Agricultural Drainage Design
& Water Management Workshop

Design I

Practice Problems

Gary Sands
Extension Engineer
Dept. of Biosystems & Agricultural Engineering
University of Minnesota
(612) 625-4756
grsands@umn.edu

University of Minnesota
Extension
SERVICE

Short Exercises

1. Drain Spacing & Depth

2. Drainage Layout

3. Drainage Coefficient

4. Grade/Area

5. Drain Sizing Tools

Spacing (MN Drainage Guide)

1. A farmer wants to pattern drain a 100-acre field. The predominant soil type is a Blue Earth clay loam. What drain depth and spacing will you use?

2. Closer drains result in a (higher/ lower) drainage coefficient.

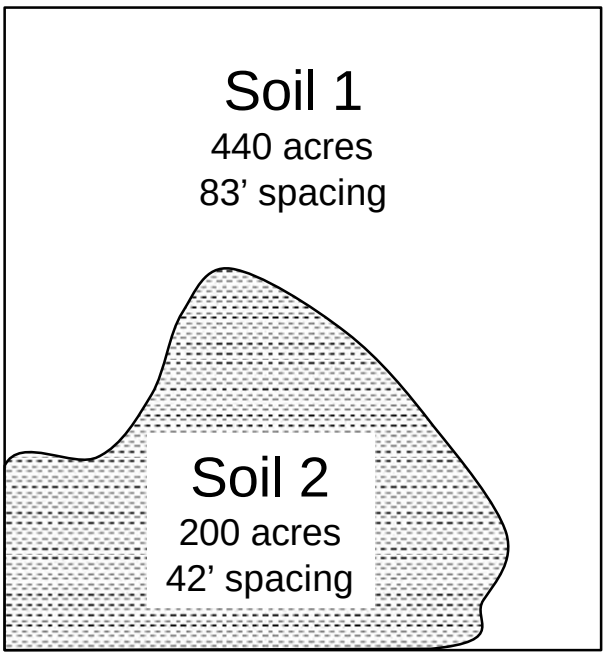
3. Deeper drains result in a (higher/ lower) drainage coefficient.

SOIL NAME UNIT KIND MODIFIER	ID NO.	DRAIN DESIGN RECOMMENDATIONS COMMENTS	DSN GRP	DRAIN DEPTH In.	SPACINGS, Ft. DRAINAGE COEFF. In./24 Hrs. 1/4	3/8	1/2	3/4	HORIZ DEPTH In.	
BLUE EARTH SERIES	MN0064		1						0-10	PT
			5	36	95	74	62	49	0-10	OL,ML
			5	48	121	96	81	64	10-60	OL,ML
									60-70	CL,ML

Spacing (cont.)

