WORKBOOK—

Applied Math FOR WASTEWATER PLANT OPERATORS

JOANNE KIRKPATRICK PRICE

CRC PRESS

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Applied Math
FOR WASTEWATER PLANT OPERATORS

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Dedication

This book is dedicated to my family:

To my husband Benton C. Price who was patient and supportive during the two years it took to write these texts, and who not only had to carry extra responsibilities during this time, but also, as a sanitary engineer, provided frequent technical critique and suggestions.

To our children Lisa, Derek, Kimberly, and Corinne, who so many times had to pitch in while I was busy writing, and who frequently had to wait for my attention.

To my mother who has always been so encouraging and who helped in so many ways throughout the writing process.

To my father, who passed away since the writing of the first edition, but who, I know, would have had just as instrumental a role in these books.

To the other members of my family, who have had to put up with this and many other projects, but who maintain a sense of humor about it.

Thank you for your love in allowing me to do something that was important to me.

J.K.P.

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Preface to the Second Edition

The first edition of these texts was written at the conclusion of three and a half years of instruction at Orange Coast College, Costa Mesa, California, for two different water and wastewater technology courses. The fundamental philosophy that governed the writing of these texts was that those who have difficulty in math often do not lack the ability for mathematical calculation, they merely have not learned, or have not been taught, the "language of math." The books, therefore, represent an attempt to bridge the gap between the reasoning processes and the language of math that exists for students who have difficulty in mathematics.

In the years since the first edition, I have continued to consider ways in which the texts could be improved. In this regard, I researched several topics including how people learn (learning styles, etc.), how the brain functions in storing and retrieving information, and the fundamentals of memory systems. Many of the changes incorporated in this second edition are a result of this research.

Two features of this second edition are of particular importance:

- the **skills check section** provided at the beginning of every basic math chapter

- a **grouping of similar types of calculations** in the applied math texts

The skills check feature of the basic math text enables the student to pinpoint the areas of math weakness, and thereby customizes the instruction to the needs of the individual student.

The first six chapters of each applied math text include calculations grouped by type of problem. These chapters have been included so that students could see the common thread in a variety of seemingly different calculations.

The changes incorporated in this second edition were field-tested during a three-year period in which I taught a water and wastewater mathematics course for Palomar Community College, San Marcos, California.

Written comments or suggestions regarding the improvement of any section of these texts or workbooks will be greatly appreciated by the author.

Joanne Kirkpatrick Price

Acknowledgments

"From the original planning of a book to its completion, the continued encouragement and support that the author receives is instrumental to the success of the book." This quote from the acknowledgments page of the first edition of these texts is even more true of the second edition.

First Edition

Those who assisted during the development of the first edition are: Walter S. Johnson and Benton C. Price, who reviewed both texts for content and made valuable suggestions for improvements;
Silas Bruce, with whom the author team-taught for two and a half years, and who has a down-to-earth way of presenting wastewater concepts; Mariann Pape, Samuel R. Peterson and Robert B. Moore of Orange Coast College, Costa Mesa, California, and Jim Catania and Wayne Rodgers of the California State Water Resources Control Board, all of whom provided much needed support during the writing of the first edition.

The first edition was typed by Margaret Dionis, who completed the typing task with grace and style. Adele B. Reese, my mother, proofed both books from cover to cover and Robert V. Reese, my father, drew all diagrams (by hand) shown in both books.

Second Edition

The second edition was an even greater undertaking due to many additional calculations and because of the complex layout required. I would first like to acknowledge and thank Laurie Pilz, who did the computer work for all three texts and the two workbooks. Her skill, patience, and most of all perseverance has been instrumental in providing this new format for the texts. Her husband, Herb Pilz, helped in the original format design and he assisted frequently regarding questions of graphics design and computer software.

Those who provided technical review of various portions of the texts include Benton C. Price, Kenneth D. Kerri, Lynn Marshall, Wyatt Troxel and Mike Hoover. Their comments and suggestions are appreciated and have improved the current edition.

Many thanks also to the staff of the Fallbrook Sanitary District, Fallbrook, California, especially Virginia Grossman, Nancy Hector, Joyce Shand, Mike Page, and Weldon Platt for the numerous times questions were directed their way during the writing of these texts.

