# Fire Protection Hydraulics and Water Supply Analysis

FPST 2483 Chapter 8

Analysis of water supply system

**1**

## Outline

- Upon completing this module, the student should be able to:
  - Draw water supply curve
  - Read data from water supply curve
  - Modify water supply curve based on
    - Friction loss
    - Elevation difference

- Reading material
  - Brock's book, chapter 8

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**2**

## Example 1

- A hydrant flow test was conducted with the following results:
- Static pressure: 92 psi
- Residual pressure: 41 psi
- Pitot pressure: 28 psi; Cd=0.9; d= 2½
  24 psi; Cd=0.8; d= 2 9/16

Plot the graph using these test results and from the graph answer the following questions:
- a. What flow is available at a pressure of 20 psi?
- b. What pressure is available at a flow of 1000 gpm?

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**3**

## Example 1

$$Q_1 = 29.83 \times 0.9 \times 2.5^2 \times \sqrt{28} = 888 \, \text{gpm}$$

$$Q_2 = 29.83 \times 0.8 \times 2.5625^2 \times \sqrt{24} = 768 \, \text{gpm}$$

$$Q_T = Q_1 + Q_2 = 1656 \, \text{gpm}$$

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**4**

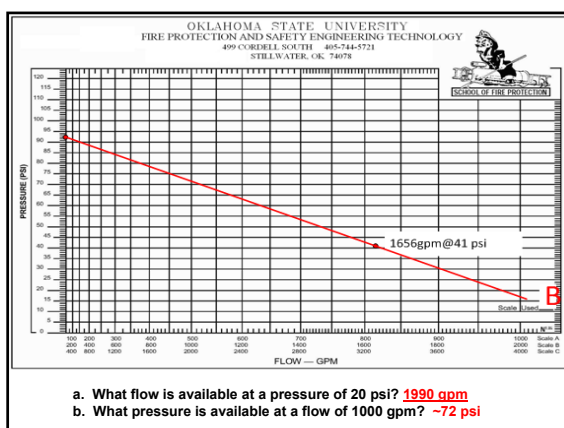OKLAHOMA STATE UNIVERSITY
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SCHOOL OF FIRE PROTECTION

1656gpm@41 psi

FLOW — GPM

a.  What flow is available at a pressure of 20 psi? **1990 gpm**
b.  What pressure is available at a flow of 1000 gpm?  **~72 psi**

**5**

## What if there is no diagram?

$$\frac{P_S - P_A}{P_S - P_R} = \left(\frac{Q_A}{Q_T}\right)^{1.85}$$

$$Q_A = Q_T \left(\frac{P_S - P_A}{P_S - P_R}\right)^{0.54} = 1656 \times \left(\frac{92 - 20}{92 - 41}\right)^{0.54} = 1995 \, \text{gpm}$$

$$\frac{P_S - P_A}{P_S - P_R} = \left(\frac{Q_A}{Q_T}\right)^{1.85} \quad \blacktriangleright \quad \frac{92 - P_A}{92 - 41} = \left(\frac{1000}{1656}\right)^{1.85} \quad \blacktriangleright \quad P_A = 71.94 \, \text{psi}$$

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## Example 2

- A flow test was conducted and yielded the following results:
- Static Pressure:     93 psi
- Residual Pressure:    42 psi
- Pitot Readings:     33 psi on 2 9/16-inch hydrant outlet,
  Cd=0.8, 42 psi on 1 3/4-inch U.L. Playpipe

Plot the water flow test results on the attached hydraulic graph paper.

- From the graph, a residual pressure of _?_ psi  is available at a flow of 750 gpm.
- From the graph, the flow indicated to be available at a residual pressure of 20 psi is_?_ gpm.
- Can this water supply provide a fire protection demand  of 1250 gpm at a pressure of 56 psi?

