Second National Access Management Conference

Conference Proceedings

August 11-14, 1996
Vail, Colorado

U.S. Department of Transportation
Federal Highway Administration

SECOND NATIONAL CONFERENCE ON ACCESS MANAGEMENT

A Compendium of Papers From The
2nd National Conference On Access Management
Held In Vail, Colorado
August 1 - 14, 1996

Final Report

December 1996

Sponsored By:
Transportation Research Board
Federal Highway Administration
Office of Technology Applications

Hosted By:
Colorado Department of Transportation

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SECTION I

INTRODUCTION

Access
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I Introduction

Compendium Content

This compendium of conference proceedings contains abstracts and papers from the Second National Conference on Access Management which took place in Vail, Colorado on August 1 l-14, 1996. Papers and presentation summaries are grouped by session and appear in the order that they were presented at the conference. For each session, there is a brief introductory summary followed by copies of the papers presented in that session.

The formal papers were taken from the diskettes submitted by the authors and formatted with uniform fonts and spacing formats where possible. The papers were not edited for content. In those few cases where speakers did not submit a formal, written paper, key points from those presentations were excerpted from recordings of the sessions.

All sessions were recorded to capture comments and questions from the audience as well as responses from the speakers. Many of these are included in this compendium.

Organization of the Conference Proceedings

This compendium is organized into the following ten sections:

Section I - Introduction: This section provides information regarding the content and structure of the compendium as well as insights on the activities of the TRB Committee on Access Management.

Section II - Conference Staff The individuals responsible for setting up and conducting the Second National Conference are identified in this section.

Section III - Conference Summary: Brief summaries of each of the sessions held during the conference are displayed in this section.

Section IV- Conference Schedule: The conference program complete with the titles, authors and presenters for each paper are listed here.

Section V-Abstracts/Papers: This section contains all the abstracts and papers that were presented at the Second National Access Management Conference.

Section VI - Seminar/Workshop: This section contains information on the special seminar and workshop held on Sunday Afternoon.

Section VII - Luncheon Speaker: This section contains a summary of the presentation on the status of ISTEA by Mr. Francis B. Francois, Executive Director of the American Association of State Highway and Transportation Officials.

Section VIII - Closing Remarks: This section contains the conference closing remarks by the Conference Chairman, Philip Demosthenes and the Transportation Research Board Access Management Committee Chairman, Mr Ron Giguere.

Section IX- Conference Attendees: The name, affiliation, mailing address, telephone number and e-mail address (where available) for each conference attendee are listed here.

Section X - The Third National Conference: This section contains information and contacts for the Third National Conference on Access Management scheduled for Fort Lauderdale, Florida in October of 1998.

National Conferences on Access Management

The Second National Conference was sponsored by the Transportation Research Board (TRB) Committee on Access Management and the Federal Highway Administration (FHWA) Office of Technology Applications (OTA). It was hosted by the Colorado Department of Transportation.

In attendance were more than 230 professionals representing a wide range of disciplines, organizations and geographical areas. Disciplines included engineers, planners, designers, researchers, right-of-way specialists as well as technical, legal, and administrative experts. Federal agencies, State Departments of Transportation, MPOs, cities, counties, universities and private consultants were all represented.

The conference featured 11 formal paper sessions with a total of 37 papers presented. In addition, there was a workshop on the capacity of non-signalized intersections and an introductory seminar on access management conducted on Sunday afternoon. Plenary sessions were held on Monday. On Tuesday and Wednesday, technical and administrative tracks for the sessions ran concurrently.

The First National Conference on Access Management, also, took place in Vail, Colorado in 1993. The proceedings for that Conference were printed and distributed and are currently available on a very limited basis from FHWA. Anyone interested in obtaining a copy of those proceedings should contact Mr. Ron Giguere at ***(202) 366-2203.***

The Third National Conference is scheduled for October 4-7, 1998 in Fort Lauderdale, Florida. Individuals interested in presenting papers or attending should look for formal conference announcements coming out in 1997 or contact Mr. Gary Sokolow of the Florida Department of Transportation at (904) 488-9747.

TRB Committee on Access Management

The Access Management Committee (AlD07) provides the focus and much of the person power for the organization of the national conferences. The Access Management Committee became a full TRB committee in March 1994. The full committee currently boasts 20 members. In addition, there are over 50 “friends” of the committee who participate in many of the activities sponsored by the full committee.

Aside from sponsoring the national conference, Committee AlD07 has produced a TRB Circular entitled, “Driveway and Street Intersection Spacing” and has sponsored a number of research and outreach projects in access management. The committee is currently involved in the development of a comprehensive access management manual.

In order to better accommodate present and future projects and programs, a number of subcommittees and task forces were established to support AlD07. The following subcommittees and task forces were recommended and approved in August, 1996 at the mid-year meeting of AlD07.

Design and Standards Subcommittee, Herb Levinson, Chair
Administrative Elements Subcommittee, Del Huntington, Chair

Planning and Site Design Subcommittee, Eddie Shafie, Chair
Legal and Right-of- Way Issues Subcommittee, Phil Demosthenes, Chair

Benefits and Case Studies Subcommittee, Jerry Gluck, Chair
Third National Conference Chairman, Gary Sokolow

Research Task Force, Gail Yezertsky-Ritzer, Chair
Outreach Task Force, Bud Koepke, Chair

Anyone interested in serving on one of these subcommittees or task forces should contact the appropriate chairperson.

SECTION II

CONFERENCE STAFF

Access Management

II Conference Staff

CONFERENCE CHAIRMAN:

Philip Demosthenes, *Colorado Department of Transportation*

CONFERENCE STEERING TASK FORCE:

Arthur Eisdorfer, *New Jersey Department of Transportation*
Del Huntington, *Oregon Department of Transportation*
Dane Ismart, *Federal Highway Administration*
J. L. **Gattis,** *University ofArkansas*

Ron Giguere, *Federal Highway Administration*
Jerry *Gluck, Urbitran Associates, New York*
Frank "Bud" Koepke, *S/K Consultants, Wisconsin*
Bill R. McShane, *Polytechnic University, New York*

Eddie Shafie, *Texas Department of Transportation*
Gary Sokolow, *Florida Department of Transportation*
Vergil Stover, S/K *Consultants, Texas*
John Taber, *Taber Engineering, Utah*

TRANSPORTATION RESEARCH BOARD STAFF:

James Scott, *Transportation Research Board*

With Assistance from the TUB Committee on Operational Effects of Geometrics (A3AO8),
Dan Turner, *University of Alabama, Chairman*

COLORADO DOT SUPPORT STAFF:

Michael Anders, *Real Estate Specialist*
Mehdi Baziar, *Access Program Specialist*
Jennifer Kramer, *Administrative Assistant*
Peggy Law, *Business Manager*

SECTION III

CONFERENCE SUMMARY

Access Management

III Conference Summary

The Second National Conference on Access Management emphasized how comprehensive access management is an effective response to both the loss of arterial capacity and the high incidence of access related accidents that are plaguing our nation's street systems. Many of the papers presented at the conference showed that a properly administered program of access management can reduce the frequency of fatal, injury, and property damage accidents; prolong the functional life of existing highways; and maintain the efficiency of the transportation system.

While elements of access management have been used for years, comprehensive access management is still relatively new in practice. Only a few states have developed comprehensive access management programs. However, based upon comments from attendees and interest shown in this conference, access management appears to have an increased awareness within the transportation profession.

A primary objective of this and the other national conferences is to provide an overview of access management and to identify the administrative, legal, and engineering processes that can work to ensure successful programs. The conference demonstrated the importance of forums for transportation officials and practitioners to exchange ideas, methodologies and experiences; and to learn about access management from those who are currently practicing it. It is hoped that this and other conferences will encourage other states and local agencies to develop or enhance their own access management programs.

Summaries of each of the sessions are provided below.

Session 1 - What's Happening In Access Management

The opening session provided an overview of access management policies, standards, practices and issues. The focus was on what is happening at both State and local levels of govemment.

The first speaker was Mr. Herb Levinson, a transportation consultant from New Haven, Connecticut. In his presentation, entitled "An Overview of Access Management at Selected State DOTS", Mr. Levinson presented the results of a survey of eleven state departments of transportation. The survey addressed existing standards, codes, policies and design guidelines. Court decisions that reinforced or had a negative impact on existing practices were identified as were the reasons for past or planned revisions in practices.

The second speaker was Ms. Kristine Williams, a research associate with the Center for Urban Transportation Research at the University of South Florida. Her presentation, entitled "Local Governments and MPO's Implementing Access Management" provided information on access management implementation activities practiced by selected local governments and MPO's.

Session 2 - Public Involvement and the Selling of Access Management

This session focused on methods, techniques and practices that can be implemented to generate public and political support for access management programs and plans. This session focused on new ideas and lessons learned in educating the public and obtaining "buy-in' from politicians, developers and citizens.

The first speaker was Ms. Kristine Williams from the Center for Urban Transportation Research at the University of South Florida. Her presentation entitled, "Public Involvement and the Politics of Access Management", reviewed federal requirements for public involvement in transportation, principles of public involvement, and findings on how to effectively involve the public in access management decisions.

The next speaker was Mr. Del Huntington of the Oregon Department of Transportation. His paper, entitled "Marketing of Access Management", identified innovative and traditional methods for marketing access management. Mr. Huntington discussed the limitations of some traditional marketing practices and identified non-traditional techniques that he felt could overcome many of these limitations.

The final speaker was Mr. David Parisi, PE with the consulting firm of CH2M HILL. He presented a paper entitled "A Process to Obtain Public Buy-In for a Retrofit Access Management Project". The presentation focused on the development of public involvement process for retrofitting access management along a corridor in Oregon. Mr. Parisi described how the process dealt with the various interest groups. He identified the tools that proved most effective in gaining public consensus. In addition, he detailed the methodology used to develop alternative designs and recounted some of the challenges that were encountered during the project.

Session 3 - Legal Issues

The third session dealt with the many legal facets such as property rights, police powers, and eminent domain issues that get attached to access management. The speakers addressed the roles that constitutional and case law have played in both the structuring of access control statutes and in the process of denying or modifying access. The views of both public agencies and developers were represented.

The first speaker was Mr. Richard Forester from Dispute Resolution Services, Oregon. In his presentation, entitled "The Interface of Access and Land Use - Developments in the Law", Mr. Forrester discussed several legal cases attributable to access management programs and how some of the potential conflicts can be resolved. He, also, summarized the current thinking of the courts as to what extent access controls can legally impact land use.

The second speaker was Ms. Lorinda Lasus, Deputy Attorney General, New Jersey Department of Law and Public Safety. Her presentation, entitled "Access Changes within Highway Reconstruction Projects and Eminent Domain' gave the goals and some of the features of New Jersey's access management program. The different types of impacts that result from highway improvement projects were discussed. Ms. Lasus demonstrated, using selected examples, the importance of coordinating access regulation and property acquisition in the planning and design of improvement projects.

The third speaker was Mr. Robert Duncan LLB, Colorado who presented a paper entitled "Property Rights May Not be Ignored". He stressed the importance of property rights for businesses, merchandisers and their clientele. He discussed some of the basic conflicts that arise when access to private business is restricted or otherwise controlled and how the promulgating agency(s) should approach such conflicts.

Discussion Session

Following Session 3, conference participants were given an opportunity to query a group of experts on legal issues related to access management. The highlights of this session are provided in this compendium.

