DEQ Certification Class Presentations

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July 2024

VIRGINIA DEPARTMENT OF ENVIRONMENTAL QUALITY

Module 7

Outlet Protection Problems

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1. Tailwater Condition and Apron Details

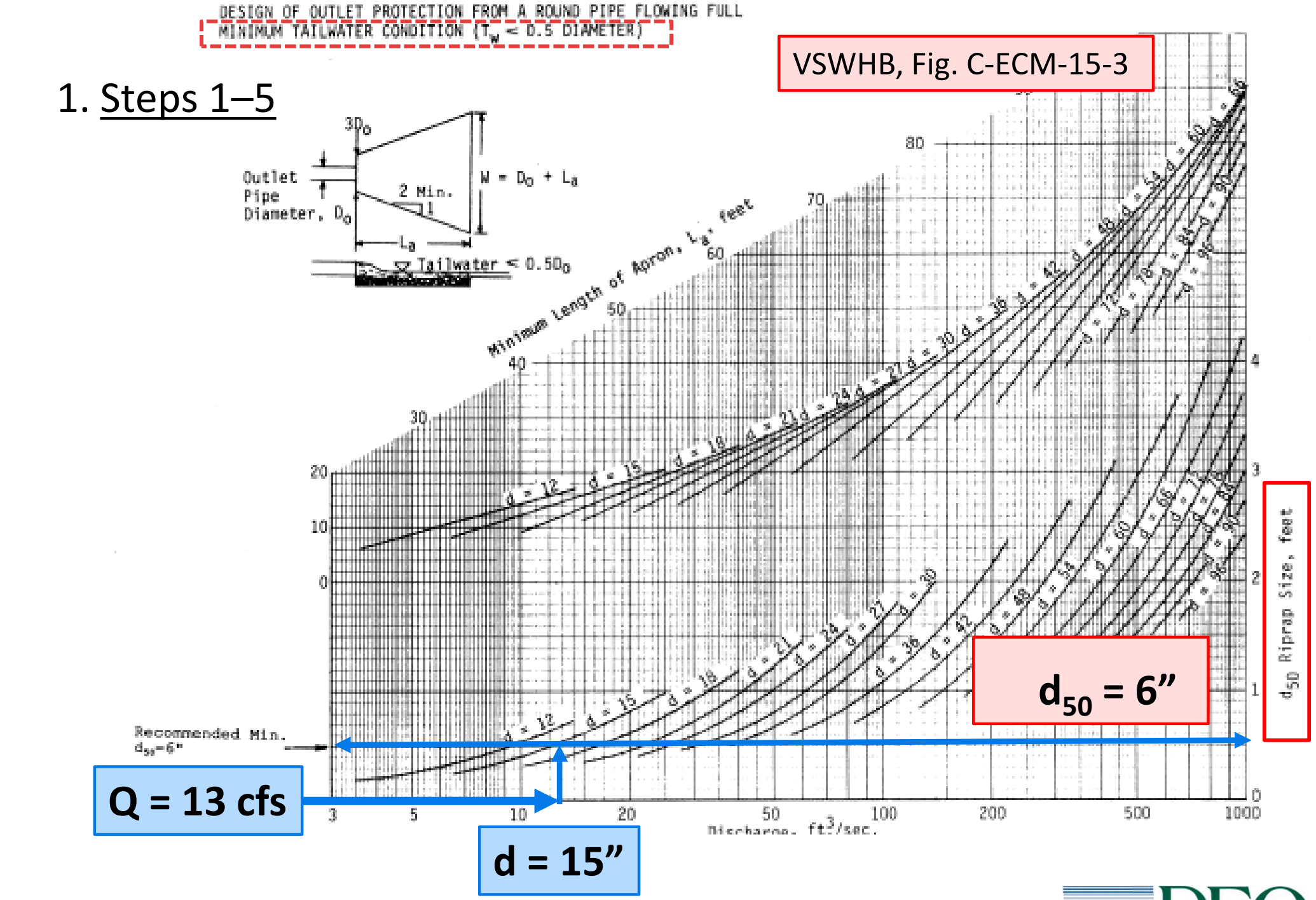
Complete Steps #1-5 on your own

Use VSWHB, Chapter 7.4, C-ECM-15.
Round final answers to one decimal place, when practical.