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**7**

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1474gpm@42 psi

**From the graph, a residual pressure of _78_ psi  is available at a flow of 750 gpm.**
**From the graph, the flow indicated to be available at a residual pressure of 20 psi is_1780_ gpm.**
**Can this water supply provide a fire protection demand  of 1250 gpm at a pressure of 56 psi?**
**_NO_**

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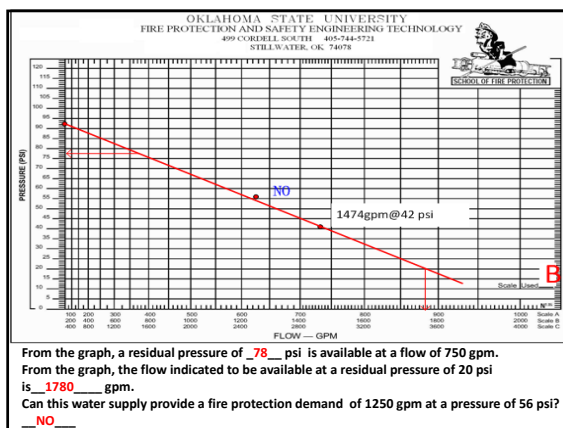
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## What if there is no diagram?

$$\frac{P_S - P_A}{P_S - P_R} = \left(\frac{Q_A}{Q_T}\right)^{1.85}$$

$$Q_A = Q_T \left(\frac{P_S - P_A}{P_S - P_R}\right)^{0.54} = 1474 \times \left(\frac{93 - 20}{93 - 42}\right)^{0.54} = 1789.0\,\text{gpm}$$

$$\frac{P_S - P_A}{P_S - P_R} = \left(\frac{Q_A}{Q_T}\right)^{1.85} \quad \blacktriangleright \quad \frac{93 - P_A}{93 - 42} = \left(\frac{750}{1474}\right)^{1.85} \quad \blacktriangleright \quad P_A = 78.4\,\text{psi}$$

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## Example 3

- Static pressure: 82 psi
  Residual pressure: 36 psi
  Two Outlets flowing with 18 psi Pitot pressure at each and each with 2 ½ -inch rounded outlets.
- a. What flow is available at 20 psi?
  b. What pressure is available at 1150 gpm?

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1424 gpm@36 psi

B
Scale Used

PRESSURE (PSI)

FLOW — GPM

- a. What flow is available at 20 psi?      ____~1690 gpm____
  b. What pressure is available at 1150 gpm?_~52 psi____   11
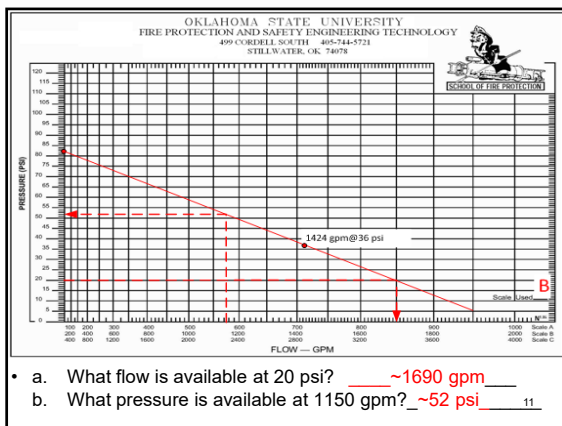
11

## Example 4

- A water supply test was conducted with the following results:
  Static Pressure:      90 psi
  Residual Pressure:    40 psi
  Pilot Pressures:      21, 21, 27, and 28 psi
- If flow hydrants have a coefficient of discharge of 0.8 and have 2 ½ inch outlets, draw a graph of the water supply available and determine the following:
  – GPM available at 20 psi residual pressure
  – Residual pressure available at 2000 gpm

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**Slide 13**



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PRESSURE (PSI)

2931 gpm@40psi

C

Scale Used

FLOW — GPM

- **If flow hydrants have a coefficient of discharge of 0.8 and have 2 ½ inch outlets, draw a graph of the water supply available and determine the following:**
- **GPM available at 20 psi residual pressure: ___~3500_____**
- **Residual pressure available at 2000 gpm: ___~65 psi_____**

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**13**

**Slide 14**

# Example 5:
# Water Supplies

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- In the situation shown below, a flow test was conducted with the test hydrant located at Point A. Graph the original flow test results, then correct the graph for friction and elevation so it reflects the water supply available at Point C and determine the gpm available at the pressure of 20 psi at Point C.