Session 4A - The Management of Access Management

This session focused on current access management programs and practices and the requirements for developing and administering them. Good examples of what works and what doesn't were provided by the speakers.

The first presenter was Mr. Del Huntington, Access Management Coordinator, Oregon Department of Transportation. His presentation entitled "Access Management Program Development in Oregon" presented the background (history) and steps taken in developing Oregon's access management program. Mr. Huntington presented his thoughts as to the successes and pitfalls that occurred along the way.

The next speaker was Mr. David Geiger with the Michigan Department of Transportation. His presentation, entitled "Access Management in Michigan: the Good, the Bad and the Ugly", provided the results from a review of Michigan DOT's driveway permit process. Mr. Geiger presented recommended actions for both improving the process and providing better guidelines on the design and location of access.

The third presenter, Dr. Raymond Brindle, ARRB from the Transport Research LTD, Australia, presented a paper entitled "An Australian Review of Access Management and the Land Planning Connection". His presentation focused on a review of current access management practice in Australia. Issues from the review were examined and observations and conclusions were presented. Dr. Brindle observed two different policy directions evolving in Australia: employing enhanced practices to separate arterial traffic from local activities and integrating traffic into urban activities in response to new urban design and "traffic calming" trends.

The fourth speaker was Mr. Yvan Rompre with the Ministere des Transports, du Quebec (MTQ), Canada. His paper, entitled "Road Corridor Management and Access Control", provided an overview of MTQ and their access management practices. Mr. Rompre described how MTQ, because the provincial government no longer has regulatory power over accesses, has been working with the regional bodies in Quebec to implement access management programs. He provided his thoughts on how well this process has worked to date and what needs to be accomplished in the future.

Session 4T - Signal Spacing

This session focused on the role that the spacing and density of signalized intersections plays in managing access. Emphasis was placed on how signal spacing can dramatically impact the capacity, speed, flow and safety on arterial.

The first speaker was Mr. Herb Levinson who presented a paper entitled "Signal Density - A Key To Access Management". Mr. Levinson explained how signal spacing impacts speeds. He demonstrated the importance of uniform and widely spaced signalized intersections for good traffic flow. The presentation stressed the importance of incorporating minimum spacing or bandwidth criteria into access management policies and programs.

The next speaker was Mr. Freddie Vargas, Florida Department of Transportation. His presentation, entitled "Access Management Warrant In Traffic Signal Justification?", examined the merits of using access management, specifically signal spacing, as a criterion for warranting the signalization of intersections. Mr. Vargas argued that existing warrants allow a proliferation of signals that often make it impossible to achieve good progression along a roadway. He suggested that, perhaps, directional median openings and other treatments can be used to eliminate the need for signals at certain locations.

The third speaker was Dr. Lee Han, Professor, University of Tennessee. His presentation, entitled "Spacing, Timing and Operational Interference Between Signalized Intersections", reviewed the effects that spacing, timing and other operational characteristics of signalized intersections can have on traffic operations.

Session 5A - Access Planning And Development

This session focused on what local governments can do to better manage access within their jurisdiction. Examples of existing access management programs being practiced at the local level were presented.

The first speaker was Ms. Mary Jo Vobejda, P.E. of CH2M HILL, Colorado. Her presentation, entitled "Development and Administration of an Access Management Program for Local Government", addressed the development and operation of the access management program in Parker, Colorado. Ms. Vobejda laid out and discussed the guiding elements of the program and explained the administrative process used to operate the program.

The next speaker was Mr. Stephan R. Ferranti, P.E., of SRF & Associates, New York. In his presentation, entitled "The Challenges (and Early Successes) of a Town Initiated Access Management "Retrofit" Program on Two State Highways", Mr. Ferranti described the development and implementation of a Land Use and Access Management Plan (LUAMP) in Penfield, New York. The plan specified the retrofit of a number of access management techniques and measures on the existing routes that fall within the scope of the plan. Mr. Ferranti discussed the progress to date and presented some observations on the past, present, and future impacts of this LUAMP.

The last speaker was Mr. Freddie Vargas, P.E. from the Florida Department of Transportation (FDOT). His presentation, entitled "Access Management by Consensus, A Success Story", covered the development of the access management process in Florida and explained how consensus building at project level has improved the process. Mr. Vargas discussed how the process has worked in FDOT's District 4 and detailed some of the efficiencies that have resulted.

Session 5T - Access Spacing

This session, which was jointly sponsored with the TRB Committee on Operational Effects of Geometrics, focused on the development of access spacing(s) guidelines on urban arterial roads, The effects of access densities on operations of these facilities were addressed.

The first speaker was Mr. Timothy White with the Virginia Department of Transportation. His presentation, entitled "Guidelines for Commercial Driveway Spacing on Urban and Suburban Arterial Roads", discussed research that was conducted to establish guidelines for driveway spacing. Data was collected from a number of urban and suburban sites in Virginia. Models that correlate both level of service and accident rate with driveway spacing were developed using the data. Mr. White presented the conclusions of the research and the resultant recommendations for spacing guidelines.

Next was a joint presentation by Dr. Kent Lall, Professor, and Mr. Ali Edhtedari, both of the Portland State University. The presentation was entitled "Access Management and Traffic Safety". It was based on a study of accidents over a 29 mile section of Oregon Coast Highway 9 that was part of a research project to assist the Oregon Department of Transportation in developing and maintaining the state's Access Management Program. Data bases were developed and analyses showed the direct relationship between access density and both the number of accidents and their severity. Results also showed the improvements in accident rates that are realized when non-traversable medians are introduced. Overall conclusions and recommendations were discussed by the presenters.

The third speaker was Dr. James L. Gattis with the Mack-Blackwell Transportation Center at the University of Arkansas, and his presentation was entitled "Comparison of Delay and Accidents on Three Roadway Access Designs". Three segments in a city with a population of 40,000 were compared. Quality of service measured by travel time runs and accident frequency over a three year period were compared for the three sections. The impact of signalization, terrain, development bordering the roadways and driveway access were analyzed in an attempt to explain the operational and safety differences among the three sections.

Session 6A - More on the Management of Access Management

This session addressed some of the major issues relating to project level access. It focused on permitting processes and how the interests of developers and businesses are taken into consideration within these processes.

The first speaker, Mr. Arthur Eisdorfer with the New Jersey DOT, presented a paper entitled "Variances-An Important Part of Access Management Decisions". Mr. Eisdorfer explained the importance of providing for variances in the application of any law, set of rules or guidelines. He stressed that there must be uniformity and consistency when variances are granted. He discussed the evolution of the variance processes that are contained in New Jersey's access management rules. Mr. Eisdorfer suggested how a hierarchy for variances might be established and outlined conditions under which the granting of variances would be valid.

The next presenter was Ms. Denise Kors, P.E., Ministry of Transportation and Highways of British Columbia. Her presentation entitled, "Preliminary Consultation Program for the Access Management Project - British Columbia", discussed the process that was utilized to consult with and gather information from stakeholders. The objectives were to ascertain the issues, concerns and expectations these groups had with respect to the Ministry's authority, policies, procedures or standards for controlling access.

The third speaker was Mr. Herbert S. Levinson, Consultant, Connecticut. The paper entitled "Access Management Practices in Connecticut" described and assessed the State of Connecticut's past and ongoing access management actions within the broader context of the State's history, geography, and political structure. Mr. Levinson presented access management proposals for a specific route in Connecticut. He discussed emergent access management implications for local governments, regional planning agencies and the State.

The last speaker was Mr. Gary Sokolow with the Florida DOT. The presentation entitled, "Deviations from Median Opening Spacing Standards", detailed a procedure for making decisions regarding median treatments . The starting point for identifying median opening standards was given. Deviations and problems associated with different types of median openings were covered. Mr. Sokolow also discussed the public involvement process used in Florida to build consensus regarding median design.

Session 6T - Geometric Design, Roadway Operation and Access

This session, which was sponsored jointly with the TRB Committee on Operational Effects of Geometrics, presented studies that investigated the impacts of geometric design(s) on the operations and safety of traffic at driveway and intersection locations.

The first speaker was Professor Peter S. Parsonson of the Georgia Institute of Technology. His presentation, entitled “Prefabricated Medians to Reduce Crashes at Driveways Close to Intersections”, dealt with alternative countermeasures for medians. Treatments were reviewed and recommendations for a prefabricated raised median were suggested.

Next was Mr. Christopher Poe with the Texas Transportation Institute. Mr. Poe’s presentation, entitled “Influence of Access and Land Use on Vehicle Operating Speeds Along Low-Speed Urban Streets,” covered geometric design impacts on vehicle operating speed and safety for low-speed urban streets. Results of the FHWA sponsored study that investigated the relationships between geometric design elements and vehicle operating speeds were discussed. Mr. Poe presented the speed estimation model, developed in the study, which provides feedback on how access density influences operating speeds.

The third speaker was Mr. Russell Micsky , a civil engineer with Gannett Fleming in Pennsylvania. The presentation, entitled “Sight Distance for Vehicles Turning Left Off Major Roadways”, provides the results of field observations for vehicles turning left off major roadways. Mr. Micsky emphasized the importance of achieving sufficient at-grade sight distance and stressed that access management policies should recognize the needs in their established standards and guidelines.

The last speaker was Mr. Patrick Hawley of the firm Howard, Needles, Tammin & Burgendoff in Wisconsin. Mr. Hawley’s presentation, entitled “Guidelines for Left Turn Bays at Unsignalized Access Locations”, demonstrated guidelines for left-turn lanes at unsignalized locations that were developed using simulation models. The subject guidelines show that a left-turn lane should be warranted at lower directional volumes than are traditionally employed.

Session 7A - Corridor Case Studies

This session covered several corridor access management plans and case studies from Montana, Delaware, Colorado and Kansas. The emphasis was on project scoping, the planning and design processes, and implementation.

The first speaker was Mr. Joseph Hart, P.E., Carter & Burgess Inc., Denver, Colorado. His presentation, entitled “US 93, Somers to Whitefish, Montana Access Management Issues”, analyzed the issues encountered in the planning and design of divided four- lane versus five- lane alternatives on US 93. The configurations were analyzed in relation to the number of access points they would generate as well as to the anticipated benefits and impacts. Possible treatments for induced U-turns were also discussed.

The next speaker was Mr. Robert Kleinburd, who is with FHWA in Delaware. His paper, entitled “Corridor Preservation in Delaware”, analyzed the corridor preservation project along State Route (SR) 1 from Dover to the Beaches. The Delaware DOT and FHWA, in cooperation with 2 counties, developed the goals and objectives and project strategies. A major initiative was taken to control existing and planned access by controlling growth and diverting access to the side roads Mr. Kleinburd presented the findings from the first 5 years of the project.

The third speaker was Mr. Greg Walker of In Motion Inc., Denver, Colorado. He presented a paper entitled “A Case Study of Access Control - The History and Findings of Sheridan Boulevard Access Planning”. The setting of Sheridan Boulevard when access planning began and the planning objectives were discussed. Mr. Walker explained that the plan addressed the amount and location of access, turn restrictions and potential future signalization. The implementation process for the plan and lessons learned were delineated by the speaker.