The staff of Technomic Publishing Company, Inc., also provided much advice and support during the writing of these texts. First, Melvyn Kohudic, President of Technomic Publishing Company, contacted me several times over the last few years, suggesting that the texts be revised. It was his gentle nudging that finally got the revision underway. Joseph Eckenrode helped work out some of the details in the initial stages and was a constant source of encouragement. Jeff Perini was copy editor for the texts. His keen attention to detail has been of great benefit to the final product. Leo Motter had the arduous task of final proof reading.

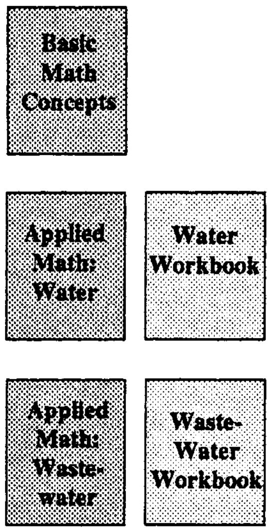
I wish to thank all my friends, but especially those in our Bible study group (Gene and Judy Rau, Floyd and Juanita Miller, Dick and Althea Birchall, and Mark and Penny Gray) and our neighbors, Herb and Laurie Pilz, who have all had to live with this project as it progressed slowly chapter by chapter, but who remained a source of strength and support when the project sometimes seemed overwhelming.

Lastly, the many students who have been in my classes or seminars over the years have had no small part in the final form these books have taken. The format and content of these texts is in response to their questions, problems, and successes over the years.

To all of these I extend my heartfelt thanks.

How To Use These Books

The *Mathematics for Water and Wastewater Treatment Plant Operators* series includes three texts and two workbooks:



- Basic Math Concepts for Water and Wastewater Plant Operators
- Applied Math for Water Plant Operators
- Workbook—Applied Math for Water Plant Operators
- Applied Math for Wastewater Plant Operators
- Workbook—Applied Math for Wastewater Plant Operators

Basic Math Concepts

All the basic math you will need to become adept in water and wastewater calculations has been included in the Basic Math Concepts text. This section has been expanded considerably from the basic math included in the first edition. For this reason, students are provided with more methods by which they may solve the problems.

Many people have weak areas in their math skills. It is therefore advisable to take the skills test at the beginning of each chapter in the basic math book to pinpoint areas that require review or study. If possible, it is best to resolve these weak areas <u>before</u> beginning either of the applied math texts. However, when this is not possible, the Basic Math Concepts text can be used as a reference resource for the applied math texts. For example, when making a calculation that includes tank volume, you may wish to refer to the basic math section on volumes.

Applied Math Texts and Workbooks

The applied math texts and workbooks are companion volumes. There is one set for water treatment plant operators and another for wastewater treatment plant operators. Each applied math text has two sections:

- Chapters 1 through 6 present various calculations **grouped by type of math problem**. Perhaps 70 percent of all water and wastewater calculations are represented by these six types. Chapter 7 groups various types of pumping problems into a single chapter. The calculations presented in these seven chapters are common to the water and wastewater fields and have therefore been included in both applied math texts.

  Since the calculations described in Chapters 1 through 6 represent the heart of water and wastewater treatment math, if possible, it is advisable that you master these general types of calculations before continuing with other calculations. Once completed, a review of these calculations in subsequent chapters will further strengthen your math skills.

- The remaining chapters in each applied math text include calculations **grouped by unit processes**. The calculations are presented in the order of the flow through a plant. Some of the calculations included in these chapters are not incorporated in Chapters 1 through 7, since they do not fall into any general problem-type grouping. These chapters are particularly suited for use in a classroom or seminar setting, where the math instruction must parallel unit process instruction.

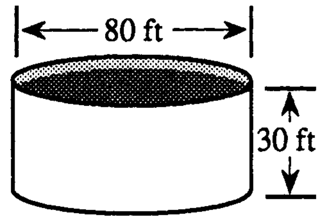
The workbooks support the applied math texts section by section. They have also been vastly expanded in this edition so that the student can build strength in each type of calculation. A detailed answer key has been provided for all problems. The workbook pages have been perforated so that they may be used in a classroom setting as hand-in assignments. The pages have also been hole-punched so that the student may retain the pages in a notebook when they are returned.

