of span is 11.5 gpm at 20 psi on spacing of 6.5 feet.
e. Nozzle wetted diameter is 45 feet.

Step 7. Check the maximum application rate, Item 10.

a. Time per revolution to apply gross application = 60 hrs (from manufacturer).

b. Velocity of outside tower:

$$v, \text{ft/hr} = \frac{\text{outside circumference, ft}}{\text{hours per revolution}}$$

$$= \frac{(2)(Pi)\ (1{,}314)}{60 \text{ hours}} = 138 \text{ ft/hr}$$

c. Time of application (i.e., time it takes the sprinkler to move past one point):

d. $$T, \text{hrs} = \frac{\text{wetted diameter (ft)}}{\text{velocity of travel (ft/hr)}}$$

$$\frac{45 \text{ ft}}{138 \text{ ft/hr}} = 0.33 \text{ hrs}$$

e. Average application rate, in/hr = gross application, in / time of application, hrs

$$\frac{1.25 \text{ in}}{0.33 \text{ hrs}} = 3.8 \text{ in/hr}$$

f. Maximum application rate (in/hr) is 1.5 times the average application rate. Maximum application rate = (1.5) x (3.8 in/hr) = 5.7 in/hr

Step 8. Complete Item 11 for sizing the mainline and determining the total dynamic head required for the pump.

a. The mainline is 1,850 ft of 8-in diameter PVC, SDR 26, IPS pipe. The friction head loss is 1.71 ft/100 ft and is taken from Appendix. The total head loss in the mainline is

1.71 ft/100 ft x 1,850 ft = 31.6 feet.

b. The pressure at the pivot was given by the manufacturer and is 38 psi or 87.8 feet.

c. The miscellaneous and fitting losses were estimated to be 3.0 feet.

d. The elevation difference was measured to be 11.5 feet.

e. The sum of a., b., c., and d. gives a pump discharge pressure required of 133.9 ft. or 58.0 psi.

f. The total dynamic head (TDH) is the pumping lift plus the pump discharge pressure, 133.9 ft + 100.0 ft = 233.9 ft = 101.3 psi.

Step 9. Complete the plans. The specifications, location of the pipe, check valve, air vents, pressure relief valves, etc., should be shown on the plans.

CONSTRUCTION REQUIREMENTS

Once a system is designed it must be installed as planned to function properly. The following is a list of key points that should be checked during construction to assure quality installation:

a. Depth of cover over the buried mainline (important for protection from vehicular traffic and farming operation).
b. Thrust block dimension and location for prevention of pipe joint separation.
c. Location and size of air vents and pressure relief valve.
d. Size and proper direction of installed check valve.
e. Riser material and dimension, as well as location for pivots.
f. Length and quality of pipe, diameter, location, appropriate ASTM designation, size, pressure rating, and SDR as measured or found written on the pipe.
g. Determine if IPS or PIP is used; which will have an effect on the total head loss of the system.
h. Verification of length of the center-pivot lateral, and if spray or impact type sprinklers.

LAYOUT CONSIDERATIONS

During planning and layout of a center-pivot system there are many things to be considered. Items such as soil limitations, obstacles (fences, ponds, ditches, and trees), topography of the field, the farming operation, and safety hazards such as electrical buried gas lines.

The soil limitations might affect the pivot's ability to traverse the field and/or increase the erosion potential from runoff if using high application rates.

Obstacles, if not considered, could result in severe damage to the pivot. Bridges or culvert crossings may be needed for crossing wet areas or diches. Electrical lines and buried cable or gas lines must be located prior to burying the pipe or locating the pivot, not only to facilitate installation, but to prevent a safety hazard.

Topography must be considered because center-pivots are limited as to the slope on which it can function properly.

The greater the land slope the greater the erosion potential. Therefore, the application rate must be compatible with the slope to prevent erosion.

Procedure for Determining Gross Application of Center-Pivot Sprinkler

The objective of this procedure is to develop a table that relates the dial setting of the center-pivot timer to the gross water (inches) applied. The table may be used by the irrigator to adjust the system speed to obtain a desired gross application. The procedure described applied to electric system timers which read from 0 to 100 percent. However, the procedure can be adapted to other timers.

