

---

# Chapter 15

# Resource Planning and Evaluation Tools and Worksheets

---

---

<b>Contents:</b>	<b>652.1500</b>	<b>General</b>	<b>15-1</b>
	<b>652.1501</b>	<b>Water quality, water management, and irrigation evaluation tools</b>	<b>15-1</b>
	<b>652.1502</b>	<b>Irrigation system selection, design, costs, and evaluation tools</b>	<b>15-2</b>
	<b>652.1503</b>	<b>Irrigation system planning, design, and evaluation worksheets</b>	<b>15-3</b>
	<b>652.1504</b>	<b>Blank worksheets</b>	<b>15-5</b>
		Irrigation Planning Worksheet .....	15-7
		Irrigation System Inventory Worksheet .....	15-9
		Sprinkler Irrigation System Planning/Design Worksheet .....	15-15
		Irrigation Water Management Plan–Sprinkler Irrigation System .....	15-21
		Soil Water Holding Worksheet .....	15-25
		Worksheet, Soil-Water Content .....	15-26
		Determination of Soil Moisture and Bulk Density (dry) Using Eley .....	15-27
		Volumeter and Carbide Moisture Tester	
		Typical Water Balance Irrigation Scheduling Worksheet .....	15-28
		Surface Irrigation System Detailed Evaluation Graded Border .....	15-29
		Worksheet	
		Profile and Cross Section .....	15-37
		Cylinder Infiltrometer Curves .....	15-38
		Cylinder Infiltrometer Test Data .....	15-39
		Advance and recession curves .....	15-40
		Cylinder Infiltrometer Curves .....	15-41
		Depth infiltrated curve .....	15-42
		Surface Irrigation System Detailed Evaluation Level Border .....	15-43
		and Basins Worksheet	
		Soil Water Intake Curves .....	15-49
		Surface Irrigation System Detailed Evaluation Graded .....	15-51
		Furrow Worksheet	
		Surface Irrigation System Detailed Evaluation Furrow Worksheet .....	15-57
		Advance and recession curves .....	15-61
		Flow volume curves .....	15-62
		Soil water intake curves .....	15-63
		Surface Irrigation System Detailed Evaluation Contour Ditch .....	15-65
		Irrigation System Worksheet	

Soil Water Intake Curves .....	15-71
Cylinder Infiltrometer Test Data .....	15-72
Sprinkler Irrigation System Detailed Evaluation Periodic Move and .....	15-73
Fixed Set Sprinkler System	
Lateral move system catch can data .....	15-79
Sprinkler Irrigation System Detailed Evaluation Center Pivot .....	15-81
Lateral Worksheet	
Center pivot lateral evaluation, distribution profile of catch .....	15-88
Sprinkler Irrigation System Detailed Evaluation Contonuous Move, .....	15-89
Large Sprinkler Gun Type	
Micro Irrigation System Detailed Evaluation Worksheet .....	15-95
Pumping Plant Detailed Evaluation Worksheet .....	15-99
Pump performance curve .....	15-104
Soil Description .....	15-105
Cylinder Infiltrometer Test Data .....	15-106
Soil water intake curves .....	15-107
Intake curve overlay .....	15-108
Accumulated intake vs. time .....	15-109
Intake families as used with furrow irrigation .....	15-110
<b>652.1505 Estimating Soil Moisture by Feel and Appearance</b>	<b>15-111</b>

---

### 652.1500 General

Chapter 15 lists and describes resource planning and evaluation tools and worksheets commonly used by the Natural Resources Conservation Service (NRCS). These tools and worksheets can assist the irrigation planner in:

- Addressing irrigation related environmental concerns relating to soil, water, air, plants, and animals.
- Providing technical assistance to the farmer and irrigation decisionmaker in irrigation system—planning, design, cost analysis, evaluation, and management.
- Providing technical assistance for evaluating and planning river basin, watershed, and project activities.

---

### 652.1501 Water quality, water management, and irrigation evaluation tools

Computer software programs and models include:

**NRCS (SCS) Scheduler**—NRCS Scheduler is a computer assisted method to predict up to 10 days ahead when irrigation will be needed. Predictions are based on daily climatic data from a weather station and calculated plant water use. Periodic calibration to actual soil moisture is used to maintain accuracy. Developed by Michigan State University with support from NRCS.

**FIRI**—Farm Irrigation Rating Index is used to evaluate effects of existing irrigation systems and management, and to evaluate changes. Changes can be improvements or reversals in management techniques and system condition. Developed by NRCS West National Technical Center.

**SIDESIGN**—Subsurface Irrigation Design program involves an analysis of providing water table control for irrigation through buried conduits. Developed by Michigan State University with support from NRCS.

**NLEAP**—Nitrate Leaching and Economic Analysis Package. The model provides site specific estimates of nitrate leaching potential under agricultural crops and impacts on associated aquifers. Irrigations are included as precipitation events. This model is generally used as a planning tool. Developed by the Agricultural Research Service (ARS), Water Management Research Laboratory, Fort Collins, Colorado.

**CREAMS**—A field scale model for Chemical, Runoff, and Erosion from Agricultural Management Systems. This mathematical model evaluates nonpoint source pollution from field-size areas. Developed by ARS laboratories in Chickasha, OK, West Lafayette, IN, and Athens, Georgia.

**GLEAMS**—Groundwater Loading Effects of Agricultural Management Systems. GLEAMS uses CREAMS technology to evaluate surface chemical response, hydrology, and erosion. It provides a water budget of precipitation, crop evapotranspiration, runoff, deep percolation, soil moisture, and irrigation applications. Crop evapotranspiration is checked and adjusted for localized conditions. Developed by University of Georgia in cooperation with ARS, Southeast Watershed Laboratory, Tifton, Georgia.

**WEPP**—Water Erosion Prediction Program is proposed to provide an analysis of precipitation and irrigation related erosion and sediment deposition. When complete, WEPP will include furrow and border surface irrigation and periodic move, fixed, and continuous move sprinkle irrigation systems. The FUSED, RUSLE, and SPER programs are available for field use until WEPP is validated and available. Being developed by ARS, National Erosion Laboratory, (Purdue University), West Lafayette, Indiana; and (University of Nebraska), Lincoln, Nebraska.

**SWRRB**—This basin scale water quality model process considers surface runoff, return flow percolation, evapotranspiration, transmission losses, pond storage, sedimentation, and crop growth. Crop evapotranspiration must be checked and may need to be localized. Developed by ARS, Temple, Texas.

**EPIC**—Process considers climate factors, hydrology, soil temperature, erosion, sedimentation, nutrient cycling, tillage, management, crop growth, pesticide and nutrient movement with water and sediment, and field scale costs and returns. Crop evapotranspiration is checked and adjusted for local conditions. Developed by ARS, Temple, Texas.

**DRAINMOD**—An evaluation tool for analysis of water table control for subsurface drainage systems. Included is an estimated value for upward water movement (upflux) based upon specific soil series. Developed by North Carolina State University with support from NRCS.

**Instream Water Temperature Model**—The model provides a process to predict instream water temperature based on either historical or synthetic hydrological, meteorological parameters, streamside vegetation, and stream channel geometry.

## 652.1502 Irrigation system selection, design, costs, and evaluation tools

Many programs are available from commercial sources and Universities. Most need to be purchased, but some are available as *cooperative agency programs*. A few require site licenses to use multiple program copies at several locations at one time. Several irrigation programs are available from ARS, universities, and the U.S. Bureau of Reclamation. Some of the more common programs available include:

- REF-ET—Reference crop Evapotranspiration model, from Utah State University.
- SIRMOD—Surface Irrigation Model includes surge and conventional analysis for furrow irrigation, from Utah State University.
- CPNOZZLE—Center Pivot Nozzling and surface storage program, from University of Nebraska.
- SPACE—Sprinkler Profile And Coverage Evaluation program evaluates all sprinkler heads manufactured and currently available, from California Agricultural Technology Institute, California State University.
- SRFR—Surface irrigation simulation program uses zero inertia and kinematic wave relationships to model surface irrigation, from ARS, Phoenix, Arizona.
- AGWATER—Surface irrigation system (furrow, border) model using measured advance time and field specific information for management improvements (inflow, time of set, length of run), from California Polytechnic State University.
- PUMP—Centrifugal pump selection program, from Cornell Pump Company, Portland, Oregon.
- CATCH3D—Sprinkler pattern overlap evaluation and 3D plot program, from Utah State University.
- Water Management Utilities, Interactive Simulation of One-Dimensional Water Movement in Soils, IRRIGATE—An irrigation decision aid, potential evapotranspiration, citrus irrigation scheduling.
- CMLS—Chemical Movement in Layered Soils, from University of Florida.
- Flowmaster—Open channel flow and pressure pipeline design program, from Haestad Methods, Inc., Waterbury, Connecticut.
- KYPIPE2—Pipe network flow analysis program, from Haestad Methods, Inc., Waterbury, Connecticut.

---

## 652.1503 Irrigation system planning, design, and evaluation worksheets

Example evaluations and blank worksheets are included at the back of this chapter. They may be copied and used as needed. They include:

### **Irrigation Planning**

- Irrigation Planning
- Irrigation System Inventory

### **Irrigation System Design**

- Sprinkler Irrigation System Planning/Design

### **Irrigation System Evaluation**

- Walk Through Sprinkler Irrigation System Analysis

#### Sprinkler Irrigation Systems Evaluation

- Periodic Move Sprinkler—Side Wheel-roll, Lateral Tow, Hand Move and Fixed (Solid) Set Systems
- Continuous/Self Move Sprinkler—Pivot System

#### Pumping Plant Evaluation

- Electric Motor Powered
- Natural Gas Engine Powered

#### Micro Irrigation Systems Evaluation

#### Surface Irrigation Systems Evaluation

- Graded Borders
- Basins, Level Border
- Graded Furrows
- Level furrows

### **Irrigation Water Management**

- Irrigation Water Management Plan
- Soil Moisture—Feel and Appearance Method, Speedy Moisture Meter and Eley Volumeter
- Crop and Soil Data for Irrigation Water Management
- Checkbook Method of Irrigation Scheduling
- Pan Evaporation Method of Irrigation Scheduling



---

**652.1504 Blank worksheets**



### Irrigation Planning Worksheet

OWNER/OPERATOR \_\_\_\_\_ FIELD OFFICE \_\_\_\_\_  
 JOB DESCRIPTION \_\_\_\_\_  
 LOCATION \_\_\_\_\_  
 ASSISTED BY \_\_\_\_\_ DATE \_\_\_\_\_

**Soil—Data for limiting soil**

Soil series	Percent of area (%)	Cumulative AWC					Depth to restrictive layer <sup>1</sup>	Intake fam., grp. max. rate
		1 ft (in)	2 ft (in)	3 ft (in)	4 ft (in)	5 ft (in)		

<sup>1</sup> Actual observed depth in the field

**Maximum time between irrigations for any method/system based on peak crop ET**

Crop	Management root zone (ft)	Total AWC (in)	MAD percent (in)	Maximum net replacement		Peak daily crop ET (in/d)	Maximum irrigation frequency (days)
				(in/d)	(days)		

**Minimum system flow requirement for irrigation system**

System description	Depth of irrigation application			Peak daily crop ET (in/d)	Max. irrig. frequency (days)	Minimum system flow requirement total flow	
	Net (F <sub>N</sub> ) (in)	Efficiency (%)	Gross (F <sub>G</sub> ) (in)			(gpm)	(ft <sup>3</sup> /s)

Minimum dependable flow available to system \_\_\_\_\_ gpm, ft<sup>3</sup>/s, inches, etc.

Total irrigated area \_\_\_\_\_ acres. Total operating hours per day \_\_\_\_\_ .



## Irrigation System Inventory Worksheet

OWNER/OPERATOR \_\_\_\_\_ FIELD OFFICE \_\_\_\_\_

JOB DESCRIPTION \_\_\_\_\_

LOCATION \_\_\_\_\_

ASSISTED BY \_\_\_\_\_ DATE \_\_\_\_\_

**(Collect and fill out only portions of this form that apply and are needed)**

Area irrigated \_\_\_\_\_ acres

**Crops**

Crops now grown			
Typical planting date			
Typical harvest date			
Typical yield (unit)	(    )	(    )	(    )
Age of planting			
Cultivation and other cultural practices			

**Water**

Water source(s)				
irrigation organization				
Water available (ft <sup>3</sup> /sec, gpm, miners inches, mg/da)				
Seasonal total water available (ac-ft, million gal)				
Water availability	continuous	demand	rotation	fixed schedule
Typical water availability times (schedule and ordering procedure)				
Method of determining when and how much to irrigate:				
Is flow measuring device maintained and used?				
Method of measuring water flow rate				
Water quality: Sediment			Debris, moss	
Electrical conductivity		mmhos/cm	SAR	
Comments				

Example Irrigation System Inventory Worksheet—Continued

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Soils** (principal soil in field)

**Soil # 1**

Map symbol		Soil series & surface texture		
Percentage of field (%)		Area (acres)		
Depth	Texture	AWC (in/in)	AWC (in)	Cum AWC (in)
Depth to water table or restrictive layer <sup>1</sup>				
Intake family/intake group/max application rate				
Comments				

**Soil # 2**

Map symbol		Soil series & surface texture		
Percentage of field (%)		Area (acres)		
Depth	Texture	AWC (in/in)	AWC (in)	Cum AWC (in)
Depth to water table or restrictive layer <sup>1</sup>				
Intake family/intake group/max application rate				
Comments				

**Soil # 3**

Map symbol		Soil series & surface texture		
Percentage of field (%)		Area (acres)		
Depth	Texture	AWC (in/in)	AWC (in)	Cum AWC (in)
Depth to water table or restrictive layer <sup>1</sup>				
Intake family/intake group/max application rate				
Comments				

<sup>1</sup> If restrictive for root development or water movement

Irrigation System Inventory Worksheet—*Continued*

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Water supply and distribution system**

Supply system to field (earth ditch, lined ditch, plastic pipeline, etc.):

Type
Size
Capacity (ft <sup>3</sup> /sec, gpm, miners inches, mgal/day)
Pressure/Elevation at head of field or turnout (lb/in <sup>2</sup> ) (ft)
System condition
Estimated conveyance efficiency of supply system (%)

In-field distribution system (earth or lined ditch, buried pipe, surface portable pipe, lay flat tubing):

Type
Size
Capacity
Total available static head (gravity) (ft)
System condition
Estimated efficiency of delivery system (%)
Comments

**Water application system**

**Existing sprinkler system** (attach design and/or system evaluation. if available):

Type system (center pivot, sidewheel-roll, hand move, traveler, big gun)
Manufacturer name and model
Tower spacing (pivot or linear) (ft) End gun (pivot)?
Wheel size (sidewheel-roll) diameter
Type of drive
Pressure at lateral entrance (first head) (lb/in <sup>2</sup> )
Mainline diameter/length
Lateral diameter/length
Lateral spacing (S <sub>1</sub> ) Sprinkler head spacing (S <sub>m</sub> )
Sprinkler make/model
Nozzle size(s) by type
Design nozzle pressure (lb/in <sup>2</sup> ) Wetted diameter (ft)
(Attach sprinkler head data for pivot)
Maximum elevation difference: Along lateral
Between sets
Application efficiency low 1/4 (E <sub>Q</sub> ) (%) (Estimated or attach evaluation)
Wind - Prevailing direction and velocity
Comments

Irrigation System Inventory Worksheet—Continued

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Existing surface system** (attach system evaluation if available)

Type of system (graded border, level border, graded furrow, level furrow, contour levee, contour ditch, wild flooding)			
Leveled fields:	Field slope:	In direction of irrigation	ft/ft
Cross slope		ft/ft	
Smoothness:	<input type="checkbox"/> Rough	<input type="checkbox"/> Smooth	<input type="checkbox"/> Very smooth
			Laser equipment used <input type="checkbox"/> yes <input type="checkbox"/> no
Border or levee width		Furrow/corrugation/rill spacing	
ft		in	
Length of run:	Minimum	ft	Maximum
		ft	Average
ft			
Number of furrows or borders per set			
Border or levee dike heights			
Application efficiency, low 1/4 (E <sub>q</sub> )		% (Estimated or attach evaluation)	
General maintenance of system			

**Drainage, tail water reuse facility**

Method for collection and disposal of field runoff (tailwater, precipitation)
Final destination of runoff water
Surface/subsurface drainage system
Environmental impacts of existing drainage system

**Existing micro irrigation system** (Attach design or system evaluation if available)

Type of system:	Drip emitters	Mini spray/sprinklers	Line source
Spacing between discharge devices along distribution laterals		(ft, in)	
Laterals - diameter, length			
Main lines and submains - diameter, length, etc.			
Spacing between distribution laterals		(ft, in)	
Average application device discharge pressure (lbs/in <sup>2</sup> )			
Are pressure compensating devices required?		<input type="checkbox"/> yes	<input type="checkbox"/> no
Are pressure compensating devices used?		<input type="checkbox"/> yes	<input type="checkbox"/> no
Average application device discharge (gph, gpm)			
Area irrigated by one irrigation set		(acres)	
Typical irrigation set time		(hr, min)	
Maximum elevation difference with one irrigation set		(ft)	
Type and number of filters used			
Irrigation is initiated by: <input type="checkbox"/> manual control <input type="checkbox"/> programmed timer <input type="checkbox"/> clock timer <input type="checkbox"/> soil moisture sensing device			
Comments:			

Irrigation System Inventory Worksheet—Continued

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Existing subsurface irrigation system**

Water table control type and number of system or segments	
Water table control devices	<input type="checkbox"/> flashboard <input type="checkbox"/> float
Buried laterals	<input type="checkbox"/> diameter <input type="checkbox"/> spacing <input type="checkbox"/> depths
Water table elevation(s): Existing	Planned

Month	Elevation	Depth below surface

**Pumping plant  
 Pump**

(Attach pump characteristic curves and/or pump system analysis if available)			
Pump elevation above mean sea level (approx) (ft)			
Pump type: <input type="checkbox"/> centrifugal <input type="checkbox"/> turbine <input type="checkbox"/> submersible <input type="checkbox"/> Propeller <input type="checkbox"/> axial flow			
Make		Model	
Electric motor RPM		Engine operating RPM	
Pump design discharge		gpm @ _____ ft or lb/in <sup>2</sup>	
Impeller size	Impeller diameter	Number of impellers	
Pressure at outlet of pump or inlet to pipeline		lb/in <sup>2</sup>	date
Discharge	gpm	How measured	date
Valves, fittings			

**Power unit**

Rated HP	at RPM
----------	--------

**Gear or belt drive mechanism**

Type (direct, gear, belt)	
RPM at driver	RPM at pump
Energy (A pump evaluation is required to get this data)	
Energy input (from evaluation) (KW) (gal/hr) (mcf)	
Pumping plant efficiency (from evaluation) ( %)	
Energy cost per acre foot (from evaluation)	
General condition of equipment, problems	

Irrigation System Inventory Worksheet—*Continued*

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Irrigation management**

Irrigation scheduling method(s)
Typical number of irrigations per season
Typical time between irrigations
Set times or time per revolution
Method of determining soil moisture
Typical water application per (set, revolution, pass)
Source, availability and skill of irrigation labor

Comments about management of the existing system and reasons for improvement. What are the objectives of the irrigation decisionmaker?

**What management level is planned?**


**Other observations and comments**


## Sprinkler Irrigation System Planning/Design Worksheet

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_  
 DISTRICT \_\_\_\_\_ COUNTY \_\_\_\_\_ ENGR JOB CLASS \_\_\_\_\_

**Inventory**

Water source \_\_\_\_\_ Amount available \_\_\_\_\_ ft<sup>3</sup>/sec \_\_\_\_\_ gpm \_\_\_\_\_ acre-ft Seasonal variation \_\_\_\_\_  
 Power source: Electric \_\_\_\_\_ volts, \_\_\_\_\_ phase; Internal combustion engine \_\_\_\_\_ fuel type; Other \_\_\_\_\_

**Soils Data**

Design Soil Series	Available water capacity, AWC (in/ft depth)					Depth to <sup>1</sup>		Sprinkler intake rate (in/hr)
	0-1	1-2	2-3	3-4	4-5	Inhibiting layer (ft)	Water table (ft)	

<sup>1</sup> Actual observed depth in the field.

**Crop Evapotranspiration (Monthly)**

Crops	Acres	Month		Month		Month	
		Depth (in)	Volume (ac-in)	Depth (in)	Volume (ac-in)	Depth (in)	Volume (ac-in)
Totals (1)		(2)		(3)		(4)	

**Crop Weighted Evapotranspiration (Monthly)** (Note: Maximum Monthly Total ET is greatest of nos. 2, 3, or 4 above)

ET, depth =  $\frac{\text{Maximum Total Monthly ET, ac-in/mo}}{\text{Total Acres, A (1)}}$  = \_\_\_\_\_ = \_\_\_\_\_ in /mo

**Irrigation Requirements**

Crops	Root zone depth <sup>2</sup> (ft)	Total AWC (in)	Management allowed depletion (%)	Max Net replacement (in)	Peak daily ET (in)	Max freq @ peak E T @ max net (days)

<sup>2</sup> Use weighted peak monthly ET and net irrigation to determine weighted peak daily E T.

Sprinkler Irrigation System Planning/Design Worksheet—Continued

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Design Data** — (Based on weighted crop ET, \_\_\_\_\_ % irrigation efficiency)

	Application		Weighted <sup>2</sup> peak daily crop ET (in)	Frequency, F (days)	System requirements	
	Net, D (in)	Gross F <sub>g</sub> (in)			Total gpm, Q	gpm/ac

<sup>2</sup> Use weighted peak monthly ET and net irrigation to determine weighted peak daily E T.

Q = system requirements—gpm  
 H = Total operating hours/day  
 (suggest using 23 hours for one move per day)  
 (suggest using 22 hours for two moves per day)

$$Q = \frac{453 A D}{F H \text{ Eff}/100} = \text{_____ gpm} = \text{_____ gpm}$$

Sprinkler head spacing, (S<sub>L</sub>) \_\_\_\_\_ ft, Lateral spacing on mainline (S<sub>M</sub>) \_\_\_\_\_ ft, Minimum Required wetted diameter = \_\_\_\_\_ ft

Sprinkler head: make \_\_\_\_\_; model \_\_\_\_\_; nozzle size \_\_\_\_\_; lb/in<sup>2</sup> \_\_\_\_\_ gpm \_\_\_\_\_; wetted dia \_\_\_\_\_ ft

Application rate \_\_\_\_\_ in/hr, Application time \_\_\_\_\_ hr/set. Net application = ( \_\_\_\_\_ in/hr) ( \_\_\_\_\_ eff) ( \_\_\_\_\_ hr/set) = \_\_\_\_\_ in

Maximum irrigation cycle = Net application \_\_\_\_\_ in/peak ET in/d = \_\_\_\_\_ days

Minimum number of laterals = \_\_\_\_\_ number of lateral sites \_\_\_\_\_  
 (irrigation frequency, \_\_\_\_\_ days) (moves/day, \_\_\_\_\_)

Designed laterals: Number \_\_\_\_\_, Diameter \_\_\_\_\_ in, Type \_\_\_\_\_, Moves/day \_\_\_\_\_

Total number of sprinkler heads = (number of laterals) (number of heads/lateral) = \_\_\_\_\_

System capacity = (Total number of sprinkler heads \_\_\_\_\_) (gpm/head \_\_\_\_\_) = \_\_\_\_\_ gpm

**Lateral design**

Allowable pressure difference along lateral = 0.2 (sprinkler head operating pressure in lb/in<sup>2</sup>) = \_\_\_\_\_ lb/in<sup>2</sup>

Actual head loss (worst condition) \_\_\_\_\_ lb/in<sup>2</sup>

Pressure required at mainline: P = (sprinkler head lb/in<sup>2</sup> \_\_\_\_\_) + (0.75) (Lateral friction lb/in<sup>2</sup> \_\_\_\_\_) +/- (ft elev) / (2) (2.31) = \_\_\_\_\_ lb/in<sup>2</sup>

(plus for uphill flow in lateral, minus for downhill flow). Use sprinkler head lb/in<sup>2</sup> only if elevation difference along lateral is = or > 0.75 (lateral friction loss lb/in<sup>2</sup>)

(2.31). Under this condition, flow regulation may be required at some sprinkler heads to maintain proper sprinkler head operating near the mainline.