Static: 80 psi
Residual: 60 psi    Flow: 1600 gpm

C

6"          6"
A   300'   B   800'      $\Delta h = 35\,'$

Piping is CL 150 PVC

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**14**

**Slide 15**



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PRESSURE (PSI)

Original curve

Corrected for Pf

Corrected for Pf & Pe

B

Scale Used

FLOW — GPM

$$P_f = \frac{4.52 \times 1600^{1.85} \times 1100}{150^{1.85} \times 6.09^{4.87}} = 60\ psi$$
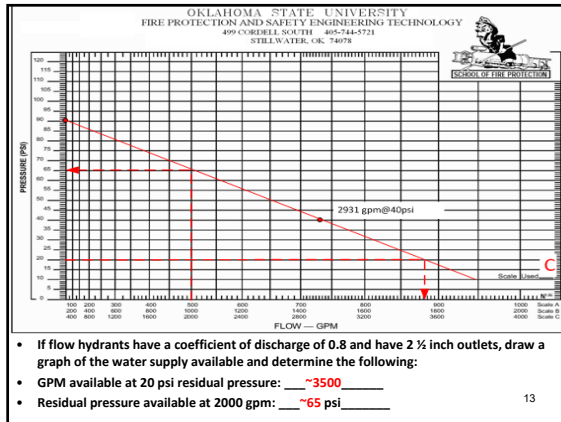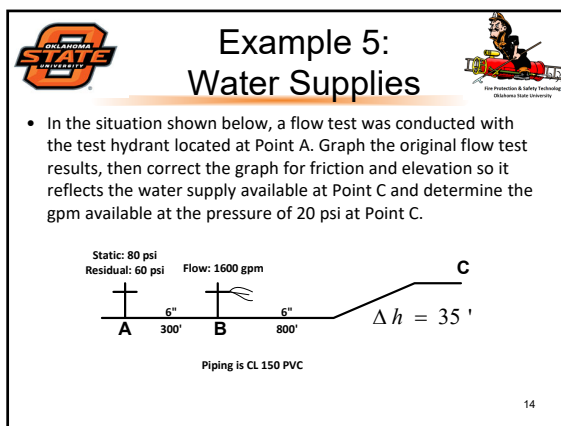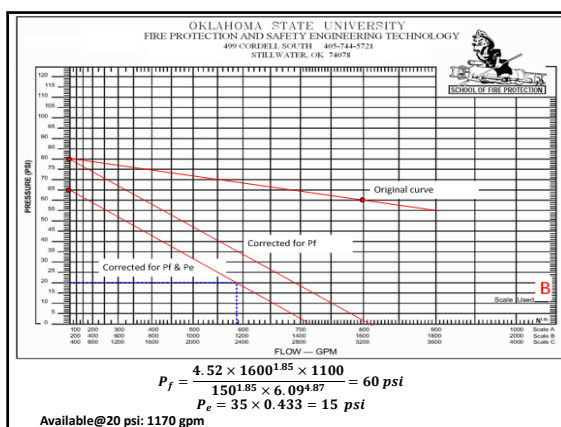$$P_e = 35 \times 0.433 = 15\ psi$$

Available@20 psi: 1170 gpm

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## Example 6

A flow test has been conducted with the following results:
Static Pressure = 95 psi
Residual Pressure = 71 psi
Measured Flow = 1600 gpm

Provide a graph of the water supply at Point A located 1050 feet away from the test location and connected to the test location with 6 -inch plastic Blue Brute pipe (d = 6.13 in.).

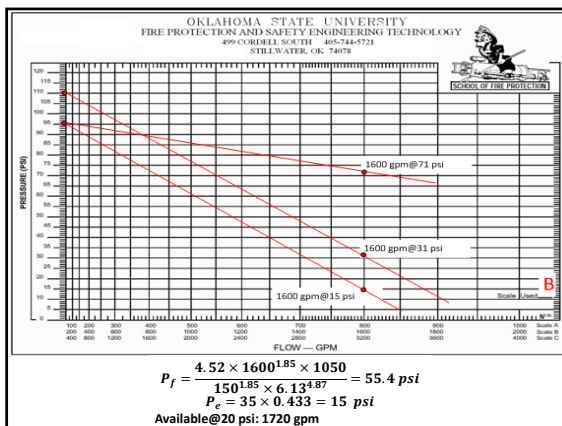*Point A is also 35 feet lower in elevation than the test location.*

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**16**



$$P_f = \frac{4.52 \times 1600^{1.85} \times 1050}{150^{1.85} \times 6.13^{4.87}} = 55.4 \; psi$$
$$P_e = 35 \times 0.433 = 15 \; psi$$
**Available@20 psi: 1720 gpm**

**17**