

TABLE OF CONTENTS

1. INTRODUCTION	1-1
1.1 References	1-4
2. TRAFFIC STREAM CHARACTERISTICS	2-1
2.1 Definitions and Terms	2-2
2.1.1 The Time-Space Diagram	2-2
2.1.2 Definitions of Some Traffic Stream Properties	2-2
2.1.3 Time-Mean and Space-Mean Properties	2-4
2.1.4 Generalized Definitions of Traffic Stream Properties	2-4
2.1.5 The Relation Between Density and Occupancy	2-6
2.1.6 Three-Dimensional Representation of Vehicle Streams	2-8
2.2 Measurement Issues	2-9
2.2.1 Measurement Procedures	2-9
2.2.2 Error Caused by the Mismatch Between Definitions and Usual Measurements	2-12
2.2.3 Importance of Location to the Nature of the Data	2-13
2.2.4 Selecting intervals from which to extract data	2-14
2.3 Bivariate Models	2-15
2.3.1 Speed-Flow Models	2-16
2.3.2 Speed-Concentration Models	2-21
2.3.3 Flow-Concentration Models	2-26
2.4 Three-Dimensional Models	2-29
2.5 Summary and Links to Other Chapters	2-31
3. HUMAN FACTORS	3-1
3.1 Introduction	3-1
3.1.1 The Driving Task	3-1
3.2 Discrete Driver Performance	3-3
3.2.1 Perception-Response Time	3-3
3.3 Control Movement Time	3-7
3.3.1 Braking Inputs	3-7
3.3.2 Steering Response Times	3-9
3.4 Response Distances and Times to Traffic Control Devices	3-9
3.4.1 Traffic Signal Change	3-9
3.4.2 Sign Visibility and Legibility	3-11
3.4.3 Real-Time Displays and Signs	3-12
3.4.4 Reading Time Allowance	3-13
3.5 Response to Other Vehicle Dynamics	3-13
3.5.1 The Vehicle Ahead	3-13
3.5.2 The Vehicle Alongside	3-14
3.6 Obstacle and Hazard Detection, Recognition, and Identification	3-15
3.6.1 Obstacle and Hazard Detection	3-15
3.6.2 Obstacle and Hazard Recognition and Identification	3-15
3.7 Individual Differences in Driver Performance	3-16
3.7.1 Gender	3-16
3.7.2 Age	3-16
3.7.3 Driver Impairment	3-17

3.8	Continuous Driver Performance	3-18
3.8.1	Steering Performance	3-18
3.8.1.1	Human Transfer Function for Steering	3-18
3.8.1.2	Performance Characteristics Based on Models	3-19
3.9	Braking Performance	3-20
3.9.1	Open-Loop Braking Performance	3-20
3.9.2	Closed-Loop Braking Performance	3-21
3.9.3	Less-Than-Maximum Braking Performance	3-21
3.10	Speed and Acceleration Performance	3-23
3.10.1	Steady-State Traffic Speed Control	3-23
3.10.2	Acceleration Control	3-23
3.11	Specific Maneuvers at the Guidance Level	3-23
3.11.1	Overtaking and Passing in the Traffic Stream	3-23
3.11.1.1	Overtaking and Passing Vehicles (4-Lane or 1-Way)	3-23
3.11.1.2	Overtaking and Passing Vehicles (Opposing Traffic)	3-24
3.12	Gap Acceptance and Merging	3-24
3.12.1	Gap Acceptance	3-24
3.12.2	Merging	3-24
3.13	Stopping Sight Distance	3-25
3.14	Intersection Sight Distance	3-26
3.14.1	Case I: No Traffic Control	3-26
3.14.2	Case II: Yield Control for Secondary Roadway	3-26
3.14.3	Case III: Stop Control on Secondary Roadway	3-26
3.15	Other Driver Performance Characteristics	3-27
3.15.1	Speed Limit Changes	3-27
3.15.2	Distractors On/Near Roadway	3-27
3.15.3	Real-Time Driver Information Input	3-28
	References	3-28