Sprinkler Irrigation System Planning/Design Worksheet—Continued

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Mainline Design**

Mainline material \_\_\_\_\_ (IPS, PIP, SDR, CLASS) lb/in<sup>2</sup> rating \_\_\_\_\_, other description, \_\_\_\_\_

Friction factor used \_\_\_\_\_. Formula (check one)  Hazen-Williams  Manning's  Darcy-Weibach  Other (name) \_\_\_\_\_

Station		Diameter pipe (in)	Flow (gpm)	Velocity (fps)	Distance (ft)	Friction loss (ft/100 ft)	Friction loss this section (ft)	Accumulated friction loss (ft)	Remarks
From	To								

NOTE: desirable velocities—5 ft/sec or less in mainlines, 7 ft/sec or less in sprinkler laterals.

**Determination of Total Dynamic Head (TDH)**

Pressure required at main \_\_\_\_\_ lb/in<sup>2</sup> \_\_\_\_\_ ft

Friction loss in main \_\_\_\_\_ lb/in<sup>2</sup> \_\_\_\_\_ ft

Elevation raise/fall in main \_\_\_\_\_ lb/in<sup>2</sup> \_\_\_\_\_ ft (2.31 feet = 1 psi pressure)

Lift (water surface to pump) \_\_\_\_\_ lb/in<sup>2</sup> \_\_\_\_\_ ft

Column friction loss \_\_\_\_\_ lb/in<sup>2</sup> \_\_\_\_\_ ft

Miscellaneous loss \_\_\_\_\_ lb/in<sup>2</sup> \_\_\_\_\_ ft

Total (TDH) \_\_\_\_\_ lb/in<sup>2</sup> \_\_\_\_\_ ft (NOTE; TDH must be in feet for horsepower equation)

$$\text{Approximate brake horsepower} = \frac{\text{TDH (ft)} \times \text{Q (gpm)}}{3960 \times \text{Eff} / 100} = \frac{\text{_____ ft} \times \text{_____ gpm}}{3960 \times \text{_____ \%} / 100} = \text{_____ HP}$$

Mean sea level elevation of pump \_\_\_\_\_ ft (NOTE: check required versus available NPSL for centrifugal pumps)

Pump curve data attached yes  no , If not, pumping plant efficiency assumed = \_\_\_\_\_% (recommended using 65-75%)

Bill of materials attached yes  no

Sprinkler Irrigation System Planning/Design Worksheet—Continued

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Other Design Considerations**

Item	Evaluation performed	NOT needed	Location	Size
Measuring device				
Expansion couplers				
Reducers				
Enlargers (expanders)				
Manifolds				
Bends & elbows				
Tees				
Valved outlets				
Surge facilities (valves, chambers)				
Control valves				
Check non-return flow valves				
Pressure relief valves				
Air-vacuum valves				
Drain facilities				
Thrust blocks				
Anchors				
Pipe supports				
Other				

Remarks

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Special drawing(s) attached \_\_\_\_\_

\_\_\_\_\_

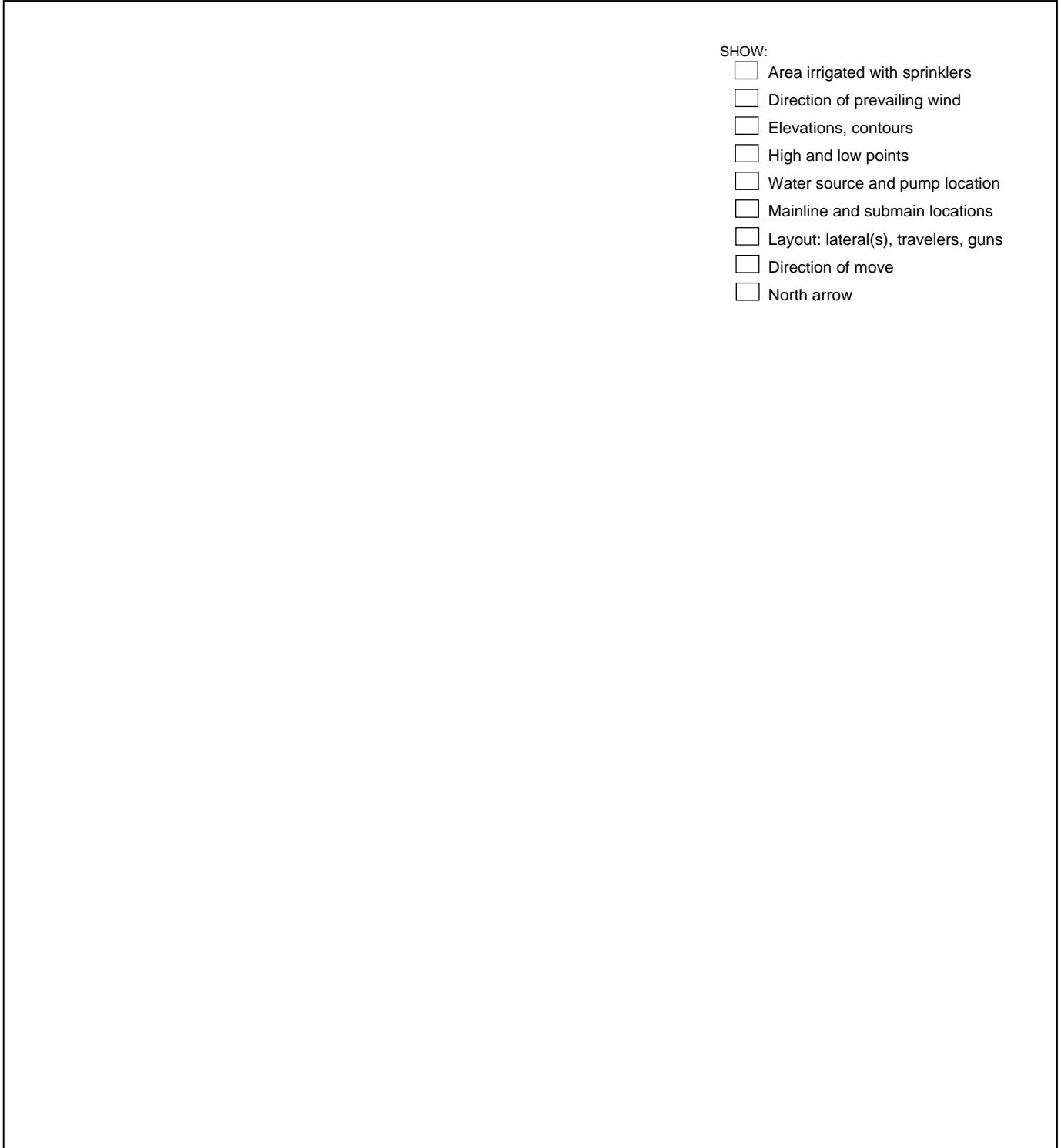
Irrigation system design by \_\_\_\_\_ Date \_\_\_\_\_

Reviewed and approved by \_\_\_\_\_ Date \_\_\_\_\_

Sprinkler Irrigation System Planning/Design Worksheet—Continued

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Irrigation System Location and Layout Map**



SHOW:

- Area irrigated with sprinklers
- Direction of prevailing wind
- Elevations, contours
- High and low points
- Water source and pump location
- Mainline and submain locations
- Layout: lateral(s), travelers, guns
- Direction of move
- North arrow

Scale	Community	Section	Township	Range
-------	-----------	---------	----------	-------



## Irrigation Water Management Plan—Sprinkler Irrigation System

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_  
 DISTRICT \_\_\_\_\_ COUNTY \_\_\_\_\_ ENGR JOB CLASS \_\_\_\_\_

**Crop information**

Field number(s)				
Crop irrigated				
Acres Irrigated (acres)				
Normal rooting depth (feet, inches)				
Management allowable depletion (MAD) (percent, inches)				
Peak daily crop requirements (ac-in/day)				
Average annual net irrigation requirements (ac-in/ year)				

**Soil Information**

Soils series and surface texture		
Capability class		
Allowable soil loss (T=tons per-acre per year)		
Wind Erodibility Group (WEG)		
Actual on-site (observed and measured) average root zone depth		
Total available water capacity (AWC) of soil plant root zone		
Soil intake (Maximum application rate for sprinkler system)		
Available water capacity (AWC) for crop rooting depth:	Depth (inches)	AWC
		(inch/inch)      (total inches)

**Irrigation system management information**

Irrigation system
Source of water
Delivery schedule
Estimated overall irrigation efficiency
Management allowable depletion for pasture
Irrigation set time to apply full irrigation and replace full MAD
Gross application
Net application
Actual gross sprinkler application rate
Irrigation system flow capacity requirement for full time irrigation, Q (gpm)

Irrigation Water Management Plan— Sprinkler Irrigation System—*Continued*

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

**Irrigation scheduling Information**

Month	Monthly net <sup>1</sup> irrigation requirement (inches)	Crop evapo- transpiration use rate (in/day)	Irrigation frequency needed (days)	Average <sup>2</sup> number of Irrigations needed
April				
May				
June				
July				
August				
September				
October				
Total				

<sup>1</sup> Net irrigation requirement (NIR) represents crop evapotranspiration less effective rainfall.

<sup>2</sup> Assuming a full soil profile at start of season. Check soil moisture before irrigating. Account for rainfall that can replace soil moisture depletion. If soil moisture depletion is less than 50% wait for a few days and check it again.

Warmer than “average” months will typically require additional irrigation water; cooler than “average months will typically require less irrigation water; months with more than “average” effective rainfall will typically require less irrigation water.

Only operate the system when needed to furnish water for crop needs. The preceding irrigation schedule can be used as a guide to determine when to irrigate. It is a guide only for average month and year conditions. Optimizing use of rainfall to reduce unnecessary irrigations during the growing season is a good management practice. In semi-humid and humid areas, it is recommended to not replace 100 percent of the soil moisture depletion each irrigation. Leave room in the plant root zone for containing water infiltration from rainfall events. This will vary with location, frequency, and amount of rainfall occurring during the growing season. It should be approximately 0.5 to 1.0 inches.

Maintaining to a higher soil moisture level (MAD) typically does not require more irrigation water for the season, just more frequent smaller irrigations. This is especially true with crops such as root vegetables, potatoes, onions, garlic, mint, and sweet corn.

The attached chart for evaluating soil moisture by the feel and appearance method can be used to help determine when to irrigate. Other common methods to monitor crop water use and soil moisture include: plant signs (crop critical moisture stress periods), atmometer, evaporation pan (applying appropriate factors), tensiometers, electrical resistance blocks (moisture blocks), and crop water stress index (CWSI gm).

NRCS (SCS) - SCHEDULER computer software is available to provide calculations of daily crop evapotranspiration when used with local daily weather station values. On-site rainfall data is necessary to determine effective rainfall, whereas local weather station rainfall data is not sufficiently accurate due to spatial variability. Current rainfall and soil moisture data can be input manually or electronically to assist in predicting when irrigation is needed.

Irrigation Water Management Plan—Sprinkler Irrigation System—Continued

NAME \_\_\_\_\_ DATE \_\_\_\_\_ PREPARED BY \_\_\_\_\_

A properly operated, maintained, and managed sprinkle irrigation system is an asset to your farm. Your system was designed and installed to apply irrigation water to meet the needs of the crop without causing erosion, runoff, and losses to deep percolation. The estimated life span of your system is 15 years. The life of the system can be assured and usually increased by developing and carrying out a good operation and maintenance program.

Pollution hazards to ground and surface water can be minimized when good irrigation water management practices are followed. Losses of irrigation water to deep percolation and runoff should be minimized. Deep percolation and runoff from irrigation can carry nutrients and pesticides into ground and surface water. Avoiding spills from agricultural chemicals, fuels, and lubricants. will also minimize potential pollution hazards to ground and surface water.

Leaching for salinity control may be required if electrical conductivity of the irrigation water or soil water exceeds plant tolerance for your yield and quality objectives. If this condition exists on your field(s), a salinity management plan should be developed.

The following are system design information and recommendations to help you develop an operation and maintenance plan (see irrigation system map for layout):

- average operating pressure = \_\_\_\_\_ lb/in<sup>2</sup> (use a pressure gage to check operating pressure)
- nozzle size = \_\_\_\_\_ inch (use shank end of high speed drill bit to check nozzle wear)
- average sprinkler head discharge \_\_\_\_\_ gpm
- sprinkler head rotation speed should be 1 - 2 revolutions per minute
- sprinkler head spacing on lateral = \_\_\_\_\_ ft; outlet valve spacing on main line \_\_\_\_\_ ft
- lateral, number(s) \_\_\_\_\_, \_\_\_\_\_ ft, \_\_\_\_\_ inch diameter \_\_\_\_\_
- main line = \_\_\_\_\_ ft \_\_\_\_\_ inch diameter, type \_\_\_\_\_, class \_\_\_\_\_
- pump = \_\_\_\_\_, \_\_\_\_\_ gpm @ \_\_\_\_\_ ft Total Dynamic Head (TDH)

Make sure that all measuring devices, valves, sprinkler heads, surface pipeline, and other mechanical parts of the system are checked periodically and worn or damaged parts are replaced as needed. Always replace a worn or improperly functioning nozzle with design size and type. Sprinkler heads operate efficiently and provide uniform application when they are plumb, in good operating condition, and operate at planned pressure. Maintain all pumps, piping, valves, electrical and mechanical equipment in accordance with manufacturer recommendations. Check and clean screens and filters as necessary to prevent unnecessary hydraulic friction loss and to maintain water flow necessary for efficient pump operation.

Protect pumping plant and all associated electrical and mechanical controls from damage by livestock, rodents, insects, heat, water, lightning, sudden power failure, and sudden water source loss. Provide and maintain good surface drainage to prevent water pounding around pump and electrical equipment. Assure all electrical/gas fittings are secure and safe. Always replace worn or excessively weathered electric cables and wires and gas tubing and fittings when first noticed. Check periodically for undesirable stray currents and leaks. Display appropriate bilingual operating instructions and warning signs as necessary. During non-seasonal use, drain pipelines and valves, secure and protect all movable equipment (i.e. wheel lines).

If you need help developing your operation and maintenance plan, contact your local USDA Natural Resources Conservation Service office for assistance.



### Soil Water Holding Worksheet

Field \_\_\_\_\_ Location in field \_\_\_\_\_  
 Year \_\_\_\_\_ By \_\_\_\_\_  
 Crop \_\_\_\_\_  
 Planting data \_\_\_\_\_ Emergence data \_\_\_\_\_  
 Soil name if available \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Factor	Season	
	1st 30 days	Remainder of season
Root zone depth or max soil depth - ft		
Available water capacity AWC - in		
Management allowed deficit MAD - %		
Management allowed deficit MAD - in		

(Note: Irrigate prior to the time that SWD is equal to or greater than MAD - in)

Estimated irrigation system application efficiency \_\_\_\_\_ percent

Data obtained during first field check					Data obtained each check		
(1) Depth range (in)	(2) Soil layer thickness (in)	(3) Soil texture	(4) Available water capacity (AWC) (in/in)	(5) AWC in soil layer (in)	(6) Field check number	(7) Soil water deficit (SWD) (%)	(8) Soil water deficit (SWD) (in)
					1		
					2		
					3		
					4		
					5		
					6		
					7		
					8		
					1		
					2		
					3		
					4		
					5		
					6		
					7		
					8		

Total AWC for root zone depth of \_\_\_\_\_ ft=

Total AWC for root zone depth of \_\_\_\_\_ ft=

$AWC(5) = \text{layer thickness}(2) \times AWC(4)$

$SWD(8) = \frac{AWC(5) \times SWD(7)}{100}$

SWD summary		
Check number	Check date	SWD totals
1		
2		
3		
4		
5		
6		
7		
8		

**Worksheet**  
**Soil-Water Content**  
**(Gravimetric Method)**

Land user \_\_\_\_\_ Date \_\_\_\_\_ Field office \_\_\_\_\_  
 Taken by \_\_\_\_\_ Field name/number \_\_\_\_\_  
 Soil name (if available) \_\_\_\_\_ Crop \_\_\_\_\_ Maximum effective root depth \_\_\_\_\_ ft

Depth range inches	Soil layer thickness inches d	Soil texture	Sample			Tare weight g Tw	Net dry weight g Dw	Volume of sample cc Vol	Moisture percentage % Pd	Bulk density g/cc Dbd	Soil-water content in/in SWC	Layer water content inches TSWC
			Wet weight g WW	Dry weight g DW	Water loss g Ww							

Dry weight (Dw) of soil = DW - TW = \_\_\_\_\_ g      Weight of water lost (Ww) = WW - DW = \_\_\_\_\_ g      Bulk density (Dbd) =  $\frac{Dw(g)}{Vol (cc)}$  = \_\_\_\_\_ g/cc

Percent water content, dry weight Pd =  $\frac{Ww}{Dw} \times 100$  = \_\_\_\_\_ %      Soil-water content (SWC) =  $\frac{Dbd \times Pd}{100 \times 1}$  = \_\_\_\_\_ in/in

Total soil-water content in the layer (TSWC) = SWC x d = \_\_\_\_\_ inches

**Determination of Soil Moisture and Bulk Density (dry)  
 Using Eley Volumeter and Carbide Moisture Tester**

Farm \_\_\_\_\_ Location \_\_\_\_\_ SWCD \_\_\_\_\_  
 Crop \_\_\_\_\_ Soil type \_\_\_\_\_ Date \_\_\_\_\_ Tested by \_\_\_\_\_

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	
Texture	Thickness of layer	Volumeter							Bulk density (g/cc)	Soil-water content (in)	Soil-water content at field capacity	Soil-water deficit (in)	
		Reading before (cc)	Reading after (cc)	Volume (cc)	% Wet wt.	% Dry wt.	% Wilting point	% Soil-water					
	d			V	W <sub>p</sub>	P <sub>d</sub>	P <sub>w</sub>	SWC <sub>p</sub>	Db <sub>d</sub>	SWC	AWC	SWD	
Wet weight of all samples in grams unless otherwise shown.										Totals			

$$Db_d = \frac{26}{\frac{V(1 + P_d)}{100}}$$

$$SWC = \frac{Db_d \times SWC_p \times d}{100 \times 1}$$

$$SWC_p = P_d - P_w$$

### Typical Water Balance Irrigation Scheduling Worksheet

Grower \_\_\_\_\_ Field ID \_\_\_\_\_ Crop \_\_\_\_\_  
 Planting date \_\_\_\_\_ Full cover date \_\_\_\_\_ Harvest date \_\_\_\_\_  
 Soil water holding capacity (in/ft) \_\_\_\_\_ ; \_\_\_\_\_ ; \_\_\_\_\_ ; \_\_\_\_\_ Rooting depth \_\_\_\_\_  
 Management allowable depletion \_\_\_\_\_ Minimum soil-water content \_\_\_\_\_

Date	Daily crop ET (in)	Forecast crop ET (in)	Cum total ET (in)	Rainfall (in)	Irrigation applied (in)	Cumulative total irrigation (in)	Allowable depletion balance (in)	Soil-water content (in)	Predicted irrigation date

**Surface Irrigation System  
 Detailed Evaluation Graded Border Worksheet**

Land user \_\_\_\_\_ Field office \_\_\_\_\_

Field name/number \_\_\_\_\_

Observer \_\_\_\_\_ Date \_\_\_\_\_ Checked by \_\_\_\_\_ Date \_\_\_\_\_

**Field Data Inventory:**

Field area \_\_\_\_\_ acres

Border number \_\_\_\_\_ as counted from the \_\_\_\_\_ side of field

Crop \_\_\_\_\_ Root zone depth \_\_\_\_\_ ft MAD \_\_\_\_\_ %

Stage of crop \_\_\_\_\_

Soil-water data for controlling soil:

Station \_\_\_\_\_ Moisture determination method \_\_\_\_\_

Soil series name \_\_\_\_\_

Depth	Texture	AWC (in)*	SWD (%)*	SWD (in)*
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
Total		_____	_____	_____

MAD, in =  $\frac{\text{MAD, \%} \times \text{total AWC, in}}{100}$  = \_\_\_\_\_ = \_\_\_\_\_ in

Comments about soils: \_\_\_\_\_

Typical irrigation duration \_\_\_\_\_ hr, irrigation frequency \_\_\_\_\_ days

Typical number of irrigation's per year \_\_\_\_\_

Annual net irrigation requirement, NIR (from irrigation guide) \_\_\_\_\_ in

Type of delivery system (gated pipe, turnouts, siphon tubes) \_\_\_\_\_

Delivery system size data (pipe size & gate spacing, tube size & length, turnout size) \_\_\_\_\_

Border spacing \_\_\_\_\_, Strip width \_\_\_\_\_, Wetted width \_\_\_\_\_, Length \_\_\_\_\_

**Field Observations:**

Evenness of water spread across border \_\_\_\_\_

Crop uniformity \_\_\_\_\_

Other observations \_\_\_\_\_

NOTE: MAD = Management allowed deficit    AWC = Available water capacity    SWD = Soil water deficit

**Surface Irrigation System  
 Detailed Evaluation Graded Border Worksheet**

**Data:** Inflow \_\_\_\_\_ Outflow \_\_\_\_\_

Type of measuring device \_\_\_\_\_

Clock <sup>1/</sup> time	Elapsed time (min)	Δ T (min)	Gage H (ft)	Flow rate (gpm)	Average flow rate (gpm)	Volume <sup>2/</sup> (ac-in)	Cum. volume (ac-in)
Turn on							
Turn off							

Total volume (ac-in) \_\_\_\_\_

Average flow rate =

$\text{Total irrigation volume (ac-in)} \times 60.5 = \text{_____} = \text{_____} \text{ ft}^3/\text{s}$       Inflow time (min)

Unit flow:

$q_u = \frac{\text{Average flow rate}}{\text{Border strip spacing}} = \text{_____} = \text{_____} \text{ ft}^3/\text{s}/\text{ft}$

1/ Use a 24-hour clock reading; i.e., 1:30 p.m. should be recorded as 1330 hours.

2/ Flow rate to volume factors:

Find volume using  $\text{ft}^3/\text{s}$ :  $\text{Volume (ac-in)} = .01653 \times \text{time (min)} \times \text{flow (ft}^3/\text{s)}$

Find volume using gpm:  $\text{Volume (ac-in)} = .00003683 \times \text{time (min)} \times \text{flow (gpm)}$



**Surface Irrigation System  
 Evaluation Graded Border Worksheet**

**Depth infiltrated**

Station	Opportunity time <sup>1/</sup> T <sub>Q</sub> (min)	Typical intake curve		Adjusted intake curve	
		Depth <sup>2/</sup> infiltrated (in)	Ave. depth infiltrated (in)	Depth <sup>3/</sup> infiltrated (in)	Ave. depth infiltrated (in)
Sum of ave. depths					

- 1/ Difference in time between advance and recession curve.
- 2/ From "typical" cumulative intake curve.
- 3/ From "adjusted" cumulative intake curve.