Given a discharge of 13 cubic feet per second (cfs) from a 15-inch pipe into water depth less than half the pipe diameter, what is required for the following for outlet protection:

- Apron length, La (feet)
- Median stone size of riprap, d_{50}
- Upstream apron width, W_u (feet)
- Downstream apron width, W_d (feet),?

1. Steps 1–5



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1. Tailwater Condition and Apron Details

Complete Steps #6-7 on your own

Step 6: From discharge (Q = 13 cubic feet per second), read up to the top half of the chart to the pipe diameter.

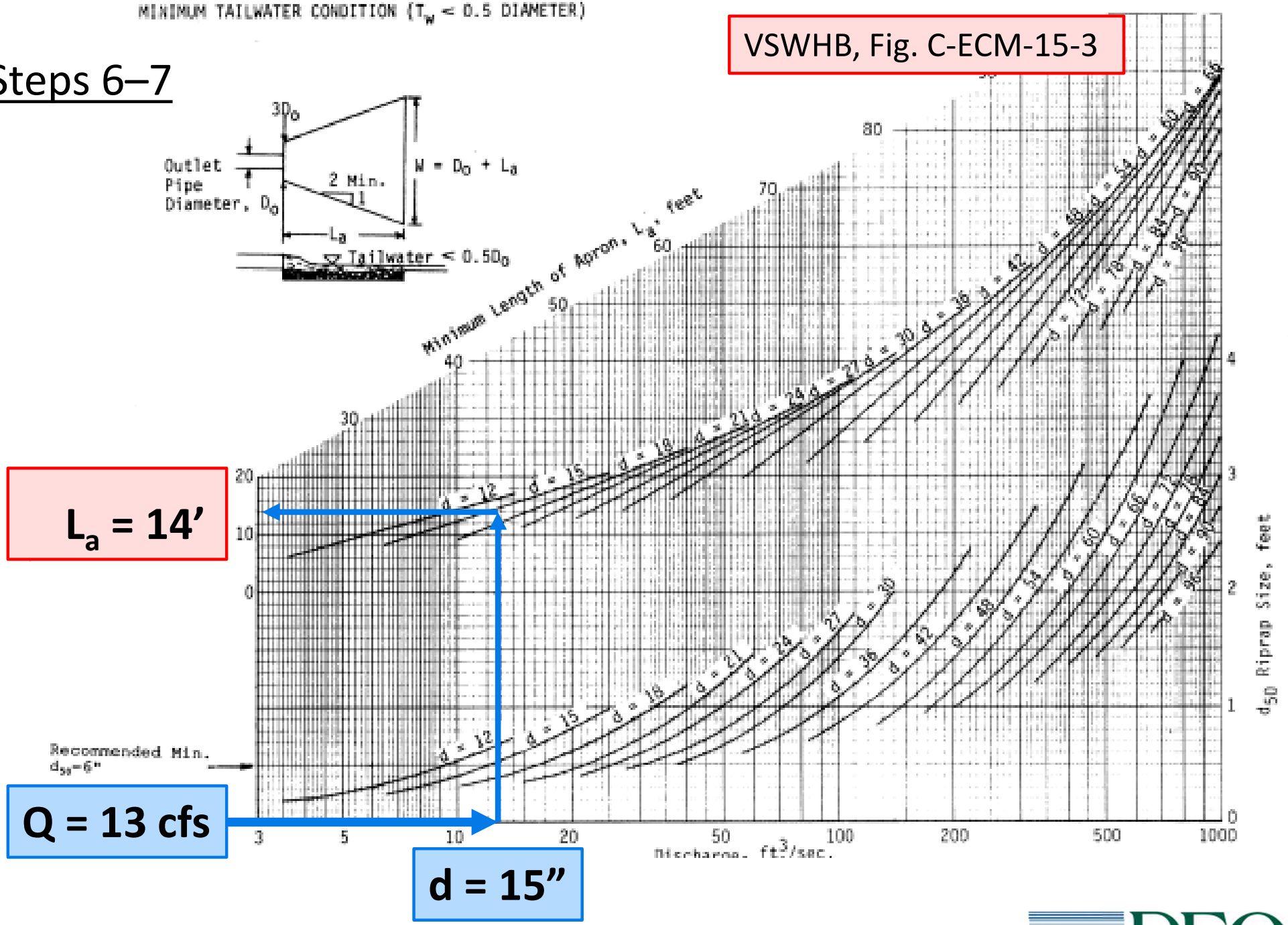
d = _____ inches

Step 7: Read to the left for the minimum apron length.

L_a = _____ feet

1. Steps 6–7

VSWHB, Fig. C-ECM-15-3



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1. Tailwater Condition and Apron Details

Complete Steps #8-9 on your own