1. To keep the drainage coefficient the same, putting drains deeper requires a (closer/wider) spacing.

2. What spacing should be used if the soils are distributed as shown below?



Drainage Coefficient

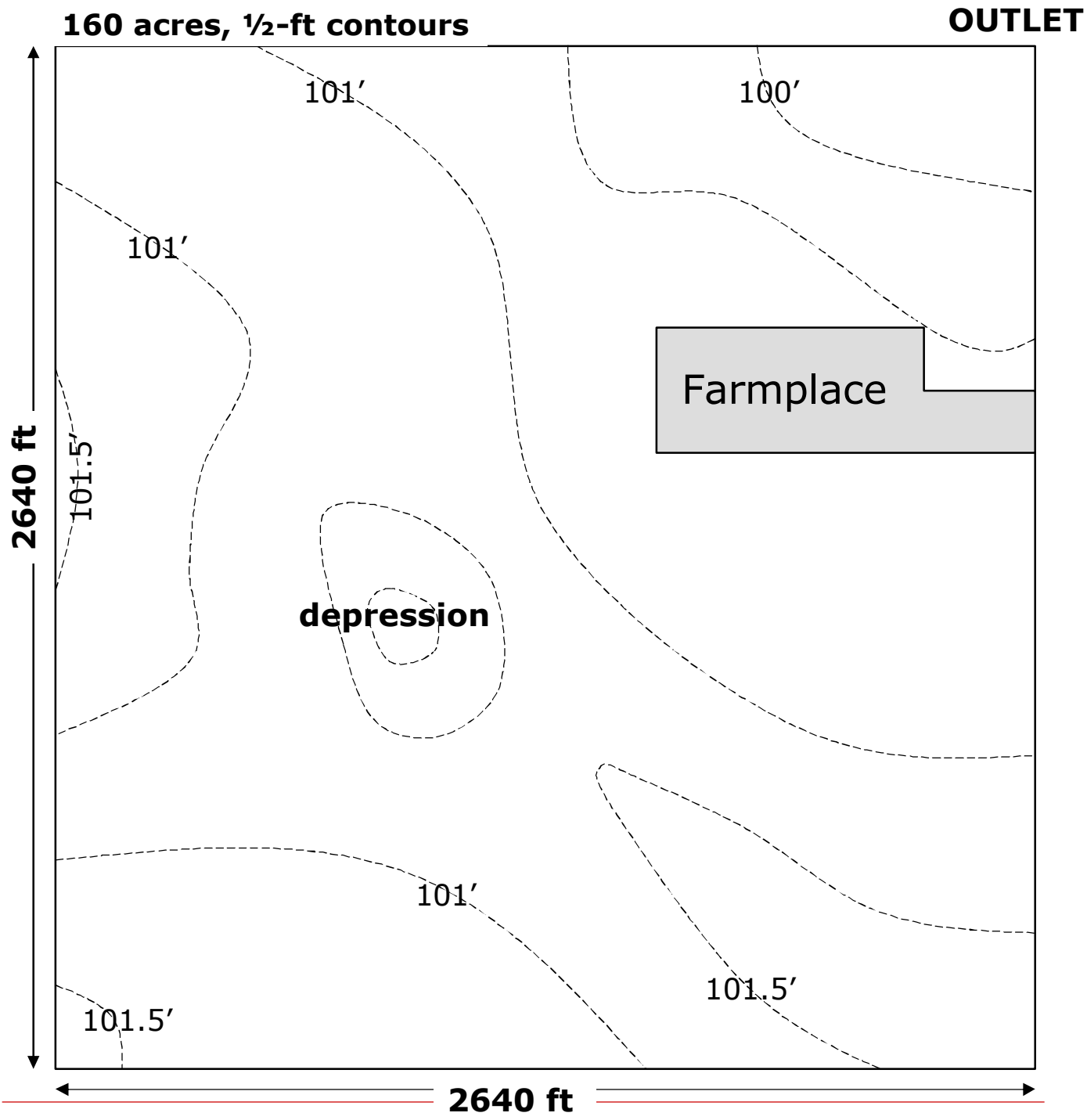
1. What drainage coefficient should be used for a corn/soybean rotation, for:
   a. No surface inlets?
   b. With surface inlets?
   c. Organic production instead corn/soybean?

2. A higher drainage coefficient requires a closer drain spacing (T/F)

	Inches to be removed in 24 hours	
Soil Type	***Field Crops***	***Truck Crops***
Mineral	3/8 – ½	½ – ¾
w/ surface inlets	½ – 1	1 – 1-½
Organic	½ – ¾	¾ – 1-½
w/ surface inlets	1 – 1-½	2 – 4

