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PE Civil Exam Review Guide: Water Resources & Environmental Depth Preview Edition

Errata

(updated 4/10/2021)

This document will be updated regularly.

CHAPTER 2: Hydraulics—Closed Conduit

(1) p. 2-2: In the table of contents, add **2.4.2: Parallel** (p. 2-44) between **2.4.1: Series** and **2.4.3: Loops**.

(2) pp. 2-15 to 2-16: There are calculation errors in the solution to Example 2.3. The corrections appear below in red boxes.

$$\dot{m} = Q\rho \text{ and } Q = vA$$

$$A = 0.25\pi D^2 = 0.25\pi(0.100\text{ m})^2 = 0.0079\text{ m}^2$$

$$Q = (2\text{ m/s})\boxed{(0.0079\text{ m}^2)} = 0.016\text{ m}^3\text{/s}$$

$$\dot{m} = \boxed{(0.016\text{ m}^3\text{/s})}(1{,}000\text{ kg/m}^3) = \boxed{16.0}\text{ kg/s}$$

$$F_X = \dot{m}[v - v(\cos\theta)] + PA - (PA)(\cos\theta)$$

$$F_X = (\boxed{16.0}\text{ kg/s})(2\text{ m/s})(1 - \cos 45°) + (200 \times 10^3\text{ Pa})\boxed{(0.0079\text{ m}^2)(1} - \cos 45°)$$

$$F_X = 472\text{ N}$$

$$F_Y = \dot{m}(-v)(\sin\theta) - (PA)(\sin\theta)$$

$$F_Y = (\boxed{16.0}\text{ kg/s})(-2\text{ m/s})(\sin 45°) - (200 \times 10^3\text{ Pa})\boxed{(0.0079\text{ m}^2)}(\sin 45°)$$

$$F_Y = -1{,}140\text{ N}$$

(3) p. 2-23: In Equation 2-37 and the following "where" statement, change *D* to *d*.

(4) p. 2-30 – 2-31: In Example 2.11, several numbers need to be corrected. In the problem statement, change 40 m to 32 m, and 43 m to 34 m.

Example 2.11: Siphon Analysis

A 50-mm-diameter siphon tube is used to drain water from an elevated storage tank over a wall and into a tank at ground level. The water surface elevation in the lower tank is maintained at 30 m. What is the discharge (in m^3/s) into the lower tank when the water surface in the elevated tank is 32 m? Also, what is the absolute pressure (in kPa) in the tube at the apex if the top of the wall is 34 m? Ignore energy losses.

Multiple changes to the **solution** appear below in red boxes.

Gauge pressure is zero at the discharge point into the lower tank (3).

$h_{z1} = h_{z3} + h_{v3}$

$32 \text{ m} = 30 \text{ m} + v_3^2/2g$

$(2 \text{ m})(2)(9.81 \text{ m/s}^2) = v_3^2$

$v_3^2 = 39.2$

$v_3 = 6.3 \text{ m/s}$

$Q = vA = (6.3 \text{ m/s})(\pi/4)(0.050 \text{ m})^2 = 0.012 \text{ m}^3\text{/s}$

To find the absolute pressure at the apex of the siphon tube (2), an energy balance is required between the elevated tank surface (1) and the apex of the siphon tube (2).

$H_1 = H_2$

Again, gauge pressure and velocity are zero at the tank surface (1).