Average depth infiltrated (typical)  
 =  $\frac{\text{Sum of depths (typical)}}{\text{Length (hundreds of feet-extended)}}$  = \_\_\_\_\_ = \_\_\_\_\_ in

Extended border area (acres)  
 =  $\frac{\text{Extended border length} \times \text{wetted width}}{43,560}$  =  $\frac{\text{_____}}{43,560}$  = \_\_\_\_\_ acres

Actual average depth applied to extended border length  
 =  $\frac{\text{Ave inflow (ft}^3\text{/s)} \times \text{duration (hr)}}{\text{Extended border area (acres)}}$  = \_\_\_\_\_ = \_\_\_\_\_ in

Average depth infiltrated (adjusted)  
 =  $\frac{\text{Sum of depths (adjusted)}}{\text{Length (hundreds of feet - extended)}}$  = \_\_\_\_\_ = \_\_\_\_\_ in

Note: Should be close to actual depth applied.

**Surface Irrigation System Detailed Evaluation  
 Graded Border Worksheet**

**Average depth infiltrated low 1/4 (LQ):**

Low 1/4 strip length =  $\frac{\text{Actual strip length}}{4} = \frac{\text{Actual strip length}}{4} = \text{_____} \text{ ft}$

LQ =  $\frac{(\text{Depth infiltrated at begin of L1/4 strip}) + (\text{Depth infiltrated at the end of L1/4 strip})}{2}$

=  $\frac{\text{_____}}{2} = \text{_____} \text{ in}$

**Areas under depth curve:**

- 1. Whole curve \_\_\_\_\_ sq in
- 2. Runoff \_\_\_\_\_ sq in
- 3. Deep percolation \_\_\_\_\_ sq in
- 4. Low quarter infiltration \_\_\_\_\_ sq in

**Actual border strip area:**

=  $\frac{(\text{Actual border length, ft}) \times (\text{Wetted width, ft})}{43,560} = \frac{\text{_____}}{43,560} = \text{_____} \text{ acres}$

**Distribution uniformity low 1/4 (DU):**

DU =  $\frac{\text{Low quarter infiltration area} \times 100}{(\text{Whole curve area} - \text{runoff area})} = \text{_____} \%$

**Runoff (RO):**

RO, % =  $\frac{\text{Runoff area} \times 100}{\text{Whole curve area}} = \text{_____} \%$

RO =  $\frac{\text{Total irrigation volume, ac-in} \times \text{RO, \%}}{\text{Actual strip area, ac} \times 100} = \text{_____} \text{ in}$

**Deep percolation, DP:**

DP =  $\text{Deep percolation area} \times 100 = \text{_____} \%$

DP =  $\frac{\text{Total irrigation volume, ac-in} \times \text{DP, \%}}{\text{Actual strip area, ac} \times 100} = \text{_____} \text{ in}$

**Surface Irrigation System  
 Detailed Evaluation Graded Border Worksheet**

**Evaluation computations, cont:**

**Gross application,  $F_g$ :**

$$F_g = \frac{\text{Total irrigation volume, ac-in}}{\text{Actual strip area, ac}} = \underline{\hspace{4cm}} = \underline{\hspace{2cm}} \text{ in}$$

**Application efficiency,  $E_a$ :**

(Average depth stored in root zone = Soil water deficit (SWD) if entire root zone depth will be filled to field capacity by this irrigation, otherwise use  $F_g$ , in - RO, in)

$$E_a = \frac{\text{Average depth stored in root zone} \times 100}{\text{Gross application, in}} = \underline{\hspace{4cm}} = \underline{\hspace{2cm}} \%$$

**Application efficiency low 1/4,  $E_q$ :**

$$E_q = \frac{DU \times E_a, \%}{100} = \underline{\hspace{4cm}} = \underline{\hspace{2cm}} \%$$

**Average net application,  $F_n$**

$$F_n = \frac{\text{Total irrigated volume, ac-in} \times E_a, \%}{\text{Actual strip area, ac} \times 100} = \underline{\hspace{4cm}} = \underline{\hspace{2cm}} \%$$

**Time factors:**

Required opportunity time to infiltrate soil water deficit of \_\_\_\_\_ in

$$T_o = \underline{\hspace{2cm}} \text{ min (} \underline{\hspace{2cm}} \text{ hr - } \underline{\hspace{2cm}} \text{ min)}$$

Estimated required irrigation inflow time from adv.-recession curves;

$$T_{in} = \underline{\hspace{2cm}} \text{ min (} \underline{\hspace{2cm}} \text{ hr - } \underline{\hspace{2cm}} \text{ min)}$$

At inflow rate of:

$$Q = \underline{\hspace{2cm}} \text{ ft}^3/\text{s per border strip}$$

**Surface Irrigation System Detailed Evaluation  
 Graded Border Worksheet**

**Present management:**

Estimated present average net application per irrigation \_\_\_\_\_ inches

Present gross applied per year =  $\frac{\text{Net applied per irrigation} \times \text{number of irrigations} \times 100}{\text{Application efficiency (E}_a\text{)}^{1/}}$

= \_\_\_\_\_ = \_\_\_\_\_ in

<sup>1/</sup> Use the best estimate of what the application efficiency of a typical irrigation during the season may be. The application efficiency from irrigation to irrigation can vary depending on the SWD, set times, etc. If the irrigator measures flow during the season, use that information.

**Potential management:**

Annual net irrigation requirement \_\_\_\_\_ inches, for \_\_\_\_\_ (crop)

Potential application efficiency (E<sub>pa</sub>) \_\_\_\_\_ percent (from irrigation guide, NEH or other source)

Potential annual gross applied =  $\frac{\text{Annual net irrigation requirement} \times 100}{\text{Potential application efficiency (E}_{pa}\text{)}}$

= \_\_\_\_\_ = \_\_\_\_\_ in

Total annual water conserved

=  $\frac{(\text{Present gross applied} - \text{potential gross applied}) \times \text{area irrigation (ac)}}{12}$

= \_\_\_\_\_ = \_\_\_\_\_ acre feet

**Annual cost savings:**

Pumping plant efficiency \_\_\_\_\_ Kind of fuel \_\_\_\_\_

Cost per unit of fuel \_\_\_\_\_ Fuel cost per acre foot \$ \_\_\_\_\_

Cost savings = Fuel cost per acre foot x acre feet conserved per year

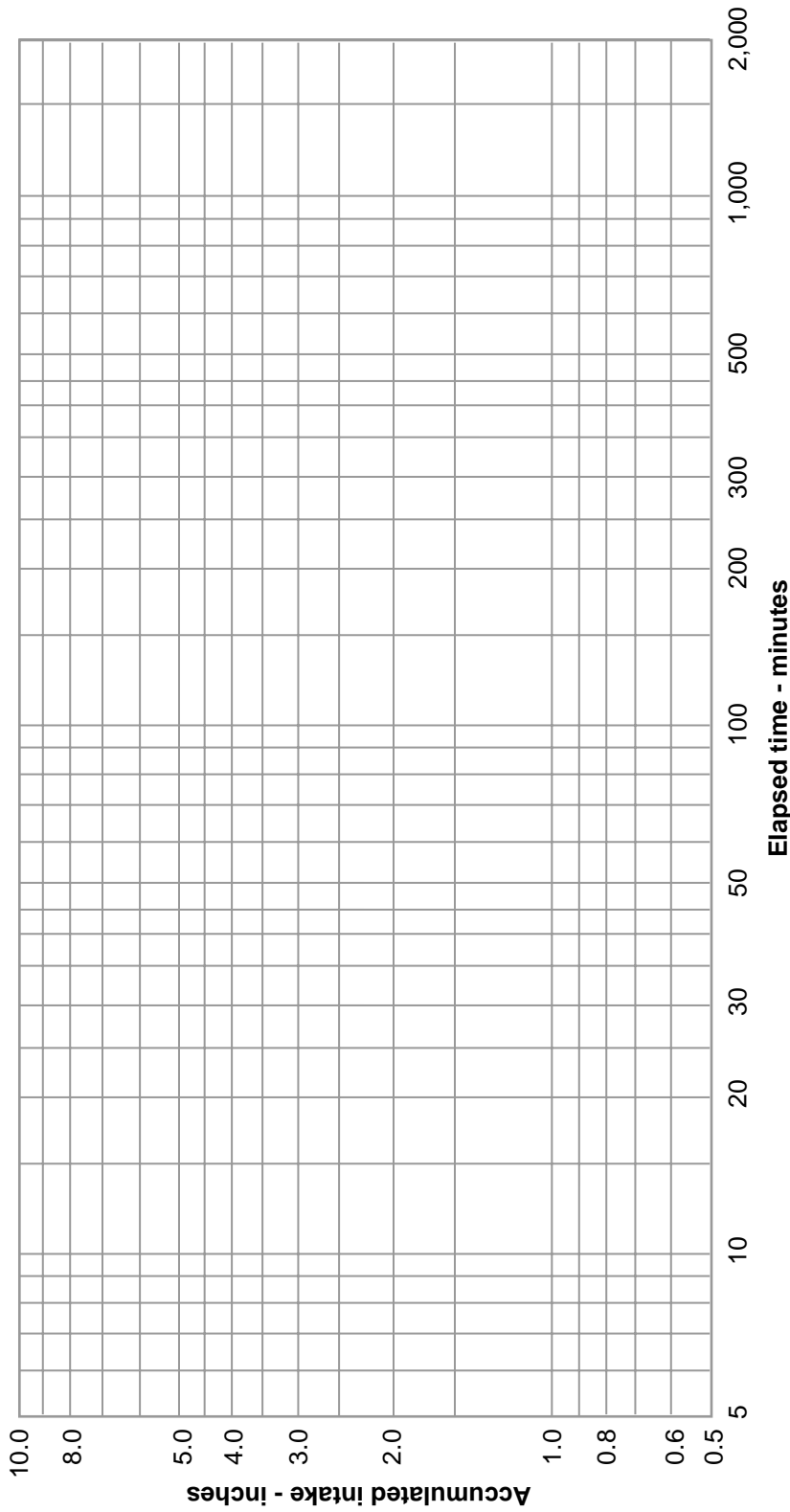
= \_\_\_\_\_ = \$ \_\_\_\_\_





# Cylinder Infiltrometer Curves

Land user \_\_\_\_\_  
Date \_\_\_\_\_  
Field office \_\_\_\_\_



U.S. Department of Agriculture  
National Resources Conservation Service

**Cylinder Infiltrometer Test Data**

-322  
02-96

FARM	COUNTY	STATE	LEGAL DESCRIPTION	DATE
SOIL MAPPING SYMBOL	SOIL TYPE		SOIL MOISTURE:	
CROP	STAGE OF GROWTH			

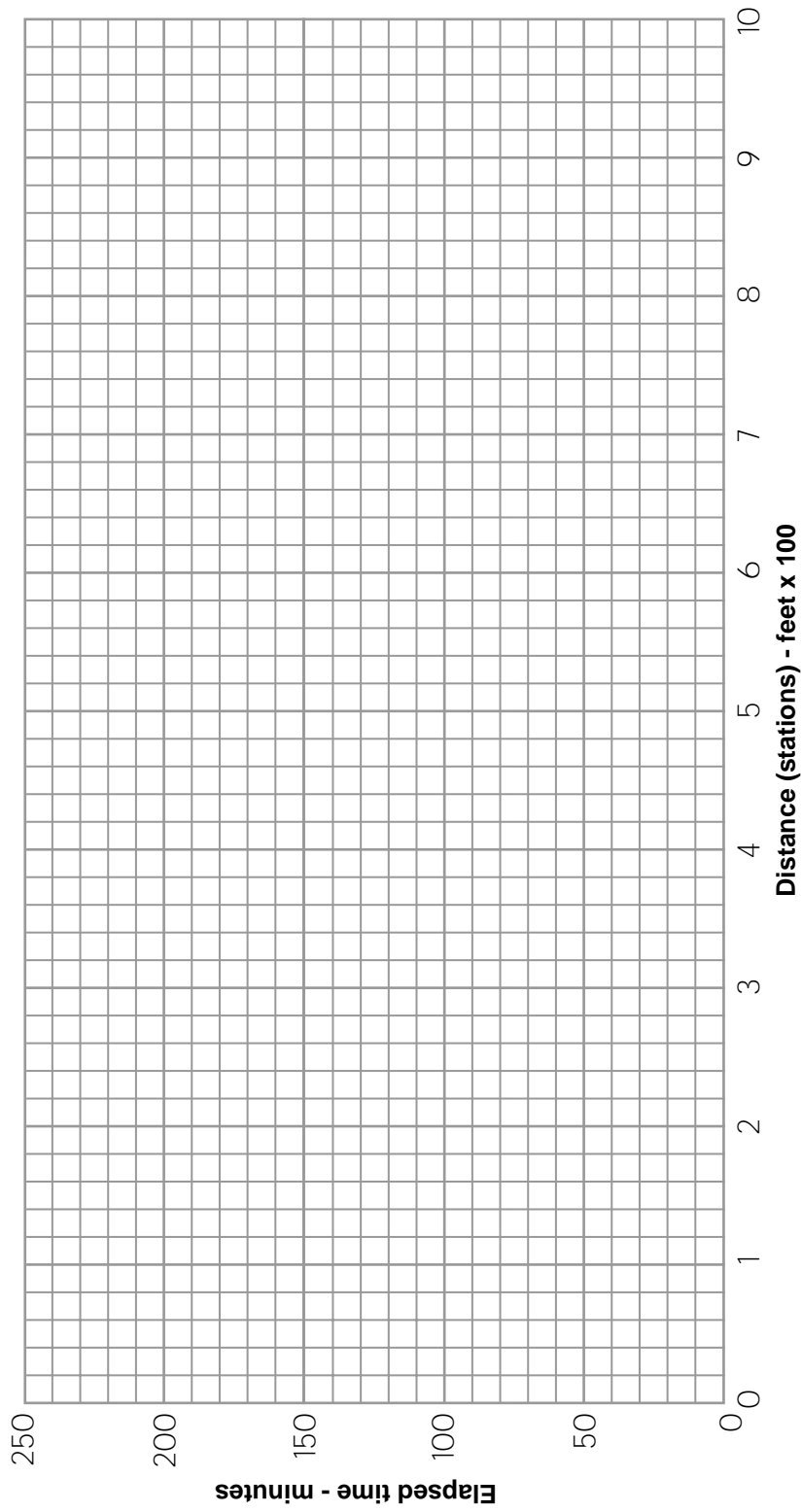
GENERAL COMMENTS

Elapsed time	Cylinder No. 1			Cylinder No. 2			Cylinder No. 3			Cylinder No. 4			Cylinder No. 5			Average accum. intake
	Time of reading	Hook gage reading	Accum. intake	Time of reading	Hook gage reading	Accum. intake	Time of reading	Hook gage reading	Accum. intake	Time of reading	Hook gage reading	Accum. intake	Time of reading	Hook gage reading	Accum. intake	
	Min.	Inches		Inches		Inches		Inches		Inches		Inches				

(210-VI-NEH, September 1997)

Land user \_\_\_\_\_  
Date \_\_\_\_\_  
Field office \_\_\_\_\_

### Advance and recession curves

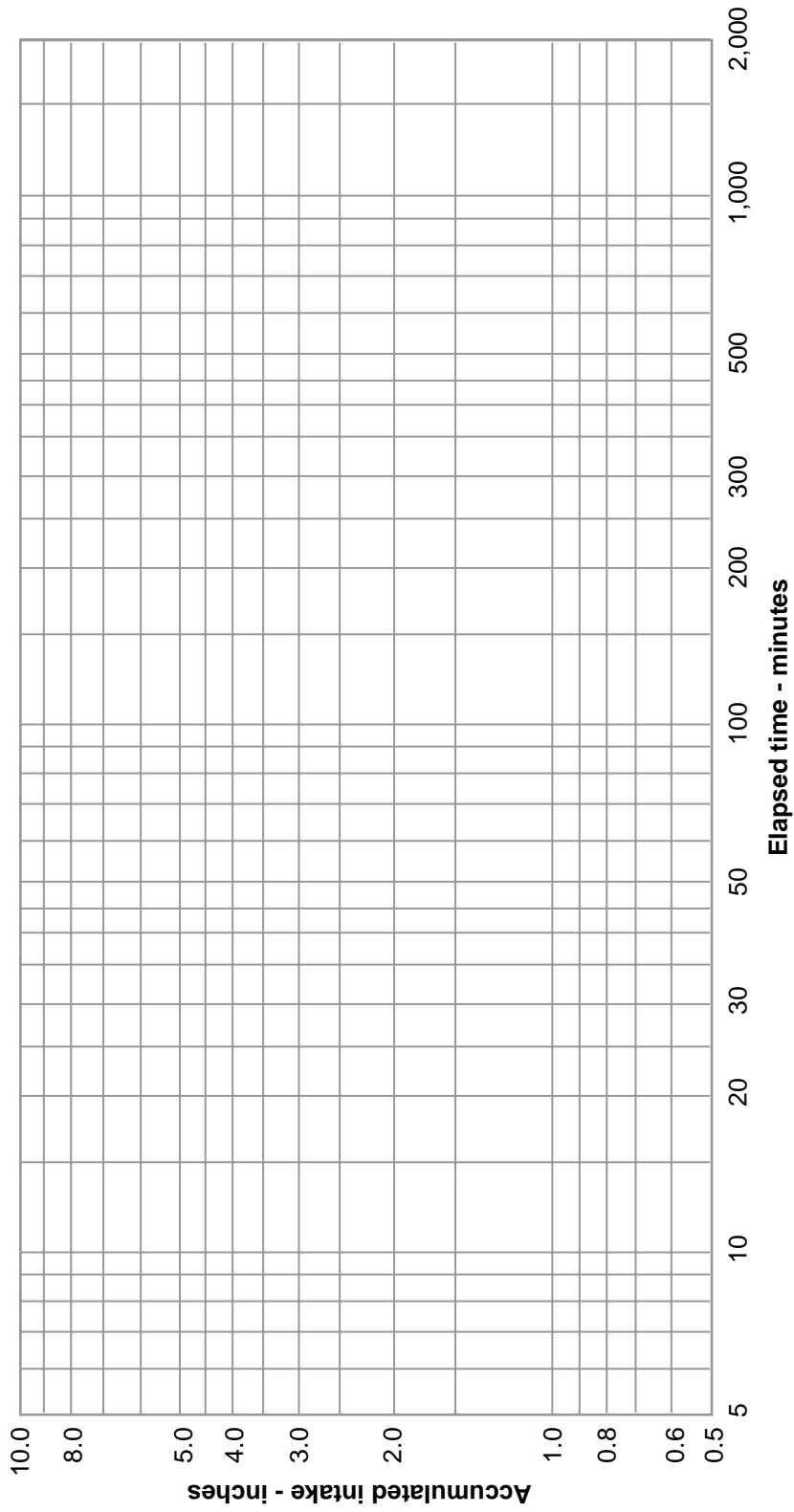


# Cylinder infiltrometer Curves

Land user \_\_\_\_\_

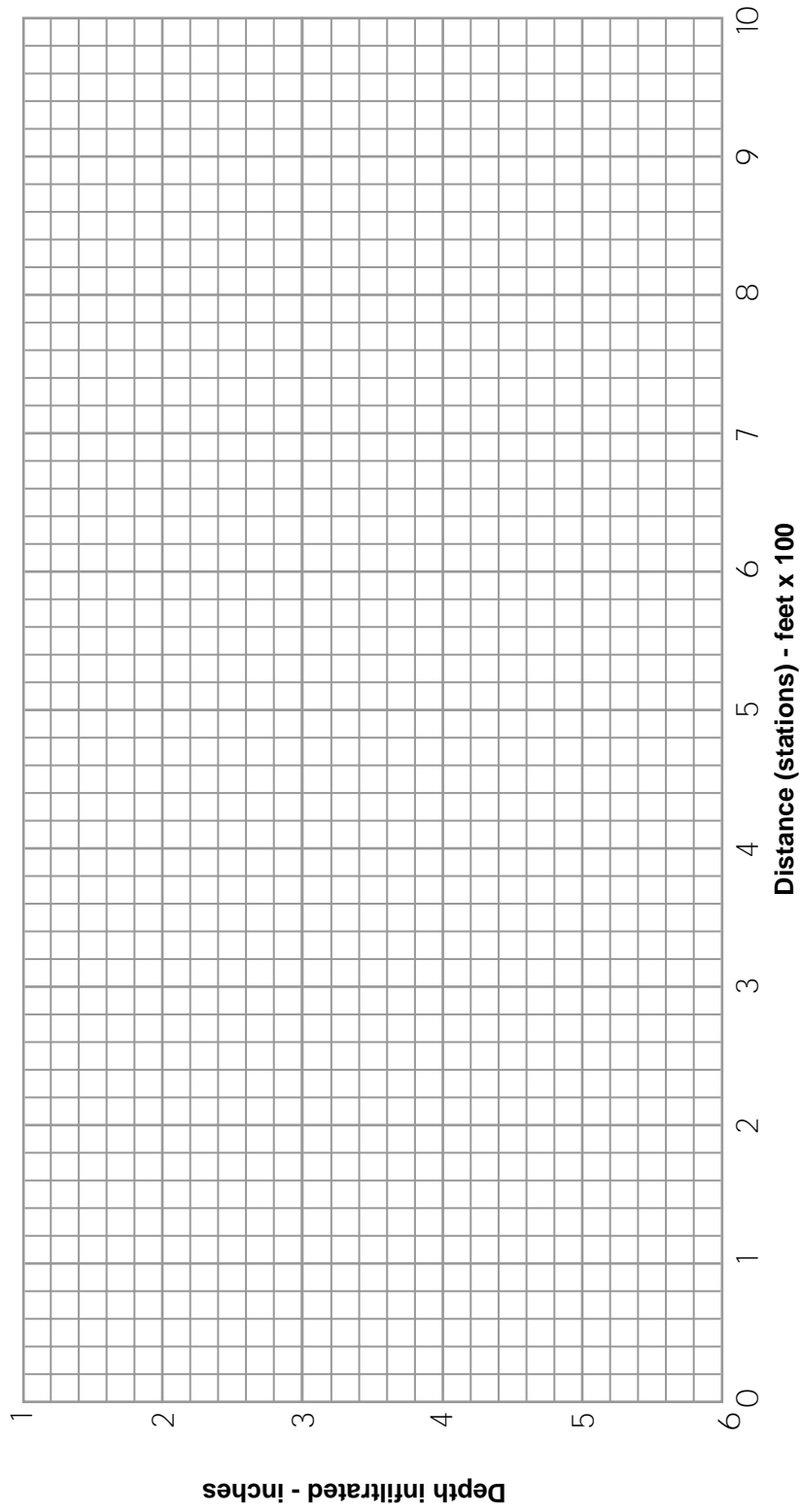
Date \_\_\_\_\_

Field office \_\_\_\_\_



Land user \_\_\_\_\_  
Date \_\_\_\_\_  
Field office \_\_\_\_\_

### Depth infiltrated curve



**Surface Irrigation System  
 Detailed Evaluation Graded Border Worksheet**

Land user \_\_\_\_\_ Field office \_\_\_\_\_

Field name/number \_\_\_\_\_

Observer \_\_\_\_\_ Date \_\_\_\_\_ Checked by \_\_\_\_\_ Date \_\_\_\_\_

**Field Data Inventory:**

Field area \_\_\_\_\_ acres

Border number \_\_\_\_\_ as counted from the \_\_\_\_\_ side of field

Crop \_\_\_\_\_ Root zone depth \_\_\_\_\_ ft MAD \_\_\_\_\_ %

Stage of crop \_\_\_\_\_

Soil-water data for controlling soil:

Station \_\_\_\_\_ Moisture determination method \_\_\_\_\_

Soil series name \_\_\_\_\_

Depth	Texture	AWC (in)*	SWD (%)*	SWD (in)*
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
	Total	_____	_____	_____