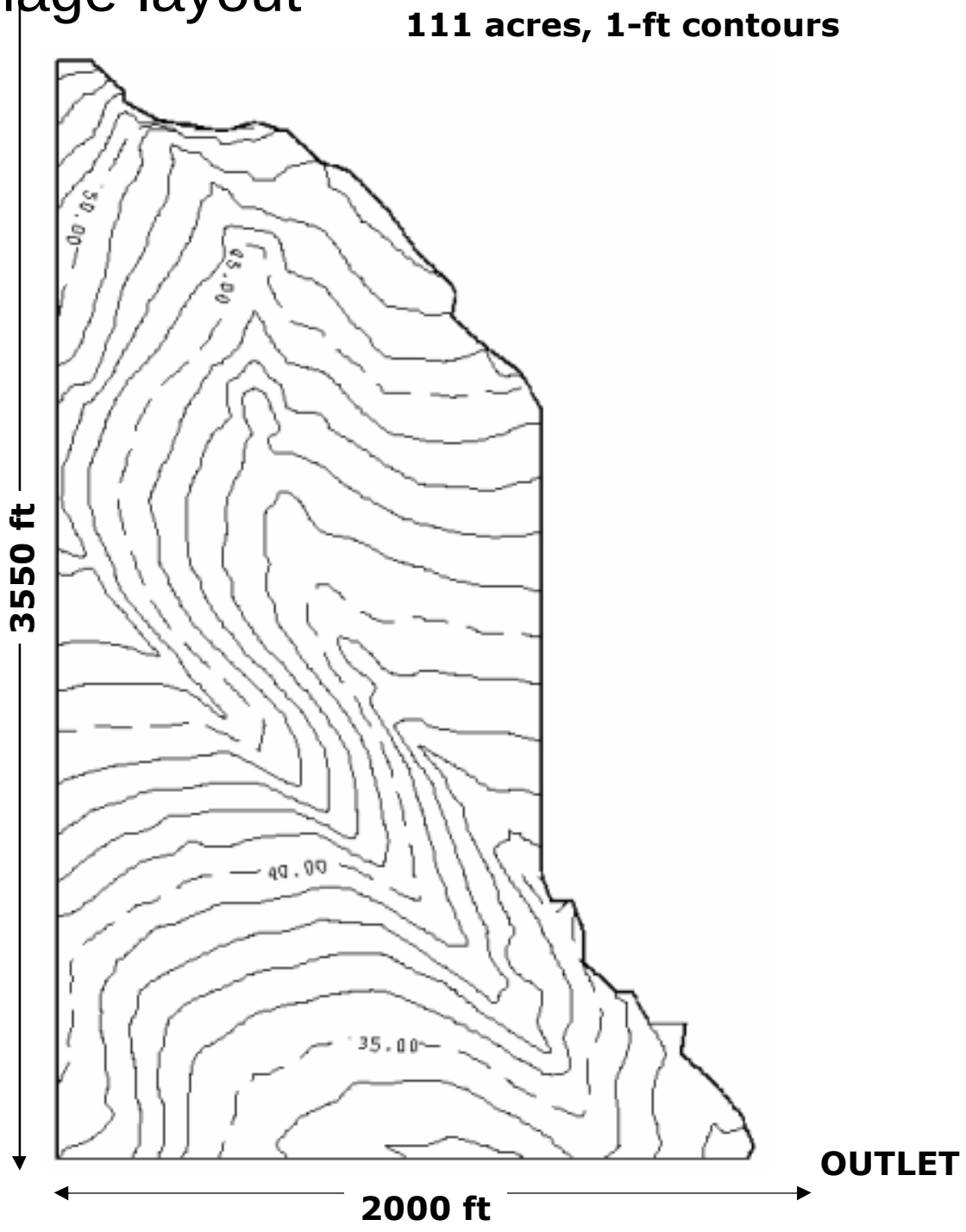
Drainage Layout

1. Sketch a drainage layout



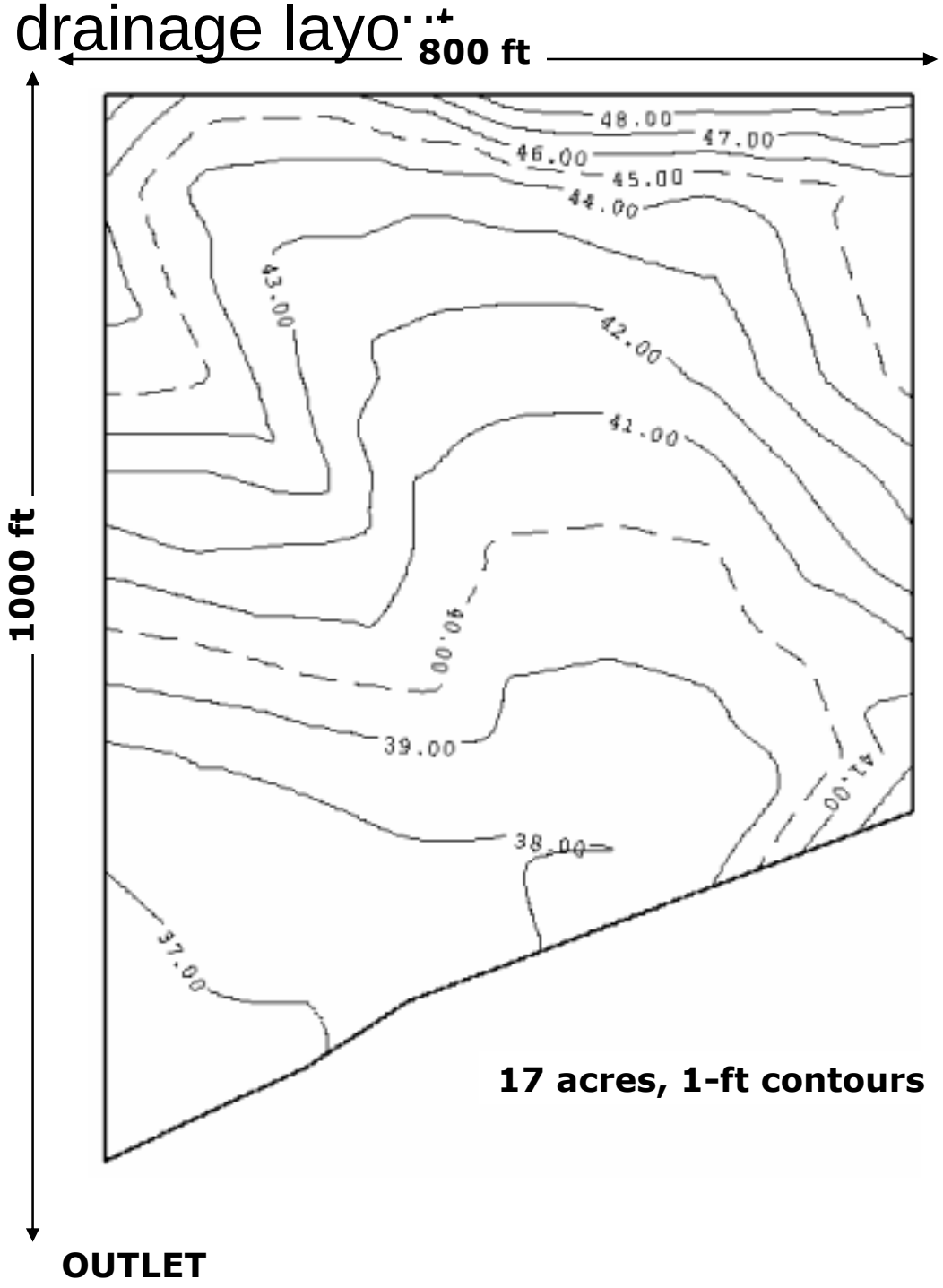
Drainage Layout

2. Sketch a drainage layout



Drainage Layout

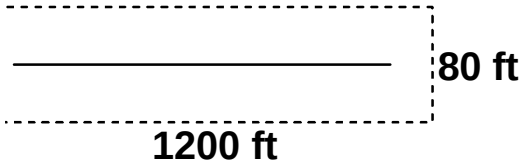
3. Sketch a drainage layout



Grade/Area Calculations

1. A field lateral drains 3 acres. How many square feet is this?

2. A group of field laterals are 1200-ft long and spaced at 80 ft.
   a. How many square ft. does each lateral drain?
   b. How many acres does each lateral drain?