$h_{z1} = h_{z2} + h_{p2} + h_{v2}$

$32 \text{ m} = 34 \text{ m} + P_2/\rho g + v_2^2/2g$

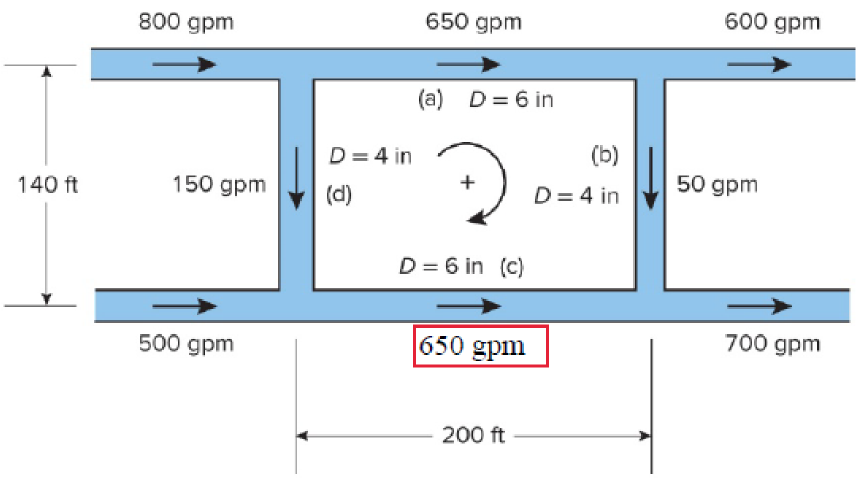
$P_{2,gauge}/\rho g = (32 \text{ m} - 34 \text{ m}) - (6.3 \text{ m/s})^2/(2 \times 9.81 \text{ m/s}^2) = -4.0 \text{ m}$

$P_{2,gauge} = (-4.0 \text{ m})(1{,}000 \text{ kg/m}^3)(9.81 \text{ m/s}^2) = -39{,}240 \text{ N/m}^2 = -39.2 \text{ kPa}$

$P_{2,abs} = P_{atm} + P_{2,gauge} = 98.1 \text{ kPa} + (-39.2 \text{ kPa}) = 58.9 \text{ kPa}$

(5) p. 2-44: A subheading is missing. After Example 2.17, add the subheading **2.4.2: Parallel**.

(6) p. 2-49: In the figure in Example 2.19, 150 gpm should be 650 gpm.



(7) pp. 2-49 to 2-50: There are calculation errors in the solution to Example 2.19. The corrections appear in red boxes below.

$h_{fc} = K_c Q_{ac}^{1.85} = -(6.76 \times 10^{-5})(650)^{1.85} = -10.8 \text{ ft}$

$h_{fd} = K_d Q_{ad}^{1.85} = -(3.41 \times 10^{-4})(150)^{1.85} = -3.6 \text{ ft}$

The algebraic sum of head losses around the pipe loop should equal zero. Step 6 in the Hardy-Cross procedure is summing the head losses calculated in the previous step.

$\Sigma h_f = 10.8 + 0.5 - 10.8 - 3.6 = -3.1 \text{ ft}$

The resulting sum is not nearly zero, which tells us that more iterations are necessary to refine flow rate assumptions. Per step 7 of the Hardy-Cross procedure:

$|h_{fa} / Q_{aa}| = |10.8/650| = 0.017$

$|h_{fb} / Q_{ab}| = |0.5/50| = 0.010$

$|h_{fc} / Q_{ac}| = |-10.8/650| = 0.017$

$|h_{fd} / Q_{ad}| = |-3.6/150| = 0.024$

$\Sigma |h_f / Q_a| = 0.017 + 0.010 + 0.017 + 0.024 = 0.068$

Finally, the flow correction factor is calculated using Equation 2-80 (step 8).

$$\Delta Q = -\frac{\sum h_f}{n \sum |h_f/Q_a|} = -\frac{7.0}{1.85(0.068)} = -56 \text{ gpm}$$

(8) p. 2-52: In the last line of the solution to Example 2.20, “gp” should read “gpm.”

CHAPTER 3: Hydraulics—Open Channel

(1) p. 3-7: In the problem statement for Example 3.1, 20 cfs should be 60 cfs.

(2) p. 3-20: In the last line of the solution for Example 3.3, "criterion 2" should read "criterion 1."