MAD, in =  $\frac{\text{MAD, \%} \times \text{total AWC, in}}{100}$  = \_\_\_\_\_ in

Comments about soils: \_\_\_\_\_  
 \_\_\_\_\_

Typical irrigation duration \_\_\_\_\_ hr, irrigation frequency \_\_\_\_\_ days

Typical number of irrigation's per year \_\_\_\_\_

Annual net irrigation requirement, NIR (from irrigation guide) \_\_\_\_\_ in

Type of delivery system (gated pipe, turnouts, siphon tubes) \_\_\_\_\_

Delivery system size data (pipe size & gate spacing, tube size & length, turnout size) \_\_\_\_\_

Border spacing \_\_\_\_\_, Strip width \_\_\_\_\_, Wetted width \_\_\_\_\_, Length \_\_\_\_\_

**Field Observations:**

Evenness of water spread across border \_\_\_\_\_

Crop uniformity \_\_\_\_\_

Other observations \_\_\_\_\_

NOTE: MAD = Management allowed deficit    AWC = Available water capacity    SWD = Soil water deficit

**Surface Irrigation System  
 Detailed Evaluation Level Border and Basins Worksheet**

1. Basin area (A):

$$A = \frac{\text{Length} \times \text{Width}}{43,560} = \frac{\quad \times \quad}{46,560} = \quad \text{acres}$$

2. Gross application,  $F_g$ , in inches:

$$F_g = \frac{\text{Total irrigation volume, in ac-in}}{A, \text{ ac}} = \quad = \quad \text{in}$$

3. Amount infiltrated during water inflow,  $V_i$ :

$$V_i = \text{Gross application} - \text{Depth infiltrated after turnoff} = \quad = \quad \text{in}$$

4. Deep percolation, DP, in inches:

$$DP = \text{Gross application} - \text{Soil water deficit, SWD} = \quad = \quad \text{in}$$

$$DP, \text{ in \%} = \frac{\text{Soil water depletion, DP in inches} \times 100}{\text{Gross application, } F_g} = \quad = \quad \%$$

5. Application efficiency,  $E_a$ :

Average depth of water stored in root zone = Soil water deficit, SWD, if the entire root zone average depth will be filled to field capacity by this irrigation.

$$E_a = \frac{\text{Average depth stored in root zone, } F_n \times 100}{\text{Gross application, } F_g} = \quad = \quad \%$$

6. Distribution uniformity, DU:

$$\begin{aligned} \text{Depth infiltrated low } 1/4 &= \frac{(\text{max intake} - \text{min intake}) + \text{min intake}}{8} \\ &= \frac{\quad + \quad}{8} = \quad \end{aligned}$$

$$DU = \frac{\text{Depth infiltrated low } 1/4}{\text{Gross application, } F_g} = \quad = \quad$$

7. Application efficiency, low 1/4,  $E_q$ :

$$E_q = \frac{DU \times E_a}{100} = \quad = \quad \%$$

**Surface Irrigation System  
 Detailed Evaluation Level Border and Basins Worksheet**

1. Present management

Estimated present average net application per irrigation = \_\_\_\_\_ inches

Present annual gross applied =  $\frac{\text{(net applied per irrigation)} \times \text{(number of irrigations)} \times 100}{\text{Application efficiency, low } 1/4, E_q}$

= \_\_\_\_\_ x 100 = \_\_\_\_\_ inches

2. Potential management

Recommended overall irrigation efficiency,  $E_{des}$  \_\_\_\_\_

Potential annual gross applied =  $\frac{\text{Annual net irrigation requirements} \times 100}{E_{des}}$

= \_\_\_\_\_ = \_\_\_\_\_ inches

3. Total annual water conserved:

=  $\frac{\text{(resent gross applied, in - potential gross applied, in)} \times \text{area irrigated, acres}}{12}$

+ \_\_\_\_\_ = \_\_\_\_\_ ac-ft

4. Annual potential cost savings

From pumping plant evaluation:

Pumping plant efficiency \_\_\_\_\_ Kind of fuel \_\_\_\_\_

Cost per unit of fuel \_\_\_\_\_ Fuel cost per acre-foot \$ \_\_\_\_\_

Cost savings = (fuel cost per acre foot) x (water conserved per year, in ac-ft)

= \_\_\_\_\_ x \_\_\_\_\_ = \$ \_\_\_\_\_

Water purchase cost per acre-foot, per irrigation season \_\_\_\_\_

Water purchase cost savings = (Cost per acre-foot) x (water saved per year, in acre-feet)

= \_\_\_\_\_ = \$ \_\_\_\_\_

Potential cost savings = pumping cost + water purchase cost = \_\_\_\_\_ = \$ \_\_\_\_\_



**Surface Irrigation System  
 Detailed Evaluation Level Border and Basins Worksheet**

**Inflow Data**

Type of measuring device \_\_\_\_\_

Clock <sup>1/</sup> time	Elapsed time (min)	$\Delta T$ (min)	Gage H (ft <sup>3</sup> /s)	Flow rate (ft <sup>3</sup> /s)	Average flow rate (ft <sup>3</sup> /s)	Volume (ac-in) <sup>2/</sup>	Cum. volume (ac-in)
Turn on							

Turn off

--	--	--	--	--	--	--	--	--

Total volume (ac-in) \_\_\_\_\_

Average flow:

$$\text{Average flow} = \frac{(\text{Total irrigation volume, in ac-in}) \times 60.5}{\text{Inflow time, in minutes}} = \text{_____} = \text{_____ ft}^3/\text{s}$$

Unit:

$$q_u = \frac{\text{Average inflow rate, in ft}^3/\text{s}}{\text{Border spacing}} = \text{_____} = \text{_____ ft}^3/\text{s}/\text{ft}$$

- 1/ Use a 24-hour clock reading; i.e., 1:30 p.m. is recorded as 1330 hours.
- 2/ Flow rate to volume factors:

To find volume using ft<sup>3</sup>/s: volume (ac-in) = .01653 x time (min) x flow (ft<sup>3</sup>/s)  
 To find volume using gpm: volume (ac-in) = .00003683 x time (min) x flow (gpm)

**Surface System  
 Detailed Evaluation Level Border and Basins Worksheet**

**Advance - Recession Data**

Station (ft)	Elevation (ft)	Advance time <sup>1/</sup> (hr: min)	Recession time <sup>1/</sup> (hr: min)	Opportunity time To (min)	Intake <sup>2/</sup> (in)	Minimum maximum intake (in)
Total						

Water surface elevation at water turnoff \_\_\_\_\_ ft <sup>3/</sup>

Average field elevation =  $\frac{\text{elevation total}}{\text{no. of elevations}}$  = \_\_\_\_\_ = \_\_\_\_\_ ft

Depth infiltrated after water turnoff  
 = (water surface at turnoff - average field elev) x 12  
 = ( \_\_\_\_\_ - \_\_\_\_\_ x 12 = \_\_\_\_\_ in

Average opportunity time =  $\frac{\text{total opportunity time}}{\text{no. of sample locations}}$  = \_\_\_\_\_ = \_\_\_\_\_ min

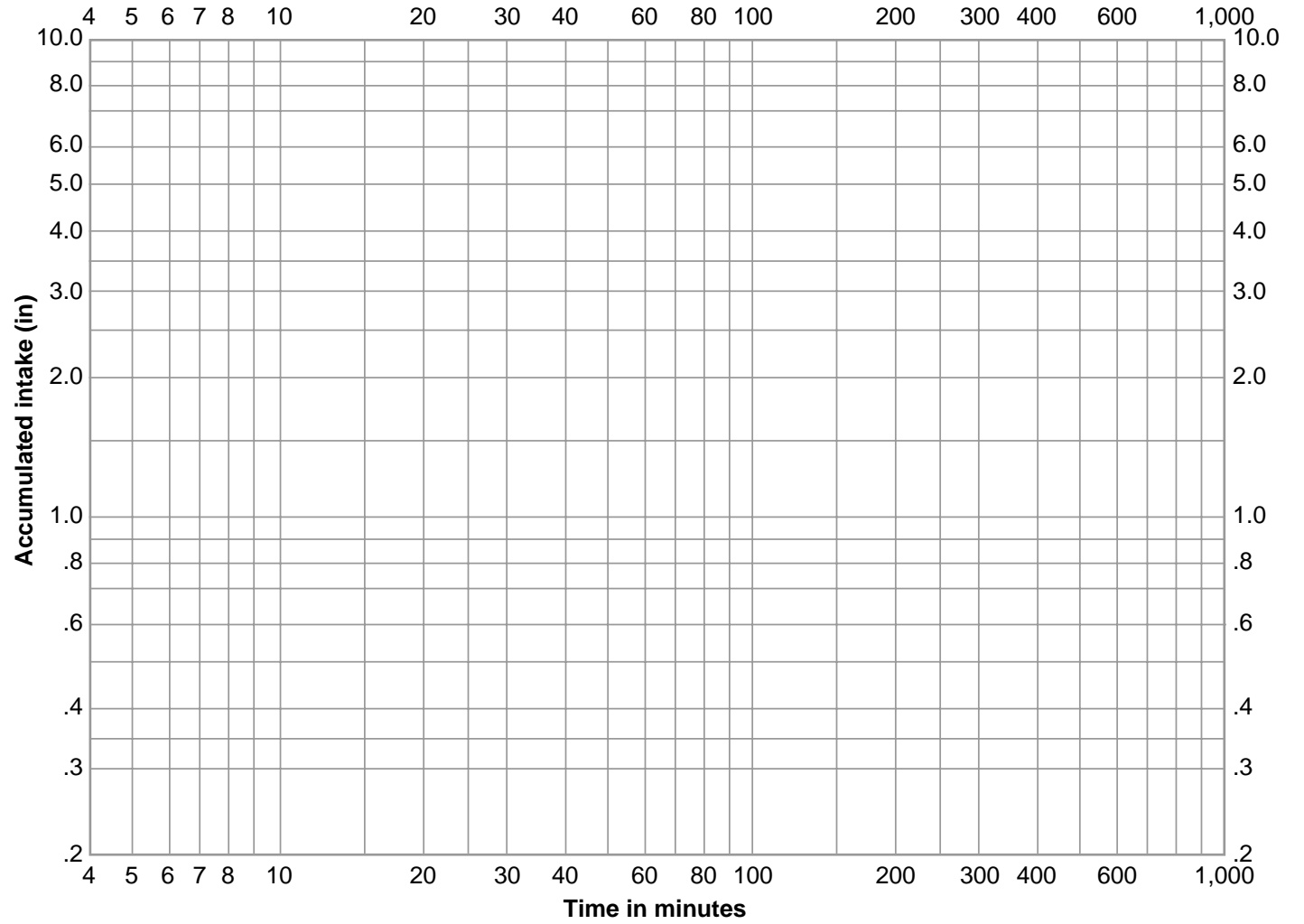
1/ Use 24-hour clock time. As a minimum, record times at upper end, mid point.  
 2/ Obtain intake from plotted intake curve.  
 3/ Water surface elevation should be read to nearest 0.01 ft.

Land user \_\_\_\_\_

Date \_\_\_\_\_

Field office \_\_\_\_\_

### Soil Water Intake Curves





**Surface Irrigation System  
 Detailed Evaluation Graded Furrow Worksheet 1**

Land user \_\_\_\_\_ Field office \_\_\_\_\_  
 Field name/number \_\_\_\_\_  
 Observer \_\_\_\_\_ Date \_\_\_\_\_ Checked by \_\_\_\_\_ Date \_\_\_\_\_

**Field Data Inventory:**

Show location on evaluation furrows on sketch or photo of field.

Crop \_\_\_\_\_ Actual root zone depth \_\_\_\_\_ MAD <sup>†</sup>/ \_\_\_\_\_ % MAD \_\_\_\_\_ in  
 Stage of crop \_\_\_\_\_ Planting date (or age of planting) \_\_\_\_\_  
 Field acres \_\_\_\_\_

**Soil-water data:**

(Show location of sample on soil map or sketch of field)

Soil moisture determination method \_\_\_\_\_  
 Soil mapping unit \_\_\_\_\_ Surface texture \_\_\_\_\_

Depth	Texture	AWC (in) <sup>1/</sup>	SWD (%) <sup>1/</sup>	SWD (in) <sup>1/</sup>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
Total				_____

Comments about soils: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Typical irrigation duration \_\_\_\_\_ hours, Irrigation frequency \_\_\_\_\_ days  
 Typical number of irrigations per year \_\_\_\_\_  
 Crop rotation \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Field uniformity condition (smoothed, leveled, laser leveled, etc., and when) \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

1/ MAD = Management allowable depletion      AWC = Available water capacity      SWD = Soil water deficit

**Surface Irrigation System  
 Detailed Evaluation Graded Furrow Worksheet 2**

Cultivation no.	Date	Crop stage	Irrigate?
1	_____	_____	_____
2	_____	_____	_____
3	_____	_____	_____
4	_____	_____	_____
5	_____	_____	_____

Delivery system size (pipe diameters, gate spacing, siphon tube size, etc.) \_\_\_\_\_  
 \_\_\_\_\_

**Field observations**

Evenness of advance across field \_\_\_\_\_

Crop uniformity \_\_\_\_\_

Soil condition \_\_\_\_\_

Soil compaction (surface, layers, etc.) \_\_\_\_\_

Furrow condition \_\_\_\_\_

Erosion and/or sedimentation: in furrows \_\_\_\_\_

head or end of field \_\_\_\_\_

Other observations (OM, cloddiness, residue, plant row spacing, problems noted, etc.) \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Furrow spacing \_\_\_\_\_ inches

Furrow length \_\_\_\_\_ feet

Irrigations since last cultivation \_\_\_\_\_

Furrow profile (rod readings or elevations at each 100 foot. station):

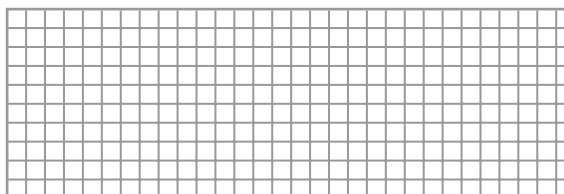
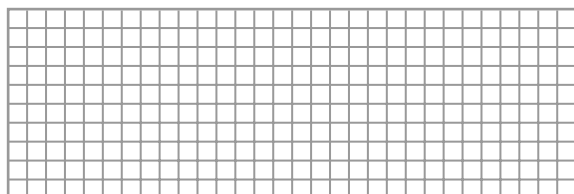
\_\_\_\_\_

\_\_\_\_\_

Furrow cross section:

Station: \_\_\_\_\_

Station: \_\_\_\_\_

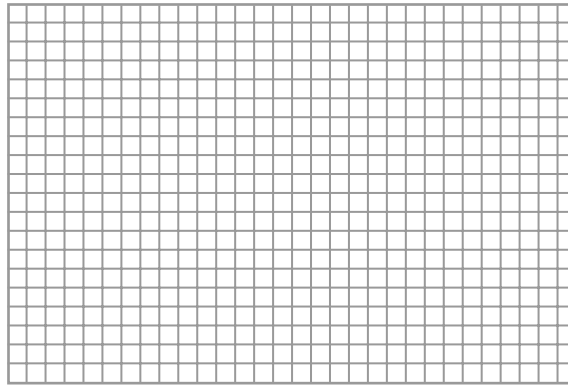


**Example - Surface Irrigation System Detailed Evaluation  
 Graded Furrow Worksheet 3**

Furrow data summary:

Evaluation length \_\_\_\_\_ Slope \_\_\_\_\_ Average \_\_\_\_\_

Section through plant root zone:



**Evaluation computations**

Furrow area, A =  $\frac{\text{(furrow evaluation length, L, ft)} \times \text{(furrow spacing, W, ft)}}{43,560 \text{ ft}^2/\text{acre}}$

A = \_\_\_\_\_ = \_\_\_\_\_ acre

43,560

Present gross depth applied,  $F_g = \frac{\text{Total inflow volume, gal.} \times .0000368}{\text{Furrow area, A, in acres}}$  (Total inflow from worksheet 7)

$F_g =$  \_\_\_\_\_ = \_\_\_\_\_ inches

Minimum opportunity time,  $T_{ox} =$  \_\_\_\_\_ min at station \_\_\_\_\_ (from field worksheet 10)

Minimum depth infiltrated,  $F_{min} =$  \_\_\_\_\_ inches (from worksheet 10)

Average depth infiltrated,  $F_{(0-1)} =$  \_\_\_\_\_ (from calculations on worksheet 10)

Distribution uniformity,  $DU = \frac{\text{Minimum depth infiltrated, inches}}{\text{Average depth infiltrated, inches}} \times 100 = \frac{F_{min} \times 100}{F_{ave}}$

= \_\_\_\_\_ = \_\_\_\_\_ %

### Example - Surface Irrigation System Detailed Evaluation Graded Furrow Worksheet 4

$$\text{Runoff, RO\%} = \frac{\text{Total outflow volume, gal} \times 100}{\text{Total inflow volume, gal}} = \text{_____} = \text{_____ \% (Total outflow, worksheet 8)} \\ \text{(Total inflow, worksheet 7)}$$

$$\text{RO, in} = \frac{\text{Total outflow volume, gal} \times .0000368}{\text{Evaluation furrow area, A, in acres}} = \text{_____} \times 0.0000368 = \text{_____ in (Furrow area, worksheet 3)}$$

Deep percolation, DP, in = Average depth infiltrated - Soil moisture deficit, SMD (Ave. depth worksheet 10 and SMD worksheet 1)

$$\text{DP} = \text{_____} = \text{_____ in}$$

$$\text{Deep percolation, DP, \%} = \frac{\text{Deep percolation, DP, in} \times 100}{\text{Gross depth applied, } F_g, \text{ inches}} = \text{_____} = \text{_____ \%}$$

Application efficiency,  $E_a$

$$E_a = \frac{\text{Ave depth stored in root zone}^* \times 100}{\text{Gross application, } F_g, \text{ inches}} = \text{_____} = \text{_____ \%}$$

\*Average depth of water stored in root zone = SWD if entire root zone depth is filled to field capacity by this irrigation. If irrigation efficiency is to be used in place of application efficiency, use average depth of water beneficially used (i.e., all infiltrated depths less than or equal to SWD) plus any other beneficial uses.

## Example - Surface Irrigation System Detailed Evaluation Graded Furrow Worksheet 5

### Potential water and cost savings

Present management

Estimated present gross net application,  $F_g$  per irrigation = \_\_\_\_\_ inches ( $F_g$  from worksheet 3)

Present gross applied per year = Gross applied per irrigation,  $F_g$  x number of irrigations

= \_\_\_\_\_ = \_\_\_\_\_ inches

Potential management

Annual net irrigation requirement \_\_\_\_\_ inches, for \_\_\_\_\_ (crop)

Potential application efficiency,  $E_{pa}$  = \_\_\_\_\_%

Potential annual gross applied =  $\frac{\text{Annual net irrigation req.} \times 100}{\text{Potential application efficiency, } E_{pa}}$

= \_\_\_\_\_ = \_\_\_\_\_ inches

Total annual water conserved =  $\frac{(\text{present gross applied} - \text{potential gross applied}) \times \text{area irrigated, ac}}{12}$

= \_\_\_\_\_ = \_\_\_\_\_ acre feet

**Surface Irrigation System  
Detailed Evaluation Graded Furrow Worksheet 6**

**Annual cost savings**

Water cost

= Cost per acre foot x acre feet saved per year = \_\_\_\_\_

= \$ \_\_\_\_\_

Cost savings = Pumping cost + water cost = \_\_\_\_\_ = \$ \_\_\_\_\_

Fuel cost savings = (fuel cost per ac-ft) x (ac-ft conserved per year) = \_\_\_\_\_ = \_\_\_\_\_

**Recommendations** \_\_\_\_\_

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

**Surface Irrigation System  
 Detailed Evaluation Furrow Worksheet 7-8**

**Data:** Furrow number \_\_\_\_\_ Inflow \_\_\_\_\_ Outflow \_\_\_\_\_

Type of measuring device \_\_\_\_\_

Clock <sup>1/</sup> time	Elapsed time (min)	Δ T (min)	Gage H (ft)	Flow rate (gpm)	Average flow rate (gpm)	Volume <sup>2/</sup> (gal)	Cum. volume (gal)
Turn on							
Total volume							

1/ Use a 24-hour clock reading; i.e., 1:30 p.m. is recorded as 1330 hours.  
 2/ Volume = Δ T x average flow rate

Average flow rate =  $\frac{\text{Total irrigation volume, gallon}}{\text{Elapsed time, minute}}$  = \_\_\_\_\_ = \_\_\_\_\_ gpm

**Surface Irrigation System Detailed Evaluation  
 Furrow Worksheet 9**

**Intake Curve Plotting Data**

Opportunity time at time "T"						Intake at time "T"			
Clock time		Inflow time		Outflow time		Opportunity time $T_o$ <sup>5/</sup>	Cumulative inflow volume <sup>6/</sup> $V_{in}$ (gal)	Cumulative Outflow volume <sup>6/</sup> $V_{out}$ (gal)	Intake $F_{0-1}$ <sup>7/</sup> (in)
(hr-min) <sup>1/</sup>	T (hr)	Start <sup>2/</sup> (hr)	T1 <sup>3/</sup> (hr)	Start <sup>2/</sup> (hr)	T2 <sup>4/</sup> (hr)				

- 1/ Use a 24-hour clock reading for collection of field data; i.e., 1:30 p.m. is 1330 hours. Use decimal hours for inflow and outflow times.  
 2/ Time at which inflow or outflow starts in decimal hours (worksheet 7-8)  
 3/ Inflow time:  $T1 = "T" - \text{inflow start time}$  (worksheet 7)  
 4/ Outflow time:  $T2 = "T" - \text{outflow start time}$  (worksheet 8)  
 5/ Opportunity time (minutes):  $T_o = 30 (T1 + T2)$   
 6/ Cumulative inflow and outflow volumes (worksheet 7-8). If data were not recorded for time T, interpolate the inflow or outflow.

Surface storage and wetted perimeter for length of furrow with water in it.  
 $L = \text{length of furrow with water in it, ft}$  (worksheet 3) = \_\_\_\_\_  
 $S = \text{average furrow slope, ft/ft}$  (worksheet 3) = \_\_\_\_\_  
 $n = \text{Mannings "n"}$  (usually 0.04 for furrows, 0.10 for corrugations) = \_\_\_\_\_  
 $Q_{av} = \text{average inflow rate, gpm}$  (worksheet 7) = \_\_\_\_\_

Surface storage:  $V_s = L \left[ 0.09731 \left( \frac{Q_{av} \times n}{S^5} \right)^{.7567} + 0.00574 \right]$  = \_\_\_\_\_

Wetted perimeter:  $P = 0.2686 \left( \frac{Q_{av} \times n}{S^5} \right)^{.4247} + 0.7462$  = \_\_\_\_\_

7/ Intake plotting point:  
 $V_{in} = \text{Cumulative inflow (gal) from worksheet 7}$   
 $V_{out} = \text{Cumulative outflow (gal) from worksheet 8}$   
 $V_s = \text{Surface storage (gal) in length of furrow with water in it}$

$$F_{0-1} = \frac{1.604 (V_{in} - V_{out} - V_s)}{L \times P}$$

### Surface Irrigation System Detailed Evaluation Furrow Worksheet 10

**Furrow advance/recession data**

Station (ft)	Advance time			Recession time			Total elapsed time <sup>3/</sup>	Opportunity time (T <sub>o</sub> ) <sup>2/</sup> (min)	Intake in wetted perimeter (in) <sup>4/</sup>	Intake in furrow width (in)
	Clock time <sup>1/</sup>	Δ T (min)	Elapsed time T <sub>t</sub> (min)	Clock time <sup>1/</sup>	Δ T (min)	Elapsed time T <sub>r</sub> (min)				
	Turn on			Turn off	Lag			Inflow T		
<b>Totals</b>										

1/ Use a 24-hour clock reading; i.e., 1:30 p.m. is 1330 hours.  
 3/ Time since water was turned on.