The workbooks may be useful in preparing for a certification exam. However, because theses texts include both fundamental and advanced calculations, and because the requirements for each certification level vary somewhat from state to state, it is advisable that you first determine the types of problems to be covered in your exam, then focus on those types of calculations in these texts.

1 *Applied Volume Calculations*

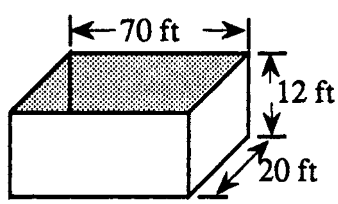
PRACTICE PROBLEMS 1.1: Tank Volume Calculations

1. The diameter of a tank is 80 ft. If the water depth is 30 ft, what is the volume of water in the tank, in gallons?



ANS________

2. The dimensions of a tank are given below. Calculate the cubic feet volume of the tank.



ANS________

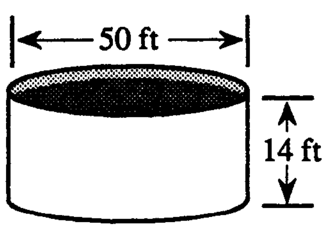
3. A tank 25 ft wide and 80 ft long is filled with water to a depth of 13 ft. What is the volume of water in the tank (in gal)?

ANS________

4. What is the volume of water in a tank, in gallons, if the tank is 15 ft wide, 30 ft long, and contains water to a depth of 10 ft?

ANS________

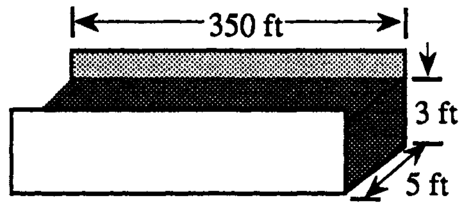
5. Given the tank diameter and depth shown below, calculate the volume of water in the tank, in gallons.



ANS________

PRACTICE PROBLEMS 1.2: Channel or Pipeline Capacity Calculations

1. What is the cubic feet volume of water in the section of rectangular channel shown below?

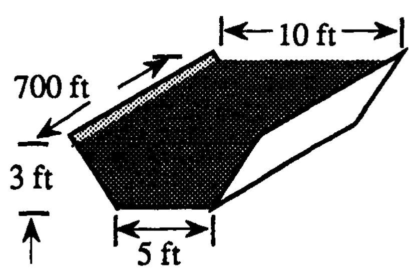


ANS________

2. A new section of 10-inch diameter pipe is to be disinfected before it is put into service. If the length of pipeline is 1500 ft, how many gallons of water will be needed to fill the pipeline?

ANS________

3. Calculate the gallon volume of the section of trapezoidal channel shown below.

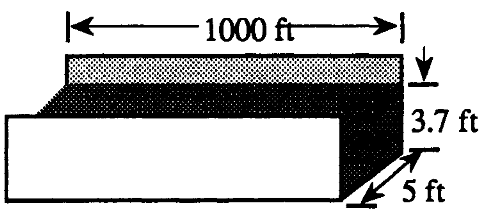


ANS________

4. A section of 6-inch diameter pipeline is to be filled with chlorinated water for disinfection. If 1778 ft of pipeline is to be disinfected, how many gallons of chlorinated water will be required?

ANS________

5. What is the volume of water (in gal) for the 1000-ft section of channel shown below?



ANS________

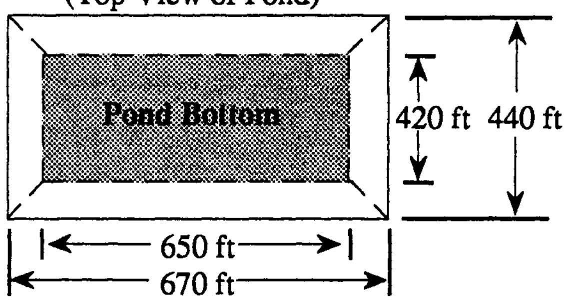
PRACTICE PROBLEMS 1.3: Other Volume Calculations

1. A trench is to be excavated that is 3 ft wide, 3.5 ft deep, and 600 ft long. What is the cubic yards volume of the trench?

