TABLE OF CONTENTS (Click an item in red and go directly to that location)

1.	. INTRODUCTION	1-1
	1.1 References	1-4
2.	. TRAFFIC STREAM CHARACTERISTICS	
	2.1 Measurement Procedures	
	2.1.1 Measurement at a Point	
	2.1.2 Measurements Over a Short Section	
	2.1.3 Measurement Along a Length of Road	
	2.1.4 Moving Observer Method	
	2.1.5 ITS Wide-Area Measurements	
	2.2 Variables of Interest	
	2.2.1 Flow Rates	
	2.2.2 Speeds	
	2.2.3 Concentration	
	2.3 Traffic Stream Models	
	2.3.1 Importance of Location to the Nature of the Data	
	2.3.2 Speed-Flow Models	
	2.3.3 Speed-Density Models	2-19
	2.3.4 Flow-Concentration Models	2-22
	2.3.5 Three-Dimensional Models	
	2.3.6 Conclusions About Traffic Stream Models	2-31
	References	2-32
3.	. HUMAN FACTORS	
	3.1 Introduction	
	3.1.1 The Driving Task	
	3.2 Discrete Driver Performance	
	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	
	3.4 Response Distances and Times to Traffic Control Devices	
	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	
	3.7.1 Gender	
	3.7.2 Age	
	3.7.3 Driver Impairment	
	•	

	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	
	3.9.3 Less-Than-Maximum Braking Performance	
	3.10 Speed and Acceleration Performance	
	3.10.1 Steady-State Traffic Speed Control	
	3.10.2 Acceleration Control	
	3.11 Specific Maneuvers at the Guidance Level	
	3.11.1 Overtaking and Passing in the Traffic Stream	
	3.11.1.1 Overtaking and Passing Vehicles (4-Lane or 1-Way)	
	3.11.1.2 Overtaking and Passing Vehicles (Opposing Traffic)	3-24
	3.12 Gap Acceptance and Merging	
	3.12.1 Gap Acceptance	
	3.12.2 Merging	
	3.13 Stopping Sight Distance	
	3.14 Intersection Sight Distance	
	3.14.1 Case I: No Traffic Control	
	3.14.2 Case II: Yield Control for Secondary Roadway	
	3.14.3 Case III: Stop Control on Secondary Roadway	
	3.15 Other Driver Performance Characteristics	
	3.15.1 Speed Limit Changes	
	3.15.2 Distractors On/Near Roadway	
	3.15.3 Real-Time Driver Information Input	
	References	3-20
4	CAR FOLLOWING MODELS	4.4
4.	CAR FOLLOWING MODELS	
	4.1 Model Development	
	4.2 Stability Analysis	
	4.2.1 Local Stability	
	4.2.2 Asymptotic Stability	
	4.2.1.1 Numerical Examples	
	4.2.1.2 Next-Nearest Vehicle Coupling	
	4.4 Experiments And Observations	
	4.4.1 Car Following Experiments	
	4.4.1.1 Analysis of Car Following Experiments	
	4.4.2 Macroscopic Observations: Single Lane Traffic	
	4.5 Automated Car Following	
	4.6 Summary and Conclusions	
	References	
	1.0101011000	
5	CONTINUUM FLOW MODELS	E 1
J.	5.1 Simple Continuum Models	
	5.1.1 The Conservation Equation	
	5.1.1 The Conservation Equation	
	5.1.2 Analytical Solution of the Conservation Equation, Shock waves	
	οτιο προιοαίοτο	