2/ T<sub>o</sub> = T<sub>i</sub> - T<sub>t</sub> + T<sub>r</sub>  
 4/ Interpolated from graph, furrows volume curve

Average opportunity time =  $\frac{\text{total opportunity time}}{\text{number of stations}}$  = \_\_\_\_\_ = \_\_\_\_\_ minutes

Average depth infiltrated in wetted perimeter, F<sub>wp</sub>:  
 F<sub>wp</sub> =  $\frac{\text{total intake in wetted perimeter}}{\text{number of stations}}$  = \_\_\_\_\_ inches

Average depth infiltrated in tested length of furrow, F<sub>0-1</sub>:  
 F<sub>0-1</sub> =  $\frac{F_{wp} \times P}{W}$  = \_\_\_\_\_ inches

**Surface Irrigation System Detailed Evaluation  
Furrow Worksheet 11**

A large grid of graph paper, consisting of 30 columns and 40 rows of small squares. The grid is intended for detailed data entry and calculations related to the surface irrigation system evaluation.

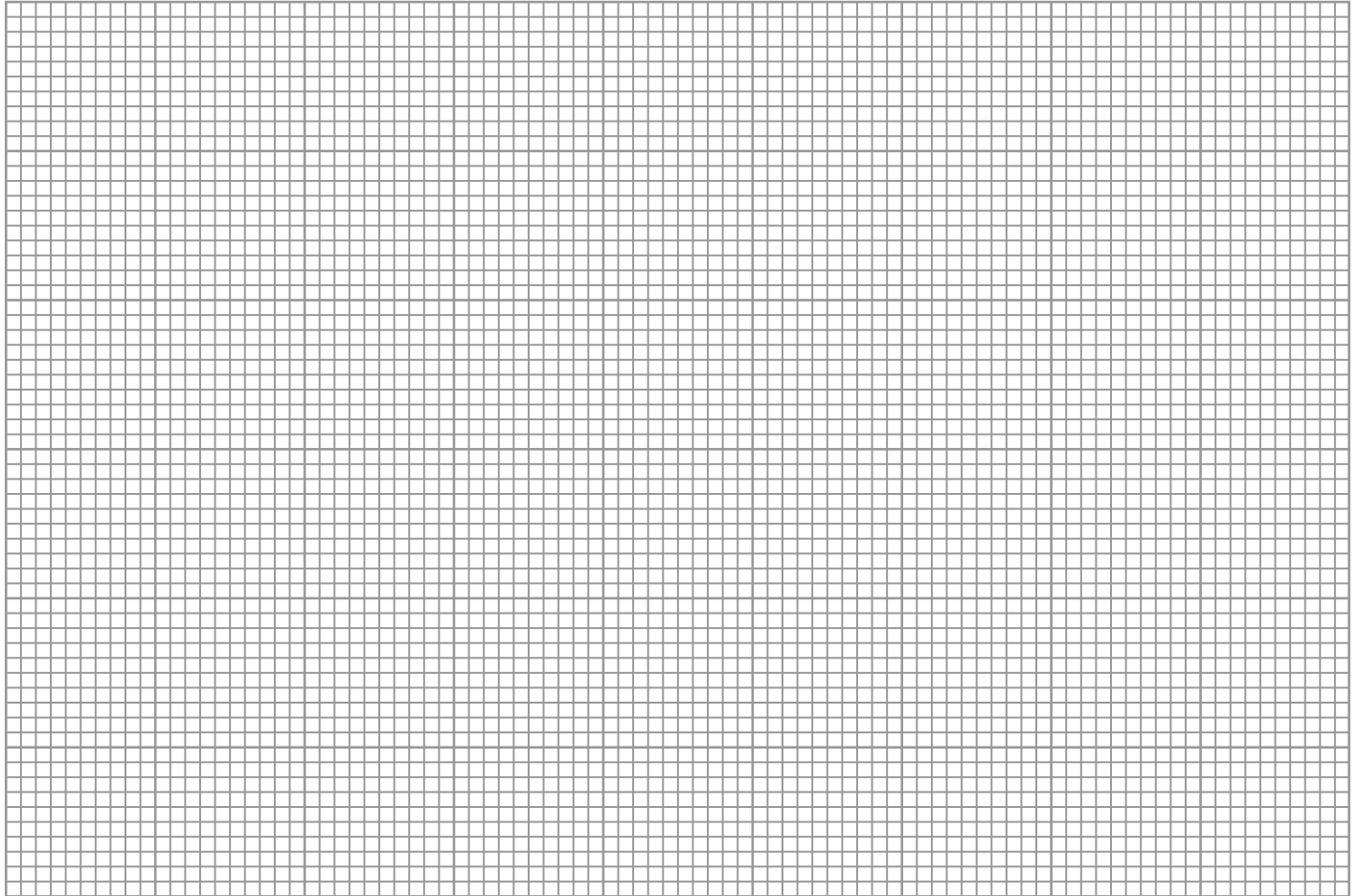
Land user \_\_\_\_\_

Date \_\_\_\_\_

Field office \_\_\_\_\_

## Advance and recession curves

Time - minutes



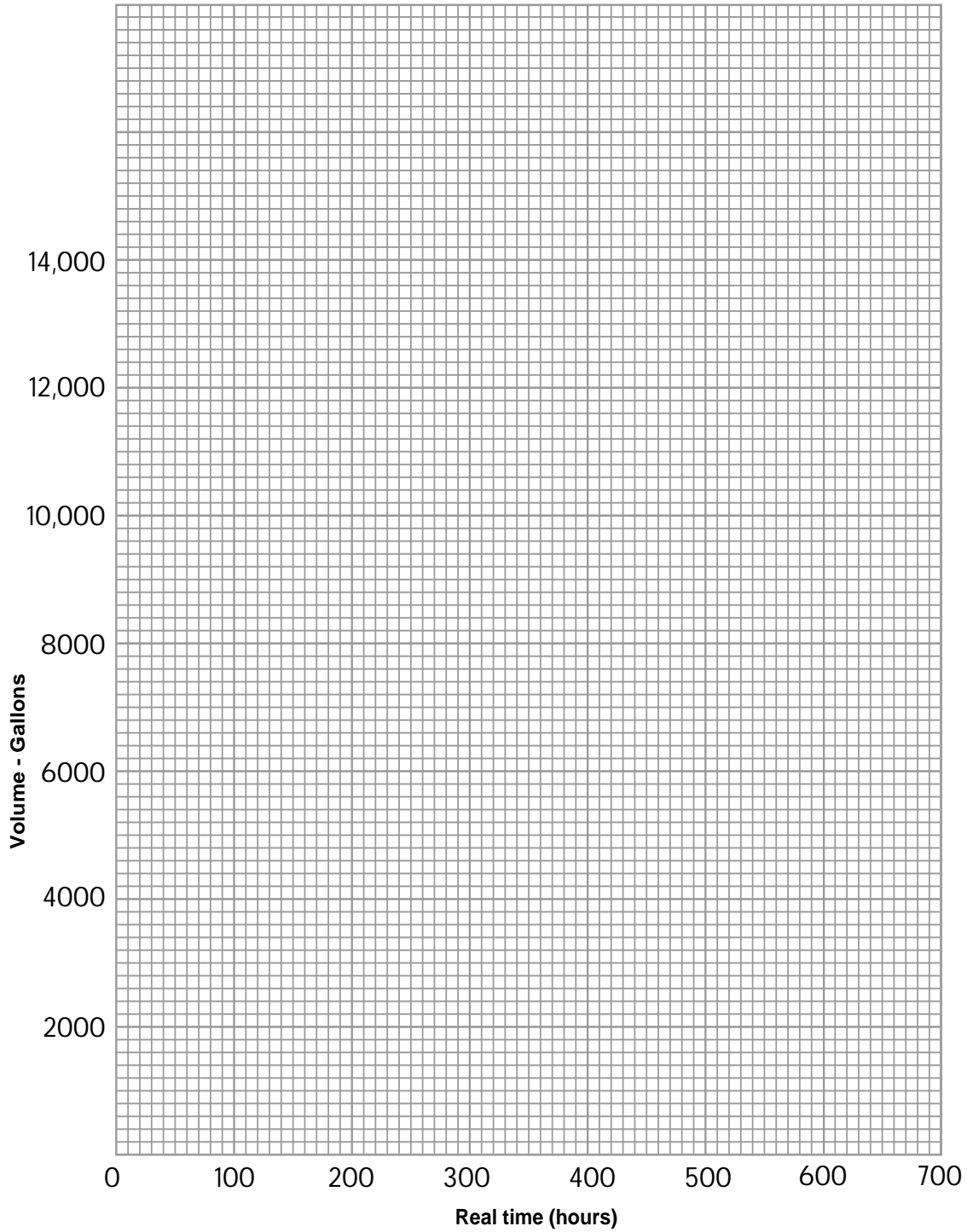
Distance (stations) - feet x 100

Land user \_\_\_\_\_

Date \_\_\_\_\_

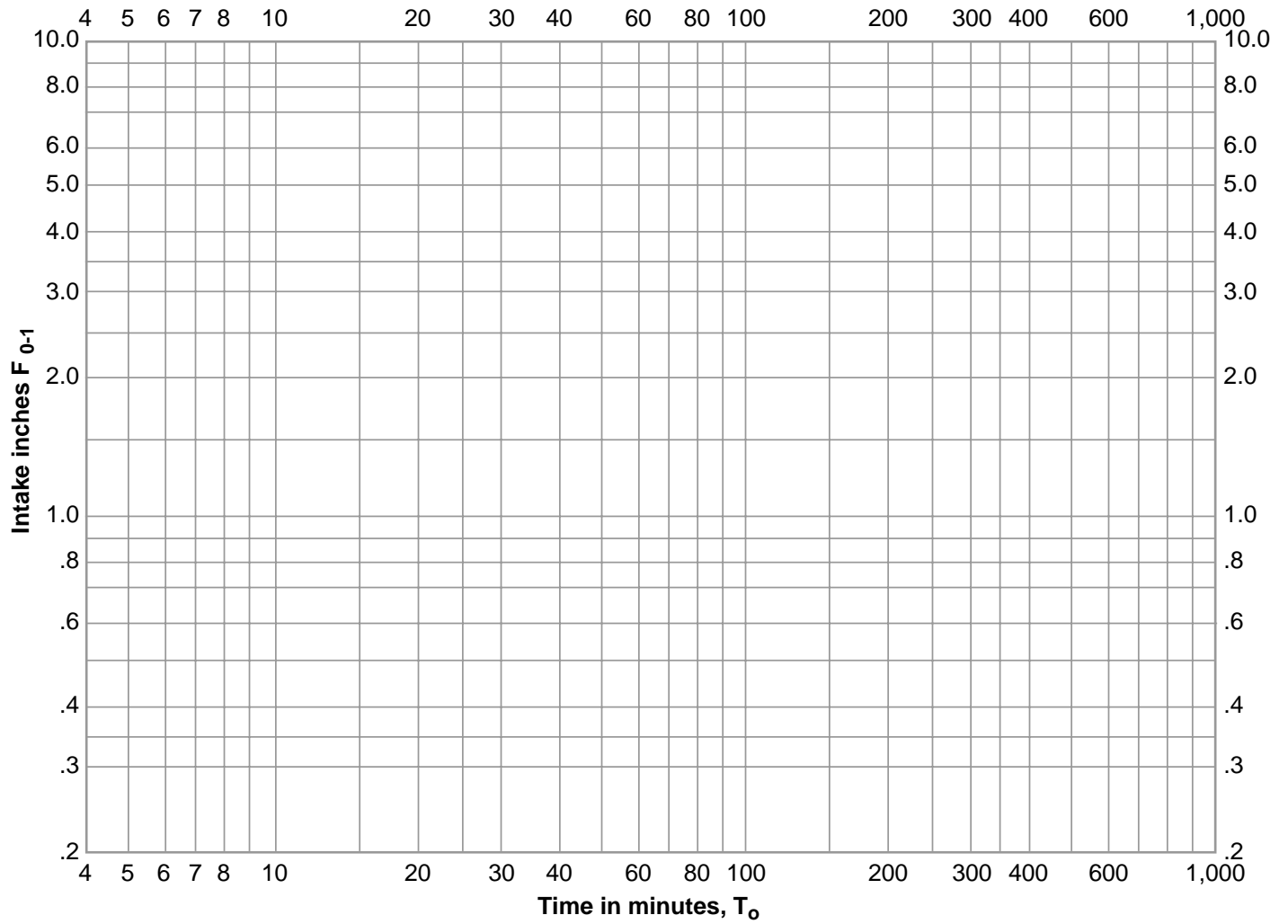
Field office \_\_\_\_\_

### Flow volume curves



### Soil water intake curves

Land user \_\_\_\_\_  
Date \_\_\_\_\_  
Field office \_\_\_\_\_





**Surface Irrigation System  
 Detailed Evaluation Contour Ditch Irrigation System Worksheet**

Land user \_\_\_\_\_ Field office \_\_\_\_\_  
 Field name/number \_\_\_\_\_  
 Observer \_\_\_\_\_ Date \_\_\_\_\_ Checked by \_\_\_\_\_ Date \_\_\_\_\_

**Field Data Inventory:**

Field size \_\_\_\_\_ acres  
 Crop \_\_\_\_\_ Root zone depth \_\_\_\_\_ ft MAD <sup>1/</sup> \_\_\_\_\_ % MAD <sup>1/</sup> \_\_\_\_\_ in  
 Stage of crop \_\_\_\_\_

**Soil-water data:**

(Show location of sample on grid map of irrigated area.)

Soil moisture determination method \_\_\_\_\_

Soil series name \_\_\_\_\_

Depth	Texture	AWC <sup>2/</sup> (in)	SWD <sup>3/</sup> (%)	SWD <sup>3/</sup> (in)
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
		Total	_____	_____

Comments about soils: \_\_\_\_\_  
 \_\_\_\_\_

Typical irrigation duration \_\_\_\_\_ hr, irrigation frequency \_\_\_\_\_ days  
 Typical number of irrigations per year \_\_\_\_\_

Type of delivery system, (earth ditch, concrete ditch, pipeline) \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

Method used to turn water out (shoveled opening, wood box turnout, siphon tubes, portable dams, concrete checks with check boards, etc.) \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

1/ MAD = Management allowable depletion  
 2/ AWC = Available water capacity  
 3/ SWD = Soil water deficit

**Contour Ditch Irrigation System  
Detailed Evaluation Worksheet**

**Field observations**

Crop uniformity \_\_\_\_\_  
\_\_\_\_\_

Wet and/or dry area problems \_\_\_\_\_  
\_\_\_\_\_

Erosion problems \_\_\_\_\_  
\_\_\_\_\_

Other observations \_\_\_\_\_  
\_\_\_\_\_

**Evaluation computations**

Irrigated test area (from grid map) = ( \_\_\_\_\_ in<sup>2</sup> ) x ( \_\_\_\_\_ in<sup>2</sup>/ac ) = \_\_\_\_\_ ac

Actual total depth infiltrated, inches:

Depth, inches =  $\frac{(\text{Irrigated volume, ac-in}) - (\text{Runoff volume, ac-in})}{(\text{Irrigated area, acres})}$

Depth, inches = \_\_\_\_\_ = \_\_\_\_\_ in

Gross application, F<sub>g</sub>, inches:

F<sub>g</sub> =  $\frac{(\text{Total inflow volume, ac-in})}{(\text{Irrigated area, acres})}$  = \_\_\_\_\_ = \_\_\_\_\_ in

Distribution uniformity low 1/4 (DU):

DU =  $\frac{(\text{Average depth infiltrated (adjusted) low 1/4, inches})}{(\text{Average depth infiltrated (adjusted), inches})}$

DU = \_\_\_\_\_ = \_\_\_\_\_

Runoff, RO, inches:

RO, inches =  $\frac{(\text{Runoff volume, ac-in})}{(\text{Irrigated area, ac})}$  = \_\_\_\_\_ = \_\_\_\_\_ in

RO, % =  $\frac{(\text{Runoff depth, inches}) \times 100}{(\text{Gross application, F}_g, \text{ inches})}$  = \_\_\_\_\_ = \_\_\_\_\_ %

**Contour Ditch Irrigation System  
Detailed Evaluation Worksheet**

Deep percolation, DP, inches:

DP, inches = (Gross applic.  $F_g$ , inches) - (Runoff depth, RO, inches) - (Soil water deficit, SWD, inches)

DP, inches = \_\_\_\_\_ = \_\_\_\_\_ inches

DP, % =  $\frac{\text{(Deep percolation, DP, inches)}}{\text{(Gross application, } F_g, \text{ inches)}} \times 100 = \text{_____} = \text{_____}\%$

Application efficiency ( $E_a$ ):

(Average depth replaced in root zone = Soil water deficit, SWD, inches)

$E_a\% = \frac{\text{(Average depth replaced in root zone, inches)}}{\text{(Gross application, } F_g, \text{ inches)}} \times 100 = \text{_____} = \text{_____}\%$

**Potential water and cost savings**

Present management:

Estimated present average net application per irrigation = \_\_\_\_\_ inches

Present gross applied per year =  $\frac{\text{(Net applied per irrigation, inches)} \times \text{(no. of irrigations)}}{\text{(Application efficiency, } E_a, \text{ percent)}} \times 100$

Present gross applied per year = \_\_\_\_\_ = \_\_\_\_\_ inches

**Potential management**

Annual net irrigation requirement: \_\_\_\_\_ inches, for \_\_\_\_\_ (crop)

Potential application efficiency,  $E_{pa}$ : \_\_\_\_\_ % (from irrigation guide or other source)

Potential annual gross applied =  $\frac{\text{(annual net irrigation requirement, inches)} \times 100}{\text{(Potential application efficiency, } E_{pa}, \text{ percent)}}$

Potential annual gross applied = \_\_\_\_\_ = \_\_\_\_\_ inches

Total annual water conserved:

=  $\frac{\text{(Present gross applied, inches)} - \text{(Potential gross applied, inches)}}{12} \times \text{Area irrigated, ac}$

=  $\left( \frac{\text{_____}}{12} \right) \times \left( \text{_____} \right) = \text{_____}$  acre-feet

**Contour Ditch Irrigation System  
Detailed Evaluation Worksheet**

**Cost savings:**

Pumping plant efficiency \_\_\_\_\_ percent, Kind of energy \_\_\_\_\_

Cost per unit of fuel \_\_\_\_\_ Fuel cost per acre foot \_\_\_\_\_

Cost savings = (Fuel cost per acre foot) x (Acre inches conserved per year)

= \_\_\_\_\_

Water purchase cost:

= (Cost per acre foot) x (Acre feet saved per year) =

= ( \_\_\_\_\_ ) x ( \_\_\_\_\_ ) = \_\_\_\_\_

Cost savings = (Pumping cost) + (Water cost) = ( \_\_\_\_\_ ) + ( \_\_\_\_\_ ) = \_\_\_\_\_

**Recommendations**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

**Contour Ditch Irrigation System  
 Detailed Evaluation Worksheet**

Inflow \_\_\_\_\_ Outflow \_\_\_\_\_

Type of measuring device \_\_\_\_\_

Clock 1/ time	Elapsed time (min)	Δ T (min)	Gauge H (ft)	Flow rate (ft <sup>3</sup> /s)	Average flow rate (ft <sup>3</sup> /s)	Volume 2/ (ac-in)	Cum. volume (ac-in)
Turn on							

Total volume (ac-in) \_\_\_\_\_

Average flow =  $\frac{\text{Total irrigation volume in (ac-in)}}{\text{Flow factor} \times \text{elapsed time (min)}}$  = \_\_\_\_\_ = \_\_\_\_\_ ft<sup>3</sup>/s

1/ Use a 24-hour clock reading; i.e., 1:30 p.m. is recorded as 1330 hours.

2/ Flow rate to volume factors:  
 To find volume using ft<sup>3</sup>/s:  
 Volume (ac-in) = .01653 x time (min) x flow (ft<sup>3</sup>/s)

To find volume using gpm:  
 Volume (ac-in) = .00003683 x time (min) x flow (gpm)

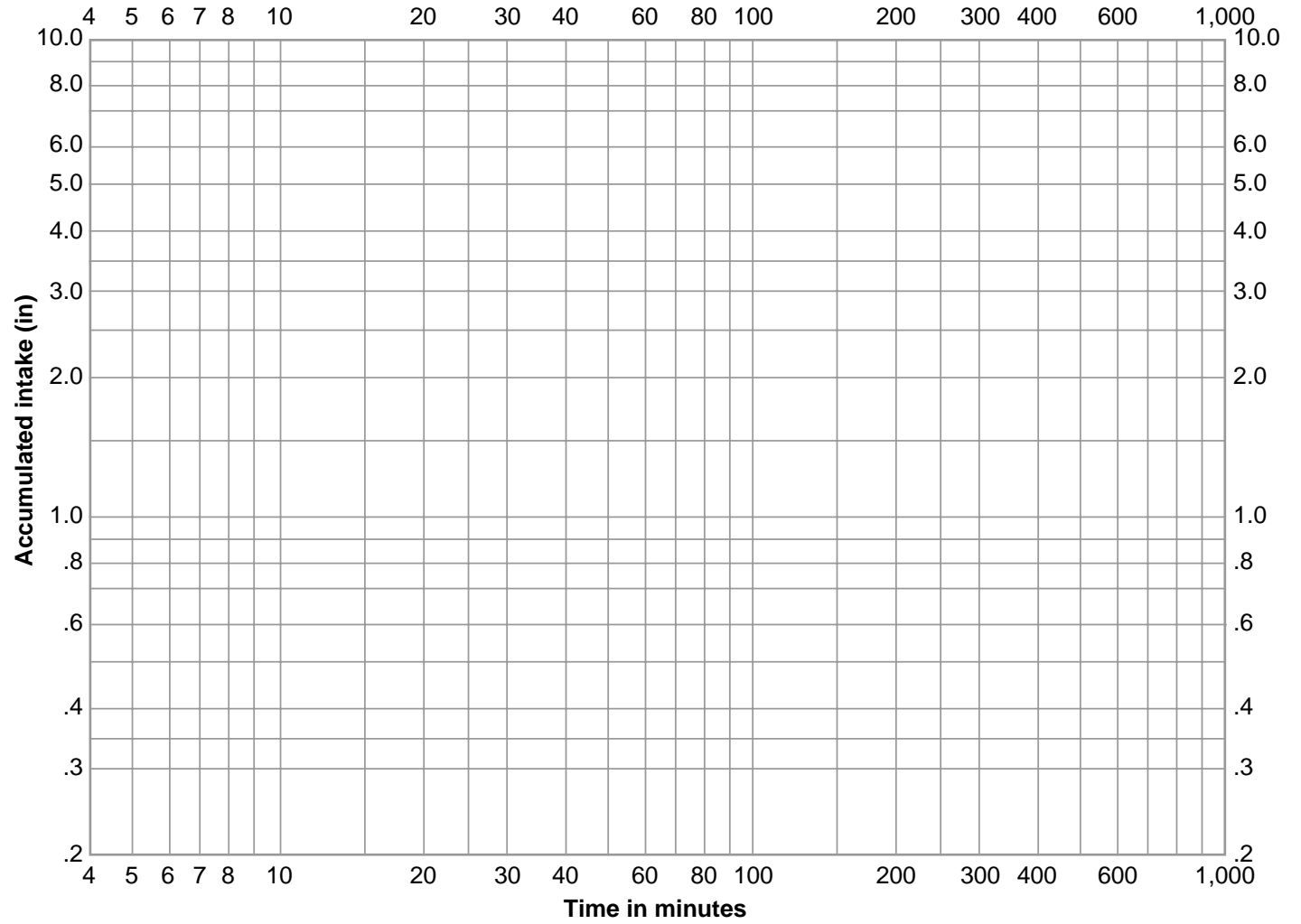


Land user \_\_\_\_\_

Date \_\_\_\_\_

Field office \_\_\_\_\_

### Soil Water Intake Curves





## Sprinkler Irrigation System Detailed Evaluation Periodic Move and Fixed Set Sprinkler System

Land user \_\_\_\_\_ Prepared by \_\_\_\_\_  
 District \_\_\_\_\_ County \_\_\_\_\_ Engineer job class \_\_\_\_\_