4.	CAR FOLLOWING MODELS	4-1
4.1	Model Development	4-2
4.2	Stability Analysis	4-6
4.2.1	Local Stability	4-6
4.2.2	Asymptotic Stability	4-9
4.2.1.1	Numerical Examples	4-10
4.2.1.2	Next-Nearest Vehicle Coupling	4-13
4.3	Steady-State Flow	4-14
4.4	Experiments And Observations	4-20
4.4.1	Car Following Experiments	4-22
4.4.1.1	Analysis of Car Following Experiments	4-23
4.4.2	Macroscopic Observations: Single Lane Traffic	4-32
4.5	Automated Car Following	4-38
4.6	Summary and Conclusions	4-38
	References	4-39

5.	CONTINUUM FLOW MODELS	5-1
5.1	Conservation and Traffic Waves	5-1
5.2	The Kinematic Wave Model of LWR	5-6
5.2.1	The LWR Model and Characteristics.	5-6
5.2.2	The Riemann Problem and Entropy Solutions.	5-7
5.2.3	Applications.	5-8

5.2.4	Extensions to the LWR Model	5-9
5.2.5	Limitations of the LWR Model	5-11
5.3	High Order Continuum Models	5-13
5.3.1	Propagation of Traffic Sound Waves in Higher-Order Models	5-15
5.3.2	Propagation of Shock and Expansion Waves	5-16
5.3.3	Traveling Waves, Instability and Roll Waves	5-20
5.3.4	Summary and Discussions	5-23
5.4	Diffusive, Viscous and Stochastic Traffic Flow Models	5-24
5.4.1	Diffusive and Viscous Traffic Flow Models	5-24
5.4.2	Acceleration Noise and a Stochastic Flow Model	5-25
5.5	Numerical Approximations of Continuum Models	5-25
5.5.1	Finite Difference Methods for Solving Inviscid Models	5-27
5.5.2	Finite Element Methods for Solving Viscous Models	5-30
5.5.3	Applications	5-33
5.5.3.1	Calibration of Model Parameters with Field Measurements	5-33
5.5.3.2	Multilane Traffic Flow Dynamics	5-35
5.5.3.3	Traffic Flow on a Ring Road With a Bottleneck	5-35
References		5-45

6. MACROSCOPIC FLOW MODELS		6-1
6.1	Travel Time Models	6-1
6.1.1	General Traffic Characteristics as a Function of the Distance from the CBD	6-2
6.1.2	Average Speed as a Function of Distance from the CBD	6-3
6.2	General Network Models	6-6
6.2.1	Network Capacity	6-6
6.2.2	Speed and Flow Relations	6-8
6.2.3	General Network Models Incorporating Network Parameters	6-11
6.2.4	Continuum Models	6-16
6.3	Two-Fluid Theory	6-16
6.3.1	Two-Fluid Parameters	6-17
6.3.2	Two-Fluid Parameters: Influence of Driver Behavior	6-20
6.3.3	Two-Fluid Parameters: Influence of Network Features (Field Studies)	6-20
6.3.4	Two-Fluid Parameters: Estimation by Computer Simulation	6-22
6.3.5	Two-Fluid Parameters: Influence of Network Features (Simulation Studies)	6-22
6.3.6	Two-Fluid Model: A Practical Application	6-23
6.4	Two-Fluid Model and Traffic Network Flow Models	6-23
6.5	Concluding Remarks	6-25
References		6-29

7. TRAFFIC IMPACT MODELS		7-1
7.1	Traffic and Safety	7-1
7.1.1	Introduction	7-1
7.1.2	Flow and Safety	7-1
7.1.3	Logical Considerations	7-2
7.1.4	Empirical Studies	7-4
7.1.4.1	Kinds Of Study And Data	7-4
7.1.4.2	Models	7-4
7.1.4.3	Parameter Estimates	7-6
7.1.5	Closure	7-7