ANS________

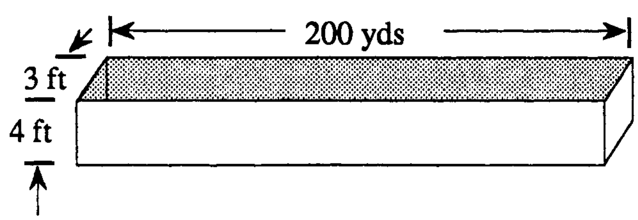
2. A pond is 6 ft deep. Given the dimensions as shown below, calculate the cu ft volume of the pond.

(Top View of Pond)



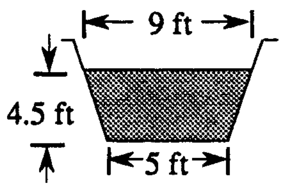
ANS________

3. Given the dimensions of the trench shown below, calculate the cubic yard volume of the trench.

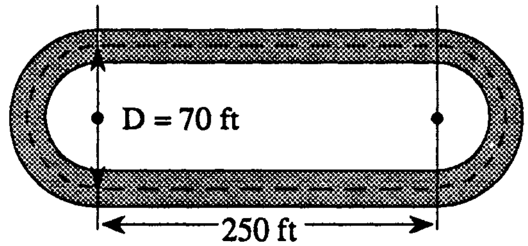


ANS________

4. Calculate the cu ft volume of the oxidation ditch shown below. The cross section of the ditch is trapezoidal.



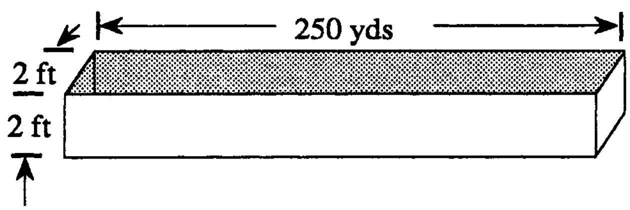
Cross-Section of Ditch



Top View of Ditch

ANS________

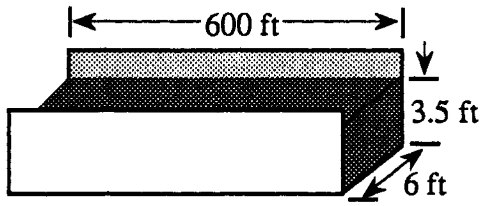
5. A trench is 250 yards long, 2 ft wide and 2 ft deep. What is the cubic feet volume of the trench?



ANS________

Chapter 1—Achievement Test

1. What is the cubic feet volume of water in the rectangular channel shown below?



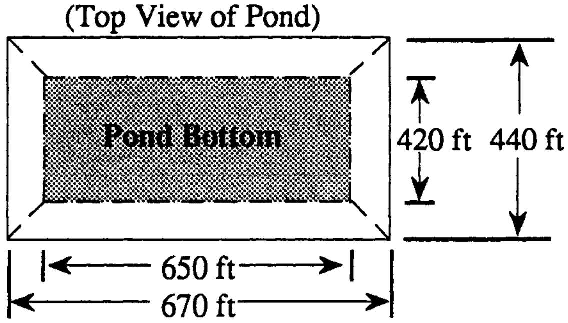
ANS________

2. The diameter of a tank is 70 ft. If the water depth in the tank is 23 ft, what is the volume of water in the tank, in gallons?

ANS________

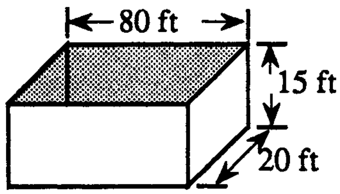
3. A pond is 4 ft deep. Given the dimensions shown below, calculate the cubic feet volume of water in the pond.