The final speaker was Mr. Mark Stuecheli, City of Overland Park, Kansas. The presentation was entitled "Trials and Tribulations of Enforcing a Locally Established, Corridor-wide, Restrictive Access Plan - Implementation of the K- 150 Study". Mr. Stuecheli outlined the experience that the city of Overland Park has had in enforcing an access management plan approved in 1986 for the K-150 corridor.

Session 7T - Models and Modeling for Access

This session focused on the use of models to simulate traffic and predict the impacts of various access management strategies.

The first speaker was Mr. Freddie Vargas with the Florida Department of Transportation. He presented a paper entitled "Does Access Management Improve Traffic Flow? Can Netsim Be Used to Prove It?". Access techniques were evaluated using TRAF-NETSIM to determine how they modify capacity and improve operational conditions on roadways. The TRAF-NETSIM model was run for a variety of scenarios and the results were evaluated. Mr. Vargas expressed a favorable experience with TRAF-NETSIM although he was surprised by the insensitivities that TRAF-NETSIM displayed in regard to a number of varied access management strategies.

The second speaker was Mr. John Taber, Taber Engineering, Utah. His presentation, entitled "Evaluating Driveway Access and Intersection Design with Multiple Measures of Effectiveness", explained the model he is developing. The model is intended to analyze access design alternatives for a multiplicity of MOEs. Mr. Taber demonstrated how the effectiveness of controlling access(es) onto the roadway or modifying the design of the intersection could be evaluated.

The next speaker was Dr. Alan Kaub with the Virginia Department of Transportation. Professor Kaub's presentation was entitled "Interactive Intersection Safety Design and the Access Management Accident (AMA) Model". Dr. Kaub described how the model was developed and discussed some of the assumptions that were employed. He presented some of the results that the model has provided to date.

The last speaker was Mr. Gary Sokolow with the Florida Department of Transportation. His presentation, entitled "Insights Into Access Management Details Using TRAF-NETSIM", addressed the usage of TRAF-NETSIM and the difficulties that can occur in determining the relative effects of driveway designs, arterial volumes, presence (or not) of driveway deceleration lanes and other factors. Mr. Sokolow warned that simulation results cannot be used without caution and care although he agreed that using TRAF-NETSIM could provide some useful insights. He displayed some results from simulation runs performed on several roadways and for a variety of alternative designs.

Workshop and Seminar

One workshop and one seminar were conducted on the Sunday before the formal sessions began. The workshop was on Highway Capacity for Non-Signalized Intersections and was conducted by Mr. Dane Ismart of FHWA. The seminar provided an introduction to access management issues for people that are new to the field. Mssrs. Demosthenes, Eisdorfer and Sokolow led this session. The highlights of the seminar are provided in this compendium.

SECTION IV

CONFERENCE SCHEDULE

Access Management

IV Conference Schedule

Sunday, August 11, 1996

1:30 pm to 3:30 pm

Workshop: Highway Capacity for Non-Signalized Intersections
Dane Ismart, Federal Highway Administration

2:30 pm to 4:30 pm

Seminar: An Introduction to Access Management Issues for People New to Access Management
Philip Demosthenes, Colorado Department of Transportation,
Gary Sokolow, Florida Department of Transportation,
Arthur Eisdorfer, New Jersey Department of Transportation

Monday, August 12, 1996

8:00 am to 9:45 am

Session 1 - What's Happening In Access Management?
Philip Demosthenes, Colorado Department Of Transportation

An Overview Of Access Management At Selected State DOT's
David Geiger, Michigan Department of Transportation,
Herbert Levinson, Consultant, Connecticut,
Jerome Gluck, Urbitran Associates, New York,
Robert Michel, Urbitran Associates, New York,
Philip Demosthenes, Colorado Department Of Transportation,
***Presented by:** Herb Levinson*

Local Governments And MPO's Implementing Access Management
Kristine Williams, University of South Florida

lo:oo am to 11:30 am

Session 2 - Public Involvement And The Selling of Access Management
Moderator: Gary Sokolow, Florida Department Of Transportation

Public Involvement And The Politics Of Access Management
Kristine Williams, University of South Florida

Marketing Of Access Management
Del Huntington, Oregon Department Of Transportation

A Process To Obtain Public Buy-In For A Retrofit Access Management Project
David Parisi, CH2M Hill, Portland, Oregon

1:30 pm to 3:00 pm

Session 3 - Legal Issues
Moderator: Richard Forester, Dispute Resolution Services, Portland, Oregon

The Interface Of Access And Land Use - Developments In The Law
Richard Forester, Portland, Oregon

Access Management And Highway Improvement Projects
Arthur Eisdorfer, New Jersey Department Of Transportation,
Lorinda Lasus, New Jersey Department Of Law & Safety,
Robert Siley, New Jersey Department Of Transportation,
Presented by: Lorinda Lasus

Property Rights May Not Be Ignored
Robert Duncan

3: 15 pm to 4:30 pm	**Discussion Session** *Moderator: Arthur Eisdorfer, New Jersey DOT* *Monday 's panelists, moderators, and audience participate in open discussion on legal issues*
Tuesday, August 13,1996	
8:00 am to 9:45 am A = Administrative	**Session 4A - The Management Of Access Management** *Moderator: Del Huntington, Oregon Department Of Transportation*
	Access Management Program Development In Oregon *Del Huntington, Oregon Department of Transportation*
	Access Management In Michigan, The Good, The Bad And The Ugly *David Geiger, Michigan Department Of Transportation,* *Jerome Gluck, Urbitran Associates, New York,* *Mark Wyckoff, Planning & Zoning Center, Lansing, Michigan,* *Presented by: David Geiger*
	An Australian Review Of Access Management And The Land Planning Connection *Raymond Brindle, ARRB Transport Research LTD, Australia*
	Road Corridor Management And Access Control In Quebec *Yvan Romvre. Ministere des Transports, Quebec, Canada*
8:00 am to 9:45 am T=Technical	**Session 4T - Signal Spacing** *Moderator: Vergil Stover, S/K Consultants, Texas*
	Signal Spacing - A Key To Access Management *Herbert Levinson, Consultant, Connecticut,* *Tim Lomax, Texas Transportation Institute,* *Shawn Turner, Texas Transportation Institute,* *Presented by: Herbert Levinson*
	Access Management Warrant In Traffic Signal Justification *Jan Thakker, Florida Department Of Transportation* *Freddie Vargas, Florida Department of Transportation* Presented By: Freddie Vargas
	Spacing, Timing And Operational Interference Between Signalized Intersections *Lee Han, University of Tennessee*
lo:oo am to 11:40 am	**Session 5A - Access Planning And Development** *Moderator: Jerry Gluck, Urbitran Associates, New York*
	Development And Administration Of An Access Management Program For Local Government *Mary Jo Vobejda, CH2M Hill, Colorado,* *William Sweeney, Town Of Parker, Colorado,* *Alan White, Town Of Parker, Colorado,* *Presented By: Mary Jo Vobejda*
	The Challenges (And Early Successes) Of A Town Initiated Access Management Retrofit Program On Two State Highways *Stephen Ferranti, New York,* *Geoff Benway, MRB Group, New York* *Presented By: Stephen Ferranti*

Access Management By Consensus, A Success Story
Freddie Vargas, Florida Department Of Transportation,
Johnathan Overton, Florida Department Of Transportation,
Presented By: Freddie Vargas

10:00 to 11:40 am — **Session 5T - Access Spacing**
TRB Committee On Operations Effects Of Geometrics
Moderator: John Mason, Pennsylvania State University

Guidelines For Commercial Driveway Spacing On Urban And Suburban Arterial Roads
Nicholas Graber, University Of Virginia,
Timothy White, Virginia Department Of Transportation,
Presented By: Timothy White

Accidents And Access Density In Oregon
Kent Lall, Professor, Portland State University
Del Huntington, Oregon Department Of Transportation
Ali Edhtedari, Portland State University
Presented By: Kent Lall and Ali Edh tedari

Comparison Of Delay And Accidents On Three Roadway Access Designs In A Small City
James L. Gattis, Mack-Blackwell Transportation Center, Arkansas

11:45 am to 1:20 pm — **Luncheon: Francis B. Francois, Speaker**
Executive Director of the American Association of State Highway and Transportation Officials

1:30 pm to 3:00 pm — **Session 6A - More On The Management Of Access Management**
Moderator: Arthur Eisdorfer, New Jersey Department Of Transportation

Variances - An Important Part Of Access Management Decisions
Arthur Eisdorfer, New Jersey Department Of Transportation,
Robert Siley, New Jersey Department Of Transportation,
Presented By: Arthur Eisdorfer

Access Management Project - British Columbia
Denise Kors, Ministry Of Transportation & Highways, Victoria, BC

Access Management Practices In Connecticut
Robert Michel, Urbitran Associates, New York,
Johnathan Chew, Houstonic Valley Council Of Elected Officials, Connecticut,
Herb Levinson, Consultant, Connecticut,
John Falcocchio, Urbitran Associates, New York,
Tanya Court, South Western Regional Planning Agency, Connecticut,
Presented By: Herb Levinson

Deviations From Median Opening Spacing Standards
Gary Sokolow, Florida Department Of Transportation

1:30 pm to 3:00 pm — **Session 6T - Geometric Design, Roadway Operation and Access**
Sponsored by the TRB Committee on Operational Effects of Geometrics
Moderator: Pat McCoy, University of Nebraska

Reducing Crashes At Driveways Close To Intersections
Peter Parsonson, Georgia Institute of Technology

Influence Of Access And Land Use On Vehicle Operating Speeds Along Low Speed Urban Street
Christopher Poe, Texas Transportation Institute,
Joseph Tarri, Pennsylvania Transportation Institute,
John Mason, Pennsylvania Transportation Institute,
Presented By: Christopher Poe

Sight Distance For Vehicles Turning Left Off Major Roadways
Russell Micsky, Gannett Fleming, Pennsylvania,
John Mason, Pennsylvania Transportation Institute,
Presented By: Russell Micsky

Warrants For Left Turn Lanes
Patrick Hawley, HNTB, Wisconsin,
Vergil Stover, Texas,
Presented By: Patrick Hawley

Tuesday Evening, August 13, 1996

5:30 pm to 9:30 pm — **Western Evening Barbecue at The 4 Eagle Ranch**

Wednesday, August 14, 1996

8:00 am to 10:15 am — **Session 7A - Corridor Case Studies**
Moderator: Eddie Shafie, Texas DOT

US 93, Somers To Whitefish, Montana - Access Management
Joseph Hart, Carter & Burgess, Colorado,
Dale Paulson, FHWA, Montana,
Jim Weaver, Montana Department Of Transportation,
Nanette Neelan, Montana,
Presented By: Joseph Hart

Corridor Preservation In Delaware
Robert Kleinburd, Delaware

A Case Study On Access Management - The History And Findings Of The Sheridan Blvd Access Plan
Robert Reish, In Motion, Colorado,
Mike Normandin, City of Westminster, Colorado,
Presented By: Greg Walker, In Motion, Colorado

Trials And Tribulation Of Enforcing A Locally Established Corridor-Wide Restrictive Access Plan - Implementation Of The K-150 Study
Mark Stuecheli, City Of Overland Park, Kansas

8:00 am to 10:15 am — **Session 7T- Models And Modeling For Access**
Moderator: Ron Giguere, FHWA Office Of Technology Applications

Does Access Management Improve Traffic Flow? Can Netsim Be Used To Prove It?
Freddie Vargas, Florida Department Of Transportation
Vivek Reddy, Florida Department Of Transportation
Presented By: Freddie Vargas

Evaluating Driveway Access And Intersection Design With Multiple Measures Of Effectiveness
John Taber, Taber Engineering, Utah

	Interactive Intersection Safety Design And The AMA Model, And Practical Design Models For Safe Intersection Spacings *Alan Kaub, Virginia Department Of Transportation*
	Insights Into Access Management Details Using TRAF-NETSIM *William McShane, Polytechnic University,* *Dae Soon Choi, Polytechnic University,* *Kurt Eichin, Florida Department Of Transportation* *Gary Sokolow, Florida Department Of Transportation* *Presented By: Gary Sokolow*
10:30 am to 11:30 am	**Closing Session** *Philip Demosthenes, Conference Chairman, Colorado Department of Transportation*
11:30 am	**Conference Ends**

SECTION V

ABSTRACTS/PAPERS

Access Management

V Abstracts/Papers - Session 1

What's Happening In Access Management?