5.1.4 Formation and Dissipation of Queues at Signalized Intersections	
5.1.4.1 Analytical Results	
5.1.4.2 Queue Length Stability	
5.1.4.3 Signalized Links and Platoon Behavior	
5.1.5 Numerical Solution of the Conservation Equation	5-9
5.1.6 Application to Multi-Lane Flow Dynamics	
5.2 High Order Models	
5.2.1 Criticism of Simple Continuum Models	
5.2.2 Transients and Stop-Start Waves	
5.2.3 Momentum Equations	
5.2.4 Viscosity Models	
5.2.5 Stability Analysis of Higher Order Models	
5.2.6 Numerical Solutions by Finite Element Method	
5.2.7 Parameter Validation with Examples from Actual Measurements	
5.2.8 Calculation of Traffic Flow at a Bottleneck	
5.2.9 Density Dependent Relaxation Time and Anticipation Coefficient	
5.3 Stochastic Continuum Models	
5.3.2 Calculations of Speed Distributions	
5.3.3 Acceleration Noise	
5.3.4 Microscopic Time Gap Distribution and Macroscopic Traffic Volume Distribution	
References	5-47
6. MACROSCOPIC FLOW MODELS	6-1
6.1 Travel Time Models	
6.1.1 General Traffic Characteristics as a Function of the Distance from the CBD	
6.1.2 Average Speed as a Function of Distance from the CBD	
6.2 General Network Models	
6.2.1 Network Capacity	
6.2.2 Speed and Flow Relations	
6.2.3 General Network Models Incorporating Network Parameters	
6.2.4 Continuum Models	
6.3 Two-Fluid Theory	
6.3.1 Two-Fluid Parameters	
6.3.2 Two-Fluid Parameters: Influence of Driver Behavior	
6.3.3 Two-Fluid Parameters: Influence of Network Features (Field Studies)	
6.3.4 Two-Fluid Parameters: Estimation by Computer Simulation	
6.3.5 Two-Fluid Parameters: Influence of Network Features (Simulation Studies)	
6.3.6 Two-Fluid Model: A Practical Application	
6.4 Two-Fluid Model and Traffic Network Flow Models	
6.5 Concluding Remarks	
References	
T. TDAFFIO IMPACT MODEL C	
7. TRAFFIC IMPACT MODELS	
7.1 Traffic and Safety	
7.1.1 Introduction	
7.1.2 Flow and Safety	
7.1.3 Logical Considerations	
7.1.4 Empirical Studies	
7.1.4.1 Kinds Of Study And Data	
7.1.4.2 Models	
7.1.4.3 Parameter Estimates	
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	
	7.2.3 Urban Fuel Consumption Models	
	7.2.4 Highway Models	
	7.2.5 Discussion	
7.3	Air Quality Models	
7.0	7.3.1 Introduction	
	7.3.2 Air Quality Impacts of Transportation Control Measures	
	7.3.3 Tailpipe Control Measures	
	7.3.4 Highway Air Quality Models	
	7.3.4.1 UMTA Model	
	7.3.4.2 CALINE-4 Dispersion Model	
	7.3.4.3 Mobile Source Emission Factor Model	
	7.3.4.4 MICRO2	
	7.3.4.5 The TRRL Model	
	7.3.5 Other Mobile Source Air Quality Models	
Refe	erences	7-20
8. UNSIG	NALIZED INTERSECTION THEORY	8-1
8.1 I	Introduction	8-1
	8.1.1 The Attributes of a Gap Acceptance Analysis Procedure	
	8.1.2 Interaction of Streams at Unsignalized Intersections	
	8.1.3 Chapter Outline	
8.2	Gap Acceptance Theory	
0.2	8.2.1 Usefulness of Gaps	
	8.2.2 Estimation of the Critical Gap Parameters	
	8.2.3 Distribution of Gap Sizes	
0.2	Headway Distributions Used in Gap Acceptance Calculations	
0.3		
	8.3.1 Exponential Headways	
	8.3.2 Displaced Exponential Distribution	
	8.3.3 Dichotomized Headway Distributions	
0.4	8.3.4 Fitting the Different Headway Models to Data	
8.4	Interaction of Two Streams	
	8.4.1 Capacity	
	8.4.2 Quality of Traffic Operations	
	8.4.3 Queue Length	
	8.4.4 Stop Rate	
	8.4.5 Time Dependent Solution	
	8.4.6 Reserve Capacity	
	8.4.7 Stochastic Simulation	
8.5	Interaction of Two or More Streams in the Priority Road	
	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	
8.7	Shared Lane Formula	
	8.7.1 Shared Lanes on the Minor Street	
	8.7.2 Shared Lanes on the Major Street	
8.8	Two-Stage Gap Acceptance and Priority	
8.9	All-Way Stop Controlled Intersections	
0.0	8.9.1 Richardson's Model	