(Top View of Pond)



ANS________

4. The dimensions of a tank are given below. Calculate the cubic feet volume of the tank.

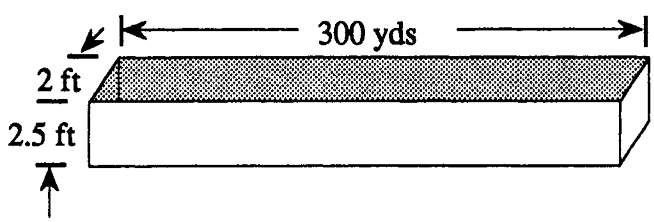


ANS________

5. A new section of 8-inch diameter pipe is to be filled with water for testing. If the length of pipeline is 3500 ft, how many gallons of water will be needed to fill the pipeline?

ANS________

6. A trench is 300 yards long, 2 ft wide, and 2.5 ft deep. What is the cubic feet volume of the trench?



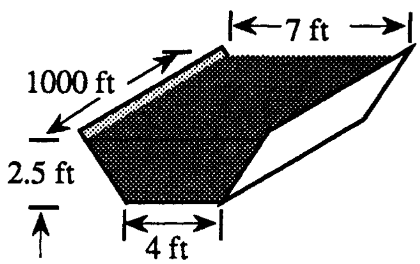
ANS________

Chapter 1—Achievement Test (Cont'd)

7. A trench is to be excavated. If the trench is 2.5 ft wide, 3 ft deep and 1500 ft long, what is the cubic yards volume of the trench?

ANS________

8. Calculate the maximum gallon capacity of the section of trapezoidal channel shown below.



ANS________

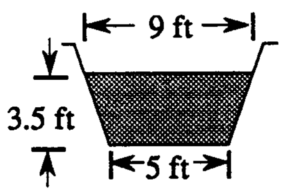
9. A tank is 20 ft wide and 60 ft long. If the tank contains water to a depth of 13 ft, how many gallons of water are in the tank?

ANS________

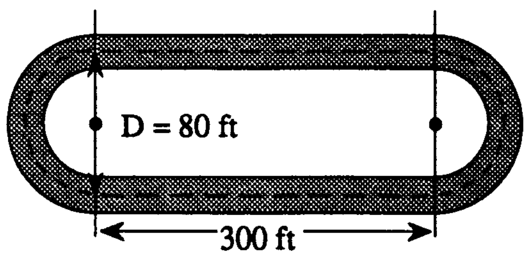
10. What is the volume of water (in gal) contained in a 2000-ft section of channel if the channel is 6 ft wide and the water depth is 3.7 ft?

ANS________

11. Calculate the cu ft capacity of the oxidation ditch shown below. The cross-section of the ditch is trapezoidal. (Round the circumference length to the nearest foot.)



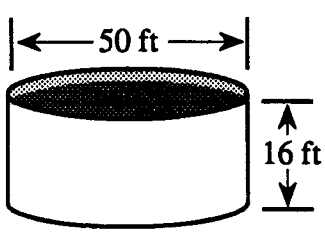
Cross-Section of Ditch



Top View of Ditch

ANS________

12. Given the diameter and water depth shown below, calculate the volume of water in the tank, in gallons.



ANS________

2 *Flow and Velocity Calculations*

PRACTICE PROBLEMS 2.1: Instantaneous Flow Rates

1. A channel 42 inches wide has water flowing to a depth of 2.6 ft. If the velocity of the water is 2.2 fps, what is the cfm flow in channel?

ANS________

2. A tank is 15 ft long and 10 ft wide. With the discharge valve closed, the influent to the tank causes the water level to rise 0.7 feet in one minute. What is the gpm flow to the tank?

ANS________

3. A trapezoidal channel is 3.5 ft wide at the bottom and 5.5 ft wide at the water surface. The water depth is 38 inches. If the flow velocity through the channel is 125 ft/min, what is the cfm flow rate through the channel?

ANS________

4. A 6-inch diameter pipeline has water flowing at a velocity of 2.6 fps. What is the gpm flow rate through the pipeline? Assume the pipe is flowing full. (Round to the nearest tenth.)

ANS________

5. A pump discharges into a 2-ft diameter barrel. If the water level in the barrel rises 26 inches in 30 seconds, what is the gpm flow into the barrel?

ANS________

6. A 10-inch diameter pipeline has water flowing at a velocity of 3.2 fps. What is the gpm flow rate through the pipeline if the water is flowing at a depth of 5 inches?