Moderator: Philip Dentosthenes, Colorado Department of Transpotiation

An Overview Of Access Management At Selected State DOT's

Local Governments And MPO's Implementing Access Management

An Overview of Access Management At Selected State DOTS

David Geiger, Michigan Department Of Transportation
Robert Michel, Urbitran Associates, New York
Herbert Levinson, Consultant, New Haven, Connecticut
Jerome Gluck, Urbitran Associates, New York
Robert Michel, Urbitran Associates, New York
Philip Demosthenes, Colorado Departrnent Of Transportation, Denver

ABSTRACT

As part of a review of Michigan Department of Transportation (MDOT) access management practices, an in-depth telephone survey was conducted of a selected group of eleven other state departments of transportation. The information assembled on the access management policies, standards, practices, and problems of the various states was used in reviewing MDOT procedures and in identifying potential improvement options. This paper presents thefindings of the surveys and their implications for states planning to strengthen their access management activities.

PRESENTATION

Access management practices vary among states. These variations reflect differences in needs, perceptions, and precedents. To obtain information on current practices, including their strengths and weaknesses, in-depth telephone surveys were conducted of access management activities in a selected group of state departments of transportation. The surveys were performed as part of an access management study for the Michigan Department of Transportation (MDOT). This paper summarizes the information obtained on access management practices, policies, and problems; and presents the implications for states desiring to strengthen their access management activities.

I. SURVEY APPROACH

Telephone surveys were conducted with six Midwestern states -- Illinois, Indiana, Iowa, Minnesota, Ohio and Wisconsin; with three states with formal access codes -- Colorado, Florida, and New Jersey; and with two other states -- Maryland and Oregon -- that were identified in meetings with MDOT and other groups involved in the Michigan Access Management Study. Representatives from each state department of transportation and, as appropriate, the Attorney General's office were interviewed by telephone. In addition, information for Michigan was compiled for inclusion with the results of the telephone interviews.

The surveys focused on the key issues that surfaced during meetings with MDOT staff and with a group representing developers, consultants and local government agencies, external from MDOT. The surveys were intended to identify current access management practices and their legislative basis, the strengths and weaknesses of those practices, and opportunities for improvement. The information obtained included the status of access management and methods of access control; the types of rules, regulations, and/or guidelines used; the permit process; coordination practices with local agencies; case law relevant to the application of police power; and plans for improving access management.

II. SURVEY HIGHLIGHTS

The responses from each of the 12 states surveyed are summarized in Tables 1 through 6. These tabulations compare: the current status of access management, rules, regulations, standards and guidelines used; the permit process; local coordination; legal aspects and future plans.

a. Current Status of Access Management

All the states surveyed manage access to some degree. The scope of considerations, as shown in Table 1, may vary in its detail and sophistication. Most states require traffic studies prior to granting access permits for major developments. However, most do not have numerical thresholds for when studies are needed. While most consider signal progression to some degree; Colorado, New Jersey, and Wisconsin may deny signalized driveways based upon traffic signal progression requirements.

Access management is exerted through spacing standards and acquiring access rights. Almost all the states reported some spacing criteria -- the most common being median openings. Acquiring access rights, when it is an option, is viewed as the most effective and long-term means of access management. Iowa and Minnesota control access through purchase of access rights but may still permit some access onto these highways. In those instances, access is controlled through the application of spacing standards.

States generally limit the number of driveways for any given property or subdivision. Illinois and Wisconsin DOTs have authority for subdivision plat review and approval.

Most states do not have specific variance procedures or criteria, although they do have flexibility in the application of their guidelines and regulations.

b. Rules, Regulations, Standards, and/or Guidelines

States exert a variety of types of controls over access; these include advance acquisition of right-of-way, geometric design standards, driveway permit requirements, and/or access regulations. For example:

- Colorado, Florida, Iowa and New Jersey have access codes
- Oregon and Wisconsin have statutory access controls
- Iowa and Minnesota rely on advance acquisition.

c. Permit Process

All states surveyed have established a mandatory permitting process for new driveways. Six of the twelve states have established a fee for permits. This fee ranges from $30 to $12,000. Permits are normally reviewed at a regional level with optional central office review or assistance, usually for larger projects. Colorado requires central office participation when litigation is involved; Illinois and Ohio where there is a change in (purchased) access control Maryland, in contrast, performs the main reviews in the central office; Iowa requires central office review for large developments and/or situations where access rights have been acquired.

d. Local Coordination

Coordination with local agencies takes place on an ad hoc basis. Colorado, Maryland, and Wisconsin have prepared access management plans in some metropolitan areas. Minnesota becomes involved in site plan review for large developments. In Ohio, access management plans have been prepared by the metropolitan planning organizations. Iowa assigns specific people to the coordination task.

State DOTs generally have no direct authority in the land use zoning process, but they do become involved when rezoning occurs along a state highway. The state is viewed as an abutting land owner, and is therefore part of the zoning process. Site plan review occurs either informally or formally in most states, often for large projects or where highway connections are involved.

Most states do not record driveway permits in local property records.

e. Legal Aspects

Safety was reported as the main reason for access control in many states.

Courts have consistently supported DOTs when median openings are closed. Courts vary in their position when a driveway is closed. Where courts require direct access, compensation is required for any closure. "Direct Access" is used in Indiana, Minnesota, and Ohio; and is perceived to have a compensable monetary value in

Indiana and Minnesota. Iowa and Colorado can deny access to a state highway where access to a secondary road exists. "Reasonable" access is used by courts in Colorado, Maryland, New Jersey, Oregon, and Wisconsin.

Most states consolidate/close driveways when roads are reconstructed, but compensation is sometimes required. Indiana, Minnesota and Ohio pay property damages when an access is closed, Colorado and Wisconsin do not; Iowa, Maryland and Oregon may, depending on the situation.

Almost all states control access along state roads in municipalities. Wisconsin controls access up to "jurisdictional limits" (located within the municipal boundaries). Ohio is the exception.

f. Future Plans

The states are pursuing a broad spectrum of program improvements. Illinois DOT would like the state statute modified to recognize "operational integrity" in access decisions (safety is now the sole criterion). Minnesota is pursuing a Colorado-like access regulation. Indiana and Ohio cited the need for a regulation (but neither indicated strong actions now) and Illinois would like to implement some aspects of a regulation. Indiana would like internal site plan review. Oregon is developing a comprehensive set of standards and policies, and eventually a modification to their rules. Wisconsin is exploring the proper state role in access decisions, is updating its procedures and guidelines, and is trying to improve its role in land-use planning.

Despite these broad efforts, access management did not appear to be high on the priorities of top DOT officials in many states. To be effective, an access management program needs a clear mandate from top DOT management.

Negative attitudes against "more government" were also alluded to in Indiana, Ohio, and Oregon as inhibiting further activities in the development, expansion, or strengthening of access management.

III. IMPLICATIONS FOR OTHER STATES

The survey identified a wide range of practices that reflect individual state's needs, priorities, perceptions, and precedents. As one respondent indicated, "each state has its own peculiarities that must be recognized;" thus, what works well in one setting may not apply in another.

The legal basis for access management and court decisions are important determinants. The use of the police power is widely supported for median closures. Direct access is not deemed by most states to be an automatic right of property owners. Reasonable access, even with some circuity, is considered sufficient. There is a tendency to improve access management by developing or enhancing codes; but these efforts are tempered in part by the political climate, the priorities of top management, and the current trend toward less, rather than more government control.

The acquisition (purchase) of access rights was reported by all states queried as the most effective means of access management. To the extent that funds are available, states could acquire access rights (and, in turn, specify allowable spacing) where roads are relocated, new highway alignments are established, and where major upgrading is envisioned -- especially in undeveloped or developing areas. Efforts also could be directed at purchasing access rights for given distances along major highways in the vicinity of freeway interchanges.

In addition to purchasing access, more easily-implementable actions should be pursued. These include greater use of physical medians, upgrading access design standards, improving permit procedures, achieving better land-use/access coordination, and providing greater public out-reach.

a. <u>Physical Medians</u>. The installation of physical medians (as an alternative to two-way left-turn lanes) will reduce left-turn and crossing conflicts. Where appropriate, median openings to developments could be limited to left-turn entry movements with left-turn exits routed via other public streets, or by means of indirect left turns. The medians -- when coupled with spacing standards for signalized and unsignalized intersections -- would achieve many of the benefits normally resulting from access management codes. Florida, in addition to its access code, has placed priority on the use of medians and the spacing of median openings.

b. **Access Design Manual.** An access design manual could be prepared (or updated) to reflect current access management thinking and to provide better guidance to district offices, developers, and local communities. It could include:

- Specific requirements for providing left-turn and right-turn lanes.
- Spacing standards for signalized intersections. (These could be expressed as a function of through-band width).
- Spacing standards for unsignalized intersections and comer clearances.
- Access driveway design concepts, and principles (i.e., separate exit lanes for left and right turns, lining up driveways on opposite sides of a roadway, and alternative access).
- Examples of shared driveways, reverse frontage, and side street access.
- Standards for the number of allowable driveways per property.

c. **Drivewav Permit Procedures.** Improvement options involving driveway permit procedures could include:

- As required in Iowa, access plans for State highways should reflect comments from local agencies before obtaining State approval.
- Traffic impact study requirements could be set for when studies are required and what they should contain. This includes establishing numerical thresholds based on the amount of traffic generation, and requiring these studies whenever traffic signals are involved.
- Thresholds should be set for what constitutes a significant change in existing development for which a traffic study would be required.
- Criteria could be established for how and when State site plan and internal circulation reviews should be performed.
- Standards or decisions concerning the allowable number of driveways (e.g., one driveway per 200 feet of frontage).

d. **Land Subdivision Guidelines.** Model land development and subdivision regulations that support access management could be developed. A model has been developed for Florida cities and counties and may serve as a prototype. Model regulations could be given to counties and communities within a state for their use. These regulations could address:

- Applicability guidelines
- Spacing standards
- Joint access
- Access connection and driveway design
- Reverse (rear) frontage
- Requirements for out parcels and flag lots
- How to deal with non-conforming access
- Variance standards
- Site plan review features

e. **State- Local Coordination.** Since the State is an abutting land owner, it should be involved in all zoning or rezoning decisions along state highways. This is common practice in many of the States surveyed. Other improvement options could include:

- Special access management teams could be established to maintain continuous dialogue with county, regional, and local officials on land-use planning and access issues.

a Informal luncheon meetings, on a regular basis, have been identified as being effective in some of the states surveyed.