Step 8: Calculate upstream apron width.

Upstream Apron Width (W_u, in feet) = 3 × Pipe Diameter (D_0, in feet)

_____ feet = 3 × _____ feet

Step 9: Calculate downstream apron width.

Downstream Apron Width (W_d, in feet)

= Pipe Diameter (D_0, in feet) + Apron Length (L_a, in feet)

_____ feet = _____ feet + _____ feet

1. Tailwater Condition and Apron Details

Step 8: Calculate the upstream apron width.

Upstream Apron Width (W_u, in feet)

= 3 × Pipe Diameter (D_0, in ***feet***)

$W_u = 3 \times 1.25$ feet

$W_u =$ 3.75 feet

1. Tailwater Condition and Apron Details

Step 9: Calculate the downstream apron width.

Downstream Apron Width (W_d, in feet)

= Pipe Diameter (D_0, in ***feet***) + Apron Length (L_a, in feet)

1.25 feet + 14 feet

W_d = 15.25 feet

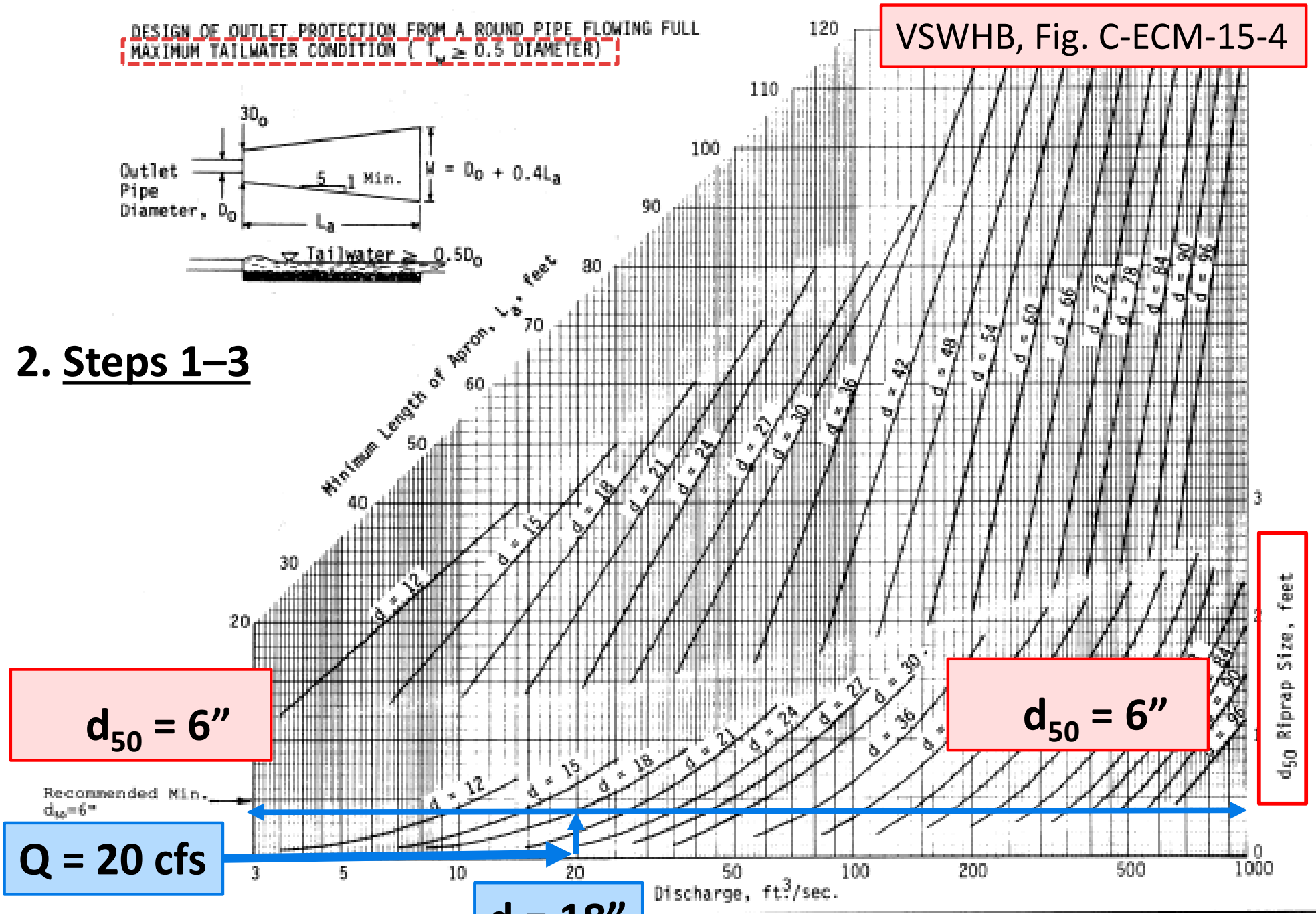
2. Apron Details for Maximum Tailwater Condition