0.10	Empirical Methods	
0.44	8.10.1 Kyte's Method	
	Conclusions	
Reie	erences	. 8-41
9. TRAFF	TIC FLOW AT SIGNALIZED INTERSECTIONS	
9.1		
9.2	Basic Concepts of Delay Models at Isolated Signals	
9.3	Steady-State Delay Models	
	9.3.1 Exact Models	
	9.3.2 Approximate Models	
	Time-Dependent Delay Models	
9.5	Effect of Upstream Signals	
	9.5.1 Platooning Effect On Signal Performance	
	9.5.2 Filtering Effect on Signal Performance	
9.6	Theory of Actuated and Adaptive Signals	
	9.6.1 Theoretically-Based Models	
	9.6.2 Approximate Delay Models	
	9.6.3 Adaptive Signal Control	
	Concluding Remarks	
Refe	erences	. 9-28
10 TPAE	FIC SIMILITATION	10 1
	FIC SIMULATION	
10.1	Introduction	. 10-1
10.1 10.2	Introduction	. 10-1 . 10-1
10.1 10.2 10.3	Introduction An Illustration Car-Following	. 10-1 . 10-1 . 10-2
10.1 10.2 10.3 10.4	Introduction An Illustration Car-Following Random Number Generation	. 10-1 . 10-1 . 10-2 . 10-2
10.1 10.2 10.3 10.4 10.5	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models	. 10-1 . 10-1 . 10-2 . 10-2 . 10-3
10.1 10.2 10.3 10.4 10.5 10.6	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models	. 10-1 . 10-1 . 10-2 . 10-2 . 10-3 . 10-5
10.1 10.2 10.3 10.4 10.5 10.6	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5
10.1 10.2 10.3 10.4 10.5 10.6	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5
10.1 10.2 10.3 10.4 10.5 10.6	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data 10.8.1 Statistical Analysis for a Single System	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5 10-17
10.1 10.2 10.3 10.4 10.5 10.6	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data 10.8.1 Statistical Analysis for a Single System 10.8.1.1 Fixed Sample-Size Procedures	. 10-1 . 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5 10-17 10-17
10.1 10.2 10.3 10.4 10.5 10.6	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data 10.8.1 Statistical Analysis for a Single System 10.8.1.1 Fixed Sample-Size Procedures 10.8.1.2 Sequential Procedures	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5 10-17 10-17 10-20 10-21
10.1 10.2 10.3 10.4 10.5 10.6	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data 10.8.1 Statistical Analysis for a Single System 10.8.1.1 Fixed Sample-Size Procedures 10.8.2 Alternative System Configurations	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5 10-17 10-17 10-20 10-21
10.1 10.2 10.3 10.4 10.5 10.6	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data 10.8.1 Statistical Analysis for a Single System 10.8.1.1 Fixed Sample-Size Procedures 10.8.1.2 Sequential Procedures 10.8.2 Alternative System Configurations 10.8.3 Variance Reduction Techniques	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5 10-17 10-20 10-21 10-22 10-22
10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data 10.8.1 Statistical Analysis for a Single System 10.8.1.1 Fixed Sample-Size Procedures 10.8.2 Alternative System Configurations 10.8.3 Variance Reduction Techniques 10.8.4 Conclusions	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5 10-17 10-20 10-21 10-22 10-23
10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data 10.8.1 Statistical Analysis for a Single System 10.8.1.1 Fixed Sample-Size Procedures 10.8.2 Sequential Procedures 10.8.3 Variance Reduction Techniques 10.8.4 Conclusions Descriptions of Some Available Models	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5 10-17 10-20 10-21 10-22 10-23 10-23
10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data 10.8.1 Statistical Analysis for a Single System 10.8.1.1 Fixed Sample-Size Procedures 10.8.2 Alternative System Configurations 10.8.3 Variance Reduction Techniques 10.8.4 Conclusions Descriptions of Some Available Models 0 Looking to the Future	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5 10-17 10-20 10-21 10-22 10-23 10-23 10-24
10.1 10.2 10.3 10.4 10.5 10.6 10.7 10.8	Introduction An Illustration Car-Following Random Number Generation Classification of Simulation Models Building Simulation Models Illustration Statistical Analysis of Simulation Data 10.8.1 Statistical Analysis for a Single System 10.8.1.1 Fixed Sample-Size Procedures 10.8.2 Sequential Procedures 10.8.3 Variance Reduction Techniques 10.8.4 Conclusions Descriptions of Some Available Models	. 10-1 . 10-2 . 10-2 . 10-3 . 10-5 . 10-5 10-17 10-20 10-21 10-22 10-23 10-23 10-24