- Access management "retrofit" plans could be undertaken cooperatively with local agencies to show how access can be improved in developed areas. These plans, in turn, can be added to the local zoning and/or subdivision regulations.

f. **Driveway Consolidation.** Driveway consolidation could be actively pursued whenever major road reconstruction takes place. Every attempt should be made to ensure reasonable alternative access to minimize (or avoid) compensation.

IV. CONCLUSION

The survey observations indicate that much can be done by most states to improve their access management activities. Initial efforts should focus on improving access design standards, permit procedures and interagency dialogue. A main emphasis along roadways could involve, where possible, more widespread use of medians and redirecting left turn exits from driveways. The logical next step is to prepare a more comprehensive access management code.

ACKNOWLEDGMENTS

The paper was adapted from materials contained in "Improvement Options", Michigan Access Management Study, October 1995 prepared for the Michigan Department of Transportation by Urbitran Associates, Inc. in association with Planning & Zoning Center, Inc.; Herbert S. Levinson; Philip Demosthenes; Rossman Martin & Associates; and Miller, Porter & Muller.

Table 1: Current Status of Access Management

State	Methods of Access Control	Access Code	Spacing Standards	Traffic Impact Studies	Traffic Signal Progression	Variances
Colorado	Purchase of rights Comprehensive code	Yes	Yes	For trip generation >I00 per hour	Yes	Procedures in code
Florida	Access Management Act	Yes	Yes	Traffic study for only those over 1,200 veh per day	Yes	Procedures in the new rule of 14-96
Illinois	Purchase of rights State access policy	No	Only for corner clearances	Required, but usually waived for small developments	Some consideration	Negotiated appeal
Indiana	Purchase of rights Guidelines	No	Guidelines for signal, drive-ways, streets and median openings	Where traffic signals are involved	Some consideration	No procedures
Iowa	Purchase of rights Administrative rule	Yes	Yes	For developments with more than 150 peak-hour vehicles	No mention in access code	Centralized process
Maryland	Purchase of rights State access policy	No	Standards for drives, streets, and median openings	For developments which generate more than 50 peak-hour trips	Some consideration	Not applicable
Michigan	Statute and administrative rules	No, but has some formal regulations	Only for corner clearance	May be required for major developments	No mention in statute or rules	Hearings and appeals process
Minnesota	Purchase of rights Using authority of Commissioner of DOT	No (drafting of one in progress)	For corner clearances and median openings	Required for major develop-ments	Considered, but no statewide policy	Not applicable
New Jersey	State Access Code Purchase access rights	Yes	Yes	For developments with 200 or more peak-hour trips	Considered after spacing criteria -- Yes	Waivers in code
Ohio	Purchase of rights	No	None	Required for high volume driveways	Minor consideration	(No Response)
Oregon	Purchase of rights Driveway standards in administrative rule	No	Yes (Guidelines)	At discretion of review manager	Considered, but more refined standards in development	No systematic variance procedure
Wisconsin	Statutory access control - may freeze access	No (has policy though)	Yes (Guidelines)	Not required	Considered	Not applicable

Table 2: Rules, Regulations, Standards, and/or Guidelines

State	Current Practice	Flexibility/Consistency	Court Challenges
Colorado	Administrative rules	Limited leeway	Active - Courts generally support code
Florida	Administrative rules	Very flexible	Occasionally
Illinois	Administrative rules	Reasonable consistency achieved	Rare. Agreements usually reached out of court
Indiana	Regulations for median openings Rules for purchase of access rights	Very flexible Reasonable consistency achieved	'Over median closings
Iowa	Administrative rules	Some flexibility	Rare
Maryland	Regulations give State right to place limits on access	Very flexible, but consistency obtained through training	Mixed history
Michigan	Administrative rules	Very flexible	Rare
Minnesota	Rules for corner clearance Design guideline for other features	Very flexible	Support access practices
New Jersey	Administrative rules	Flexible in some features	Few. Code generally supported in court
Ohio	Design Manual	Very flexible	Support DOT decisions
Oregon	Administrative rules covers driveway design and spacing	Flexible	Mixed history
Wisconsin	"Facility Development Manual" for guidelines and rules for program development. Statutory Access Control	Reasonable consistency achieved	Support access practices

Table 5: Legal Aspects

State	Legal Basis	Police Power -- Direct versus Reasonable Access (1)	Property Damages	Enforcement	Control of Municipal Streets
Colorado	State statute	Supports reasonable access	Not paid	Formal, through courts	Yes, if State Road
Florida	State statute	Supports reasonable access	Not usually	Formal process	Yes, if State Road
Illinois	State statute	Access can be denied only for safety reasons	In some cases	Notification, then through courts	Yes, if State Road
Indiana	State statute	Direct access can be denied for safety reasons	(No response)	(No Response)	Yes, if State Road
Iowa	State legislation	Can deny direct access where alternate public access is available	In some cases	Notification, then through courts	Yes, if State Road
Maryland	In broad sense, code of Maryland regulations	Reasonable access must be provided	In some cases	Notification or District Engineer may block drive	Yes, if State Road
Michigan	State statute	Reasonable access must be provided	In some cases	Notification	Yes, if State Road
Minnesota	Legislation defining DOT operations	Direct access can be denied only where access control is purchased	Where commercial drives are closed	Area Maintenance Engineer makes contact, may block drive	Yes, if State Road
New Jersey	State legislation	Reasonable access must be provided	Generally not	Owners notified with 30 days to remedy	Yes, if State Road
Ohio	Internal department directives	Direct access must be provided unless access rights are purchased	Where commercial drive closed	In accordance with State statute	None
Oregon	Different activities supported by different legislation	Reasonable access must be provided	Where commercial drive closed	Defined procedure initiated by notification	Yes, if State Road
Wisconsin	Department policy, based on State statute	Reasonable access (not direct) must be provided	Usually none	Owner notified, County closes on behalf	None

(1) Where access rights have not been purchased.

Table 3: Permit Process

State	Process and Procedures	Fees	Permit Review
Colorado	Defined process for permits Required for 20% increase in size or trip generation	$50 - $300	At District Offices Central Office only is involved where there is litigation
Florida	Defined process for permits	$50 - $5,000	At District Offices
Illinois	Defined process for permits	None	At District Offices. At Central Office where there is a change in access control
Indiana	Procedures set forth in Permit Handbook	$150 -$300	At District Offices
Iowa	Defined process for permits	None	At District Offices Large developments (>150 trips in peak hour) reviewed at Central Office
Maryland	Defined process for permits	$50 per entrance	At Central Office with local input
Michigan	Defined process for permits	$30 - $700	At District Offices Central Office may be involved in major project
Minnesota	Defined application process	None	At District Offices
New Jersey	Defined process for permits	$35 up to $9,000	Minor permits at Regional Office Major permits at Central Office
Ohio	Defined application process	Yes	At District Office, except where State has purchased access rights
Oregon	Defined process for permits	$50	At District, Regional or Central Office depending on size of project
Wisconsin	Defined process for permits	None	At District Office

Table 6: Future Plans

State	Existing Programs		Possible Improvements
	Strengths	Weaknesses	
Colorado	Established code with sound design standards	Bad engineering decisions	Better standards
Florida	**Access** code. Restrictive median policy	Lack of staff	Better training programs
Illinois	Flexibility	Lack of consistency and precedents	State statute should recognize operational integrity
Indiana	Flexibility Extension of purchase rights	Inability to control internal circulation	Input on site design More comprehensive management program
Iowa	Ensures proper spacing of access points.	Openings constructed at defined locations even if not needed	None
Maryland	Flexibility	None perceived	None
Michigan	Flexibility	Standards need updating	Considering improved administration, procedures, guidelines/enforcement
Minnesota	Advance purchase	Needs more proactive plans	Comprehensive "multi-functional" policy for State and County highways
New Jersey	Comprehensive and well publicized code	Definition of significant increase in traffic too high, complexity	None expected
Ohio	None cited	No consistent set of procedures	Develop comprehensive access code
Oregon	DOT involved in land use planning process	Lack of variance procedures Standards are not part of rules	Adopt new rules and statues
Wisconsin	Broad scope Flexibility Consistency	Lack of follow-through capabilities Division of land-use responsibilities among State agencies	Update guidelines Change driveway permit procedures Redefine State role in land use planning

Access Management At The Local And Regional Level

Kristine M. Williams, AICP, Center for Urban Transportation Research, University of South Florida

PRESENTATION

Metropolitan planning organizations, regional planning agencies, and local governments are advancing access management in a variety of ways. Metropolitan planning organizations are incorporating access management into their corridor plans, congestion management programs, and safety management systems. Corridor management and improvement plans have provided a forum through which MPOs have facilitated collaboration among the state and local agencies with jurisdiction over a corridor. Some MPOs are also providing technical assistance to local governments on development of access management plans and regulatory strategies.

A more comprehensive approach to access management is also emerging at the local level-beginning with the comprehensive plan, extending to specific planning studies, and encompassing a broader range of land management strategies. For example, access management can be facilitated through land use strategies that discourage strip development and promote clustering of land uses into unified developments with shared access systems.

Access management has also been used to advance growth management objectives. Discouraging urban sprawl, maintaining roadway level of service, protecting community character, and coordination and consistency of land use and transportation decisions are areas where access management and growth management converge.

Local methods of regulating access vary widely. Some communities apply access management requirements only to designated corridors through a corridor overlay ordinance, allowing them to target access standards to the unique circumstances of a specific corridor. Service drive requirements have also been added to planned unit development (PUD) zoning and applied to developing commercial corridors. Other communities integrate access management principles and regulations into their entire planning and regulatory program.

This presentation reviews a few examples of the diversity of local and regional approaches to access management. For additional information on these strategies and examples, see NCHRP Synthesis 233: Land Development Regulations that Promote Access Management, Transportation Research Board, Washington, D. C. : National Academy Press, 1996.

Access Management

at the Local and Regional Level

Kristine M. Williams, AICP

Center for Urban Transportation Research

MPOs and Access Management

- Long Range Plans
  - congestion management systems
  - safety management systems
- Corridor Initiatives
  - collaborative approaches
- Technical Assistance

Regional Initiatives

- Corridor management and improvement plans
  - CRCOG - Hartford, Connecticut
- Access classification studies
  - Pinellas County MPO - Florida

Regional Initiatives

- Access management plans and agreements
  - East Central Wisconsin RPC/ Waushara County
  - Charlotte-Mecklenburg, NC Joint Policy Agreement

Access Management at the Local Level

- Comprehensive Plans
  - Integrating transportation and land use
  - growth management strategies
- Land Development Codes
  - coordinated regulatory strategies
  - broader range of techniques

Local Strategies

- Special corridor zoning
  - Austin, Texas - Principal Roadways, Hill Country Roadways
  - Fairfax County, Virginia - Highway Corridor Overlay District

Local Strategies

- **Joint and cross access**
  - Orlando, Florida - cross **access corridors**
  - **Sharonville,** Ohio - **PUD service** drive **provisions**
  - Frederick County, **Virginia** - addressing **lot splits**

Local Strategies

- **Overcoming piecemeal and strip development**
  - **Province of** Newfoundland - cluster zoning on highways
  - **Acton,** Massachusetts - transfer of development tights **(TDR)** on commercial **corridor**
  - Orange County, **Florida - specific** plans and **TDR** program

Local Strategies

- Comprehensive approaches
  - Washington **County,** Oregon - planning and regulatory strategies
  - **Orlando,** Florida - planning and **regulatory** strategies
  - **Broward** County, FL - **countywide trafficways** plan
  - Gloucester County, NJ - **comprehensive** access management code

Questions and Answers
What's Happening In Access Management

An Overview of Access Management at Selected State DOT's
Local Governments and MPO's Implementing Access Management

Question I: What proactive things can be done to build communication between state and local officials?