1. Determine Speed of End Tower - Select a reference mark on a wheel on the end tower. Set a stake by this mark. Start timing when the wheel starts moving forward. Continue timing until the wheel has moved 20 to 30 feet, or until after the can catch is made. Mark distance traveled by placing a second stake by reference mark on wheel and stop timing just as the wheel starts to move forward again. Read time and measure distance between the two stakes.

Speed of end tower, ft/hr =

$$\frac{\text{Distance travelled, ft} \times 60}{\text{Time, min}}$$

2. Determine Time Per Revolution - Once speed is determined, compute time of travel for one revolution at the percent setting on the timer.

Time per revolution, hrs (at % setting on timer) =

$$\frac{\text{Distance travelled by end tower, ft.}}{\text{Speed of end tower, ft/hr}}$$

Distance traveled by end tower, ft =
2 x (Pi) x Distance from pivot to end tower, ft

3. Determine Hrs/Revolution for 100% Dial Setting

Hrs/revolution (at 100%) =

$$\frac{(\text{Hrs/revolution}) \times (\text{Dial Setting})}{100}$$

Note: Use the dial setting on the control panel at the time the speed was determined and hrs/revolution corresponding to this setting.

4. Determine Hrs/Revolution for Each Dial Setting

Hrs/revolution at X% =

$$\frac{(\text{Hours per revolution at 100\%})\ 100}{X\%}$$

5. Determine Gross Application for Each Dial Setting

Gross application, in. =

$$\frac{(\text{Hrs/revolution for dial setting})\ (\text{gpm})}{(453) \times (\text{Acres irrigated})}$$

Note: For acres irrigated, use designed acres. If not available, use the effective wetted area.

Example

The center-pivot timer was set on 60% and end tower traveled 87.7 ft in 19 minutes. Distance from pivot to end tower is 1,205 feet. System applies 850 gpm on 130.19 acres.

End tower speed = $\frac{(87.7)\ (60)}{19}$ = 276.9 ft/hr

Time/revolution at 60% = $\frac{(2)\ (Pi)\ (1{,}205)}{276.9}$ = 27.34 hrs

Hrs/revolution at 100% = $\frac{(27.34)\ (60\%)}{100}$ = 16.4 hrs

Hrs/revolution for each of the other dial settings:

For 90% = $\frac{(16.4)\ (100)}{90}$ = 18.22 hrs

For 80% = $\frac{(16.4)\ (100)}{80}$ = 20.50 hrs

For 70% = $\frac{(16.4)\ (100)}{70}$ = 23.43 hrs

For 60% = $\frac{(16.4)\ (100)}{60}$ = 27.34 hrs

For 50% = $\frac{(16.4)\ (100)}{50}$ = 32.80 hrs

For 40% = $\frac{(16.4)\ (100)}{40}$ = 41.00 hrs

For 30% = $\frac{(16.4)\ (100)}{30}$ = 54.67 hrs

For 20% = $\frac{(16.4)\ (100)}{20}$ = 82.00 hrs

For 10% = $\frac{(16.4)\ (100)}{10}$ = 164.00 hrs

Gross application for each dial setting:

For 100% = $\frac{(16.4)\ (850)}{(453)\ (130.19)}$ = 0.24 in.

For 90% = $\frac{(18.27)\ (850)}{(453)\ (130.19)}$ = 0.26 in.

For 80% = $\frac{(20.50)\ (850)}{(453)\ (130.19)}$ = 0.30 in.

For 70% = $\frac{(23.43)\ (850)}{(453)\ (130.19)}$ = 0.34 in.

For 60% = $\frac{(27.34)\ (850)}{(453)\ (130.19)}$ = 0.39 in.

For 50% = $\frac{(32.80)\ (850)}{(453)\ (130.19)}$ = 0.47 in.

For 40% = $\frac{(41.00)\ (850)}{(453)\ (130.19)}$ = 0.59 in.

For 30% = $\frac{(54.67)\ (850)}{(453)\ (130.19)}$ = 0.79 in.

For 20% = $\frac{(82.00)\ (850)}{(453)\ (130.19)}$ = 1.18 in.

For 10% = $\frac{(164.00)\ (850)}{(453)\ (130.19)}$ = 2.36 in.