LIST OF FIGURES

2. TRAFFIC STREAM CHARACTERISTICS

Figure 2.1	
	2-2
Figure 2.2	
Figure 2.3 Speed-Flow Curves Accepted for 1994 HCM	
Figure 2.4	
	by Hall, Hurdle, & Banks
Figure 2.5	•
Speed-Flow Data for Queue Discharge Flow at Varie	
Figure 2.6	0.45
•	
Figure 2.7 Results from Fitting Polygon Speed-Flow Curves to G	German Data2-16
Figure 2.8	Jennan Data2-10
	per Direction)2-17
Figure 2.9	, ,
UK Speed-Flow Curve	
Figure 2.10	
Figure 2.11	0.00
	2-20
Figure 2.12 Speed-Concentration Data from Marritt Parkway and	Fitted Curves
Figure 2.13	Titled Guives
	sity Function, Fitted to Chicago Data 2-23
Figure 2.14	,
Greenshields' Speed-Flow Function Fitted to Chicago	o Data2-24
Figure 2.15	
	nto
Figure 2.16	0.00
	ns
Figure 2.17 Two Dimonsional Projection of Data Used in Three-F	Dimensional Study2-27
Figure 2.18	Jimensional Study2-27
One Perspective on Three-Dimensional	
Figure 2.19	
Second Perspective on the Three-Dimensional Relat	ionship
Figure 2.20	
	ophe Theory Surface Using the Maxwell Convention . 2-29
Figure 2.21	tad vain n Oatastaanka Thaan Malal
· · · · · · · · · · · · · · · · · · ·	ted using Catastrophe Theory Model2-30
Figure 2.22 Comparison of Observed Speeds with Speeds Estimates.	ated by Edie's Model
Companion of Coocieta Operas with Operas Estille	4.04 by Edio 6 Model

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	0.46
A Model of Traffic Control Device Information Processing.	3-10
Figure 3.4	0.44
Looming as a Function of Distance from Object.	3-14
Figure 3.5 Duravit Tracking Configuration	2.40
Pursuit Tracking Configuration	3-18
Figure 3.6 Typical Deceleration Profile for a Driver without Antiskid Braking System on a Dry Surface	3-25
Figure 3.7	5-22
Typical Deceleration Profile for a Driver without Antiskid Braking System on a Wet Surface	3-22
Typical Deceleration Frome for a Differ without Artificial Drawing Cystem on a Wet Cartace.	
4 CAR FOLLOWING MODELS	
4. CAR FOLLOWING MODELS	
Figure 4.4	
Figure 4.1 Schematic Diagram of Relative Speed Stimulus and a Weighing Function Versus Time	1-1
Figure 4.1a	4-4
Block Diagram of Car-Following	1 -F
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	4.46
Envelope of Minimum Inter-Vehicle Spacing Versus Vehicle Position	4-13
Figure 4.8	1 1 1
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	4-17
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 4.47	
Figure 4.17 Gain Factor, λ, Versus the Reciprocal of the Average Spacing for Holland Tunnel Tests	4-25
Figure 4.18	. 4 -23
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 Sansitivity Coefficient Versus the Regionage of the Average Specing	4 20
Sensitivity Coefficient Versus the Reciprocal of the Average Spacing	. 4-29
Sensitivity Coefficient Versus the Ratio of the Average Speed	. 4-29
Figure 4.22	
Relative Speed Versus Spacing	. 4-31
Figure 4.23	4 00
Relative Speed Thresholds Versus Inter-Vehicle Spacing for Various Values of the Observation Time Figure 4.24	4-32
Speed Versus Vehicle Concentration	. 4-34
Figure 4.25	
Flow Versus Vehicle Concentration	. 4-34
Figure 4.26	4.05
Speed Versus Vehicle Concentration (Comparison of Three Models)	. 4-35
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	- 0
Road Section Used for Deriving the Conservation Equation	5-2
Shock Wave Formation Resulting from the Solution of the Conservation Equation	5-5
Figure 5.3	
Queue Length Developments at a Signalized Intersection During a Saturated Cycle	5-7
Figure 5.4	
Shock Wave Developments Between Two Signalized Intersections During a Saturated Downstream Cycle	5-10
Figure 5.5	. 5-10
Space Discretization of a Simple Link	. 5-11
Figure 5.6	
Space Discretization of a 2-Lane, One Dimensional Freeway Section.	. 5-13
Figure 5.7 Macroscopic Models	5-16
Figure 5.8	. 5 10
Hysteresis Phenomenon as an Example of Dynamic Behavior of Traffic Flow	. 5-16