**Irrigation system hardware inventory:**

Type of system (check one) : Side- roll \_\_\_\_\_ Handmove \_\_\_\_\_ Lateral tow \_\_\_\_\_ Fixed set \_\_\_\_\_  
 Sprinkler head: make \_\_\_\_\_, model \_\_\_\_\_, nozzle size(s) \_\_\_\_\_ by \_\_\_\_\_ inches  
 Spacing of sprinkler heads on lateral,  $S_1$  \_\_\_\_\_ feet  
 Lateral spacing along mainline,  $S_m$  \_\_\_\_\_ feet, total number of laterals \_\_\_\_\_  
 Lateral lengths: max \_\_\_\_\_ feet, minimum \_\_\_\_\_ feet, average \_\_\_\_\_ feet  
 Lateral diameter: \_\_\_\_\_ feet of \_\_\_\_\_ inches, \_\_\_\_\_ feet of \_\_\_\_\_ inches  
 Manufacturer rated sprinkler discharge, \_\_\_\_\_ gpm at \_\_\_\_\_ psi giving \_\_\_\_\_ feet wetted diameter  
 Total number sprinkler heads per lateral \_\_\_\_\_, lateral diameter \_\_\_\_\_ inches  
 Elevation difference between first and last sprinkler on lateral (=/-) \_\_\_\_\_ feet  
 Sprinkler riser height \_\_\_\_\_ feet, mainline material \_\_\_\_\_  
 Spray type: \_\_\_\_\_ fine (>30psi), \_\_\_\_\_ coarse (<30psi)

**Field observations:**

Crop uniformity \_\_\_\_\_  
 Water runoff \_\_\_\_\_  
 Erosion \_\_\_\_\_  
 System leaks \_\_\_\_\_  
 Fouled nozzles \_\_\_\_\_  
 Other observations \_\_\_\_\_

**Field data inventory & Computations:**

Crop \_\_\_\_\_, root zone depth \_\_\_\_\_ feet, MAD 1/ \_\_\_\_\_ %, MAD 1/ \_\_\_\_\_ inches  
 Soil-water data (typical):  
 (Show locations of sample on soil map or sketch of field)  
 Moisture determination \_\_\_\_\_  
 Soil series and surface texture \_\_\_\_\_

Depth	Texture	AWC <sup>1/</sup> (in)	SWD <sup>1/</sup> (%)	SWD <sup>1/</sup> (in)
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
Totals		_____	_____	_____

1/ MAD = Management allowable depletion, AWC = Available water capacity, SWD = Soil water deficit

## Sprinkler Irrigation System Detailed Evaluation Periodic Move and Fixed Set Sprinkler System

Comments about soils (including restrictions to root development and water movement): \_\_\_\_\_

---

---

---

---

---

---

---

**Present irrigation practices:**

Typical irrigation duration \_\_\_\_\_ hr, irrigation frequency \_\_\_\_\_ days

Typical number irrigations per year \_\_\_\_\_

Distance moved per set \_\_\_\_\_ ft, Alternate sets? \_\_\_\_\_

Measured nozzle diameters (using shank of high speed drill bit)

Sprinkler no. \_\_\_\_\_

Diameter \_\_\_\_\_

Size check \_\_\_\_\_

(state whether t = tight, m = medium, l = loose)

**Actual sprinkler pressure and discharge data:**

Sprinkler number on test lateral

1st

end

Initial pressure (psi) \_\_\_\_\_

Final pressure (psi) \_\_\_\_\_

Catch volume (gal) \_\_\_\_\_

Catch time (sec) \_\_\_\_\_

Discharge (gpm) \_\_\_\_\_

**Test:**

Start \_\_\_\_\_ stop \_\_\_\_\_ duration \_\_\_\_\_ = \_\_\_\_\_ hours

Atmospheric data:

Wind: Direction: Initial \_\_\_\_\_ during \_\_\_\_\_ final \_\_\_\_\_

Speed (mph): initial \_\_\_\_\_ during \_\_\_\_\_ final \_\_\_\_\_

Temperature: initial \_\_\_\_\_ final \_\_\_\_\_ Humidity: \_\_\_\_\_ low \_\_\_\_\_ med \_\_\_\_\_ high

Evaporation container: initial \_\_\_\_\_ final \_\_\_\_\_ loss \_\_\_\_\_ inch

## Sprinkler Irrigation System Detailed Evaluation Periodic Move and Fixed Set Sprinkler System

**Lateral flow data:**

Flow meter reading \_\_\_\_\_ gpm

Average discharge of lateral based on sprinkler head discharge

$$= [1\text{st gpm} - .75 \text{ times } (1\text{st gpm} - \text{last gpm})] \text{ times } (\text{number of heads})$$

$$= \text{_____} = \text{_____ gpm (ave flow per head)}$$

$$= \text{_____ heads} \times \text{_____ gpm/head} = \text{_____ gpm}$$

**Calculations:**

$$\text{Gross application per test} = \frac{(\text{flow, gpm}) \times (\text{time, hr}) \times 96.3}{(\text{lateral length}) \times (\text{lateral spacing})}$$

$$= \frac{(\text{_____ gpm}) \times (\text{_____ hours}) \times 96.3}{(\text{_____ feet}) \times (\text{_____ feet})} = \text{_____ inches}$$

$$\text{Gross application per irrigation} = \frac{(\text{gross application per test, in}) \times (\text{set time, hour})}{(\text{time, hour})}$$

$$= \frac{(\text{_____ inches}) \times (\text{_____ hour})}{(5.95 \text{ hour})} = \text{_____ inches}$$

Catch container type \_\_\_\_\_

\_\_\_\_\_ cc (mL) or in, measuring container = \_\_\_\_\_ inches in container

Total number of containers \_\_\_\_\_

$$\text{Composite number of containers} = \frac{\text{Total number of containers}}{2} = \text{_____} = \text{_____}$$

Total catch, all containers = \_\_\_\_\_ cc (mL) = \_\_\_\_\_ inches  
 cc/in

$$\text{Average total catch} = \frac{\text{Total catch}}{\text{composite no. containers}} = \text{_____} = \text{_____ inches}$$

$$\text{Number of composite containers in low } 1/4 = \frac{\text{composite no. containers}}{4} = \text{_____} = \text{_____}$$

Total catch in low 1/4 composite containers = \_\_\_\_\_ cc(mL) = \_\_\_\_\_ inches  
 cc/in

### Sprinkler Irrigation System Detailed Evaluation Periodic Move and Fixed Set Sprinkler System

$$\text{Average catch of low 1/4 composite containers} = \frac{\text{total catch in low 1/4}}{\text{no. composite low 1/4 containers}}$$

$$= \frac{\text{_____}}{\text{_____}} = \text{_____ inches}$$

$$\text{Average catch rate} = \frac{\text{Average total catch, inches}}{\text{Test time, hour}} = \frac{\text{_____}}{\text{hour}} = \text{_____ inch/hour}$$

NOTE: Average catch rate is application rate at plant canopy height.

Distribution uniformity low 1/4 (DU):

$$\text{DU} = \frac{\text{Average catch low 1/4 composite containers}}{\text{Average total catch}} \times 100 = \frac{\text{_____ inches}}{\text{_____ inches}} \times 100 = \text{_____ \%}$$

Approximate Christiansen Uniformity (CU):

$$\text{CU} = 100 - [0.63 \times (100 - \text{DU})] = 100 [0.63 \times (100 - \text{_____})] = \text{_____ \%}$$

Effective portion of applied water ( $R_e$ ):

$$R_e = \frac{\text{Average total catch, inch}}{\text{Gross applications/test, inches}} = \frac{\text{_____ inches}}{\text{_____ inches}} = \text{_____ inches}$$

Application efficiency of low 1/4 ( $E_q$ ):

$$E_q = \text{DU} \times (R_e) = \text{_____} \times \text{_____} = \text{_____ \%}$$

NOTE: Use for medium to high value crops.

Approximate application efficiency low 1/2 ( $E_h$ ):

$$E_h = \text{CU} \times (R_e) = \text{_____} \times \text{_____} = \text{_____ \%}$$

NOTE: Use for lower value field and forage crops.

## Sprinkler Irrigation System Detailed Evaluation Periodic Move and Fixed Set Sprinkler System

Application efficiency, ( $E_a$ ):

$$F_n = \frac{(\text{gross application per irrigation})}{100} \times E_q = \left( \frac{\text{inches}}{100} \right) \times \text{_____} = \text{_____ inches}$$

$$E_a = \frac{(\text{water stored in root zone})}{(\text{gross application per irrigation})} \times 100 = \left( \frac{\text{inches}}{\text{inches}} \right) \times 100 = \text{_____ \%}$$

Losses = (runoff, deep percolation) = gross application per irrigation minus SWD

$$= (\text{_____}) = \text{_____ inches}$$

### Potential Water and Cost Savings:

#### Present management:

Gross applied per year = (gross applied per irrigation) x (number of irrigations) =

$$= (\text{_____ inches}) \times (\text{_____}) = \text{_____ inches/year}$$

#### Potential management:

Annual net irrigation requirement \_\_\_\_\_ inches/year, for \_\_\_\_\_ (crop)

Potential application efficiency ( $E_q$  or  $E_h$ ) \_\_\_\_\_ % (from NEH, Part 623, Ch 11)

Potential annual gross applied =  $\frac{(\text{annual net irrigation requirement})}{\text{Potential } E_q \text{ or } E_h} \times 100$

$$= (\text{_____ inches}) \times 100 = \text{_____ inches}$$

Total annual water conserved

$$= \frac{(\text{Present gross applied} - \text{potential gross applied}) \times (\text{area irrig. (ac)})}{12} = \text{_____ acre/feet}$$

$$= \left( \frac{\text{_____ inches} - (\text{_____ inches}) \times (\text{_____ acres})}{12} \right) = \text{_____ acre/feet}$$

## Sprinkler Irrigation System Detailed Evaluation Periodic Move and Fixed Set Sprinkler System

**Cost savings:**

Pumping plant efficiency \_\_\_\_\_ Kind of fuel \_\_\_\_\_

Cost per unit of fuel \$ \_\_\_\_\_ Fuel cost per acre/foot \$ \_\_\_\_\_

Cost savings = (fuel cost per acre-foot) x (acre-feet conserved per year) = \$ \_\_\_\_\_

= ( \_\_\_\_\_ ) x ( \_\_\_\_\_ ) = \$ \_\_\_\_\_

**Water purchase cost:**

= (Cost per acre-foot) x (acre-feet saved per year) = \_\_\_\_\_ x \_\_\_\_\_ = \$ \_\_\_\_\_

**Cost Savings:**

= Pumping cost + water cost = \_\_\_\_\_ + \_\_\_\_\_ = \$ \_\_\_\_\_

**Recommendations:** \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Lateral move system  
catch can data**

Land user \_\_\_\_\_

Date \_\_\_\_\_

Field office \_\_\_\_\_

The form consists of a large grid of small squares. A horizontal line is drawn across the grid, approximately one-third of the way from the bottom. The word "Lateral" is printed in the left portion of the grid, just above the horizontal line. The word "flow" is printed in the right portion of the grid, also just above the horizontal line. The grid is otherwise empty.



## Sprinkler Irrigation System Detailed Evaluation Center Pivot Lateral Worksheet

Land user \_\_\_\_\_ Field office \_\_\_\_\_

Observer \_\_\_\_\_ Date \_\_\_\_\_ Checked by \_\_\_\_\_ Date \_\_\_\_\_

Field name/number \_\_\_\_\_

Center pivot number \_\_\_\_\_ pivot location in field \_\_\_\_\_

Acres irrigated \_\_\_\_\_

**Hardware inventory:**

Manufacturer: name and model \_\_\_\_\_

Is design available? \_\_\_\_\_ (attach copy) Number of towers \_\_\_\_\_ Spacing of towers \_\_\_\_\_

Lateral: Material \_\_\_\_\_, Inside diameter \_\_\_\_\_ inches

Nozzle: Manufacturer \_\_\_\_\_

Position \_\_\_\_\_ Height above ground \_\_\_\_\_

Spacing \_\_\_\_\_

Is pressure regulated at each nozzle? \_\_\_\_\_ operating pressure range \_\_\_\_\_

Type of tower drive \_\_\_\_\_

System design capacity \_\_\_\_\_ gpm, system operating pressure \_\_\_\_\_ psi

Nozzle data, design:	Pivot				end
Sprinkler position number	_____	_____	_____	_____	_____
Manufacturer	_____	_____	_____	_____	_____
Model	_____	_____	_____	_____	_____
Type (spray, impact, etc.)	_____	_____	_____	_____	_____
Nozzle or orifice size	_____	_____	_____	_____	_____
Location	_____	_____	_____	_____	_____
Wetted diameter (ft)	_____	_____	_____	_____	_____
Nozzle discharge (gpm)	_____	_____	_____	_____	_____
Design pressure (psi)	_____	_____	_____	_____	_____
Operating pressure	_____	_____	_____	_____	_____

End gun make, model \_\_\_\_\_ (when continuously used in corners)

End gun capacity \_\_\_\_\_ gpm, Pressure \_\_\_\_\_ psi, boosted to \_\_\_\_\_ psi

End swing lateral capacity \_\_\_\_\_ gpm, pressure \_\_\_\_\_ psi

**Field observations:**

Crop uniformity \_\_\_\_\_

Runoff \_\_\_\_\_

Erosion \_\_\_\_\_

Tower rutting \_\_\_\_\_

System leaks \_\_\_\_\_

Elevation change between pivot and end tower \_\_\_\_\_

## Sprinkler Irrigation System Detailed Evaluation Center Pivot Lateral Worksheet

Wind: Speed \_\_\_\_\_ mph Direction (from) \_\_\_\_\_  
 Line direction: From center to outer tower \_\_\_\_\_ moving \_\_\_\_\_  
 Time of day \_\_\_\_\_, Humidity: \_\_\_\_\_ low \_\_\_\_\_ med \_\_\_\_\_ high, Air temp \_\_\_\_\_  
 Evaporation: start depth \_\_\_\_\_ inches, end depth \_\_\_\_\_ inches, Evaporation \_\_\_\_\_ inches  
 Crop \_\_\_\_\_, Root zone depth \_\_\_\_\_ foot, MAD<sup>1/</sup> \_\_\_\_\_ %, MAD \_\_\_\_\_ inches

**Soil-water data (typical):** (show location of sample site on soil map or sketch of field)

Moisture determination method \_\_\_\_\_  
 Soil series name, surface texture \_\_\_\_\_

Depth	Texture	*AWC (in) <sup>1/</sup>	*SWD (%) <sup>1/</sup>	*SWD (in) <sup>1/</sup>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
Totals		_____	_____	_____

**Comments about soils:**

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Present irrigation practices:**

Typical system application:

Crop	Stage of growth percent	Hours per <sup>2/</sup> revolution	Speed setting	Net application (in)
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

Hours operated per day \_\_\_\_\_ hours  
 Approximate number of pivot revolutions per season \_\_\_\_\_

1/ MAD = Management allowed depletion, AWC = Available water capacity, SWD = Soil water deficit  
 2/ To calculate the hours per revolution around the field, first calculate the average speed the end tower moves per cycle (start to start) = distance in feet divided by time in seconds.

Then: hours per revolution = 
$$\frac{2 \text{ (distance to end tower in feet)} \times \pi}{\text{(end tower speed in ft/s)} \times 3,600 \text{ seconds per hour}}$$

## Sprinkler Irrigation System Detailed Evaluation Center Pivot Lateral Worksheet

**System data:**

Distance from pivot point to : end tower \_\_\_\_\_ ft, wetted edge \_\_\_\_\_ ft

\* End tower speed: Distance between stakes \_\_\_\_\_

Time at first stake \_\_\_\_\_, Time at second stake \_\_\_\_\_

Time to travel between stakes \_\_\_\_\_ min

\* This method is satisfactory for a continuous moving system, but need to allow for moving in start-stop cycles.

Recommend using end tower move distance and from start to star. Typically, percent speed setting for end tower represents, 60% = 36 seconds of each minute, 72 seconds of each 2 minutes, etc.

Measured system flow rate \_\_\_\_\_ gpm, method \_\_\_\_\_

Calculations: \_\_\_\_\_

**Evaluation computations:**

Circumference of end tower:

$$\text{Distance to end tower} \times 2\pi = \frac{(6.2832)}{2} \times \text{Distance to end tower} = \text{_____ ft}$$

End tower speed:

$$\frac{\text{Distance traveled (ft)} \times 60}{\text{Time in minutes}} = \text{_____} \times 60 = \text{_____ ft/hr}$$

Hours per revolution:

$$\frac{\text{Circumference at end tower (ft)}}{\text{End tower speed (ft/hr)}} = \text{_____} = \text{_____ hr}$$

Area irrigated:

$$\frac{(\text{Distance to wetted edge})^2 \times \pi}{43,560 \text{ square feet/acre}} \times \frac{(3.1416)}{43,560} = \text{_____} \times 3.1416 = \text{_____ ac}$$

Gross application per irrigation:

$$\frac{\text{Hours per revolution} \times \text{gpm}}{435 \times \text{acres irrigated}} = \frac{\text{_____}}{453 \times \text{ac}} = \text{_____ in}$$

Weighted system average application:

$$\frac{\text{Sum of: catch x factors}}{(\text{Sum of: factors}) \times \text{number of containers}} = \text{_____} = \text{_____ cc (ml)}$$

## Sprinkler Irrigation System Detailed Evaluation Center Pivot Lateral Worksheet

Convert cc (ml) in measuring cylinder to inches depth in catch container:

\_\_\_\_\_ cc (ml) = 1 inch in catch container

Average application =  $\frac{\text{Average catch (cc)}}{\text{cc/inch}}$  = \_\_\_\_\_ = \_\_\_\_\_ in

Weighted low 1/4 average application:

$\frac{\text{Sum of low 1/4 catch x factors}}{(\text{Sum of low 1/4 factors}) \times \text{number of low 1/4 containers}}$  = \_\_\_\_\_ = \_\_\_\_\_ cc (ml)

Low 1/4 average application =  $\frac{\text{Average low 1/4 (cc)}}{\text{cc/inch}}$  = \_\_\_\_\_ = \_\_\_\_\_ in

Distribution uniformity low 1/4 a (DU):

DU =  $\frac{\text{Weighted low 1/4 average applic.}}{\text{Weighted system average application}}$  = \_\_\_\_\_ = \_\_\_\_\_ %

Approximate Christiansen uniformity (CU):

CU = 100 - [0.63 x (100 - DU)] = 100 - [0.63 x (100 - \_\_\_\_\_)] = \_\_\_\_\_ %

Effective portion of water applied ( $R_e$ ):

$R_e = \frac{\text{Weighted system average application (in)}}{\text{Gross applicaiton (in)}}$  = \_\_\_\_\_ = \_\_\_\_\_

Application efficiency of low 1/4 ( $E_q$ ):

$E_q = DU \times R_e =$  \_\_\_\_\_ = \_\_\_\_\_ %

(Use for medium to high value crops)

Approximate application efficiency low 1/2 ( $E_h$ ):

$E_h = DU \times R_e =$  \_\_\_\_\_ = \_\_\_\_\_ %

(Use for low value field and forage crops)

## Sprinkler Irrigation System Detailed Evaluation Center Pivot Lateral Worksheet

Application:

$$\frac{\text{Gross application x hours operated per day x } (E_q \text{ or } E_h)}{\text{Hours per revolution x 100}}$$

= \_\_\_\_\_ = \_\_\_\_\_ in/day

Maximum average application rate:

$$\frac{\text{Maximum catch inches x 60}}{\text{Time containers are uncovered in minutes}} = \text{_____} = \text{_____ in/hr}$$

Pivot revolutions required to replace typical annual moisture deficit:

(Based on existing management procedures)

Annual net irrig. requirement \_\_\_\_\_ in, for \_\_\_\_\_ (crop)

Pivot revolutions required:

$$\frac{\text{Annual net irrig. requirement x 100}}{(E_q \text{ or } E_h) \times \text{gross applic. per irrig.}} = \text{_____} = \text{_____}$$

Potential water and cost savings

Present management:

Gross applied per year = gross applied per irrig x number of irrig

= \_\_\_\_\_ = \_\_\_\_\_ in/yr

Potential management:

Potential application efficiency ( $E_{pq}$  or  $E_{ph}$ ) \_\_\_\_\_ percent (from irrigation guide, NEH Sec 15, Ch 11, or other source)

$$\text{Potential annual gross applied} = \frac{\text{Annual net irrig. requirement x 100}}{\text{Potential } E_{pq} \text{ or } E_{ph}}$$

= \_\_\_\_\_ = \_\_\_\_\_ inches





# Center pivot lateral evaluation, distribution profile of catch

$E_h =$  \_\_\_\_\_

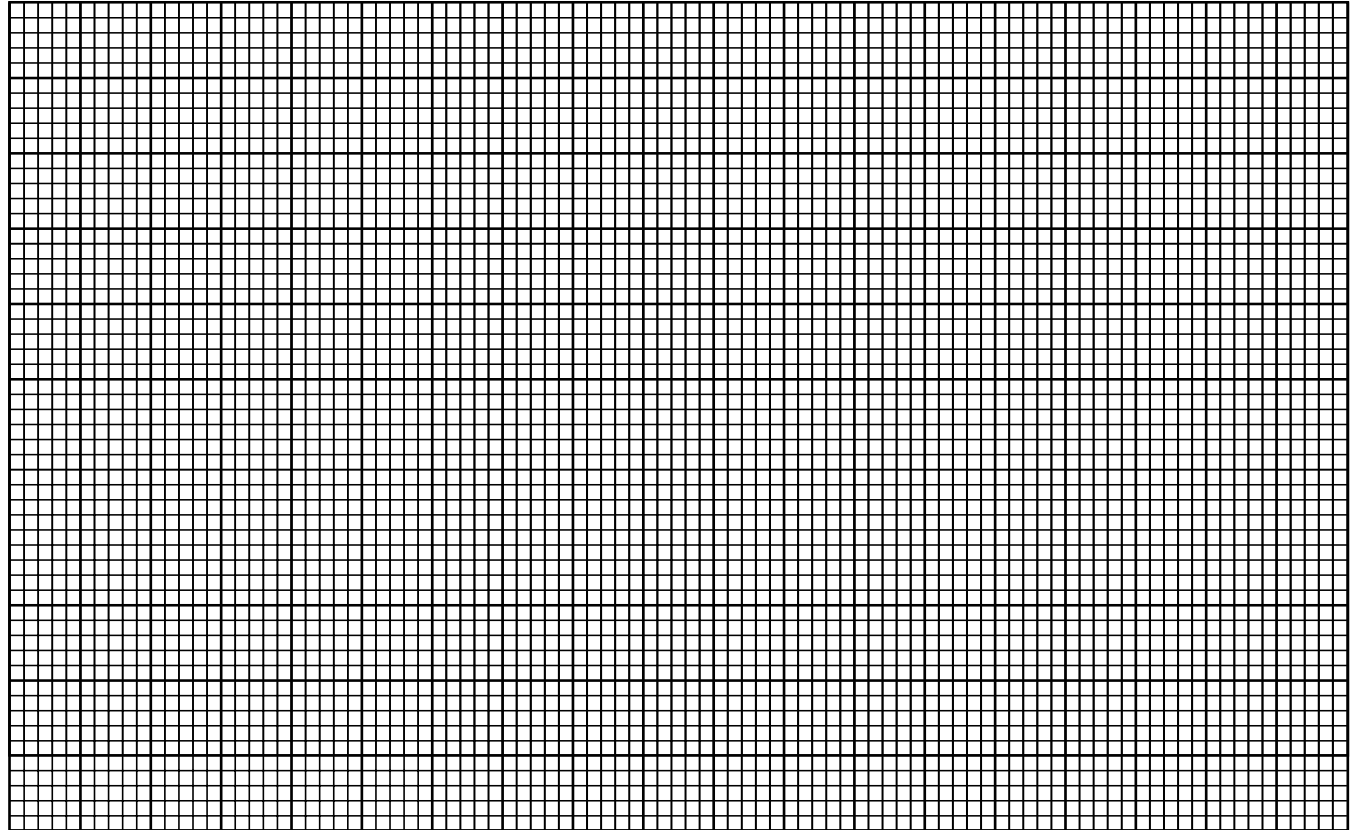
$E_q =$  \_\_\_\_\_

Land user \_\_\_\_\_

Date \_\_\_\_\_

Field office \_\_\_\_\_

Container catch (inches)