Summary

Dial Setting	Hours/ Revolution	Gross Application (in.)
100	16.40	0.24
90	18.22	0.26
80	20.50	0.30
70	23.43	0.34
60	27.34	0.39
50	32.80	0.47
40	41.00	0.59
30	54.67	0.79
20	82.00	1.19
10	164.00	2.36

TABLE AL6-C-1. CENTER-PIVOT IRRIGATION SYSTEMS.

% of water applied in last 100 ft 1/	Total system length (in ft) 2/	Total area of square field twice length of system (acres)	Area covered in Acres		
			With gun 3/ sprinkler used only in corners	With gun sprinkler used on entire circle	Without end gun
30.6	600	33.1	30.8	35.3	26.0
28.4	650	38.8	36.0	40.6	30.5
26.5	700	45.0	41.3	46.1	35.3
24.8	750	51.8	47.2	52.1	40.6
23.4	800	58.8	53.3	58.4	46.1
22.1	850	66.3	59.8	65.0	52.1
21.0	900	74.5	66.7	72.2	58.4
20.0	950	82.9	74.0	79.5	65.0
19.0	1000	91.8	81.7	87.4	72.2
18.1	1050	101.3	89.5	95.3	79.5
17.3	1100	211.0	98.0	104.0	87.4
16.6	1150	121.3	106.6	112.6	95.3
16.0	1200	232.2	115.7	121.9	104.0
16.4	1250	143.3	123.8	131.4	112.6
14.8	1300	155.0	134.0	141.3	121.9
14.3	1350	167.3	145.0	151.6	131.4
13.8	1400	179.8	155.2	162.0	141.3
13.3	1450	193.0	166.5	173.2	151.6
12.9	1500	206.0	177.7	184.7	162.0

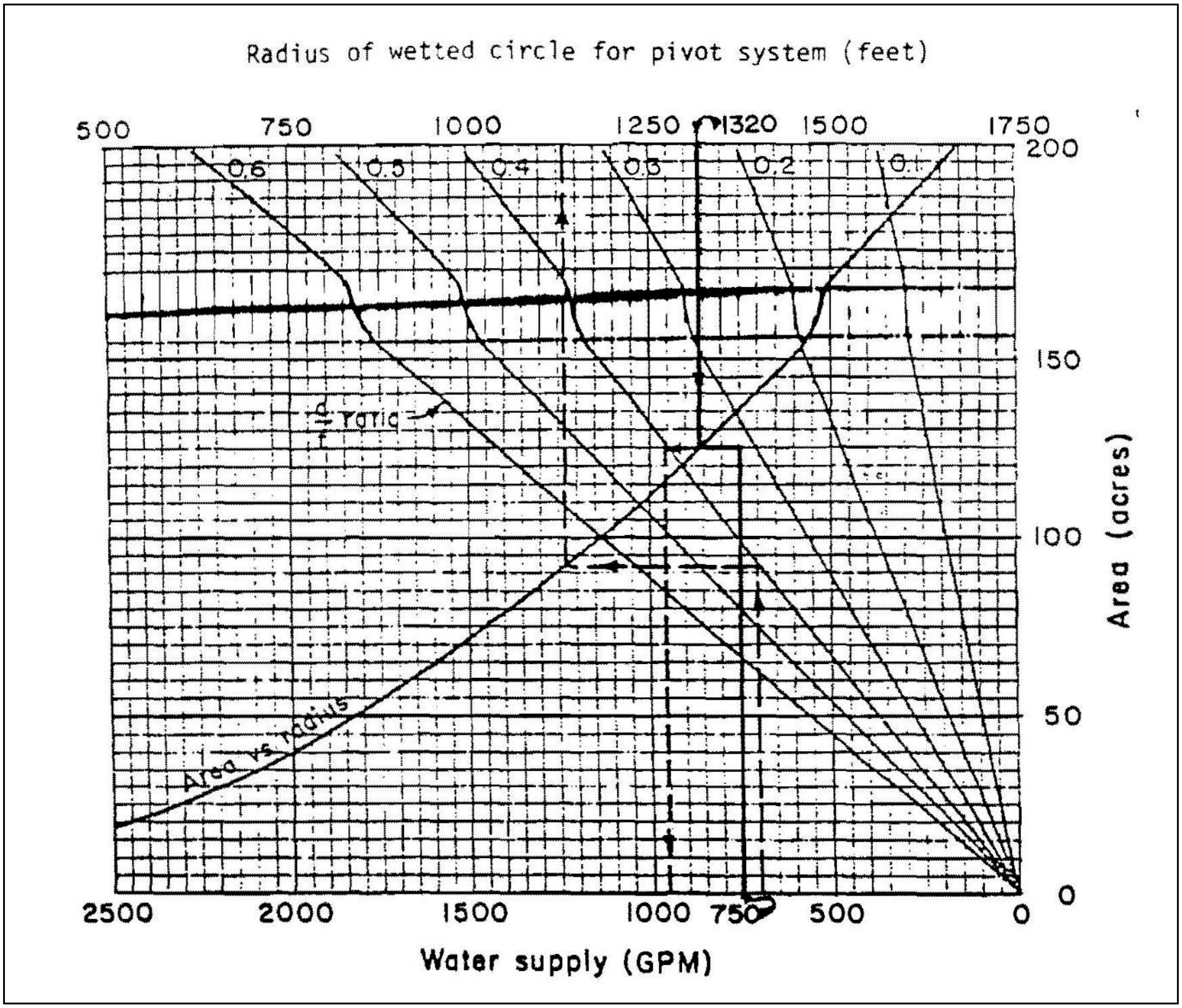
1/ Less volume of end gun when used.