Figure 5	5.9 a.b	
9	Time Series of Mean Speed for Unstable Traffic Flow	5-18
Figure 5		- 40
Figure 5	Time Series of Mean Speed for Unstable Traffic Flow with Small Undulations	5-18
i iguie c	Time Development of Mean Speed from Adjacent Measurement Sites	5-19
Figure 5	·	
	Time Development of Speed Upstream on Toll Gate at Tokyo Expressway	5-19
Figure 5	5.12a Speed Measurements from Interstate 80 between Oakland and San Jose	E 21
Figure 5	·	3-Z I
i igaio c	Measurement Array for Speed Measurements from Interstate 80 between Oakland and San Jose	5-22
Figure 5		
- :	Construction of Partially Continuous Wave Solutions	5-25
Figure 5	Wave Number Dependence from the Linear Stability Analysis	5-28
Figure 5		0 20
Ü	Traffic Parameter a and Stability Domain of the Homogeneous Traffic Flow	5-28
Figure 5		- 04
Figure 5	Stepwise Integration of the Quasi Linear Differential Equation in Time and Space Grid	5-31
i igui e c	Flow Chart of the Numerical Solution Procedure	5-33
Figure 5		
	Principal Arrangement for Parameter Validation by Comparison of Measurements and Calculations	5-33
Figure 5		E 2E
Figure 5	Autobahn Section for Validation of the Macroscopic Freeway Model	ე - აე
i igaio c	Measurement and Simulated Time Series at the Mean Speed of the	
	Intermediate Cross Section on the Test Section.	5-35
Figure 5		r 20
Figure 5	Temporal Traffic Density Development One to Four Minutes	5-36
i iguic c	Traffic Density Course after Six to Ten Minutes.	5-37
Figure 5	5.21c	
	Density Speed Course after 12 to 24 Minutes	5-37
Figure 5	Density Speed Course at the Bottleneck after 30 Minutes	5-38
Figure 5		J-30
	Density-Dependent Relaxation Time	5-39
Figure 5		
Ciaura E	Speed Distribution Idealized Gaussian Distribution for Free and Nearly Free Traffic Flow	5-40
Figure 5	Anticipation Coefficient	5-40
Figure 5	·	0 .0
Ü	Time Series of Mean Speed on Autobahn A5 Bruchsal-Karlsruhe	5-41
Figure 5		- 40
Figure 5	Speed Distribution During Congestion Formation of Figure 5.25.	5-42
i igui e c	Standard Deviation of the Acceleration Noise for Different Traffic Densities	5-44
Figure 5	5.28	
_	Time Gap Distribution for the Median Lane From the Autobahn A8 near Stuttgart, Germany.	5-46
Figure 5	5.29 Traffic Volume Distribution as Result of a Laplace Transformation	5_17
	Tranic volume Distribution as Nesult of a Laplace Transformation.	J-4 <i>1</i>

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
Figure 6.2
Grouped Data for Nottingham Showing Fitted (a) Power Curve,
(b) Negative Exponential Curve, and (c) Lyman-Everall Curve
Complete Data Plot for Nottingham; Power Curve Fitted to the Grouped Data
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
Figure 6.6
Vehicles Entering the CBDs of Towns Compared with the Corresponding Theoretical Capacities of the Road Systems
Figure 6.7
Speeds and Flows in Central London, 1952-1966, Peak and Off-Peak
Figure 6.8
Speeds and Scaled Flows, 1952-1966
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
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 Case6-12
Figure 6.13
Effect of Capacity of Intersections on Relation Between
Average (Journey) Speed and Flow in Typical Case
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
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 Trends6-19
Figure 6.21
Trip Time vs. Stop Time Two-Fluid Model Trends Comparison
Figure 6.22 Two-Fluid Trends for Aggressive, Normal, and Conservative Drivers
Two-filling Treffus for Aggressive, Northal, and Conservative Drivers