(3) p. 3-21: In the solution to Example 3.4, there is an error. $AR^{2/3}$ = 4.98 should read $AR^{2/3}$ = 7.85.

(4) p. 3-22: The following text should be added at the end of the Example 3.5 problem statement:
Assume a Manning's coefficient of 0.05.

(5) p. 3-22: In the first sentence of Section 3.9.1.1.3, *y* should be *d.*

(6) p. 3-23: There are numbering errors in Section 3.9.2. Two references to Equation 3-28 should read Equation 3-30, and Figure 3.18 should read 3.21. See below for corrections.

Optimum channel dimensions for various cross-section shapes can be found using the equations in Table 3.5. A circle has the least wetted perimeter, *P*, for a given cross-section area, *A*, of any geometric shape. The most efficient circular cross section is a semicircle, which is the most efficient cross section of all. All cross sections that satisfy Equation 3-30 are such that a semicircle can be inscribed in them, as shown in Figure 3.21 The most efficient trapezoidal cross section is half of a hexagon. The most efficient rectangular cross section is half of a square.

Semicircular and circular shapes are practical for pipes, but earthen channels must be trapezoidal. The trapezoidal section determined from Equation 3-30 will be the most economical section to build as far as excavation and channel lining are concerned. Triangular (or v-shaped) channels are not very efficient, in general. The most efficient triangular section has a 90° vertex angle.

(7) pp. 3-28 – 3-29: In the problem statement for Example 3.9, "30-ft-wide" should read "32-ft-wide." In addition, the final answer should be 10.1 cfs (not 9.52 cfs).

(8) p. 3-30: There is a typographical error in Equation 3-40 (1 should be *i*). It should appear as: $E = \frac{Q_i}{Q} \times 100\%$.

(9) p. 3-36: In the fourth line of the solution to Example 3.11, 0.46 should be 1.34.

(10) p. 3-45: In Equation 3-57, replace *C* with C_d.

(11) p. 3-47: In Table 3.9, both instances of K_e should be k_e (lowercase *k*).

(12) p. 3-48: In Equation 3-66, K_c should be moved to the numerator. The equation should appear as follows:

$$H_L = k_e\left(\frac{v^2}{2g}\right) + \frac{K_c v^2 n^2 L}{R^{4/3}} + \frac{v^2}{2g} \qquad \textbf{Equation 3-66}$$

(13) p. 3-48: In the solution to Example 3.14, there are several errors. Please see the corrections below.

Replace $v = \sqrt{\frac{H_L}{\frac{1+k_e}{2g}+\frac{n^2 L}{K_C R^{4/3}}}}$ **with** $v = \sqrt{\frac{2gH_L}{1+k_e+\frac{K_C n^2 L}{R^{4/3}}}}$

Replace $v = \sqrt{\frac{2.0}{\frac{1+0.5}{2(32.2)}+\frac{(0.013)^2(50)}{(29)(0.75)^{4/3}}}}$ **with** $v = \sqrt{\frac{2(32.2)(2.0)}{1+0.5+\frac{29(0.013)^2(50)}{(0.75)^{4/3}}}}$

Replace $v = 9.2$ ft/s **with** $v = 8.3$ ft/s.

CHAPTER 4: Hydrology

(1) p. 4-11: There are corrections to some of the numbers in the solution for Example 4.3. These appear in red boxes below.

Example 4.3: Mean Areal Precipitation—Isohyets

Calculate the mean areal precipitation using the isohyetal map in Figure 4.7.

Solution

Starting with step 2, construct a table. In this case, because there is a significant portion of area to the right of the 1.0-in isohyet and to the left of the 2.0-in isohyet, the estimated isohyets at the edges of the watershed are included in the table (0.8 in and 2.1 in).