2/ Generally outside drive wheel approximately 50 ft from end.

3/ Based on 100 ft gun coverage.

EXAMPLE: System is 900 ft long. Then 21% of water is applied in last 100 feet. 66.7 acres are covered with gun used in corners only.

at 1,300 feet. Figure AL6-C-1 shows Qt = 960 gpm
If an end gun is desired then its discharge must be added directly to the 960 gpm.



Rules for Use of Chart

1) Reading up from known water supply, read vertically to d/f line; move horizontally to area vs. radius curve; then vertically to find radius.

2) Reading down from known system length, drop vertically to area vs. radius curve; move horizontally to appropriate d/f line; then drop vertically to water supply.

Example

1) Given: Water supply is 750 gpm; crop requirements are 1.29 in. with a 4-day irrigation period.

Find: Maximum acreage that can be adequately irrigated, and center-pivot radius associated with this acreage.

Solution:

$d/f = \frac{1.29}{4} = 0.32$; Enter 750

gpm: Apply Rule 1; find area is about 125 acres and system radius is about 1,320 feet.

2) Given: Center-pivot length is 1,320 feet; crop needs 1.29 in. (gross) in 4-day irrigation period; d/f = 0.32

Find: Water supply required.

Solution: Apply rule 2; find 750 gpm required.

Figure AL6-C-1. Capacity Requirements for Center-Pivot Systems.

U.S. Department of Agriculture
Natural Resources Conservation Service

IRRIGATION DATA SHEET

Sheet 1 of 4

CENTER PIVOT IRRIGATION SYSTEM

CONSERVATION DISTRICT BALDWIN FIELD OFFICE FOLEY
COOPERATOR Hurry I. Dry LOCATION Silverhill
IDENTIFICATION NO. — FIELD NO. 1

1. Design area 145 acres
Description of soils 0 – 54 inches LS, S, FS

Design Soil Series:

Soil Depth (in.)	Average AWC (in./in.)
0-12	0.056
12-24	0.050
24-36	0.050

2. Crops:

Crop	Acres	Planting Date	Maturity Date
Corn	145	March 20	July 3
Total	145		

3. Water Supply:

Source of supply: (stream, well, reservoir, etc.) 10" diameter

Reservoir: Storage ___ ac-ft Available for Irrigation ___ ac-ft

Well: Static Water Level 80 ~~gpm~~ ft

Measured Capacity 1400 gpm @ 20 ft drawdown

Design Pumping Lift 100 ft

Stream: Measured flow (season of peak use) ___ gpm

Quality of water (evidence of suitability): good

Distance supply source to field 1,850 ft

4. Other Data:

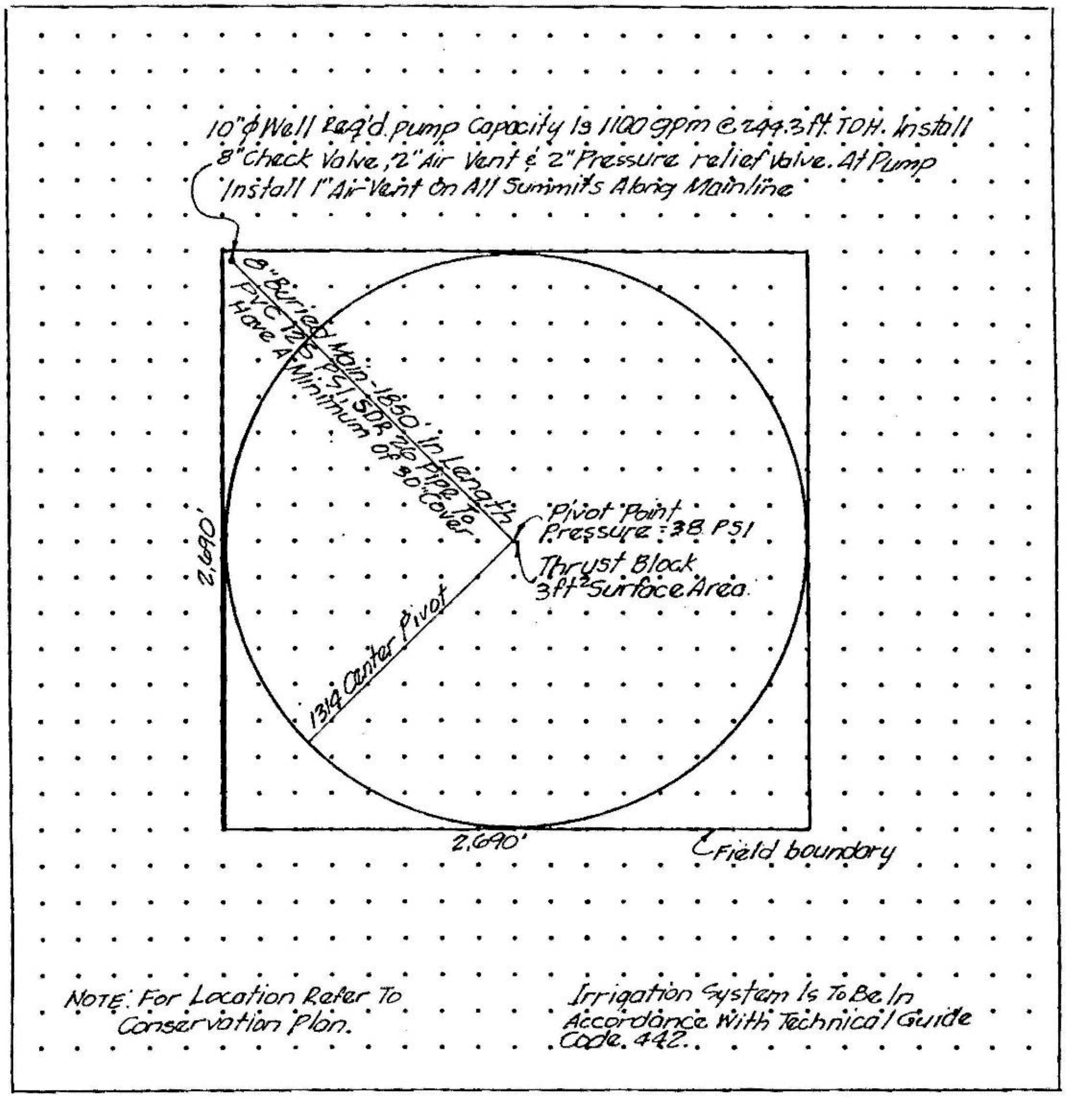
Type of power unit and pump to be used: Electric Motor With Direct Drive Deep Well Turbine Pump.

Exhibit AL6-C-1.