7.2 Fuel Consumption Models	7-8
7.2.1 Factors Influencing Vehicular Fuel Consumption	7-8
7.2.2 Model Specifications	7-8
7.2.3 Urban Fuel Consumption Models	7-9
7.2.4 Highway Models	7-11
7.2.5 Discussion	7-12
7.3 Air Quality Models	7-13
7.3.1 Introduction	7-13
7.3.2 Air Quality Impacts of Transportation Control Measures	7-13
7.3.3 Tailpipe Control Measures	7-14
7.3.4 Highway Air Quality Models	7-15
7.3.4.1 UMTA Model	7-15
7.3.4.2 CALINE-4 Dispersion Model	7-15
7.3.4.3 Mobile Source Emission Factor Model	7-16
7.3.4.4 MICRO2	7-18
7.3.4.5 The TRRL Model	7-19
7.3.5 Other Mobile Source Air Quality Models	7-20
References	7-20

8. UNSIGNALIZED INTERSECTION THEORY	8-1
8.1 Introduction	8-1
8.1.1 The Attributes of a Gap Acceptance Analysis Procedure	8-1
8.1.2 Interaction of Streams at Unsignalized Intersections	8-1
8.1.3 Chapter Outline	8-1
8.2 Gap Acceptance Theory	8-2
8.2.1 Usefulness of Gaps	8-2
8.2.2 Estimation of the Critical Gap Parameters	8-3
8.2.3 Distribution of Gap Sizes	8-6
8.3 Headway Distributions Used in Gap Acceptance Calculations	8-6
8.3.1 Exponential Headways	8-6
8.3.2 Displaced Exponential Distribution	8-7
8.3.3 Dichotomized Headway Distributions	8-7
8.3.4 Fitting the Different Headway Models to Data	8-8
8.4 Interaction of Two Streams	8-11
8.4.1 Capacity	8-11
8.4.2 Quality of Traffic Operations	8-16
8.4.3 Queue Length	8-19
8.4.4 Stop Rate	8-22
8.4.5 Time Dependent Solution	8-23
8.4.6 Reserve Capacity	8-26
8.4.7 Stochastic Simulation	8-27
8.5 Interaction of Two or More Streams in the Priority Road	8-28
8.5.1 The Benefit of Using a Multi-Lane Stream Model	8-28
8.6 Interaction of More than Two Streams of Different Ranking	8-31
8.6.1 Hierarchy of Traffic Streams at a Two Way Stop Controlled Intersection	8-31
8.6.2 Capacity for Streams of Rank 3 and Rank 4	8-32
8.7 Shared Lane Formula	8-35
8.7.1 Shared Lanes on the Minor Street	8-35
8.7.2 Shared Lanes on the Major Street	8-35
8.8 Two-Stage Gap Acceptance and Priority	8-36
8.9 All-Way Stop Controlled Intersections	8-37
8.9.1 Richardson's Model	8-37

8.10 Empirical Methods	8-39
8.10.1 Kyte's Method	8-39
8.11 Conclusions	8-41
References	8-41

9. TRAFFIC FLOW AT SIGNALIZED INTERSECTIONS	9-1
9.1 Introduction	9-1
9.2 Basic Concepts of Delay Models at Isolated Signals	9-2
9.3 Steady-State Delay Models	9-3
9.3.1 Exact Models	9-3
9.3.2 Approximate Models	9-5
9.4 Time-Dependent Delay Models	9-10
9.5 Effect of Upstream Signals	9-15
9.5.1 Platooning Effect On Signal Performance	9-15
9.5.2 Filtering Effect on Signal Performance	9-17
9.6 Theory of Actuated and Adaptive Signals	9-19
9.6.1 Theoretically-Based Models	9-19
9.6.2 Approximate Delay Models	9-23
9.6.3 Adaptive Signal Control	9-27
9.7 Concluding Remarks	9-27
References	9-28