Complete Steps #1-3 on your own

Given an 18-inch pipe that discharges 20 cubic feet per second (cfs) into water depth greater than half the pipe diameter (Maximum Tailwater Condition), what is required for the following for outlet protection:

- Apron length, La (feet)
- Median stone size of riprap, d_{50}
- Upstream apron width, Wu (feet)
- Downstream apron width, Wd (feet),?

VSWHB, Fig. C-ECM-15-4



2. Steps 1–3

2. Apron Details for Maximum Tailwater Condition

Complete Steps #4-5 on your own

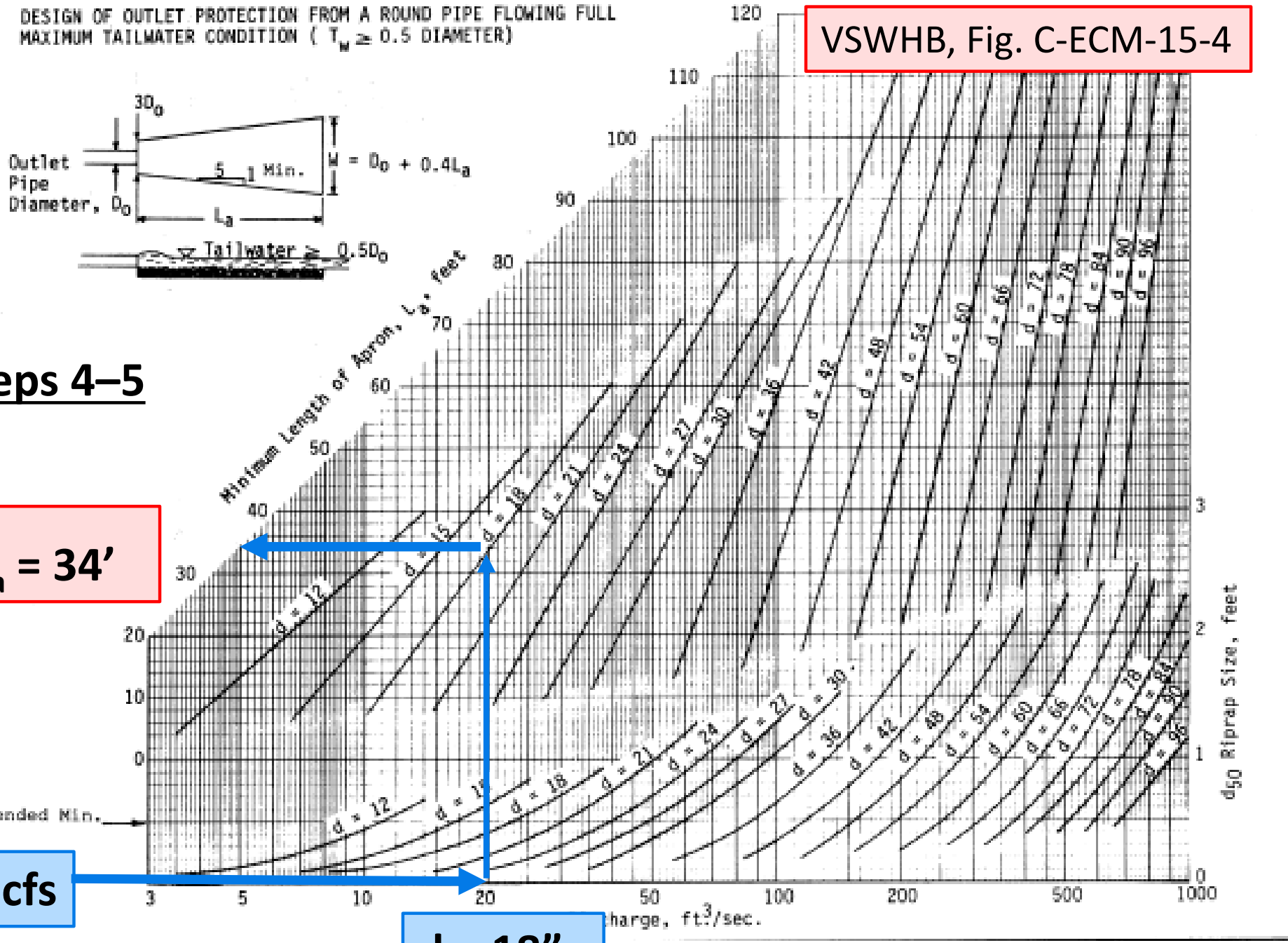
Step 4: From discharge (Q = 20 cfs), read up to the top half of the chart to the pipe diameter.

d = _____ inches

Step 5: Read to the left for the minimum apron length.

L_a = _____ feet

VSWHB, Fig. C-ECM-15-4



2. Steps 4–5

L_a = 34’

Q = 20 cfs

d = 18”

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2. Apron Details for Maximum Tailwater Condition

Complete Steps #6-7 on your own

Step 6: Calculate the upstream apron width.

Upstream Apron Width (W_u, in feet) = 3 × Pipe Diameter (D_0, in feet)

_____ feet = 3 × _____ feet

Step 7: Calculate downstream apron width.

Downstream Apron Width (W_d, in feet)

= Pipe Diameter (D_0, in feet) + 0.4 × Apron Length (L_a, in feet)

_____ feet = _____ feet + (0.4 × _____ feet)

2. Apron Details for Maximum Tailwater Condition

Step 6: Calculate the upstream apron width.

Upstream Apron Width (W_u, in feet)

= 3 × Pipe Diameter (D_0, in ***feet***)

W_u = 3 × 1.5 feet

W_u = 4.5 feet

2. Apron Details for Maximum Tailwater Condition

Step 7: Calculate the downstream apron width.

Downstream Apron Width (W_d, in feet)

W_d = Pipe Diameter (D_0, in feet) + [0.4 × Apron Length (L_a, in feet)]

$$W_d = 1.5 \text{ feet} + (0.4 \times 34 \text{ feet})$$

$$W_d = \boxed{15.1 \text{ feet}}$$

Questions?

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