Container number

## Sprinkler Irrigation System Detailed Evaluation Continuous Move, Large Sprinkler Gun Type

Land user \_\_\_\_\_ Date \_\_\_\_\_ Prepared by \_\_\_\_\_  
 District \_\_\_\_\_ County \_\_\_\_\_ Eng job class \_\_\_\_\_

**Irrigation system hardware inventory:**

Sprinkler gun make \_\_\_\_\_, model \_\_\_\_\_, nozzle type \_\_\_\_\_  
 Nozzle: size \_\_\_\_\_ inches, \_\_\_\_\_ mm  
 Manufacturer rated discharge, \_\_\_\_\_ gpm at \_\_\_\_\_ psi giving \_\_\_\_\_ ft wetted diameter  
 Hose: length, \_\_\_\_\_ ft, diameter \_\_\_\_\_ inches  
 Towpath: spacing \_\_\_\_\_ ft  
 Elevation difference between first and last location on towpath (+/-) \_\_\_\_\_ ft or \_\_\_\_\_ % slope  
 Gun: height \_\_\_\_\_ ft  
 Mainline: material \_\_\_\_\_ diameter \_\_\_\_\_ inches

**Field observations:**

Crop uniformity \_\_\_\_\_  
 Water runoff \_\_\_\_\_  
 Erosion \_\_\_\_\_  
 System leaks \_\_\_\_\_  
 Wind drift \_\_\_\_\_  
 Other observations \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

**Field data inventory and computations:**

Crop \_\_\_\_\_, root zone depth \_\_\_\_\_ ft, MAD <sup>1/</sup> \_\_\_\_\_ %, MAD <sup>1/</sup> \_\_\_\_\_ inches

Soil-water data (typical):

(Show locations of sample on soil map or sketch of field)

Moisture determination method _____				
Soil series and surface texture _____				
Depth	Texture	AWC (in) <sup>1/</sup>	SWD (%) <sup>1/</sup>	SWD (in) <sup>1/</sup>
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
Totals		_____	_____	_____

Comments about soils and soil condition: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_

<sup>1/</sup> MAD = Management Allowable depletion, AWC = Available water capacity, SWD = Soil water deficit

## Sprinkler Irrigation System Detailed Evaluation Continuous Move, Large Sprinkler Gun Type

**Present irrigation practices:**

Typical irrigation duration \_\_\_\_\_ hr, irrigation frequency \_\_\_\_\_ days

Typical number of irrigations per year \_\_\_\_\_

**Test:**

Start \_\_\_\_\_, Stop \_\_\_\_\_, Duration \_\_\_\_\_ = \_\_\_\_\_ hour

Atmospheric data;

Wind: Direction: Initial \_\_\_\_\_, during \_\_\_\_\_, final \_\_\_\_\_

Speed (mph): Initial \_\_\_\_\_, during \_\_\_\_\_, final \_\_\_\_\_

Temperature: initial \_\_\_\_\_ final \_\_\_\_\_, humidity: \_\_\_\_\_ low \_\_\_\_\_ med \_\_\_\_\_ high

Evaporation container: initial \_\_\_\_\_, final \_\_\_\_\_, loss \_\_\_\_\_ inches

Pressure: \_\_\_\_\_ psi, at start of test

\_\_\_\_\_ psi, at end of test

Measured flow into the system \_\_\_\_\_ gpm

**Sprinkler travel speed:**

at beginning \_\_\_\_\_ ft \_\_\_\_\_ min = \_\_\_\_\_ ft/min

at test site \_\_\_\_\_ ft \_\_\_\_\_ min = \_\_\_\_\_ ft/min

at terminal end \_\_\_\_\_ ft \_\_\_\_\_ min = \_\_\_\_\_ ft/min

average \_\_\_\_\_ ft/min

Calculations:

Gross average depth of water applied =  $\frac{(\text{gun discharge, gpm}) \times (1.605)}{(\text{tow path spacing, ft}) \times (\text{travel speed, ft/min})}$

=  $\left( \frac{\text{gpm}}{\text{ft}} \right) \times (1.605) = \text{_____ in}$

Average overlapped catches

System =  $\frac{(\text{sum all catch totals _____ in})}{(\text{number of totals _____})} = \text{_____ in}$

Low 1/4 =  $\frac{(\text{sum of low 1/4 catch totals _____ in})}{(\text{number of low 1/4 catches _____})} = \text{_____ in}$

Average application rate =  $\frac{(\text{Flow, gpm}) \times (13,624)}{(\text{tow path spacing, ft}) \times (\text{wet sector, deg.})}$

=  $\left( \frac{\text{gpm}}{\text{ft}} \right) \times (13,624) = \text{_____ in/hr}$

Maximum application rate = (average application rate, in/hr) x (1.5)

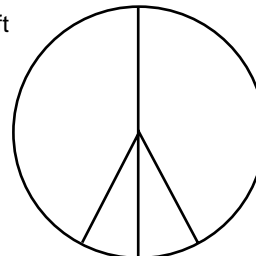
## Sprinkler Irrigation System Detailed Evaluation Continuous Move, Large Sprinkler Gun Type

**Container test data**

Catch can type \_\_\_\_\_, \_\_\_\_\_ cc (mL)/in

Left Right

Note part circle operation  
 and the dry wedge size in degrees



Towpath  
 and travel  
 direction

← 4, 3, 2, 1 Container catch row 1, 2, 3, 4 →

Path spacing (ft)	Container catch volume				Right plus left side catch totals	
	Left side of path		Right side of path		mL	inches
	Catch no.	Catch (mL)	Catch no.	Catch (mL)		
330	1		33			
320	2		32			
310	3		31			
300	4		30			
290	5		29			
280	6		28			
270	7		27			
260	8		26			
250	9		25			
240	10		24			
230	11		23			
220	12		22			
210	13		21			
200	14		20			
190	15		19			
180	16		18			
170	17		17			
160	18		16			
150	19		15			
140	20		14			
130	21		13			
120	22		12			
110	23		11			
100	24		10			
90	25		9			
80	26		8			
70	27		7			
60	28		6			
50	29		5			
40	30		4			
30	31		3			
20	32		2			
10	33		1			

Sum of all catch totals \_\_\_\_\_

Sum of low 1/4 catch totals \_\_\_\_\_

## Sprinkler Irrigation System Detailed Evaluation Continuous Move, Large Sprinkler Gun Type

**Potential water and cost savings:**

**Present management:**

Gross applied per year = (Gross applied per irrigation) x (number of irrigation) = \_\_\_\_\_ in/yr  
 + ( \_\_\_\_\_ in) x ( \_\_\_\_\_ ) = \_\_\_\_\_ in/yr

**Potential management:**

Annual net irrigation requirement \_\_\_\_\_ in/yr, for \_\_\_\_\_ (crop)

Potential application efficiency ( $E_q$  or  $E_h$ ) \_\_\_\_\_ % (estimated at 55 - 65%)

Potential annual gross applied =  $\frac{\text{(annual net irrigation requirement)} \times 100}{\text{Potential } E_q \text{ or } E_h}$  = \_\_\_\_\_ in

= ( \_\_\_\_\_ in) x 100 = \_\_\_\_\_ inches

Total annual water conserved

=  $\frac{\text{(Present gross applied, inches - potential gross applied, inches)}}{12}$  x (area irrigated, ac) = \_\_\_\_\_ ac-ft

=  $\frac{\text{( _____ in) - ( _____ in)} \times \text{( _____ ac)}}{12}$  = \_\_\_\_\_ ac-ft

**Cost savings:**

Pumping plant efficiency \_\_\_\_\_ kind of energy \_\_\_\_\_

Cost per unit of energy \$ \_\_\_\_\_ energy cost per ac-ft \$ \_\_\_\_\_

Cost savings = (energy cost per ac-ft) x (ac-ft conserved per year) = \$ \_\_\_\_\_

= ( \_\_\_\_\_ ) x ( \_\_\_\_\_ ) = \$ \_\_\_\_\_

**Water purchase cost:**

= (Cost per ac-ft) x (ac-ft saved per year) = \$ \_\_\_\_\_ x \_\_\_\_\_ = \$ \_\_\_\_\_

**Cost savings:**

= Pumping cost + water cost = \_\_\_\_\_ + \_\_\_\_\_ = \$ \_\_\_\_\_





## Micro Irrigation System Detailed Evaluation Worksheet

Land user \_\_\_\_\_ Date \_\_\_\_\_ Prepared by \_\_\_\_\_

District \_\_\_\_\_ County \_\_\_\_\_

Crop: \_\_\_\_\_ age \_\_\_\_\_ plant and row spacing \_\_\_\_\_

Soil: mapping unit \_\_\_\_\_ surface texture \_\_\_\_\_

actual depth \_\_\_\_\_ AWC \_\_\_\_\_ inches/feet

Irrigation: duration \_\_\_\_\_ frequency \_\_\_\_\_ MAD \_\_\_\_\_ % \_\_\_\_\_ inches/feet

Irrigation system hardware:

Filter: pressure at: inlet \_\_\_\_\_ psi, outlet \_\_\_\_\_ psi, loss \_\_\_\_\_ psi

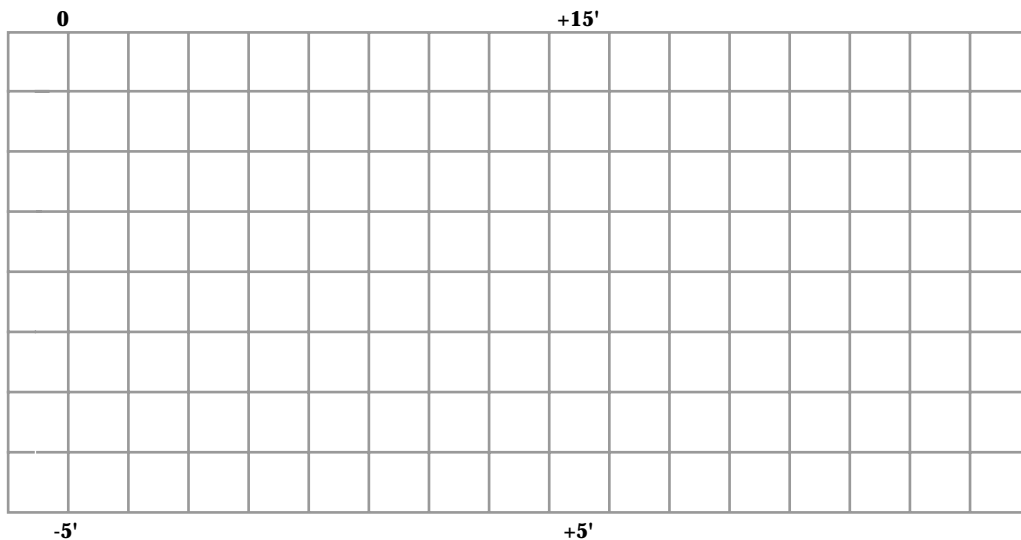
Emitter: manufacturer \_\_\_\_\_ type \_\_\_\_\_ spacing \_\_\_\_\_

Rated discharge per emitter (emission point): \_\_\_\_\_ gph at \_\_\_\_\_ psi

Emission points per plant \_\_\_\_\_ giving \_\_\_\_\_ gallons per plant per day

Later: diameter: \_\_\_\_\_ material \_\_\_\_\_ length \_\_\_\_\_ spacing \_\_\_\_\_

Sketch of micro irrigation system layout:



## Micro Irrigation System Detailed Evaluation Worksheet

System discharge: \_\_\_\_\_ gpm, number of manifolds \_\_\_\_\_ and blocks \_\_\_\_\_

Average test manifold emission point discharges at \_\_\_\_\_ psi

Manifold =  $\frac{(\text{sum of all averages } \text{gph})}{(\text{number of averages})} = \text{_____ gph}$

Low 1/4 =  $\frac{(\text{sum of low 1/4 averages } \text{gph})}{(\text{number of low 1/4 averages})} = \text{_____ gph}$

Adjusted average emission point discharges at \_\_\_\_\_ psi

System = (DCF \_\_\_\_\_) x (manifold average \_\_\_\_\_) = \_\_\_\_\_ gph

Low 1/4 = (DCF \_\_\_\_\_) x (manifold low 1/4 \_\_\_\_\_) = \_\_\_\_\_ gph

Discharge test volume collected in \_\_\_\_\_ minutes (1.0 gph = 63 ML/min)

Outlet location on lateral		Lateral location on the manifold							
		inlet end		1/3 down		2/3 down		far end	
		mL	gph	mL	gph	mL	gph	mL	gph
inlet end	A								
	B								
ave									
1/3 down	A								
	B								
ave									
2/3 down	A								
	B								
ave									
far end	A								
	B								
ave									

### Micro Irrigation System Detailed Evaluation Worksheet (cont.)

Lateral:            inlet pressure            \_\_\_\_\_ psi    \_\_\_\_\_ psi    \_\_\_\_\_ psi    \_\_\_\_\_ psi  
                          far end pressure            \_\_\_\_\_ psi    \_\_\_\_\_ psi    \_\_\_\_\_ psi    \_\_\_\_\_ psi  
 Wetted area per plant            \_\_\_\_\_ ft<sup>2</sup>    \_\_\_\_\_ ft<sup>2</sup>    \_\_\_\_\_ ft<sup>2</sup>    \_\_\_\_\_ ft<sup>2</sup>  
    \_\_\_\_\_ %    \_\_\_\_\_ %    \_\_\_\_\_ %    \_\_\_\_\_ %

Estimated average SMD in wetted soil volume \_\_\_\_\_

Minimum lateral inlet pressures, MLIP, on all operating, manifolds:

Manifold ID: Test    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_ Ave.  
 pressure, psi \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_    \_\_\_\_\_

Discharge correction factor, DCF, for the system is:

$$DCF = \frac{2.5 \times (\text{average MLIP} \quad \text{psi})}{(\text{average MLIP} \quad \text{psi} + (1.5 \times \text{test MLIP} \quad \text{psi}))} = \quad \text{psi}$$

or if the emitter discharge exponent, x = \_\_\_\_\_ is known,

$$DCF = \frac{(\text{average MLIP} \quad \text{psi})}{(\text{test MLIP} \quad \text{psi})} \times \text{-----} = \quad \text{psi}$$

Comments: \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_



### Pumping Plant Detailed Evaluation Worksheet

Land user \_\_\_\_\_ Field office \_\_\_\_\_  
Observer \_\_\_\_\_ Date \_\_\_\_\_ Checked by \_\_\_\_\_ Date \_\_\_\_\_  
Field name or number \_\_\_\_\_ Acres irrigated \_\_\_\_\_

**Hardware Inventory:**

Power plant:

Electric motor(s):	<u>Main pump</u>	<u>Booster (if used)</u>
Make	_____	_____
Model	_____	_____
Rated rpm	_____	_____
Rated hp	_____	_____

Internal combustion engine:

Make \_\_\_\_\_  
Model \_\_\_\_\_  
Continuous rated hp at output shaft \_\_\_\_\_ hp at \_\_\_\_\_ rpm  
Comments about condition of power plant \_\_\_\_\_  
\_\_\_\_\_

Gear or belt drive mechanism:

Type: (check one) direct drive \_\_\_\_\_ gear drive \_\_\_\_\_ belt drive \_\_\_\_\_  
\_\_\_\_\_ rpm at driver \_\_\_\_\_ rpm at pump

Pumps

Type: (centrifugal, turbine, submers.)	_____	_____
Make	_____	_____
Model	_____	_____
Impeller diameter	_____	_____
Number of impellers	_____	_____
Rated flow rate (gpm)	_____	_____
at head of (ft)	_____	_____
at rpm	_____	_____

Pump curves: Attached \_\_\_\_\_ (yes or no)

Comments about condition of equipment \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Pumping Plant Detailed Evaluation Worksheet

Land user \_\_\_\_\_ Field office \_\_\_\_\_

Existing suction or turbine column set-up (sketch showing dimensions)

Existing discharge set-up (sketch showing dimensions)

### Data and computations:

Total Dynamic Head (TDH):

Elevation difference - water surface to pump outlet \_\_\_\_\_ feet

Pressure reading at pump outlet \_\_\_\_\_ psi

Pressure at pump inlet (where supply is pressurized) \_\_\_\_\_ psi

Estimated friction loss in suction pipe or pump column \_\_\_\_\_ feet

Miscellaneous friction loss \_\_\_\_\_ feet

TDH = (elevation difference between water source and pump discharge) + (discharge pressure - pressure at inlet) times 2.31 + (estimated suction pipe friction loss) + miscellaneous =

\_\_\_\_\_ = \_\_\_\_\_ feet

Flow rate:

Flow meter:

Flow rate = \_\_\_\_\_ gpm

Velocity meter:

Pipe ID \_\_\_\_\_ inches

Velocity \_\_\_\_\_ feet/second

Flow rate, Q, in gpm = (Velocity, in feet/second) x (2.45) x (pipe ID<sup>2</sup>) =

= \_\_\_\_\_ = \_\_\_\_\_ gpm

### Pumping Plant Detailed Evaluation Worksheet

Land user \_\_\_\_\_ Field office \_\_\_\_\_

Water horsepower:

$$\text{whp} = \frac{(\text{flow rate, in gpm}) \times (\text{TDH, in feet})}{3960} = \text{_____ hp}$$

#### Energy input

Electric:

Disk revolutions \_\_\_\_\_

Time: min \_\_\_\_\_ sec \_\_\_\_\_ = \_\_\_\_\_ sec

Meter constant (Kh) \_\_\_\_\_

PTR (power transformer ratio - usually 1.0)<sup>1/</sup> \_\_\_\_\_

CTR (current transformer ratio - usually 1.0)<sup>1/</sup> \_\_\_\_\_

$$\text{KW} = \frac{(3.6) \times (\text{disk rev}) \times (\text{Kh}) \times (\text{PTR}) \times (\text{CTR})}{(\text{time, in seconds})} = \text{_____ (kwh/h)}$$

Diesel or gasoline:

Evaluation time: hours \_\_\_\_\_ minutes \_\_\_\_\_ = \_\_\_\_\_ hours

Fuel use \_\_\_\_\_ gallons (a small quantity of fuel may also be weighed, at 7.05 lb/gal for diesel and 6.0 lb/gallon for gasoline)

$$\frac{(\text{fuel use, in gallons})}{(\text{time, in hours})} = \text{_____} = \text{_____ gallons/hour}$$

Propane:

Evaluation time: hours \_\_\_\_\_ minutes \_\_\_\_\_ = \_\_\_\_\_ hours

Fuel use \_\_\_\_\_ lb (weigh fuel used from small portable tank)

$$\frac{(\text{fuel use, in lb})}{(4.25 \text{ lb/gal}) \times (\text{time, in hr})} = \text{_____} = \text{_____ gallon/hours}$$

Natural gas:

Evaluation time: hours \_\_\_\_\_ minutes \_\_\_\_\_ = \_\_\_\_\_ hours

Meter reading: End \_\_\_\_\_ minus Start \_\_\_\_\_ = \_\_\_\_\_ mcf

$$\frac{(\text{fuel used, in mcf})}{(\text{time, in hr})} = \text{_____} = \text{_____ mcf/hr}$$

1/ Some power companies use a type of meter that requires a PTR or CTR correction factor. Check with local power company.

## Pumping Plant Detailed Evaluation Worksheet

Land user \_\_\_\_\_ Field office \_\_\_\_\_

In the next step, the efficiency of the power plant and pump, as a unit, is compared to the Nebraska Standards for irrigation pumping plants. The Nebraska standard for a good condition, properly operated plant. If the comparison comes out less than 100%, there is room for improvement.

**Nebraska performance rating:**

Nebraska pumping plant performance criteria \_\_\_\_\_

**Pump and Power Plant**

Energy source	Whp-h/unit of energy	Energy unit
Diesel	12.5	gallon
Propane	6.89	gallon
Natural gas	61.7	mcf
Electricity	0.885	kW=kwh/hr
Gasoline	8.66	gallon

The Nebraska standards assume 75% pump and 88% electric motor efficiency.