10. TRAFFIC SIMULATION	10-1
10.1 Introduction	10-1
10.2 An Illustration	10-1
10.3 Car-Following	10-2
10.4 Random Number Generation	10-2
10.5 Classification of Simulation Models	10-3
10.6 Building Simulation Models	10-5
10.7 Illustration	10-5
10.8 Statistical Analysis of Simulation Data	10-17
10.8.1 Statistical Analysis for a Single System	10-17
10.8.1.1 Fixed Sample-Size Procedures	10-20
10.8.1.2 Sequential Procedures	10-21
10.8.2 Alternative System Configurations	10-22
10.8.3 Variance Reduction Techniques	10-22
10.8.4 Conclusions	10-23
10.9 Descriptions of Some Available Models	10-23
10.10 Looking to the Future	10-24
References	10-25

11. KINETIC THEORIES	11-1
11.1 Introduction	11-1
11.2 Status of the Prigogine-Herman Kinetic Model	11-2
11.2.1 The Prigogine-Herman Model	11-2
11.2.2 Criticisms of the Prigogine-Herman Model	11-3
11.2.3 Accomplishments of the Prigogine-Herman Model	11-4
11.3 Other Kinetic Models	
11.4 Continuum Models from Kinetic Equations	11-6
11.5 Direct Solution of Kinetic Equations	11-7
References	11-9

Index	12-1
--------------------	-------------

LIST OF FIGURES

2. TRAFFIC STREAM CHARACTERISTICS

Figure 2.1	Time-space Diagram	2-2
Figure 2.2	Trajectories in Time-space Region.	2-5
Figure 2.3	Trajectories of Vehicle Fronts and Rears.	2-7
Figure 2.4	Three-dimensional representation	2-9
Figure 2.5	Effect of measurement location on nature of data (modified from Hall, Hurdle, Banks 1992, and May 1990.	2-17
Figure 2.6	Generalized shape of speed-flow curve proposed by Hall, Hurdle and Banks (1992).	2-17
Figure 2.7	Generalized shape of speed-flow curve proposed by Hall, Hurdle and Banks (1992).	2-18
Figure 2.8	Results from fitting polygon speed-flow curve to German data (Heidemann and Hotop).	2-18
Figure 2.9	Data for 4-lane German Autobahns (2 lanes per direction), as reported by Stappert and Theis(1990).	2-20
Figure 2.10	Greenshields' Speed-Flow Curve and Data	2-20
Figure 2.11	Greenshields' Speed-Density Graph and Data	2-23
Figure 2.12	Speed-Concentration Data from Merritt Parkway and Fitted Curves	2-23
Figure 2.13	Three Parts of Edie's Hypothesis for the Speed-Density Function, Fitted to Chicago Data	2-25
Figure 2.14	Greenshields' Speed-Flow Function Fitted to Chicago Data	2-28
Figure 2.15	Four Days of Flow-Occupancy Data from Near Toronto	2-28
Figure 2.16	The Three-Dimensional Surface for Traffic Operations	2-30
Figure 2.17	One Perspective on Three-dimensional Relationship (Gilchrist and Hall)	2-30
Figure 2.18	Second Perspective on Three-Dimensional Relationship (Gilchrist and Hall).	2-32
Figure 2.19	Catastrophe Theory Surface Showing Sketch of a Possible Freeway Function.	2-32

3. HUMAN FACTORS

Figure 3.1	Generalized Block Diagram of the Car-Driver-Roadway System.	3-2
Figure 3.2	Lognormal Distribution of Perception-Reaction Time.	3-4
Figure 3.3	A Model of Traffic Control Device Information Processing.	3-10
Figure 3.4	Looming as a Function of Distance from Object.	3-14
Figure 3.5	Pursuit Tracking Configuration	3-19
Figure 3.6	Typical Deceleration Profile for a Driver without Antiskid Braking System on a Dry Surface.	3-22
Figure 3.7	Typical Deceleration Profile for a Driver without Antiskid Braking System on a Wet Surface.	3-22