Herb Levinson: Communication can begin through the idea of doing things informally while working together as a team to build confidence in each other. Informal lunch meetings could be a forum to sit down cooperatively. State officials have a tendency to not get into specifics, but to act as more of a liaison. State officials need to also take a hands-on approach.

Kristine Williams: In Florida, a model land development code was developed for cities and counties. This model examined a combination of regulatory strategies from urban, suburban and rural areas across Florida. The strategies were pulled together into a comprehensive code along with descriptions of how to implement this type of approach.

This model land development code has been presented through a series of training workshops across the state. Most local communities have been very receptive, and they have recognized the benefits it offers to the roadway system. The major issues have been:

1) How do we do this?
2) Is this legal?
3) Where should we start?
4) How are we going to coordinate with the DOT on permitting issues?

The training workshops have been an important forum for stimulating dialogue on these important issues. DOT districts and local governments have begun to work together on these issues.

It is recommended to look at model regulations and the best practices from around the country to see how other areas are doing things and what can be borrowed.

Question 2: Are there any sections in codes or regulations that deal with economics as it relates to development (development that improves the corridor)?

Herb Levinson: One broad construct of access management is to balance economic development and access against safety and mobility. Studies have shown that for small developments, such as a gas station or a McDonald's, less traffic will make left turns to enter if there is more traffic on the road. Most large developments are more concerned about allowing left turns to enter the site than exit the site.

Cambridge Systematics did a study of types of land uses adversely affected by medians or other access restrictions. No strong correlations were found, but pass-by type activities were more adversely affected. Peter Parsinson did a study in Georgia and found relatively few negative impacts with the closing of medians.

It is effective to have access management plans in advance when property is still vacant. This helps insure that as the area develops access can be provided while the quality of the highway is maintained.

Question 3: How many of the corridors you examined had the ability to go in and retrofit or add capacity to *the corridor in addition to instituting access management?*

Kristine Williams: Corridor initiatives are much more difficult when they are dealing with a retrofit situation. Corridor initiatives are much more limited in the retrofit context in what they can do after the fact. Retrofit initiatives do not realize the improvements that initiatives done through a more proactive strategy do.

Question 4: Are there are methods for rationally determining how much capacity you can hope to regain through access management?

Philip Demosthenes: Yes there are methods for determining this, and people will be covering these methods in this conference.

Question 5: Are seminars designedfor local governments, property owners or combinations of these groups?

Kristine Williams: Seminars are done for local governments, but notices are sent out to encourage local developers, citizens from the citizens advisory council or whoever wants to attend. The seminars are targeted toward planners, policy makers and engineers in the community. The seminars try to bring together representatives from the DOT district, the MPO, and local governments to hear each other's concerns and issues.

Learning activities are built into the seminars that allow participants to deal with issues in the context of their local area. This allows the participants to work out strategies through talking with one another.

Elected officials are often reluctant to attend workshops. If this is the case, a video can be developed that deals with access management issues. For example, District 5 of the Florida Department of Transportation has produced a video on median improvements, access management and the benefits it offers to a community.

Question 6: Are there any instances where landowners along a corridor are brought in to educate them to the benefits that may be gained through a retrofit?

Kristine Williams: Corridor initiatives are not likely to be successful if some method of dialogue with property owners is not included. Every successful initiative has some method for doing this. It could be special meetings with interest groups or other methods of keeping people informed along the way. Open house meetings will be discussed in the session on public involvement.

Question 7: What is the time frame that units of government look at for retrofitting a corridor?

Kristine Williams: The timing is related to your work program and the constraints it poses. It should be attempted to minimize the delays in the process. Bringing people into the process in the early stages will reduce delays later on in the process.

Question 8: Is joint access most often voluntary?

Kristine Williams: Voluntary joint access is similar to voluntary taxes. You will be lucky to get voluntary joint access and probably will not get it unless people see that it really benefits them.

Flexibility in administration and a comprehensive approach should be emphasized. All options should be examined, from ("can joint access be achieved" to "is joint access totally impractical". Flexibility needs to be built into the administrative procedures so as much as possible can be handled at the professional level. If things are booted up to the zoning board of appeals, the applicant is likely to attract sympathy. The professional needs to work with the applicant at the time of the application.

Question 9: Is there legal basis for requiringjoint access?

Kristine Williams: Case law is fairly clear, it supports reasonable strategies based on policies that are part of some kind of planning effort. Policy must be set to show that the joint access requirement is not an arbitrary thing being done on a case by case basis, but that there is something that is trying to be achieved that is in the public interest. You should also attempt to do everything that is possible through the variance process to avoid placing hardship on the property owner.

Question 10: Are there any methods to get people to attend meetings held in advance of retrofit projects?

Kristine Williams: You can try to find someone to attend the meetings that the people trust, such as a chamber of commerce representative or a member of an advisory committee. Another approach is to talk to people on an individual basis, bringing the process to them through a special meeting.

Question I I: How does a concurrency management type of plan work?

Kristine Williams: Concurrency can be defined as maintaining adequate infrastructure to serve the impacts of the development as these impacts occur. It is the provision of adequate public facilities. Communities in Florida are required by the Growth Management Act to maintain adequate concurrency and Level of Service (LOS).

Access management issues do affect LOS and capacity. We are beginning to see models of right-of-way preservation with concurrency. This entails the dedication of right-of-way along the corridor to serve your business.

V Abstracts/Papers - Session 2

Public Involvement And The Selling of Access Management

Moderator: Gary Sokolow, Florida Department Of Transportation

Public Involvement And The Politics Of Access Management

Kristine M. Williams, AICP, Center for Urban Transportation Research, University of Florida, Tampa

ABSTRACT

Access management poses both technical and political challenges. Efforts to control access, such as restrictive medians or driveway controls, tend to be highly controversial. They are often perceived as a threat to the viability of corridor businesses. Property rights, the potential for cut through traffic, the circuity of access, and adequate **access** *for trucks are among the other issues that frequently arise in relation to access controls.*

Access management initiatives have been impeded or derailed because the public was not involved in the decision process or was involved too late for meaningful debate. Without a process for responding to public concerns, planners and engineers will likely face intense political pressures to concede to demands for unrestricted access. This also increases the prospects for administrative hearings or costly litigation and reduces the potential for a successful outcome. Alternatively, an effective public involvement program can ultimately safeguard an access management program against arbitrary or undesirable changes and can result in better solutions.

The Center for Urban Transportation Research (CUTR) under the direction of the Florida Department of Transportation has recently completed a study on public involvement in transportation, principles of public involvement, and research findings on how to effectively involve the public in access management decisions.

PRESENTATION

Government actions that affect property access, such as restrictive medians or driveway controls, tend to be highly controversial. Circuity of access, impacts on business sales, potential for cut through traffic, adequate access for trucks, and the safety of U-turns are among the issues that frequently arise in relation to access controls. Without a process for responding to public concerns, planners and engineers will likely face intense political pressure to concede to demands for unrestricted access.

Access management initiatives have been impeded or derailed because the public was not involved in the decision process or was involved too late for meaningful debate. Excluding the public from the decision process fuels suspicions and increases the likelihood of public opposition. This can suspend or delay an action, increase the prospects for costly litigation, and reduce the potential for a successful outcome. Alternatively, an effective public involvement program can ultimately safeguard a program or project against arbitrary or undesirable changes.

The need for improved public involvement in access management has come to the forefront as a growing number of state and local governments seek to develop or expand access management policies. Without a process for involving the public, agencies will have difficulty managing the politics of access management decisions. This paper reviews some of the principles of public involvement, as well as strategies and techniques for effectively involving the public in access management decisions.

EFFECTIVE PUBLIC INVOLVEMENT

The traditional public involvement process relies on public hearings, both to inform the public and to elicit public reactions. Although public hearings are useful for establishing an official record of project decisions, they are not an effective forum for resolving public concerns related to controversial issues. Instead, they require the public to react to decisions and therefore tend to be highly adversarial-especially where affected persons have otherwise been excluded from the decision process.

Typically, the public has developed misconceptions about the project through rumors or incomplete media reports. Those most affected by the project-usually those with the most to lose-are more likely to invest time and energy in attending the hearing. Frustration grows due to procedural formalities, such as limits on the length of comments, or inability to see displays. Some may also feel intirnidated by polished presentations and having to speak into a microphone in front of a crowd.

Unaccustomed to the public spotlight, some citizens may become emotional or even militant, using uncompromising and inflammatory language. A vocal opponent may use the hearing as an opportunity to obtain public sympathy and rally opposition. Suspicious of agency intent or assumptions, the public may be easily swayed. This can cause a public hearing to deteriorate into an arguing match.

Public hearings are more of a legal precondition to agency decisions, than an occasion for citizen involvement. They are typically ineffective as a primary public involvement technique because they are held too late in the decision making process. At that point citizens often feel their concerns will be ignored or that only powerful parties will have any influence.

Early and Continuing Involvement

The preferred alternative is to involve affected groups early and often in a decision making process so their concerns can be considered in proposed alternatives. Edison Electric Institute, which relies on public involvement techniques when siting electric utilities, advises the following:

> "An effective public participation program must be instituted early in the project planning process to obtain meaningful input from interested parties. Project developers must prove to the public that their concerns and ideas will be given serious consideration."'

Even where an action is contrary to the position of a participant, he or she may still accept that project if the process that produced it is legitimate. Says Ervin, et al., for controversial development issues: "Procedures, rather than actual decisions, appear to be the origin of most people's perception of political legitimacy."[2]

The public involvement process should begin early and parallel the decision process so public concerns can be addressed in proposed solutions. Not only will this increase the legitimacy of a decision, it will also help with managing political appeals by demonstrating that the agency is committed to achieving balanced solutions. The public hearing would later ratify a decision that has already been informally worked out. This does not mean total agreement will have been reached, only that every effort has already been made to reach an agreement.

PRINCIPLES OF PUBLIC INVOLVEMENT

Public involvement implies a role for the public in agency decision-making. It goes beyond informing the public or allowing an opportunity to comment-although these are important components of any public involvement program. It also requires a mechanism for responding to public concerns and ideas. Adhering to minimum statutory requirements meets legal preconditions, but is rarely sufficient from a social or political perspective.

An objective of involving the public in access management initiatives is to achieve solutions that are both politically acceptable and technically sound. It is generally unrealistic to expect consensus for decisions related to controversial issues. Instead, strive for consentdefined in this context as "a grudging willingness to go along." At a minimum, affected parties should be able to acknowledge that the proposed action is needed or at least is better than doing nothing.

Planners and engineers must also develop skills for managing the differences that arise when diverse interests are given a voice in the decision process. Dealing with diverse interests requires strong communication skills and an understanding of the limits and objectives of the public involvement program. Knowledge of the following principles is useful for managing public opinion on controversial projects or initiatives. Several are also applicable to working with applicants in permit situations.