	Simulation Results in a Closed CBD-Type Street Network
	Comparison of Model System 1 with Observed Simulation Results
Figure 6.2	25 Comparison of Model System 2 with Observed Simulation Results
Figure 6.2	26 Comparison of Model System 3 with Observed Simulation Results
7. TRA	FFIC IMPACT MODELS
Figure 7.1	
S Figure 7.2	Safety Performance Function and Accident Rate
S	Shapes of Selected Model Equations
Figure 7.3	3 wo Forms of the Model in Equation 7.4
Figure 7.4	4 iuel Consumption Data for a Ford Fairmont (6-Cyl.)
D	Oata Points represent both City and Highway Conditions
Figure 7.5	out on the consumption Versus Trip Time per Unit Distance for a Number of Passenger Car Models
Figure 7.6	Sivel Consumption Data and the Elemental Model Fit for Two Types of Passenger Cars
Figure 7.7	7
C	Constant-Speed Fuel Consumption per Unit Distance for the Melbourne University Test Car
8. UNS	IGNALIZED INTERSECTION THEORY
Figure 8.1	
Figure 8.2	
R Figure 8.3	Regression Line Types
T	ypical Values for the Proportion of Free Vehicles8-9
	exponential and Displaced Exponential Curves (Low flows example)
Figure 8.5	5 orterial Road Data and a Cowan (1975) Dichotomized Headway Distribution (Higher flows example) 8-10
Figure 8.6	
Figure 8.7	
III Figure 8.8	Iustration of the Basic Queuing System. 8-12
C	ComparisonRelation Between Capacity (q-m) and Priority Street Volume (q-p)
	Comparison of Capacities for Different Types of Headway Distributions in the Main Street Traffic Flow 8-14
Figure 8.1	10 The Effect of Changing α in Equation 8.31 and Tanner's Equation 8.36
Figure 8.1	
Г	Tobability of all Empty Queue. Companson of Equations 0.50 and 0.52

Figure 8.12	
Comparison of Some Delay Formulae.	8-20
Figure 8.13	0.00
Average Steady State Delay per Vehicle Calculated Using Different Headway Distributions	8-20
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	0 20
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	0.00
Average Delay, D, in Relation to Reserve Capacity R	8-29
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	0.00
Traffic Streams And Their Level Of Ranking	8-32
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 Brilen and Wu (1990) with High Booking (7–9.70)	0.44
Comparison of Delay Models Evaluated by Brilon and Wu (1990) with High Peaking (z=0.70)	9-14
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	0.05
Example of a Fully-Actuated Two-Phase Timing Sequence	9-25
10. TRAFFIC SIMULATION	
10. TRAITIC SINICEATION	
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

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	2 12
Table 3.8	3-12
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	0.04
Percentile Estimates of Steady State Expected Deceleration	3-21
Critical Gap Values for Unsignalized Intersections	3-25
Table 3.13	
PRTs at Intersections	3-27
4. CAR FOLLOWING MODELS	
Table 4.1	4.05
Results from Car-Following Experiment	4-25
Comparison of the Maximum Correlations obtained for the Linear and Reciprocal Spacing Models	•
for the Fourteen Lincoln Tunnel Test Runs	
Table 4.3	
Maximum Correlation Comparison for Nine Models, a _{nm} 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)	A 25
r aranıcıcı Cumpandul (fiunanu Tunne Dala)	4-33

7. TRAFFIC IMPACT MODELS

Table 7.1 Federal Emission Standards
Table 7.2 Standard Input Values for the CALINE4
Table 7.3 Graphical Screening Test Results for Existing Network
8. UNSIGNALIZED INTERSECTION THEORY
Table 8.1
"A" Values for Equation 8.23
Evaluation of Conflicting Rank Volume $q_{\scriptscriptstyle p}$
9. TRAFFIC FLOW AT SIGNALIZED INTERSECTIONS
Table 9.1
Maximum Relative Discrepancy between the Approximate Expressions and Ohno's Algorithm9- 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)
10. TRAFFIC SIMULATION
Table 10.1
Classification of the TRAF Family of Models
Executive Routine
Table 10.3 Routine MOTIV
Table 10.4
Routine CANLN
Routine CHKLC
Table 10.6 Routine SCORE
Table 10.7
Routine LCHNG
Simulation Output Statistics: Measures of Effectiveness