4. CAR FOLLOWING MODELS

Figure 4.1	Schematic Diagram of Relative Speed Stimulus and a Weighing Function Versus Time	4-4
Figure 4.1a	Block Diagram of Car-Following	4-5
Figure 4.1b	Block Diagram of the Linear Car-Following Model.	4-5
Figure 4.2	Detailed Motion of Two Cars Showing the Effect of a Fluctuation in the Acceleration of the Lead Car	4-8
Figure 4.3	Changes in Car Spacings from an Original Constant Spacing Between Two Cars	4-9
Figure 4.4	Regions of Asymptotic Stability.	4-11
Figure 4.5	Inter-Vehicle Spacings of a Platoon of Vehicles Versus Time for the Linear Car Following.	4-11
Figure 4.6	Asymptotic Instability of a Platoon of Nine Cars.	4-12
Figure 4.7	Envelope of Minimum Inter-Vehicle Spacing Versus Vehicle Position	4-13
Figure 4.8	Inter-Vehicle Spacings of an Eleven Vehicle Platoon.	4-14
Figure 4.9	Speed (miles/hour) Versus Vehicle Concentration (vehicles/mile).	4-17
Figure 4.10	Normalized Flow Versus Normalized Concentration	4-17
Figure 4.11	Speed Versus Vehicle Concentration(Equation 4.39)	4-18
Figure 4.12	Normalized Flow Versus Normalized Vehicle Concentration (Equation 4.40)	4-18
Figure 4.13	Normalized Flow Versus Normalized Concentration (Equations 4.51 and 4.52)	4-21

Figure 4.14	Normalized Flow versus Normalized Concentration Corresponding to the Steady-State Solution of Equations 4.51 and 4.52 for $m=1$ and Various Values of ℓ	4-21
Figure 4.15	Sensitivity Coefficient Versus the Reciprocal of the Average Vehicle Spacing.	4-24
Figure 4.16	Gain Factor, λ , Versus the Time Lag, T , for All of the Test Runs.	4-24
Figure 4.17	Gain Factor, λ , Versus the Reciprocal of the Average Spacing for Holland Tunnel Tests.	4-25
Figure 4.18	Gain Factor, λ , Versus the Reciprocal of the Average Spacing for Lincoln Tunnel Tests	4-26
Figure 4.19	Sensitivity Coefficient, $a_{0,0}$, Versus the Time Lag, T	4-28
Figure 4.20	Sensitivity Coefficient Versus the Reciprocal of the Average Spacing	4-29
Figure 4.21	Sensitivity Coefficient Versus the Ratio of the Average Speed	4-29
Figure 4.22	Relative Speed Versus Spacing	4-31
Figure 4.23	Relative Speed Thresholds Versus Inter-Vehicle Spacing for Various Values of the Observation Time.	4-32
Figure 4.24	Speed Versus Vehicle Concentration	4-34
Figure 4.25	Flow Versus Vehicle Concentration	4-34
Figure 4.26	Speed Versus Vehicle Concentration (Comparison of Three Models)	4-35
Figure 4.27	Flow Versus Concentration for the Lincoln and Holland Tunnels.	4-36
Figure 4.28	Average Speed Versus Concentration for the Ten-Bus Platoon Steady-State Test Runs	4-37

5. CONTINUUM FLOW MODELS

Figure 5.1	Geometric Representation of Shocks, Sound Waves and Traffic Speeds in the k - q phase plane	5-4
Figure 5.2	Field Representation of Shocks and Conservation of Flow.	5-5
Figure 5.3	A Shock Solution	5-8
Figure 5.4	A Rarefaction Solution.	5-8
Figure 5.5	Phase Transition Diagram in the Solution of Riemann Problems	5-20
Figure 5.6	Roll Waves in the Moving Coordinate X	5-22
Figure 5.7	Traveling Waves and Shocks in the PW Modelic Models	5-22
Figure 5.8	Time-space Grid	5-26

Figure 5.9	The Kerner-Konhauser Model of Speed-Density and Flow-Density Relations.	5-36
Figure 5.10	Initial Condition (114)	5-36
Figure 5.11	Solutinos of the Homogeneous LWR Model With Initial Condition in Figure 10	5-37
Figure 5.12	Initial Condition (116)	5-38
Figure 5.13	Solutions of the Inhomogeneous LWR Model With Initial Condition (116).	5-39
Figure 5.14	Solutions of the PW Model With Initial Condition (117).	5-41
Figure 5.15	Solutions of the PW Model With Initial Condition (118).	5-42
Figure 5.16	Comparison of the LWR Model and the PW Model on a Homogeneous Ring Road	5-43
Figure 5.17	Comparison of the LWR Model and the PW Model on an Inhomogeneous Ring Road.	5-44

