



# Grades IV&V Operator Certification and Math Review

## Table of Contents

LESSON 1—Overview, Schedule & Math Approach.....	1
Overview.....	1
Schedule.....	1
Session-Lesson Correspondence.....	2
Math Approach .....	3
Area .....	3
Volume.....	6
Time (Flow and Volume) .....	9
Pounds and Pounds-per-Day.....	10
Wahlbergisms.....	16
PRACTICE PROBLEM SET 1 .....	17
LESSON 2—Work, Energy, Power & Pumping .....	19
Work, Energy, and Power .....	19
Power in Pumping Systems .....	19
Electrical Costs.....	22
PRACTICE PROBLEM SET 2 .....	23
LESSON 3—Chemicals and Chemical Dosing.....	25
Polymers.....	25
Percent Solids Recovery (PSR).....	25
Other Chemicals.....	25
Lime .....	25
Calcium Hydroxide .....	26
Ferric Chloride .....	26
Ferrous Chloride.....	26
Aluminum Sulfate .....	26
Calcium Nitrate .....	26
Chlorine.....	26
Sodium Hypochlorite .....	26
Calcium Hypochlorite.....	26
Hydrogen Peroxide.....	26
Potassium Permanganate .....	26
Chemically Enhanced Primary Treatment—CEPT .....	26
Chemical Dosing .....	27
Basic Concepts: ppM, Percent, Density and Specific Gravity .....	27

Approach to Chemical Dosing Problems .....	27
PRACTICE PROBLEM SET 3 .....	31
LESSON 4—Organics and Solids .....	33
BOD, NOD (NBOD), cBOD & Seeding .....	33
BOD .....	33
NOD .....	34
cBOD .....	35
Seeding .....	35
COD .....	35
Solids .....	36
PRACTICE PROBLEM SET 4 .....	38
LESSON 5—Coliform Testing .....	39
Multiple-Tube Fermentation Test .....	39
Presumptive Test .....	39
Confirmed Test .....	40
Completed Test .....	40
Membrane Filtration Test .....	40
Reporting Coliform Data .....	42
PRACTICE PROBLEM SET 5 .....	44
LESSON 6—Miscellaneous Topics .....	45
Industrial Wastes .....	45
Compatible Wastes .....	45
Incompatible Wastes .....	45
Industrial Wastewater Treatment and Nutrient Addition .....	45
Safety Data Sheets .....	46
Infiltration and Inflow .....	51
Definitions .....	51
Problems Caused by I/I .....	51
Addressing I/I Problems .....	51
Oxidation Reduction Potential (ORP) .....	52
Ultraviolet (UV) Disinfection .....	54
PRACTICE PROBLEM SET 6 .....	56
LESSON 7—Primary Clarification .....	57
Solids .....	57
Organics .....	58
Performance .....	60
PRACTICE PROBLEM SET 7 .....	63
LESSON 8—Activated Sludge .....	65
Process Control .....	65
Air Flow Rate .....	65
WAS Flow Rate ( $Q_{WAS}$ ) .....	65
RAS Flow Rate ( $Q_{RAS}$ ) .....	71
Modifications of the Activated Sludge Process .....	73

Operational Problems.....	77
<i>Nocardioforms</i> .....	78
Filaments .....	79
Organic and Hydraulic Loading Comparisons .....	80
PRACTICE PROBLEM SET 8 .....	82
LESSON 9—Nutrient Removal & Breakpoint Chlorination .....	83
Nitrification & Denitrification.....	83
Nitrite and Chlorine .....	86
Breakpoint Chlorination .....	86
Phosphorus Removal .....	89
PRACTICE PROBLEM SET 9 .....	90
LESSON 10—Review: Ponds & Trickling Filters .....	91
Ponds.....	91
How Ponds Work.....	91
Pond Math .....	93
Trickling Filters.....	94
How Trickling Filters Work.....	94
Filters? .....	94
Operation and Troubleshooting.....	95
Trickling Filter Math .....	96
PRACTICE PROBLEM SET 10 .....	98
LESSON 11—Anaerobic Digestion and 503 Regs .....	99
Process Objective.....	99
Microbiology.....	100
Description.....	102
Safety and Other Equipment.....	103
Pressure/Vacuum Relief Valves.....	105
Flame Arrestor.....	105
Drip Trap.....	105
Sediment Trap .....	105
Thermal Valve.....	105
Pressure Regulator.....	105
Waste Gas Burner .....	105
Auxiliary Equipment.....	105
Process Control and Performance.....	106
Process Control .....	106
Process Performance .....	106
Factors Affecting Performance .....	107
Calculations .....	107
Importance of Solids Thickening and Dewatering .....	112
Volatile Acid Measurement .....	112
Alkalinity Measurement .....	113
Class B versus Class A: The “503 Regs” .....	114

Class B Biosolids .....	114
Class A Biosolids .....	116
PRACTICE PROBLEM SET 11 .....	119
<b>LESSON 12—Thickening and Dewatering .....</b>	<b>121</b>
Gravity Thickener .....	122
Physical Description .....	122
Operational Controls.....	122
Performance Factors .....	123
Troubleshooting .....	124
Dissolved-air Flotation Thickener.....	125
Physical Description .....	125
Operational Controls.....	126
Performance Factors .....	126
Troubleshooting .....	126
Belt Filter Press (Dewatering) .....	127
Physical Description .....	127
Operational Controls.....	128
Performance Factors .....	129
Troubleshooting .....	129
Dewatering Centrifuge.....	129
Physical Description .....	129
Operational Controls.....	130
Performance Factors .....	131
PRACTICE PROBLEM SET 12 .....	132
<b>LESSON 13—Exam Info and Practice Exam .....</b>	<b>133</b>
Exam Format .....	133
Exam Subject Matter .....	133
Math .....	134
Wahlberg's Cheat Sheets .....	134
Exam-taking Strategy: Hints and Suggestions .....	134
Practice Exam .....	135
PRACTICE EXAM .....	137
<b>APPENDIX A—Math Solutions (READ ME) .....</b>	<b>151</b>
Introduction .....	151
Solution Steps.....	152
PRACTICE PROBLEM SET 1—SOLUTIONS.....	153
PRACTICE PROBLEM SET 2—SOLUTIONS.....	158
PRACTICE PROBLEM SET 3—SOLUTIONS.....	168
PRACTICE PROBLEM SET 4—SOLUTIONS.....	175
PRACTICE PROBLEM SET 5—SOLUTIONS.....	180
PRACTICE PROBLEM SET 6—SOLUTIONS.....	182
PRACTICE PROBLEM SET 7—SOLUTIONS.....	188
PRACTICE PROBLEM SET 8—SOLUTIONS.....	193

PRACTICE PROBLEM SET 9—SOLUTIONS.....	203
PRACTICE PROBLEM SET 10—SOLUTIONS.....	206
PRACTICE PROBLEM SET 11—SOLUTIONS.....	209
PRACTICE PROBLEM SET 12—SOLUTIONS.....	217
PRACTICE EXAM MATH—SOLUTIONS .....	224
APPENDIX B—Wahlberg’s Cheat Sheets.....	237
APPENDIX C—Study and Review (ANSWER EVERY QUESTION HERE).....	246
APPENDIX D—Developing a Study Plan.....	252
Distributed Study Schedule.....	252
Make a Specific Plan.....	252
Other Useful Strategies .....	254
Learning Styles .....	254
Setting Priorities.....	255
Food for Thought.....	255
APPENDIX E—Chemicals and Chemical Formulations .....	256
APPENDIX F—Abbreviations and Acronyms.....	258