363.739456tho

CONTENTS

Preface ix

1 Introduction 1

1.1 Nature of Problem 1
1.2 Waste Load Allocation Principles 4
1.3 Nature of Inputs 9
1.4 Point Source Mass Loading Rates 10
1.5 Tributary Mass Loading Rates 14
1.6 Intermittent Mass Loading Rates 17
1.7 Comparison of Continuous and Intermittent Waste Sources 21
References 25
Problems 26

2 Rivers and Streams 29

2.1 River Hydrology and Flow 30
2.2 Discharge of Residual Material into Rivers 49
2.3 Time Variable Analysis 69
2.4 Engineering Controls 78
2.5 Derivation of Steady-State Stream Equation 81
References 82
Problems 84

3 Estuaries, Bays, and Harbors 91

3.1 Physical Aspects of Estuaries: Estuarine Hydrology Tides, and Tidal Currents 92
3.2 Distribution of Water Quality in Estuaries 103
3.3 Estimation of Tidal Dispersion Coefficient 114
3.4 Slack Tide Sampling 119
3.5 Derivation of Estuary Equation 121
3.6 Modeling "Real" Estuaries—Finite Segment (Finite Differences) 123
3.7 Positivity and Numerical Dispersion of Steady State Finite Segment Models 151
3.8 Time Variable Aspects of Estuaries 159
References 165
Problems 167

4 Lakes 173

4.1 Physical and Hydrologic Characteristics 174
4.2 Lakewide Water Quality Response to Inputs 180
4.3 Finite Segment (Finite Difference) Steady State Lake Models 199
References 213
Problems 215

5 Indicator Bacteria, Pathogens, and Viruses 219

5.1 Introduction 219
5.2 Inputs of Organisms 226
5.3 Organism Decay Rate 231
5.4 Fate of Organisms 239
5.5 Environmental Controls 250
References 254
Problems 258

6 Dissolved Oxygen 261

6.1 Introduction 261
6.2 Principal Components of DO Analysis 262
6.3 Sources and Sinks of DO—Kinetic Relationships 266
6.4 Dissolved Oxygen Analysis—Streams and Rivers 301
6.5 Dissolved Oxygen Analysis—Tidal Rivers and Estuaries 327
6.6 Dissolved Oxygen Analysis—Lakes and Reservoirs 340
6.7 Finite Segment (Difference) DO Models 345
6.8 Engineering Control for Dissolved Oxygen 354
References 375
Problems 379

7 Eutrophication 385

7.1 Introduction 385
7.2 Basic Mechanisms of Eutrophication 388
7.3 External Sources of Nutrients 391
7.4 Significance of the N/p Ratio 398
7.5 Simplified Lake Phytoplankton Models 403
7.6 Phytoplankton and Nutrient Interactions 416
7.7 Phytoplankton–DO Relationships 434
7.8 Simplified River and Stream Eutrophication Analysis—Phytoplankton 437
7.9 Simplified River and Stream Eutrophication Analysis—Periphyton and Rooted Aquatic Plants 449
7.10 Finite Segment Models 460
7.11 Eutrophication Control Techniques 477
References 485
Problems 489

8 Toxic Substances 495

8.1 Introduction 495
8.2 Chemical Water Quality Criteria and Standards 498
8.3 Principal Physio-Chemical Components of Toxic Substances Analysis 503
8.4 Completely Mixed Lakes 516
8.5 Rivers and Streams 522
8.6 Estuaries 527
8.7 Multidimensional Waterbodies 528
8.8 Estimation of Net Chemical Loss Rate 530
8.9 Principal Biological Components of Toxic Substance Analysis 549
8.10 Finite Difference Applications 576
8.11 Control of Toxic Substances 588
References 591
Problems 595

9 Temperature 599

9.1 Significance of Water Temperature 599
9.2 Excess Heat Inputs 600
9.3 Heat Balance—Sources and Sinks 602
9.4 Simplified Heat Balance Equation 606
9.5 Temperature Models 608
9.6 Reduction of Excess Heat Inputs 616
References 620
Problems 621

Appendix A. Nomenclature **625**

Appendix B. Conversion Factors **631**

Appendix C. Solubility of Oxygen in Water Exposed to Water-Saturated Air at Atmospheric Pressure **635**

Index 637