6. MACROSCOPIC FLOW MODELS

Figure 6.1	Total Vehicle Distance Traveled Per Unit Area on Major Roads as a Function of the Distance from the Town Center	6-2
Figure 6.2	Grouped Data for Nottingham Showing Fitted (a) Power Curve, (b) Negative Exponential Curve, and (c) Lyman-Everall Curve	6-4
Figure 6.3	Complete Data Plot for Nottingham; Power Curve Fitted to the Grouped Data	6-4
Figure 6.4	Data from Individual Radial Routes in Nottingham, Best Fit Curve for Each Route is Shown	6-5
Figure 6.5	Theoretical Capacity of Urban Street Systems	6-7
Figure 6.6	Vehicles Entering the CBDs of Towns Compared with the Corresponding Theoretical Capacities of the Road Systems	6-7
Figure 6.7	Speeds and Flows in Central London, 1952-1966, Peak and Off-Peak	6-8
Figure 6.8	Speeds and Scaled Flows, 1952-1966	6-9
Figure 6.9	Estimated Speed-Flow Relations in Central London (Main Road Network)	6-9
Figure 6.10	Speed-Flow Relations in Inner and Outer Zones of Central Area	6-10
Figure 6.11	Effect of Roadway Width on Relation Between Average (Journey) Speed and Flow in Typical Case	6-12
Figure 6.12	Effect of Number of Intersections Per Mile on Relation Between Average (Journey) Speed and Flow in Typical Case	6-12
Figure 6.13	Effect of Capacity of Intersections on Relation Between Average (Journey) Speed and Flow in Typical Case	6-13
Figure 6.14	Relationship Between Average (Journey) Speed and Number of Vehicles on Town Center Network	6-13
Figure 6.15	Relationship Between Average (Journey) Speed of Vehicles and Total Vehicle Mileage on Network	6-14
Figure 6.16	The α -Relationship for the Arterial Networks of London and Pittsburgh, in Absolute Values	6-14
Figure 6.17	The α -Relationship for the Arterial Networks of London and Pittsburgh, in Relative Values	6-15
Figure 6.18	The α -Map for London, in Relative Values	6-16
Figure 6.19	Trip Time vs. Stop Time for the Non-Freeway Street Network of the Austin CBD	6-18
Figure 6.20	Trip Time vs. Stop Time Two-Fluid Model Trends	6-19
Figure 6.21	Trip Time vs. Stop Time Two-Fluid Model Trends Comparison	6-19
Figure 6.22	Two-Fluid Trends for Aggressive, Normal, and Conservative Drivers	6-21

Figure 6.23	Simulation Results in a Closed CBD-Type Street Network	6-24
Figure 6.24	Comparison of Model System 1 with Observed Simulation Results	6-26
Figure 6.25	Comparison of Model System 2 with Observed Simulation Results	6-27
Figure 6.26	Comparison of Model System 3 with Observed Simulation Results	6-28

7. TRAFFIC IMPACT MODELS

Figure 7.1	Safety Performance Function and Accident Rate.	7-2
Figure 7.2	Shapes of Selected Model Equations	7-5
Figure 7.3	Two Forms of the Model in Equation 7.4	7-6
Figure 7.4	Fuel Consumption Data for a Ford Fairmont (6-Cyl.) Data Points represent both City and Highway Conditions.	7-9
Figure 7.5	Fuel Consumption Versus Trip Time per Unit Distance for a Number of Passenger Car Models.	7-10
Figure 7.6	Fuel Consumption Data and the Elemental Model Fit for Two Types of Passenger Cars	7-10
Figure 7.7	Constant-Speed Fuel Consumption per Unit Distance for the Melbourne University Test Car	7-12