ISOHYET (in)	AVG. AREA BETWEEN ISOHYETS (sq)	AVG. ISOHYETS (in)	PRODUCT
0.8	–	–	–
	25	0.90	22.5
1.0	–	–	–
	111	1.25	138.8
1.5	–	–	–
	82	1.75	143.5
2.0	–	–	–
	11	2.05	22.6
2.1	–	–	–
Sum	**229**	–	**327.4**

The average area between isohyets is found by counting the colored squares. For example, there are approximately 111 blue squares between the 1.0-in and 1.5-in isohyets.

The second and fourth columns are summed and used in the equation for mean areal precipitation.

$$\overline{P} = \frac{\sum\left[A\left(\frac{P_1+P_2}{2}\right)\right]}{\sum A}$$

$$\overline{P} = \frac{327.4}{229} = 1.43 \text{ in}$$

(2) p. 4-15: In the solution to Example 4.5, the last line should start with E_p, and two additional lines (that should follow) are missing. This part should read:

$$E_p = \frac{(5.1 \text{ mm/day})}{(25.4 \text{ mm/in})} = 0.20 \text{ in/day}$$

$$E_r = K_p E_p$$

$$E_r = 0.70(0.20 \text{ in/day}) = 0.14 \text{ in/day}$$

(3) p. 4-16: In the “where” statement following Equation 4-9, K should read K_c.

(4) p. 4-18: Four numbers are incorrect in the solution to Example 4.6.

t (hr)	P_i (in/hr)	ϕ (in/hr)	Δt (hr)	Q (in)
0	0.0	2.0	0.5	0.0
0.5	3.0	2.0	0.5	0.5
1	4.5	2.0	0.5	1.25
1.5	2.5	2.0	0.5	0.25
2	1.0	2.0	0.5	0.0
2.5	2.5	2.0	0.5	0.25
3	0.0	2.0	0.5	0.0
			Sum	2.25

$Q_{volume} = Q_{depth} \times \text{Area}$

$Q = (2.25 \text{ in})(300 \text{ ac})/(12 \text{ in/ft}) = 56.25 \text{ ac-ft}$

(5) pp. 4-26 – 4-27: There are some incorrect numbers in the solution to Example 4.7. Please see the corrections in red boxes below.

Solution

30 ac – 3 ac green space = 27 ac

15% of 27 ac = 4.05 ac

16 lots × 1/2 ac/lot = 8 ac (area draining directly to creek)

Remaining lot area = 27 ac – 8 ac – 4.05 ac = 14.95 ac

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Weighted coefficient for area contributing to stormwater basin:

$$C_w = \frac{(0.25)(3\text{ ac})+(0.90)(4.05\text{ ac})+(0.40)(14.95\text{ ac})}{22\text{ ac}}$$

$$C_w = 0.47$$

CHAPTER 5: Groundwater and Wells

(1) p. 5-9: In the solution to Example 5.4, there are two corrected numbers, shown in red boxes below.

$Q = 451.2\ \text{ft}^3/\text{day}$

There are 192.5 ft^3/day in 1 gpm, therefore:

$Q = (451.2\ \text{ft}^3/\text{day}) / (192.5\ \text{ft}^3/\text{day / gpm}) = 2.3\ \text{gpm}$

CHAPTER 6: Wastewater Collection and Treatment

(1) Throughout chapter: The header of the pages throughout the chapter is incorrect. It should read "Wastewater Collection and Treatment" rather than "Water Quality."

(2) p. 6-14: In the where statement following Equation 6-7, the second instance of B_1 should instead read B_2 (B_2 = DO of seed control bottle after incubation).

(3) p. 6-17: In the solution to Example 6.2, the last line of part B should read:

$k_{15} = 0.40 \times 1.136^{(15-20)} = 0.21\ d^{-1}$ (0.21 instead of 0.021)

(4) p. 6-36: There are typographical errors in the problem statement for Example 6.13. See corrections in red below.