ANS________

PRACTICE PROBLEMS 2.2: Velocity Calculations

1. A channel has a rectangular cross section. The channel is 5 ft wide with water flowing to a depth of 2.3 ft. If the flow rate through the channel is 13,400 gpm, what is the velocity of the water in the channel (ft/sec)? (Round to the nearest tenth.)

ANS_________

2. An 8-inch diameter pipe flowing full delivers 537 gpm. What is the velocity of flow in the pipeline (ft/sec)? (Round to the nearest tenth.)

ANS_________

3. A fluorescent dye is used to estimate the velocity of flow in a sewer. The dye is injected into the water at one manhole and the travel time to the next manhole 500 ft away is noted. The dye first appears at the downstream manhole in 195 seconds. The dye continues to be visible until the total elapsed time is 221 seconds. What is the ft/sec velocity of flow through the pipeline? (Round to the nearest tenth.)

ANS_________

4. The velocity in a 10-inch diameter pipeline is 2.6 ft/sec. If the 10-inch pipeline flows into an 8-inch diameter pipeline, what is the velocity in the 8-inch pipeline in ft/sec.?

ANS________

5. A float travels 400 ft in a channel in 1 min 28 sec. What is the estimated velocity in the channel (ft/sec)? (Round to the nearest tenth.)

ANS________

6. The velocity in a 8-inch diameter pipe is 3.6 ft/sec. If the flow then travels through a 10-inch diameter section of pipeline, what is the ft/sec velocity in the 10-inch pipeline? (Round to the nearest tenth.)

ANS________

PRACTICE PROBLEMS 2.3: Average Flow Rates

1. The following flows were recorded for the week: Monday—4.6 MGD; Tuesday—5.2 MGD; Wednesday—5.3 MGD; Thursday—4.9 MGD; Friday—5.4 MGD; Saturday—5.1 MGD; Sunday—4.8 MGD. What was the average daily flow rate for the week?

ANS________

2. The totalizer reading for the month of November was 117.3 MG. What was the average daily flow (ADF) for the month of November? (Round to the nearest tenth.)

ANS________

3. The following flows were recorded for the months of April, May, and June: April—125.6 MG; May—142.4 MG; June—160.2 MG. What was the average daily flow for this three-month period? (Round to the nearest tenth.)

ANS________

4. The total flow for one day at a plant was 3,140,000 gallons. What was the average gpm flow for that day?

ANS__________

PRACTICE PROBLEMS 2.4: Flow Conversions

1. Express a flow of 5 cfs in terms of gpm.

ANS_________

2. What is 38 gps expressed as gpd?

ANS_________

3. Convert a flow of 4,270,000 gpd to cfm.

ANS_________

4. What is 5.6 MGD expressed as cfs? (Round to the nearest tenth.)

ANS_________

5. Express 423,690 cfd as gpm.

ANS________

6. Convert 2730 gpm to gpd.

ANS________

Chapter 2—Achievement Test

1. A channel has a rectangular cross section. The channel is 6 ft wide with water flowing to a depth of 2.6 ft. If the flow rate through the channel is 15,500 gpm, what is the velocity of the water in the channel (ft/sec)? (Round to the nearest tenth.)

ANS________

2. The following flows were recorded for the week: Monday—4.1 MGD; Tuesday—3.4 MGD; Wednesday—3.9 MGD; Thursday—4.6 MGD; Friday—3.2 MGD; Saturday—4.9 MGD; Sunday—3.7 MGD. What was the average daily flow rate for the week?

ANS________

3. A channel 50 inches wide has water flowing to a depth of 3.2 ft. If the velocity of the water is 3.9 fps, what is the cfm flow in the channel?

ANS________

4. The following flows were recorded for the months of June, July, and August: June—105.2 MG; July—129.6 MG; August—142.8 MG. What was the average daily flow for this three-month period? (Round to the nearest tenth.)

ANS________

5. A tank is 10 ft by 10 ft. With the discharge valve closed, the influent to the tank causes the water level to rise 8 inches in one minute. What is the gpm flow to the tank?