8. UNSIGNALIZED INTERSECTION THEORY

Figure 8.1	Data Used to Evaluate Critical Gaps and Move-Up Times	8-3
Figure 8.2	Regression Line Types.	8-4
Figure 8.3	Typical Values for the Proportion of Free Vehicles	8-9
Figure 8.4	Exponential and Displaced Exponential Curves (Low flows example).	8-9
Figure 8.5	Arterial Road Data and a Cowan (1975) Dichotomized Headway Distribution (Higher flows example).	8-10
Figure 8.6	Arterial Road Data and a Hyper-Erlang Dichotomized Headway Distribution (Higher Flow Example)	8-10
Figure 8.7	Illustration of the Basic Queuing System.	8-12
Figure 8.8	Comparison Relation Between Capacity (q-m) and Priority Street Volume (q-p)	8-14
Figure 8.9	Comparison of Capacities for Different Types of Headway Distributions in the Main Street Traffic Flow	8-14
Figure 8.10	The Effect of Changing α in Equation 8.31 and Tanner's Equation 8.36.	8-15
Figure 8.11	Probability of an Empty Queue: Comparison of Equations 8.50 and 8.52.	8-18

Figure 8.12	Comparison of Some Delay Formulae.	8-20
Figure 8.13	Average Steady State Delay per Vehicle Calculated Using Different Headway Distributions.	8-20
Figure 8.14	Average Steady State Delay per Vehicle by Geometric Platoon Size Distribution and Different Mean Platoon Sizes.	8-21
Figure 8.15	95-Percentile Queue Length Based on Equation 8.59	8-22
Figure 8.16	Approximate Threshold of the Length of Time Intervals For the Distinction Between Steady-State Conditions and Time Dependent Situations.	8-25
Figure 8.17	The Co-ordinate Transform Technique.	8-25
Figure 8.18	A Family of Curves Produced from the Co-Ordinate Transform Technique.	8-27
Figure 8.19	Average Delay, D, in Relation to Reserve Capacity R.	8-29
Figure 8.20	Modified 'Single Lane' Distribution of Headways	8-30
Figure 8.21	Percentage Error in Estimating Adams' Delay Against the Major Stream Flow for a Modified Single Lane Model	8-31
Figure 8.22	Traffic Streams And Their Level Of Ranking.	8-32
Figure 8.23	Reduction Factor to Account for the Statistical Dependence Between Streams of Ranks 2 and 3.	8-33
Figure 8.24	Minor Street Through Traffic (Movement 8) Crossing the Major Street in Two Phases.	8-36
Figure 8.25	Average Delay For Vehicles on the Northbound Approach.	8-40

9. TRAFFIC FLOW AT SIGNALIZED INTERSECTIONS

Figure 9.1	Deterministic Component of Delay Models.	9-2
Figure 9.2	Queuing Process During One Signal Cycle	9-3
Figure 9.3	Percentage Relative Errors for Approximate Delay Models by Flow Ratios	9-9
Figure 9.4	Relative Errors for Approximate Delay Models by Green to Cycle Ratios	9-9
Figure 9.5	The Coordinate Transformation Method	9-11
Figure 9.6	Comparison of Delay Models Evaluated by Brilon and Wu (1990) with Moderate Peaking ($z=0.50$).	9-14
Figure 9.7	Comparison of Delay Models Evaluated by Brilon and Wu (1990) with High Peaking ($z=0.70$).	9-14
Figure 9.8	Observations of Platoon Diffusion	9-16
Figure 9.9	HCM Progression Adjustment Factor vs Platoon Ratio Derived from TRANSYT-7F	9-18

Figure 9.10	Analysis of Random Delay with Respect to the Differential Capacity Factor (f) and Var/Mean Ratio of Arrivals (I)- Steady State Queuing Conditions	9-19
Figure 9.11	Queue Development Over Time Under Fully-Actuated Intersection Control	9-21
Figure 9.12	Example of a Fully-Actuated Two-Phase Timing Sequence	9-25