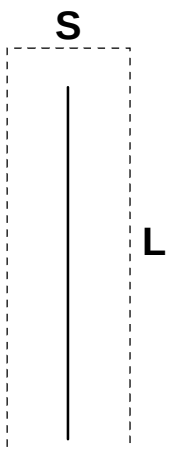


Grade/Area Calculations

1. What is the percent grade if there is 8 foot of fall in 1850 ft?

2. How many feet of fall are there in 1500 ft on a 0.12 % grade?

3. What is the maximum length of a 4-inch lateral, if it will drain 2.5 acres at 75-foot spacing?



area drained = S x L

Drain Sizing Tools

1. pipe size
   a. What pipe size is req'd. to drain 200 acres at ? " drainage coef. and 0.6% grade, for:
      - single wall?
      - dual wall?
   b. What grade is required to move to the next smaller pipe size?

2. acres drained
   a. How many acres can a 4-inch corrugated plastic lateral drain, on a 1% grade and 80-ft spacing for a ½" drainage coefficient?
   b. How many acres can a 12-inch outlet drain at 0.15% grade?

Nomograph

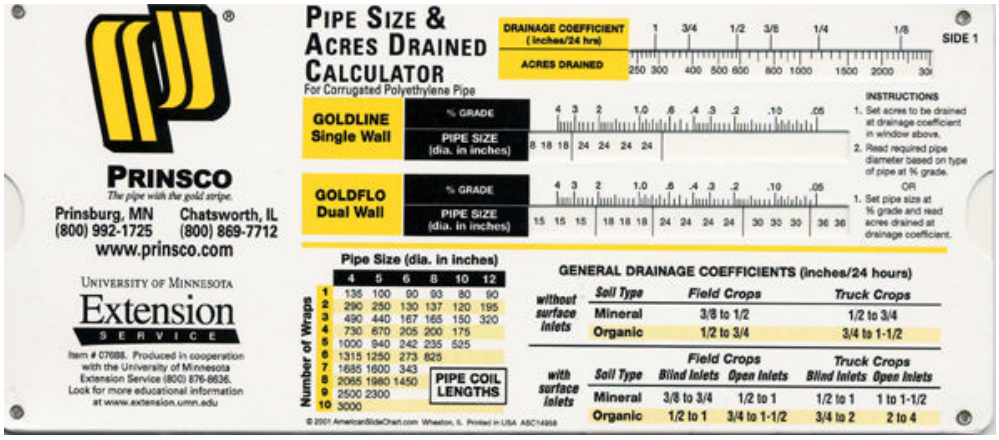
1. Find These Items:
    a. pipe material
    b. drainage coefficient
    c. acres drained
    d. drain grade
    e. pipe size
    f. flowrate (rate of discharge)
    g. flow velocity

Nomograph: Finding Pipe Size

1. Find drainage coefficient
2. Read up to no. acres drained
3. Draw a horizontal line
4. Find grade
5. Read up to line for pipe size

Nomograph:
Finding Acres Drained

1. Select pipe size line
2. Select desired grade
3. Read up to pipe size line, and across to desired drainage coefficient
4. Read acres drained



Side 1 – Acres Drained and Pipe Size

Description: Side 1 of the Prinsco slide chart is used for determining pipe size given a certain number of acres drained and a drainage coefficient (DC) and vise versa. A table is provided (lower right corner) to assist with the selection of DC.

1. Determining required pipe size based on acres drained and drainage coefficient

- Slide the insert to line up the desired number of acres drained with the DC of choice.
- Without moving the insert, read required pipe size below for SINGLE WALL or DUAL WALL by matching desired grade with pipe size in window.

  EXAMPLE: Find the outlet pipe size required for draining 250 acres with a ½" DC and 0.2% grade.

  SOLUTION:

  - Line up 250 acres with the ½" DC in the top window
  - Read the pipe size in the SINGLE WALL window under 0.2% grade – **24" required pipe size**.
  - Read the pipe size in the DUAL WALL window under 0.2% grade – **18" required pipe size**.