Process Issues

Satisfy process ***values.*** Consent is most likely to be achieved when the process values of affected parties have been met. In other words, participants should generally agree that the decision-making process is fair and reasonable, that they are being heard, and that their concerns are being considered. Explains public involvement specialist James Creighton, "When decisions are controversial, public involvement is a means of demonstrating the equity of the decision-making process to the public."[3] In particular:

- People will be less likely to accept a project or decision if they feel it is being imposed on them or that the process that produced it is not legitimate.
- Affected parties are more likely to accept some hardship, if they have been eated fairly in the decision making process.
- Political appeals can be more effectively managed if it can be demonstrated that a constituent's concerns have been carefully weighed.
- Those that refuse to participate in the decision process, only to later become vocal opponents, tend to lose credibility (provided you can demonstrate that they were invited to participate and refused).

Begin early and minimize the number of ***steps.*** Concerns raised early in a decision process are more likely to be resolved. Involve interested parties early enough to provide for meaningful involvement and allow enough time for assisted problem solving. At the same time, avoid dragging out the process. Encourage early resolution of issues and minimi ze the number of steps required for achieving a decision.

Rove to thepublic that their concerns will be addressed. Make it clear to participants that there is a process for considering modifications and show a willingness to make changes in response to valid public concerns. Experts in personal leadership advise that "being influenceable is the key to influencing others."[4] However, this does not mean that changes will always be warranted. The challenge is to balance technical considerations and public concerns, while advancing access management principles. Even where nothing should be done to change the project or regulation at hand, it is important to let the public know that their concerns have been considered and why no better solution could be achieved.

Maintain continuity of involvement. Different "publics" tend to get involved at different stages of a project or initiative. In addition, more people tend to get involved as the effort progresses. This is because issues that may be obscured in the planning phase, come to light in the design or alternative selection phase when people can more clearly see how proposed changes will affect them. Therefore, it is essential to have opportunities for involvement at each milestone of the decision process. Document concerns received and responses (to demonstrate decisions that have already been made through public dialogue), and if you are undertaking an extended decisions making process, keep it visible through newsletters, press releases or other forums. Be prepared to accept some repetition of information and relearning by newer participants, but use documentation of past decisions to help keep things moving.

Achieve clear resolution and provide prompt feedback. Nothing is more damaging to the credibility of a process than failure to resolve issues and follow-up with participants on decisions made in response to their concerns. Summarize the key recommendations or concerns that were expressed, the official response, and any future opportunities to participate. If additional analysis is called for, then it should be completed as soon as possible after meeting with affected parties and obtaining their concerns or comments. Clearly resolve the major issues or concerns. Although consensus is generally unattainable, it is important to achieve some resolution of the issues-ven if some remain unsatisfied.

Never try to slip a controversial decision past the public. Even if you can get away with this, the affected parties will find out eventually and your project (and possibly even your entire access management program), will be living on borrowed time. The damage to your agency's credibility will be difficult to reverse, and the potential for future retaliation will be high.

Managing Diverse Interests

Be inclusive. The objective of public involvement on controversial projects is to bring public concerns to the forefront so they can be debated and resolved. Seek out major stakeholders and actively solicit their involvement. Also, never exclude anyone who wants to participate. This creates suspicion of agency intentions and could transform a potential participant into an opponent.

Build networks and keep the lines of communication open. Relationship-building is crucial to long term success. Get to know agency decision makers, as well as legislators and community leaders, and keep the lines of communication open. Be available to the public and respond promptly and courteously to calls, letters, complaints, and requests for information. A prompt and courteous response will help avoid unnecessary conflicts and maintain relationships. Many misunderstandings have been created because the lines of communication were not adequately open between the agency and the public.

Be a good listener. The natural tendency in resolving disputes is to begin with an appeal to logic. This automatically puts the professional in the position of defending a particular course of action. In controversial situations, it is advisable to first establish your credibility as someone who is capable of reaching a fair decision. This means being an active listener and demonstrating an understanding of the range of concerns, before attempting to explain the logic behind the project or action.

Seek to clearly understand public concerns. An accurate diagnosis of public concerns is crucial to reaching a compromise. Learn as much as possible about the concerns and values of your audience. Begin by identifying the influential groups and their basic position toward the objective. If you don't know or understand their position, then ask them to explain it. Says planning strategist Jerome Kaufman, "whatever the concerns of the target groups, strategists should know about them in specific terms so they can anticipate or lesson perceived negative aspects."' It is surprising how often simply talking through the concerns of all those involved in a decision, will lead to discovery of an acceptable solution. Also seek to identify perceived positives of the project.

Separate interests frompositions. Position statements tend to be unilateral; for example, "we oppose driveway controls." To find common ground, it is necessary to identify the interests or concerns behind the position. Examples might include, concern that customers will stop frequenting the business, concern about through traffic in a neighborhood, and so on. These concerns may then become criteria for evaluating the various alternatives. For example, one criteria may be that the solution minimize through traffic in the neighborhood, and another might be that businesses have convenient access. The government agency may also add criteria, such as minimizing vehicular (and vehicular/pedestrian) conflicts, minimizing the overall number of driveways, reducing exceptions from standards, and so on. For clarity of decision making, the various criteria may be weighted according to perceived level of priority.

Try to maximize mutual gain. Some interests converge or are compatible, and thus provide a basis for agreement. For example, closing median openings or reducing the number of driveways not only satisfies those wishing to improve safety, but these actions can also appeal to those interested in beautifying a corridor. Public investment in landscaping can also benefit corridor businesses by improving the image of the corridor as a place to shop. At the same time, new concerns may arise. For example, landscaping might raise safety concerns regarding sight distance. Attention to this issue could then become part of the overall negotiated outcome.

Try putting the shoe on the other foot. If a group actively opposes available alternatives, then try letting them draw up their own solution. Provide technical assistance as needed and subject their solution to an honest evaluation. Sometimes, this will stimulate their understanding of the difficult trade-offs and gain their acceptance.

Clarify the parameters of access management decisions. The public should be informed of any access management laws or regulations up front, as these are important parameters of the decision process. This will help keep alternatives within the realm of possibility and avoid creating unrealistic expectations. In addition, because access management programs require some flexibility, it is highly advisable to establish a procedure for reviewing requests for deviation from access management standards. This should include review by a committee of professional engineers and planners, as well as clearly documented parameters for reviewing the technical soundness of proposed alternatives! A fair and objective review of alternatives proposed by the public is essential to maintaining credibility of the access management program. In addition, technical and policy parameters help in avoiding outcomes that are not technically sound.

Be prepared to establish need. An audience that disputes the need for a proposed access management action will be less receptive and less willing to compromise. Establish why the action is important as well as what must be done. Avoid relying on agency standards to justify a decision- stating that "this is our standard" is simply not a sufficient response to public concerns. Construct a convincing argument using data on accidents, injuries, property damage, or increases in traffic volumes to demonstrate need. Do preliminary traffic engineering analyses prior to a proposed median project or corridor retrofit to demonstrate how change has negatively affected the corridor and why the project is needed. This provides the logical basis for explaining the value of a proposed alternative to the public and why other alternatives were not selected. Before and after studies of other similar corridor projects are valuable for demonstrating project benefits.

Avoid hasty concessions or commitments. Some try to appease others by making concessions. This can backfire when managing diverse interests and rarely produces a lasting solution. Avoid committing to a project change without first considering the ramifications. Advise the concerned parties that you will look into the matter. Be aware that an approach that is popular with one group may incite the wrath of another In addition, a premature commitment that later must be revoked would put the project manager, and the agency, in an awkward position.

Keep thorough records. The political process can be fraught with pitfalls, including sudden reversals on previous agreements or attempts to influence the process through misinformation. It is extremely important to maintain good records of all persons notified or contacted, each meeting, and any issues discussed or decisions made. Keep thorough notes, put as much as possible in writing, and maintain everything related to the process on file.

PUBLIC MEETINGS

Public meetings are a versatile public involvement technique, as they can be used in combination with any number of activities. They have a dual purpose-to furnish information to the general public, and to obtain public comments on a current or proposed project. Public meetings could be held throughout the life of a project to heighten community awareness, obtain public feedback, and involve the public in project decisions. For controversial projects, public meetings are an essential intermediary step before conducting public hearings.

Small group or one-on-one meetings are useful to discuss specific issues that are of concern to a particular group or individual. These meetings can be anticipated with local officials, business or other interest groups, neighborhood associations, legislative representatives, and property owners. Small meetings tend to be more productive when they are less formal and encourage open discussion. Sometimes, the group will request a presentation. If so, keep it brief and informal and allow substantial time for discussion. If possible, attend a regularly scheduled meeting of that group or organization.

Open House Format

An open-house format promotes an open exchange of information between citizens and project staff in a casual, relaxed atmosphere. This format can be used for public meetings as well as public hearings. Open house meetings involve no formal presentations. Instead, displays are exhibited and the public is invited to study them at their leisure, with the project manager and technical specialists available to answer questions or note unanswered concerns.

Because no presentation will be made, exhibits of proposed alternatives should be clear to a lay audience and citizens should be able to interpret them with little or no explanation. They should be supplemented with handouts that include the drawing along with some facts and information on the issue at hand. Handouts could include:

- a welcome letter that briefly describes how the open house forum works and how citizens can submit comments
- a graphical depiction of the location and design of a project
- a description of a project and a statement of need or purpose
- a brief description of the decision process, including the timeline for decision making and deadlines for submission of comments

An open invitation should be extended to all those who would like to participate. Special effort should be taken to inform and invite stakeholders and those directly affected by the project. For corridor projects, this should include those who own as well as lease property on the corridor, and may include neighborhood associations and other civic or business organizations. Flyers advertising the meeting should be posted in highly visible locations near the project and distributed by hand to all businesses along the affected corridor. A notice of the event should also be published in the local newspaper and sent directly to any organizations that may have an interest in the outcome.

Attendance may be staggered by inviting different groups to attend at different times. This allows the project manager to more thoroughly address the needs and concerns of a particular group at different phases of the meeting. If this alternative is chosen, be sure to indicate that anyone may still attend at any time. The meetings should be held during non-work hours or on the weekend, unless the primary participants are retirees. Typical times run from 4:00 pm to 8:00 pm or 5:00 pm to 9:00 pm.

The room should be set up with information tables should be set up at the entrance of the meeting place and each participant should be required to sign in before receiving a copy of handouts. A "greeter" should staff this table to explain the handouts, provide comment cards, and direct the public to the displays inside. Exhibits should be displayed and a separate table could also be set up with a box for comment cards. Another option is to set aside an area with chairs so participants may view a videotape. For a public hearing, a court reporter should also be available to record lengthier comments.

With public hearings, even general acceptance can be overturned by a highly vocal minority. The open house format helps reduce counterproductive confrontations with the public, while maximizing direct communication with affected property owners regarding their specific concerns. Those wishing to grandstand have no platform for speechmaking. The number of meetings may be minimized by combining several meetings into one, and thus is less expensive in terms of staff time. And participants may come and go at their convenience, rather than waiting through lengthy harangues.

Charettes

A charette is a useful meeting format for resolving an impasse or for focusing on a single issue with a range of potential solutions.[7] Originated by architects, the charette has traditionally been applied to physical design issues. For example, the Florida Department of Transportation has used charettes to address public concerns over bridge design prior to reconstruction.