ANS_________

6. An 8-inch diameter pipe flowing full delivers 490 gpm. What is the ft/sec velocity of flow in the pipeline?

ANS_________

7. Express a flow of 8 cfs in terms of gpm.

ANS_________

8. The totalizer reading for the month of October was 127.6 MG. What was the average daily flow (ADF) for the month of October? (Round to the nearest tenth.)

ANS_________

Chapter 2—Achievement Test Cont'd

9. What is 4.8 MGD expressed as cfs? (Round to the nearest tenth.)

ANS________

10. A pump discharges into a 2-ft diameter barrel. If the water level in the barrel rises 18 inches in 30 seconds, what is the gpm flow into the barrel?

ANS________

11. Convert a flow of 1,780,000 gpd to cfm.

ANS________

12. A 6-inch diameter pipeline has water flowing at a velocity of 2.7 fps. What is the gpm flow rate through the pipeline? (Assume the pipe is flowing full.)

ANS________

13. A fluorescent dye is used to estimate the velocity of flow in a sewer. The dye is injected into the water at one manhole and the travel time to the next manhole 300 ft away is noted. The dye first appears at the downstream manhole in 77 seconds. The dye continues to be visible until there is a total elapsed time of 95 seconds. What is the ft/sec velocity of flow through the pipeline?

ANS________

14. The velocity in a 10-inch pipeline is 2.4 ft/sec. If the 10-inch pipeline flows into an 8-inch diameter pipeline, what is the ft/sec velocity in the 8-inch pipeline? (Round to the nearest tenth.)

ANS________

15. Convert 2150 gpm to gpd.

ANS________

16. The total flow for one day at a plant was 4,620,000 gallons. What was the average gpm flow for that day?

ANS________

3 *Milligrams Per Liter to Pounds Per Day Calculations*

PRACTICE PROBLEMS 3.1: Chemical Dosage Calculations

1. Determine the chlorinator setting (lbs/day) needed to treat a flow of 5.1 MGD with a chlorine dose of 2.3 mg/L.

ANS________

2. To dechlorinate a wastewater, sulfur dioxide is to be applied at a level 3 mg/L more than the chlorine residual. What should the sulfonator feed rate be (lbs/day) for a flow of 3.8 MGD with a chlorine residual of 2.9 mg/L?

ANS________

3. A total chlorine dosage of 8 mg/L is required to treat a particular water. If the flow is 1.6 MGD and the hypochlorite has 65% available chlorine, how many lbs/day of hypochlorite will be required?

ANS________

4. What should the chlorinator setting be (lbs/day) to treat a flow of 4.6 MGD if the chlorine demand is 8.5 mg/L and a chlorine residual of 2 mg/L is desired?

ANS________

5. The chlorine dosage at a plant is 4.1 mg/*L*. If the flow rate is 6,140,000 gpd, what is the chlorine feed rate in lbs/day?

ANS________

6. A storage tank is to be disinfected with 50 mg/*L* of chlorine. If the tank holds 85,000 gallons, how many pounds of chlorine (gas) will be needed?

ANS________

7. To neutralize a sour digester, one pound of lime is to be added for every pound of volatile acids in the digester liquor. If the digester contains 224,000 gal of sludge with a volatile acid (VA) level of 2,120 mg/*L*, how many pounds of lime should be added?

ANS________

8. A flow of 0.72 MGD requires a chlorine dosage of 8 mg/*L*. If the hypochlorite has 65% available chlorine, how many lbs/day of hypochlorite will be required?

ANS________

PRACTICE PROBLEMS 3.2: Loading Calculations—BOD, COD, and SS

1. The suspended solids concentration of the wastewater entering the primary system is 425 mg/*L*. If the plant flow is 1,620,000 gpd, how many lbs/day suspended solids enter the primary system?

ANS________

2. Calculate the BOD loading (lbs/day) on a stream if the secondary effluent flow is 2.98 MGD and the BOD of the secondary effluent is 26 mg/*L*.

ANS________

3. The daily flow to a trickling filter is 5,340,000 gpd. If the BOD content of the trickling filter influent is 280 mg/*L*, how many lbs/day BOD enter the trickling filter?

ANS________

4. The flow to an aeration tank is 2460 gpm. If the COD concentration of the water is 135 mg/*L*, how many pounds of COD are applied to the aeration tank daily? (Round the MGD flow to the nearest hundredth.)