10. TRAFFIC SIMULATION

Figure 10.1	Several Statistical Distributions.	10-7
Figure 10.2	Vehicle Positions During Lane-Change Maneuver.	10-8
Figure 10.3	Structure Chart of Simulation Modules.	10-9
Figure 10.4	Comparison of Trajectories of Vehicles from Simulation Versus Field Data for Platoon 123.	10-16
Figure 10.5	Graphical Displays	10-18
Figure 10.6	Animation Snapshot	10-19

11. KINETIC THEORIES

Figure 11.1	Dependence of the mean speed upon density normalized to jam density.	11-5
Figure 11.2	Evolution of the flow, according to a diffusively corrected Lighthill-Whitham model.	11-8

List of Tables

3. HUMAN FACTORS

Table 3.1	Hooper-McGee Chaining Model of Perception-Response Time	3-4
Table 3.2	Brake PRT - Log Normal Transformation	3-6
Table 3.3	Summary of PRT to Emergence of Barrier or Obstacle	3-6
Table 3.4	Percentile Estimates of PRT to an Unexpected Object	3-7
Table 3.5	Movement Time Estimates	3-9
Table 3.6	Visual Acuity and Letter Sizes	3-11
Table 3.7	Within Subject Variation for Sign Legibility	3-12
Table 3.8	Object Detection Visual Angles (Daytime) (Minutes of Arc)	3-15
Table 3.9	Maneuver Classification	3-19
Table 3.10	Percentile Estimates of Steady State Unexpected Deceleration	3-21
Table 3.11	Percentile Estimates of Steady State Expected Deceleration	3-21
Table 3.12	Critical Gap Values for Unsignalized Intersections	3-25
Table 3.13	PRTs at Intersections	3-27

4. CAR FOLLOWING MODELS

Table 4.1	Results from Car-Following Experiment	4-25
Table 4.2	Comparison of the Maximum Correlations obtained for the Linear and Reciprocal Spacing Models for the Fourteen Lincoln Tunnel Test Runs	4-27
Table 4.3	Maximum Correlation Comparison for Nine Models, $a_{v,m}$ the Fourteen Lincoln Tunnel Test Runs.	4-28
Table 4.4	Results from Car Following Experiments	4-30
Table 4.5	Macroscopic Flow Data	4-33
Table 4.6	Parameter Comparison (Holland Tunnel Data)	4-35

5. CONTINUUM MODELS

Table 5.1	Oscillation Time and Magnitudes of Stop-and-go Traffic From German Measurement.	5-12
-----------	---	------

7. TRAFFIC IMPACT MODELS

Table 7.1	Federal Emission Standards	7-14
Table 7.2	Standard Input Values for the CALINE4	7-17
Table 7.3	Graphical Screening Test Results for Existing Network	7-19

8. UNSIGNALIZED INTERSECTION THEORY

Table 8.1	"A" Values for Equation 8.23	8-8
Table 8.2	Evaluation of Conflicting Rank Volume q_p	8-34

9. TRAFFIC FLOW AT SIGNALIZED INTERSECTIONS

Table 9.1	Maximum Relative Discrepancy between the Approximate Expressions and Ohno's Algorithm	9-8
Table 9.2	Cycle Length Used For Delay Estimation for Fixed-Time and Actuated Signals Using Webster's Formula ..	9-23
Table 9.3	Calibration Results of the Steady-State Overflow Delay Parameter (k)	9-26

10. TRAFFIC SIMULATION

Table 10.1	Classification of the TRAF Family of Models	10-4
Table 10.2	Executive Routine	10-9
Table 10.3	Routine MOTIV	10-10
Table 10.4	Routine CANLN	10-11
Table 10.5	Routine CHKLC	10-12
Table 10.6	Routine SCORE	10-13
Table 10.7	Routine LCHNG	10-14
Table 10.8	Simulation Output Statistics: Measures of Effectiveness	10-25

11. KINETIC THEORIES

Table 11.1	Status of various kinetic models	11-6
------------	--	------