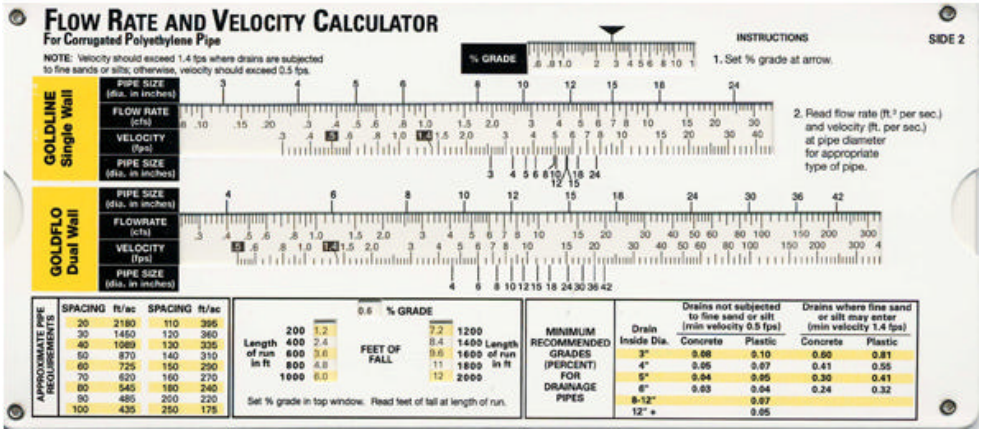
2. Determining acres drained for a given pipe size and % grade

- For either SINGLE WALL or DUAL WALL, line up the line on the right side of the pipe size with the % grade
- Without moving the insert, In the top window, read the acres drained at the desired DC.

  EXAMPLE: Find the number of acres drained for 10" SINGLE WALL and DUAL WALL at 0.15% grade and a 3/8" DC.

  SOLUTION:

  - Line up the line on the right side of the 10" size, at 0.15% grade in the SINGLE WALL window.
  - Read the acres drained under the 3/8" DC line – **approximately 42 acres drained**.
  - Repeat above starting with the DUAL WALL window – **approximately 71 acres drained**.



Side 2 – Flow Rate and Velocity; Feet of Fall

Description: Side 2 of the Prinsco Slide Chart is designed to ensure that installers provide sufficient grade to meet minimum velocity requirements for standard slot tubing. Flow rate is provided but is not necessary to determine velocity. ASAE recommends that velocity exceed 1.4 fps(ft/sec) where fine sands and silts are present, otherwise 0.5 fps. Use of a sock or envelope circumvents the need for maintaining the 1.4 fps

1. Determining velocity based on % grade

- Slide the insert to line up the desired % grade in the upper window, with the arrow.
- Read velocity and/or flow rate for SINGLE WALL or DUAL WALL at the desired pipe size. Use the pipe sizes on the top of the window for reading flow rate and the pipe sizes on the bottom of the window for velocity.

EXAMPLE: Will a 4” pipe size achieve a minimum velocity of 0.5 fps for SINGLE WALL and DUAL WALL installed at 0.07% grade?

SOLUTION:

- Line up 0.07% grade with the arrow in the top window.
- Without moving the insert, find the highlighted 0.5 fps velocity in the SINGLE WALL window. This line falls just to the left of the 4” pipe size, therefore a **4” SINGLE WALL pipe size at 0.07% grade will maintain at least 0.5 fps**.
- Now look in the DUAL WALL window. The 0.5 fps line falls well to the left of the 4” pipe size, therefore a **4” DUAL WALL pipe size is also sufficient** to maintain the desired velocity.

EXAMPLE: What flow rate (full pipe flow) will an 8” pipe deliver at 0.15% grade?

SOLUTION:

- Line up 0.15% grade with the arrow in the top window.
- Without moving the insert, read the flow rate at the 8” pipe size in the SINGLE WALL window – **flow rate = 0.4 cfs (ft^3/sec)**.
- Repeat for DUAL WALL – **flow rate = 0.6 cfs**

2. Determining feet of fall based on % grade (bottom center table)

Example: How many feet of fall are there in a 1400-foot run at 0.4% grade?

- Slide the insert until 0.4 appears in the % grade upper window, with the arrow.
- Read the feet of fall at the desired length of run – **5.6 feet of fall for a 1400-ft run**.