ANS__________

5. The daily flow to a trickling filter is 2290 gpm with a BOD concentration of 295 mg/*L*. How many lbs of BOD are applied to the trickling filter daily? (Round the MGD flow to the nearest hundredth.)

ANS__________

PRACTICE PROBLEMS 3.3: BOD and SS Removal, lbs/day

1. If 148 mg/*L* suspended solids are removed by a primary clarifier, how many lbs/day suspended solids are removed when the flow is 5.2 MGD?

ANS________

2. The flow to a primary clarifier is 1.89 MGD. If the influent to the clarifier has a suspended solids concentration of 315 mg/*L* and the primary effluent has 126 mg/*L* SS, how many lbs/day suspended solids are removed by the clarifier?

ANS________

3. The flow to a trickling filter is 4,790,000 gpd. If the primary effluent has a BOD concentration of 160 mg/*L* and the trickling filter effluent has a BOD concentration of 24 mg/*L*, how many pounds of BOD are removed daily?

ANS________

4. A primary clarifier receives a flow of 2.37 MGD with a suspended solids concentration of 387 mg/L. If the clarifier effluent has a suspended solids concentration of 166 mg/L, how many pounds of suspended solids are removed daily?

ANS________

5. The flow to the trickling filter is 4,140,000 gpd with a BOD concentration of 215 mg/L. If the trickling filter effluent has a BOD concentration of 97 mg/L, how many lbs/day BOD are removed by the trickling filter?

ANS________

PRACTICE PROBLEMS 3.4: Pounds of Solids Under Aeration

1. An aeration tank has a volume of 350,000 gallons. If the mixed liquor suspended solids concentration is 2140 mg/*L*, how many pounds of suspended solids are in the aeration tank?

ANS________

2. The aeration tank of a conventional activated sludge plant has a mixed liquor volatile suspended solids concentration of 1960 mg/*L*. If the aeration tank is 110 ft long, 35 ft wide, and has wastewater to a depth of 13 ft, how many pounds of MLVSS are under aeration? (Round tank volume to the nearest ten thousand.)

ANS________

3. The volume of an oxidation ditch is 24,500 cubic feet. If the MLVSS concentration is 2960 mg/*L*, how many pounds of volatile solids are under aeration? (Round ditch volume to the nearest ten thousand.)

ANS________

4. An aeration tank is 120 ft long and 45 ft wide. The operating depth is 15 ft. If the mixed liquor suspended solids concentration is 2440 mg/*L*, how many pounds of mixed liquor suspended solids are under aeration? (Round tank volume to the nearest ten thousand.)

ANS________

5. An aeration tank is 110 ft long and 40 ft wide. The depth of wastewater in the tank is 15 ft. If the tank contains an MLSS concentration of 2890 mg/*L*, how many lbs of MLSS are under aeration? (Round tank volume to the nearest ten thousand.)

ANS________

PRACTICE PROBLEMS 3.5: WAS Pumping Rate Calculations

1. The WAS suspended solids concentration is 6210 mg/*L*. If 5300 lbs/day solids are to be wasted, what must the WAS pumping rate be, in MGD? (Round MGD flow to the nearest hundredth.)

ANS__________

2. The WAS suspended solids concentration is 5970 mg/*L*. If 4600 lbs/day solids are to be wasted, (a) What must the WAS pumping rate be, in MGD? (Round MGD flow to the nearest hundredth.) (b) What is this rate expressed in gpm?

ANS__________

3. It has been determined that 6090 lbs/day of solids must be removed from the secondary system. If the RAS SS concentration is 6540 mg/*L*, what must be the WAS pumping rate, in gpm? (Round MGD flow to the nearest hundredth.)

ANS__________

4. The RAS suspended solids concentration is 6280 mg/*L*. If a total of 7400 lbs/day solids are to be wasted, what should the WAS pumping rate be, in gpm? (Round MGD flow to the nearest hundredth.)

ANS________

5. A total of 5700 lbs/day of solids must be removed from the secondary system. If the RAS SS concentration is 7140 mg/*L*, what must be the WAS pumping rate, in gpm? (Round MGD flow to the nearest hundredth.)

ANS________