Example 6.13: Aeration Tank Volume

An 8-MGD wastewater treatment plant uses activated sludge for secondary treatment with the following specifications:

BOD_5 concentration after primary treatment = 154 mg/L
MLVSS concentration = 2,300 mg/L
F:M ratio = 0.25 per day

(5) p. 6-40: In the where statement following Equation 6-39, *F* = as previously defined in Equation 6-31 should read:

F = as previously defined in Equation 6-37.

(6) p. 6-51: The title above Equation 6-41 should read Aerobic digestor volume (not anaerobic).

(7) p. 6-53: In the solution to Example 6.21, the units for solids settled in the primary clarifier should be lb/day.

CHAPTER 7: Water Quality

(1) p. 7-9: In Table 7.3, add K^+ after Na^+.

MOLECULAR FORMAT	MOLECULAR WEIGHT	EQUIVALENT WEIGHT
	IONS IN WATER	
Na^+	23.0	23.0
K^+	39.1	39.1
Ca^{2+}	40.1	20.0

(2) p. 7-18: In the solution to Example 7.6, waste load allocation should appear as 92 kg (remove the rest of the line following 92 kg). Remove 92 kg from the margin of safety line. These two lines should appear as follows.

Waste load allocation = 92 kg ~~$= \frac{10}{100} \times 92 = 9.2$~~

Margin of safety (MOS) = 10% of WLA = ~~92 kg =~~ $\frac{10}{100} \times 92 = 9.2$

(3) p. 7-22: In the solution to Example 7.7, O_r should read Q_r. In addition, "Using Equation 6-51 (defined previously in chapter 6 of this book)" should read "Using Equation 7-9 (defined previously)."

(4) p. 7-22: In the solution to Example 7.8, "Equation 6-51 in chapter 6 of this book" should be changed to "Equation 7-9."

(5) p. 7-24: In the where statement at the top of the page, remove the last line (DO_{sat} = DO (at the point of discharge)). The previous line should read:

D_0 = dissolved oxygen deficit in the mixing zone (mg/L) = $DO_{sat} - DO$ (at the point of discharge)

CHAPTER 8: Drinking Water Distribution and Treatment

(1) p. 8-6: In the first line of section 8.1.2: Population Estimation Methods, "quality" should be "quantity."

(2) p. 8-27: In the solution to Example 8.7, remove "or setting." The sentence should read: The flocculation tank depth will be the same as the settling tank depth…

(3) p. 8-28: In the second paragraph of section 8.5: Sedimentation, **sone settling** should be **zone settling.**

(4) p. 8-40: There is a typographical error in Equation 8-31. (Replace ϵ with ε.) It should be:

Multisized: $D_e = D(1-\varepsilon)\sum\frac{f}{1-\varepsilon_e}$ **Equation 8-31**

In the following equation, replace α with ε. It should be:

$$\varepsilon_e = \left(\frac{v_B}{v_S}\right)^{0.2247{N_R}^{0.1}}$$

(5) p. 8-41: In the fifth paragraph of section 8.6.3: Design Criteria, the units for 30 to 60 should be m/hr (not min/hr). Also, remove the phrase "per min" following 30 to 60 m/hr.

It should read: The backwash rate is 12 to 36 in/min (30 to 60 m/hr) rise rate, and…

(6) p. 8-41*:* In Example 8.13, the units listed for the clean bed filtering velocity in the problem statement and solution should be 4.6 m/hr (not min/hr).

(7) p. 8-43: In the last line of the problem statement for Example 8.16, *m* should instead read 0.25 m^3/s. The corrected version follows:

Given a design flow capacity of the water system of 0.25 m^3/s, how many filters should be installed?

(8) p. 8-43: In Equation 8-33, replace mq/L with meq/L.

(9) p. 8-61: Replace the last line in the problem statement for Example 8.28 with the following:

For the Freundlich model, the adsorption capacity, *K*, is 21 mg/g, and the slope is 0.54.

Throughout the solution, replace all instances of lowercase *k* with capital *K.*