Percent of Nebraska performance rating

$$= \frac{\text{(whp)} \times (100)}{\text{(energy input)} \times \text{(Nebraska criteria, in whp-h/unit)}} =$$

$$= \text{_____} = \text{_____} \%$$

Horsepower input:

Electric:

$$\frac{\text{(input kW)}}{(0.746 \text{ kW/bhp})} = \text{_____} = \text{_____} \text{ bhp}$$

Diesel:

$$(16.66) \times \text{(energy input, in gal/hr)} = \text{_____} = \text{_____} \text{ bhp}$$

Propane:

$$(9.20) \times \text{(energy input, in gal/hr)} = \text{_____} = \text{_____} \text{ bhp}$$

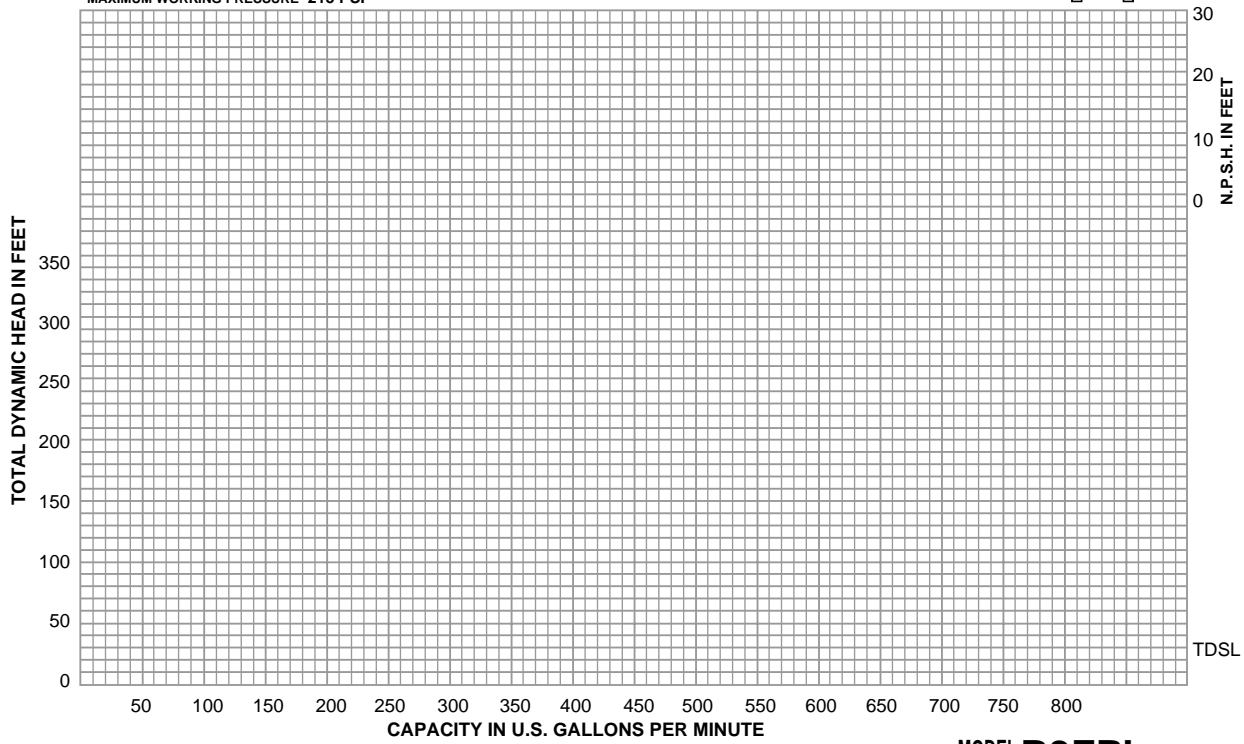
Natural gas:

$$(82.20) \times \text{(energy input, in mcf/hr)} = \text{_____} = \text{_____} \text{ bhp}$$



# Pump performance curve

Case: Material C.I. Patt. No. H-689 Mach. No. H-689 3600 NOMINAL R.P.M. 60 Cycles  
 Impeller: Material BRZ Patt. No. M-3380 Mach. No. M-3380 Dia. 9" FULL T.D.B.L. for fresh water at sea level 80° F max.  
 M-1  M-2   
 MAXIMUM WORKING PRESSURE 215 PSI



Based on T-3184

Superaades C-5006 Dated 10-30-64

Date 5-19-71

MODEL **B3ZPL**

## Soil Description

<b>Soil</b>		<b>File No.</b>	
<b>Area</b>		<b>Date</b>	<b>Stop No.</b>
<b>Classification</b>			
<b>Location</b>			
<b>N. veg. (or crop)</b>		<b>Climate</b>	
<b>Parent material</b>			
<b>Physiography</b>			
<b>Relief</b>	<b>Drainage</b>	<b>Salt or alkali</b>	
<b>Elevation</b>	<b>Gr. water</b>	<b>Stoniness</b>	
<b>Slope</b>	<b>Moisture</b>		
<b>Aspect</b>	<b>Root distrib.</b>	<b>% Clay*</b>	
<b>Erosion</b>	<b>% Coarse fragments*</b>	<b>% Coarser than V.F.S.*</b>	
<b>Permeability</b>			
<b>Additional notes</b>			

*Control section average														
Horizon	Depth	Color		Texture	Structure	Color			Reaction	Boundary	Effervescence	Roots	Pore	Line
		Dry	Moist			Dry	Moist	Wet						

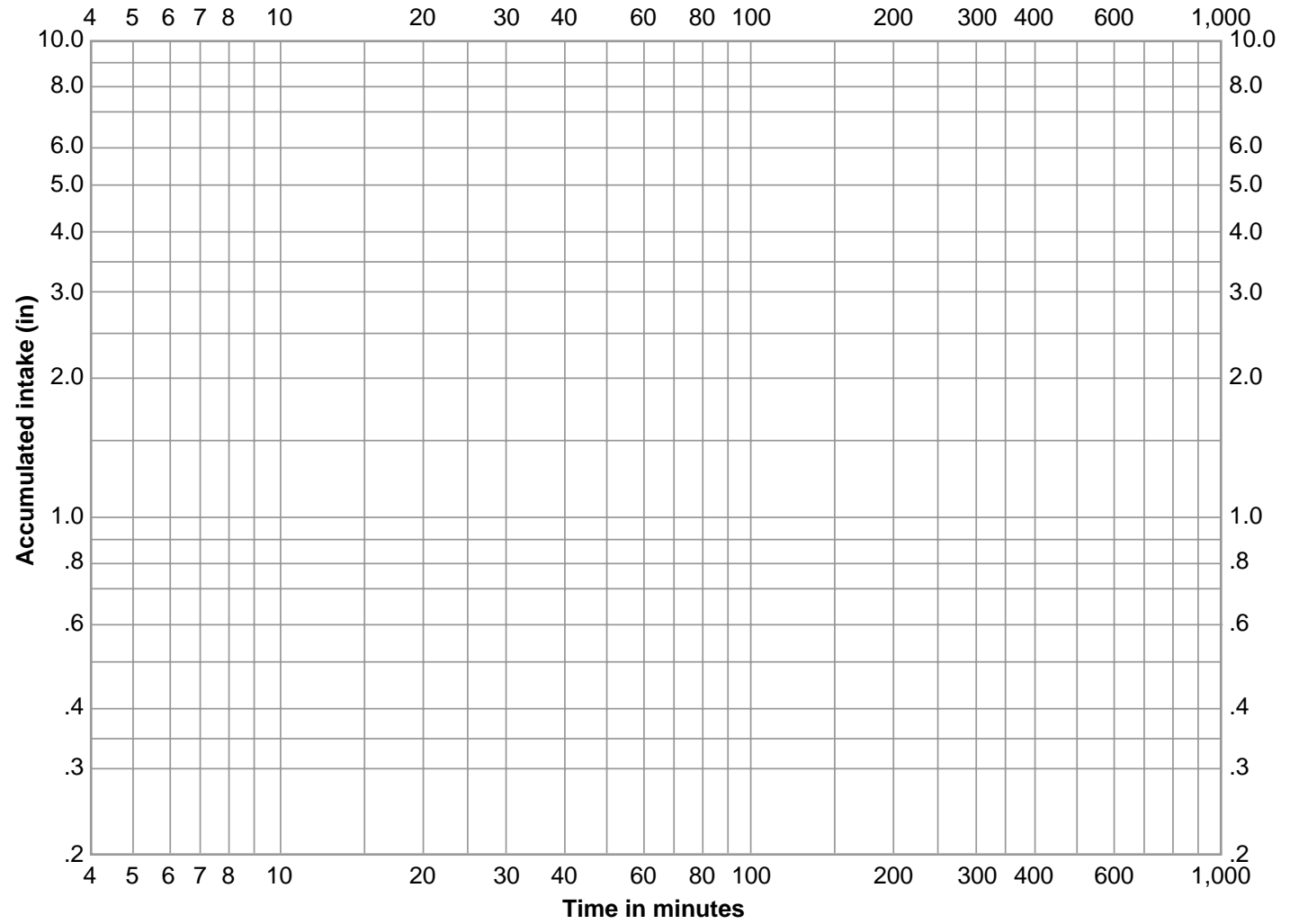


Land user \_\_\_\_\_

Date \_\_\_\_\_

Field office \_\_\_\_\_

### Soil water intake curves



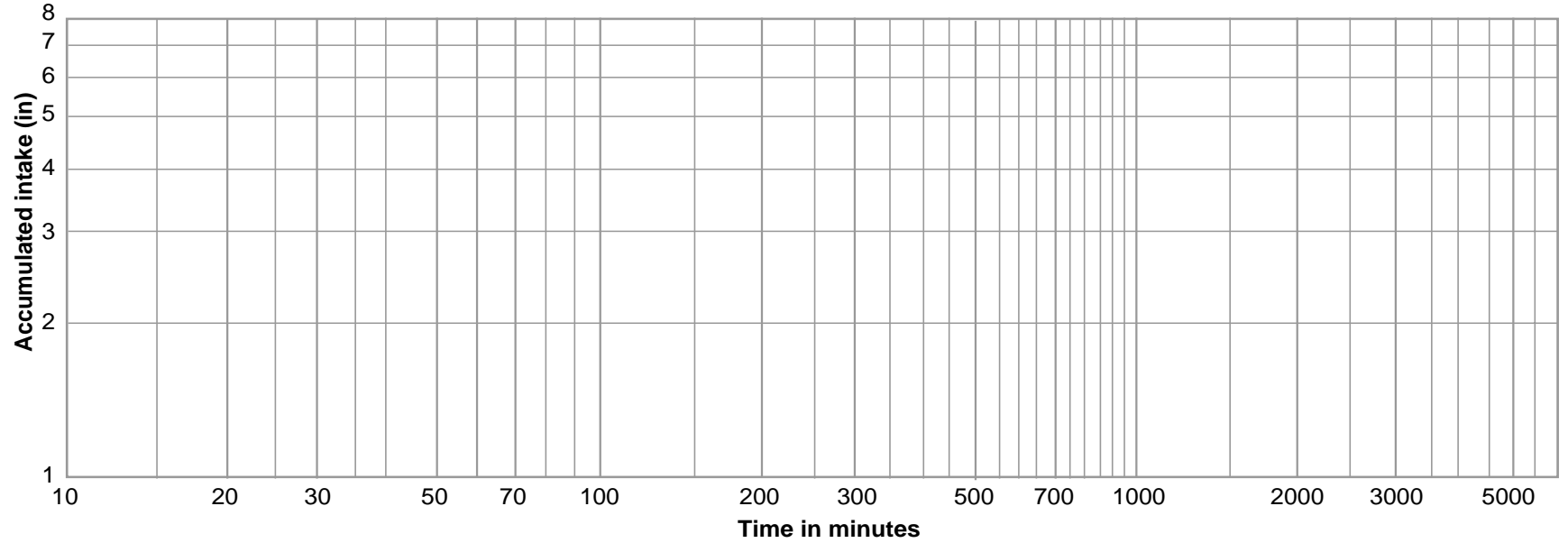
## Intake curve overlay

(Clear plastic overlay is available through NRCS State Office)

Land user \_\_\_\_\_

Date \_\_\_\_\_

Field office \_\_\_\_\_



## Intake Grouping for Border Irrigation Design

### Instructions

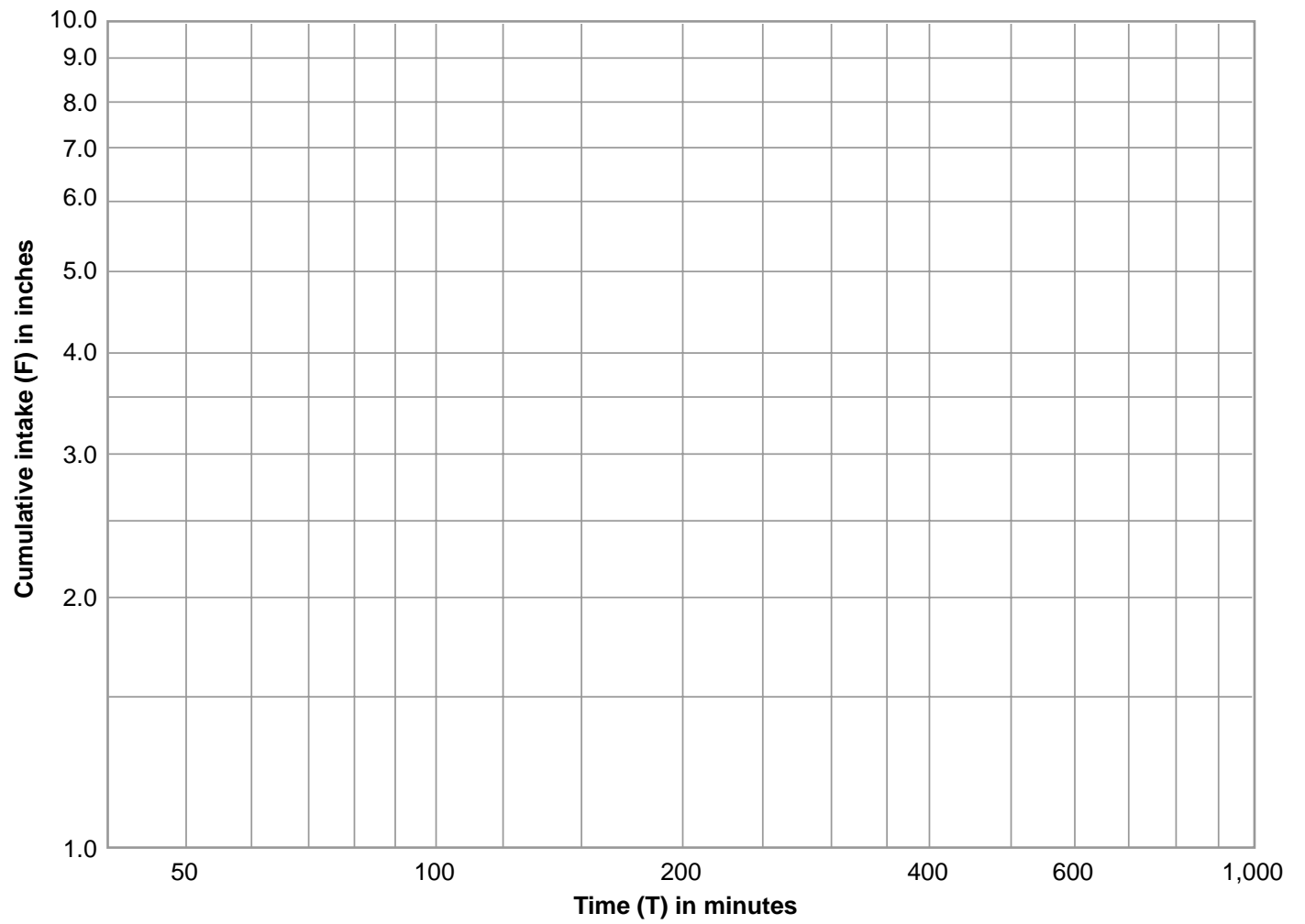
1. Plot data from cylinder intake test on matching logarithmic paper using accumulated intake (inches) as ordinates and elapsed time (minutes) as abscissas. Draw line representing test results.
2. Place overlay over plotted curve, matching the intersection of the lines for 10 minutes time and 1 inch intake. Select the intake family that best represents the plotted curve within the normal irrigation range.

Land user \_\_\_\_\_

Date \_\_\_\_\_

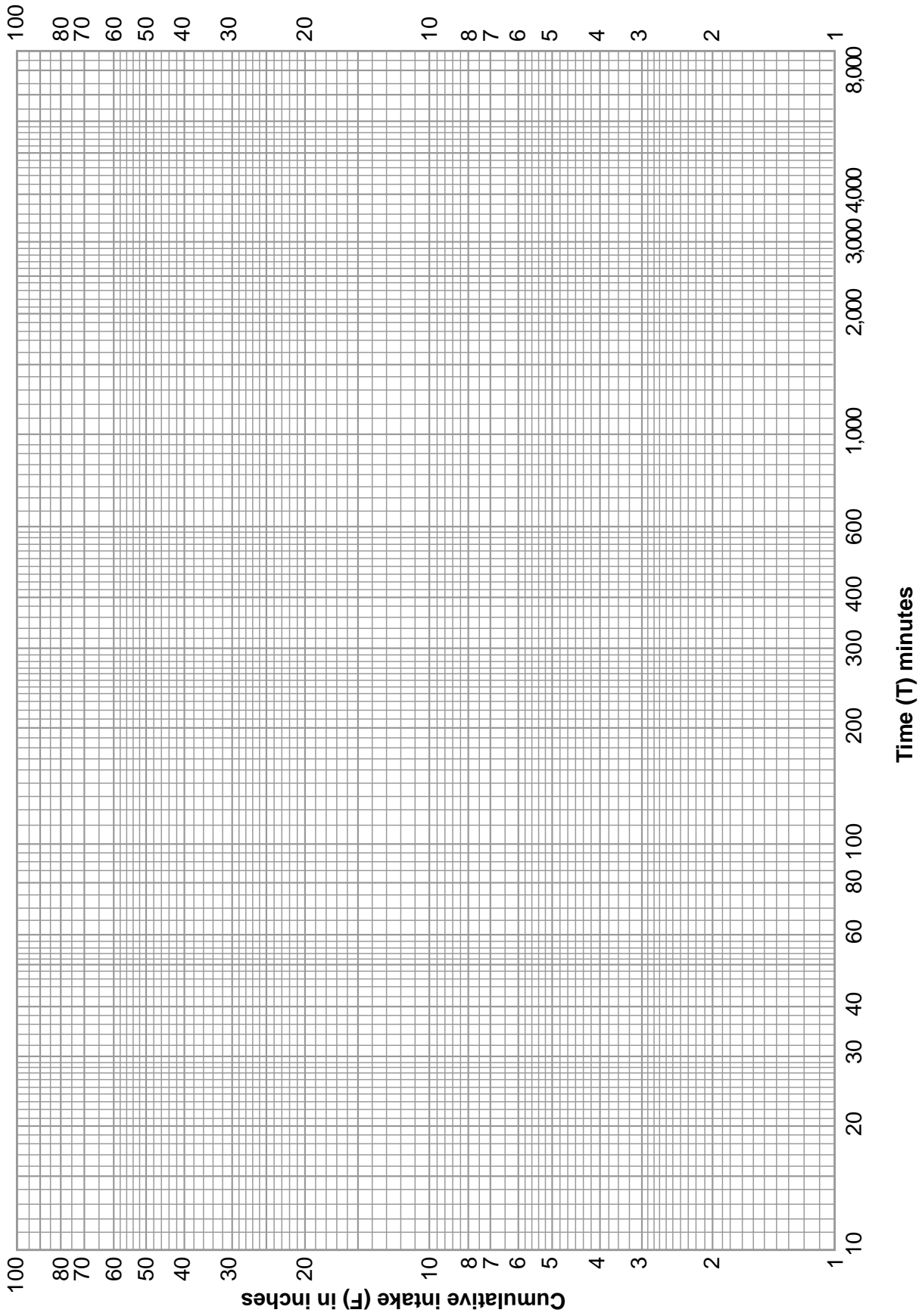
Field office \_\_\_\_\_

### Accumulated intake vs. time



Land user \_\_\_\_\_  
Date \_\_\_\_\_  
Field office \_\_\_\_\_

### Intake families as used with furrow irrigation





Natural  
Resources  
Conservation  
Service

# Estimating Soil Moisture by Feel and Appearance

Irrigation Water Management (IWM) is applying water according to crop needs in an amount that can be stored in the plant zone of the soil.

The feel and appearance method is one of several irrigation scheduling methods used in IWM. It is a way of monitoring soil moisture to determine when to irrigate and how much water to apply. Applying too much water may cause excessive runoff and/or deep percolation. As a result, nutrients and chemicals may be lost or leached into the ground water.

In applying this method, you determine the amount of irrigation water needed by subtracting water in soil storage (estimated using the feel and appearance method) from the available water capacity (AWC) of the soil. (See the example computation below.)

The feel and appearance of soil varies with texture and moisture content. Water available for plant use can be estimated, with experience, to an accuracy of about 5 percent. Soil moisture is typically sampled in

1-foot increments to the root depth of the crop at three or more sites per field. You vary the number of sample sites and depths according to: crop, field size, soil texture, and soil stratification. For each sample the feel and appearance method involves:

1. Obtaining a soil sample at the selected depth using a probe, auger, or shovel;
2. Squeezing the soil sample firmly in your hand several times to form an irregularly shaped ball;
3. Observing soil texture, ability to ribbon, firmness and surface roughness of ball, water glistening, loose soil particles, soil/water staining on fingers, and soil color;
4. Comparing observations with photographs and/or chart to estimate percent water available. (Note: A very weak ball disintegrates with one bounce of the hand. A weak ball disintegrates with 2 to 3 bounces.)

## Example for a uniform soil

Sample depth (inches)	Zone (inches)	USDA texture	Field capacity* (percent)	AWC for layer (inches)	Water available (inches)	Water need (inches)
6	0-12	sandy loam	30	1.4	.42	.98
18	12-24	sandy loam	45	1.4	.63	.77
30	24-36	loam	60	2.0	1.20	.80
42	36-48	loam	75	2.0	1.50	.50
				6.8	3.75	3.05

\* Determined by feel and appearance method




## Summary of estimation

	(inches)
AWC in 48" root zone at 100% field capacity .....	6.8
Actual water available for plant use .....	3.7
Net irrigation requirement or need .....	3.1

# Fine sand and loamy fine sand soils

Appearance of fine sand and loamy fine sand soils at various soil moisture conditions.




Available water capacity ..... 0.6–1.2 inches/foot

Available Soil Moisture	Description	Illustration
<b>0-25</b>	Appears dry, will hold together if not disturbed, loose sand grains on fingers.	
<b>25-50</b>	Slightly moist, forms a very weak ball with well-defined finger marks, light coating of loose and aggregated sand grains remain on fingers.	
<b>50-75</b>	Moist, forms a weak ball with loose and aggregated sand grains on fingers, darkened color, light uneven water staining on fingers.	
<b>75-100</b>	Wet, forms a weak ball, loose and aggregated sand grains remain on fingers, darkened color, heavy water staining on fingers, will not ribbon.	
<b>100</b> (field capacity)	Wet, forms a weak ball, light to heavy soil/water coating on fingers, wet outline of soft ball remains on hand.	

# Sandy loam and fine sandy loam soils




Appearance of sandy loam and fine sandy loam soils at various soil moisture conditions.

Available Water Capacity ..... 1.3–1.7 inches/foot

Available Soil Moisture	Description	Illustration
<b>0-25</b>	Appears dry, forms a very weak ball, aggregated soil grains break away easily from ball.	
<b>25-50</b>	Slightly moist, forms a weak ball with defined finger marks, darkened color, no water staining on fingers.	
<b>50-75</b>	Moist, forms a ball with defined finger marks, very light soil/water staining on fingers, darkened color, will not slick.	
<b>75-100</b>	Wet, forms a ball with wet outline left on hand, light to medium staining on fingers, makes a weak ribbon.	
<b>100</b> (field capacity)	Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, medium to heavy soil/water coating on fingers.	

# Sandy clay loam and loam soils




Appearance of sandy clay loam and loam soils at various soil moisture conditions.  
 Available Water Capacity..... 1.5–2.1 inches/foot

Available Soil Moisture	Description	Illustration
<b>0-25</b>	Appears dry, soil aggregations break away easily, no staining on fingers, clods crumble with applied pressure.	
<b>25-50</b>	Slightly moist, forms a weak ball with rough surfaces, no water staining on fingers, few aggregated soil grains break away.	
<b>50-75</b>	Moist, forms a ball, very light staining on fingers, darkened color, pliable, forms a weak ribbon.	
<b>75-100</b>	Wet, forms a ball with well defined finger marks, light to heavy soil/water coating on fingers, ribbons between thumb and forefinger.	
<b>100</b> (field capacity)	Wet, forms a soft ball, free water appears briefly on soil surface after squeezing or shaking, thick soil/water coating on fingers.	

# Clay, clay loam and silty clay loam soils

Appearance of clay, clay loam and silty clay loam soils at various soil moisture conditions.

Available Water Capacity ..... 1.6–2.4 inches/foot

Available Soil Moisture	Description	Illustration
<b>0-25</b>	Appears dry, soil aggregations separate easily, clods are hard to crumble with applied pressure.	
<b>25-50</b>	Slightly moist, forms a weak ball, very few soil aggregations break away, no water stains, clods flatten with applied pressure.	
<b>50-75</b>	Moist, forms a smooth ball with defined finger marks, light staining on fingers, ribbons between thumb and forefinger.	
<b>75-100</b>	Wet, forms a ball, uneven medium to heavy soil/water coating on fingers, ribbons easily.	
<b>100</b> (field capacity)	Wet, forms a soft ball, free water appears on soil after squeezing or shaking, thick soil/water coating on fingers, slick and sticky.	