CENTER PIVOT IRRIGATION SYSTEM Sheet 2 of 4

Cooperator: Hurry I. Dry Designed by: Try Hard Checked by: T.O. Bad

5. Map of design area - Scale 1" = 660 ft
   Sketch map on grid or attach photo or overlay.



Sketch map should show:

a. Source of water
b. Major elevation differences
c. Row direction
d. Sprinkler system layout
e. Plan of operation
f. Field obstructions (gullies, trees, buildings, etc.)
g. North arrow

Exhibit AL6-C-1. (con't)

CENTER PIVOT IRRIGATION SYSTEM — Sheet 3 of 4

Cooperator: Hurry I. Dry Designed by: Try Hard Checked by: T.O. Bad

	CROP NUMBER 1	2	3	4	5
6. Crop Information					
Kind of crop	Corn				
Peak use rate (in./day)	0.30				
Rooting depth (in.)	36				
Acreage to be grown (acres) 1/	145				
7. Soil Information					
Weighted AWC for rooting depth (in./in.)	0.052				
Basic intake rate (in./hr)	3 4/				
8. Design Procedure					
AWC within root zone (in.)	1.87				
Depletion allowed prior to irrigation (%)	50				
Net water applied per irrigation (in.)	0.94				
Water application efficiency (%)	75				
Gross water applied per irrigation (in.) 1/	1.25				
Irrigation interval (days)	3.1				
Irrigation period (days per irrigation) 1/	3.1				
Hours operating per day 1/	24				
Q_R = Quantity of water required (gpm) 1/	1104				
Q_A = Quantity of water actual (gpm) 2/	1100				

9. Pivot Specifications: 3/
 a. Pivot Length 1314 ft; Pivot Pressure 38 psi
 b. Spray ☑ or Sprinkler ☐
 c. Gross application per revolution 1.25 in.
 d. Nozzle gpm along last 100' of span 11.5 gpm @ 20 psi on spacing of 6.5 ft
 e. Nozzle wetted diameter 45 ft

10. Checking Maximum Application Rate:
 3/a. Time (hrs) per revolution to apply gross application = 60 hrs
 b. Velocity (V) of end of line = $\frac{\text{outside circumference, ft}}{\text{hrs/revolution}} = \frac{8251.9}{60} = 138$ ft/hr
 c. Time of application (hrs) = $\frac{\text{wetted dia. ft}}{\text{V, ft/hr}} = \frac{45}{138} = 0.33$ hr
 d. Average application rate, in./hr = $\frac{\text{gross application, in.}}{\text{time of applic. hrs}} =$ 3.8 in./hr
 e. Max. application rate = 1.5 x av. application rate = 1.5 x 3.8 in./hr = 5.7 in./hr

1/ $Q_R = \frac{453 \times \_\_\_ \text{ acres} \times \_\_\_ \text{ inches gross application}}{\_\_\_ \text{ hrs opr. per day} \times \_\_\_ \text{ days per irrig.}} = \_\_\_$ gpm

2/ Q_A must be $\geq Q_R$

3/ Provided by manufacturer

4/ The Basic Intake Rate Is 3 in./hr. However For Low Application Amounts The Intake Rate Should Be 6 in./hr. or Greater.

10-45 Rev. 7-93

Exhibit AL6-C-1. (con't)

CENTER PIVOT IRRIGATION SYSTEM Sheet 4 of 4

Cooperator: Hurry I. Dry Designed by: Try Hard Checked by: T.O. Bad

11. Determining Total Dynamic Head

Total main line length 1850 ft

Kind of Pipe	Pipe Size (in.)	Design Capacity (gpm)	IPS ☑ PIPE SIZING PIP ☐ Length (ft)	Friction Head Loss (ft/100 ft)	Total Head Loss (ft)	(psi)
PVC	8	1100	1850	1.71	31.6	13.7
Pressure at pivot					87.8	38.0
Misc. & fitting losses					3.0	1.3
Elevation difference [4/]					11.5	5.0
Pump discharge pressure					133.9	58.0
Pumping lift					100.0	43.3
Total Dynamic Head, TDH					233.9	101.3

12. Pump Requirements:

Capacity 1100 gpm @ 101.3 psi or 233.9 ft of head

13. Remarks: Use 125 PSI Rated SDR 26 PVC Pipe.

[4/] Difference in elevation of the centerline of the pump discharge and the elevation of the highest sprinkler (plus or minus).

Design Approved By: T.O. Bad Date: 6/15/82

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