For access management, a charette could be part of an effort to develop a corridor access management plan or when exploring design alternatives for a major median project. A charette allows citizens and interest groups an opportunity to gain hands on experience with the problem at hand, under the guidance of technical staff and a professional facilitator. The charette may be a day long event, or last a few hours, depending upon the issue. It typically involves extensive preparation and resources, such as graphic materials, slides of different alternatives, maps, overlays, and aerial photographs.

Charettes are beneficial in that they can generate enthusiasm toward a project, build public ownership in the solution, and educate both the public and the agency about the trade-offs involved in selecting an appropriate alternative. Project planners and engineers provide the technical knowledge essential to explore proposed alternatives from a traffic operations, policy, and design standpoint. Affected citizens provide insights into the needs and issues they face in relation to the corridor and the project.

GAUGING PUBLIC OPINION

One of the most common difficulties related to access management is the tendency for opponents to be far more active than supporters. The traveling public, which is more likely to support access management, is often not represented at public hearings. Elected officials, faced with an irate constituency, often react as if the opposition were the majority view.

One way to overcome this problem is to conduct a survey or poll to obtain public opinion related to access management and related improvements. The Florida Department of Transportation (FDOT) has used opinion surveys to assess public attitudes about the impacts of median projects and has found opinions to be generally favorable. A recent survey by FDOT District V, for example, indicated that the majority of drivers surveyed felt traffic flow was improved (84%), the roadway was safer (78%) and that they did not feel unduly inconvenienced by having to make U-turns (57%).* Favorable results such as this can be used in selling future projects to the public.

All agencies involved in access management should initiate a process for monitoring actual impacts of access management actions and documenting this information for future use. Before and after studies of similar projects can be invaluable in achieving future support-especially when the study is within the agency's service area. This could be accomplished through opinion surveys, evaluation of operational and safety impacts, information on business activity, and so on. Monitoring actual impacts will provide essential information that could assist in allaying public concerns in future access management efforts. It will also indicate impacts that may not have been anticipated and could be avoided in future projects.

Another more qualitative survey, the visual preference survey, can be used to identify corridor design characteristics that citizens prefer. This technique, developed by architect Anton Nelessen,[9] could be applied for median projects or corridor access management projects as follows. Several images of access-controlled corridors and non access-controlled corridors could be displayed on slides, with some from the affected community. Citizens would be given about 5 seconds per slide to rate the image on a scale of +l 0 to - 10.

After the survey, citizens are given a questionnaire and are asked to write down additional comments. The results would be synthesized into the 10 most positive and negative images. The visual preference survey can be helpful in providing the support of public opinion for restrictive medians and other access management improvements, as these tend to be rated highly on their aesthetic qualities when compared to typical commercial strip development.

Focus groups are an effective way of assessing public opinion regarding policy directions and regulatory alternatives. A focus group involves a small group discussion with a professional facilitator. The agenda is focused on answering only a few key questions and the emphasis is on identifying points of agreement as well as diverging opinions. Focus groups could be held to obtain the views of a particular group related to an access management or median initiative, or to obtain a random cross section of views from various groups. For example, a focus group was held by FDOT consultants with Florida developers to identify developer attitudes toward various techniques for right-of-way preservation.

DESIGNING A PROCESS

It is helpful to prepare a public involvement plan for each project in the work program to establish the appropriate level and sequence of public involvement activities. Large controversial projects, such as a corridor access management plan or an access management ordinance, require the most extensive public involvement program and public involvement should be carefully integrated into the decision-making process. Decisions affecting only a few property owners may require little involvement beyond notification.

The plan may be only a page or several pages in length, depending upon the nature and complexity of the project. It should also identify:

- who in the agency should be involved;
- whether outside expertise will be needed to assist with public involvement activities;
- major issues to be addressed in the decision process;
- who should be notified and involved; and
- what techniques will be used."

Aside from clarifying who does what, when, why and how, it can also be useful in facilitating management support for a public involvement process. The plan is a reference, and may need to be revised as circumstances change or more information becomes available. Public affairs officers or public involvement coordinators can assist with various public involvement activities, but primary responsibility for preparing and implementing the public involvement plan should rest with the project manager or consultant. This helps to assure continuity of involvement and provides a knowledgeable point person for public comment throughout the decision process.

It is also essential to gain a basic understanding of the decision context. For example, is there a history of opposition to access management in your area? Is this the first time such a project has been proposed? Have there been any previous outreach efforts on this subject? If so, who was involved and what were the public's reactions? What are the primary concerns of stakeholders? How do elected officials and community leaders feel about the project or program - who supports it, who does not, and why? For major projects it is useful to conduct interviews with community leaders and stakeholders. Stakeholder interviews are an opportunity to collect information about the ideas and concerns of various groups and how the group wants to be involved.[11]

The plan should also determine the appropriate level of public involvement. The level of involvement needed will vary according to the nature of the project and the level of public interest or concern. Large controversial projects, such as retrofitting an entire corridor, require the most extensive public involvement program and public involvement should be carefully integrated into the entire decision-making process. Projects resulting in minor changes and affecting only a few property owners may require little involvement beyond notification or individualized negotiations. The project manager must decide how the public will be consulted, and who will be consulted, at each key phase of the technical decision making process.

An understanding of the nature of the controversy or conflict, as well as situational factors, is also needed to select appropriate involvement techniques. The scope and timing of activities will vary according to the level of involvement. Agencies should ask themselves: What are we trying to accomplish through the process? What information must be provided to the public and what do we need to learn from the public? What publics do we need to reach and how can we best solicit their involvement? Also, look for ways to leverage resources and use available networks to help get the word out.[12] Finally, schedule public involvement activities to coincide with technical decision points and initiate the process as early as possible.

Be aware that elected representatives will likely be contacted by constituents for assistance in stopping a project or reversing a decision. Therefore, if an action is going to be controversial, it is advisable to brief elected officials early in the process- not only about the project, but also about the process you have established for responding to public concerns. This could involve mailing a packet of information on the project, a telephone call, a one-on-one, or a more formal meeting and presentation. Also keep them informed throughout the process of any new developments and your agency's progress at key decision points.

In working with local government agencies, keep in mind that staff support does not indicate support from elected officials. In addition, elected officials may support a project in concept, but that may deteriorate when the opposition becomes vocal without some evidence of public support for the project. This is why public opinion surveys or other indicators of public support for an action can be valuable in the political process.

Corridor Based Initiatives

A continuing problem in access management is inadequate state and local government collaboration on access management initiatives. Corridor management planning provides a forum whereby various communities and agencies with jurisdiction over a corridor can collaborate on access management and right-of-way issues. Public involvement strategies may then be carefully integrated into the entire initiative.

One example is the effort underway by the Capitol Region Council of Governments (CRCOG)- the metropolitan planning organization for the Hartford, Connecticut metropolitan area. CRCOG is currently engaged in corridor studies that will culminate in corridor management and improvement plans for four key routes.[13]

The project will include extensive public involvement activities. Special corridor committees will be formed to guide the study. These will include a technical committee of planners and engineers from each town, and an advisory committee composed of planning and elected officials as well as business representatives and residents. These committees will address development trends and regulations, assess the viability of alternatives, and provide guidance on key policy issues.

The Connecticut DOT will actively participate and special meetings will also be held with each affected town council and planning commission, as well as separate meetings with the public, at appropriate points in the planning process. At a minimum, special meetings will be held during analyses of existing and future conditions, analysis of alternatives, and development of the corridor plan. Newsletters will be prepared and distributed to keep citizens and local officials informed along the way.

The access management plans will address traffic signal location and problems with existing curb cuts. The study will review and evaluate development regulations in each town and identify options for integrating access management into local regulatory practice. Curb cut plans will be prepared that address needed improvements from a regulatory and design perspective. An access management report will be prepared for each town that sets forth the results of these analyses and study recommendations.

Collaborative efforts such as this will be essential to achieving greater local participation in managing access to high priority corridors. One way to formalize decisions made through such a process, is through adoption of an intergovernmental agreement. The agreement could specify areas of mutual concern and each agency's role in advancing access management objectives that arise from the joint planning effort. Public resolutions, indicating policy support and commitment to a particular course of action, are another option. Contingency measures could be added to the agreement or new procedure to reduce discomfort. These might include a trial period, after which the participating parties have an opportunity to refine (or rescind) the agreement if necessary, as well as conditions whereby parties may withdraw.

Medians and Public Involvement

Public opposition and political appeals are common with median projects. For this reason, a public involvement strategy is essential. To improve current practices related to median openings and public involvement for median projects, the Florida Department of Transportation formed a median opening task force in 1994. From these discussions, a new procedure was developed to improve consistency of median opening decisions, establish a committee process for review of deviation requests, and to promote more effective public involvement.

The new procedure calls for initiating public involvement on median design during PD&E and carrying this through into production, with involvement to occur again by at least the 30% design phase.[14] A tiered public involvement program was recommended, with more extensive public involvement for complex or controversial projects. An open house meeting format was suggested for this purpose, as well as personal visits and meetings with local government officials, civic associations, and others as warranted. The need for clear graphics, adequate traffic engineering analysis prior to the public meeting, involvement of all those affected (including leasers of businesses and neighbors or users of the corridor), and internal coordination were also emphasized.

Recommendations for this procedure emerged from an evaluation of median projects and public involvement practices of FDOT Districts. [15] This research found that FDOT Districts with a public involvement strategy for median design decisions had fewer problems with political or legal appeals. In particular, FDOT District IV and District V reported success in achieving access management objectives, while having fewer appeals to management or requests for administrative hearings on access management issues, than other Districts interviewed.

Each District attributes their success in implementing median projects and managing political appeals to their fair and open process for responding to public concerns? This included early public involvement in design decisions, as well as an open house meeting format to diffuse conflict and promote a more personal atmosphere. In the process, both Districts are building relationships that are fundamental to long term success. These findings hold promise for the initiation of similar public involvement programs for median projects in other States.

CONCLUSIONS

The public will get involved in access management issues, with or without a formal opportunity. The challenge, therefore, is to involve people in a way that is productive and meaningful for them and for your agency. This is achieved through techniques that help minimize conflict and foster public trust.

Public involvement is even more essential given the current political push to limit the ability of government to manage development. Opponents of access management and other development planning initiatives have in some ways been empowered by the inadequacy of state and local public involvement practices.

Effective public involvement can ultimately safeguard a project or regulatory program against arbitrary or undesirable changes and reduce resentment that can lead to future retaliation. It will also strengthen the credibility of an agency as one that makes responsible decisions and has a commitment to preserving the public trust. Finally, involving the public helps build public awareness and the capacity of the public to make appropriate policy decisions.

NOTES

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Marketing of Access Management

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ABSTRACT

Access management can be a dtfjcult topic to present, since it includes issues such as traffic engineering, philosophy, safety, economic concerns and private property owners rights, either real or perceived. Adding to the complexity is that many motorists, developers, politicians and property owners believe that they are experts in this field. There are definite opinions about where traffic signals should be placed, the optimum travel speed, proper median treatments and where driveways should be spaced just to name a few. A challenge is to learn new and innovative methods to communicate the benefits of an Access Management Program.

The ability to quote statistics and facts relating to safety and capacity is very valuable, yet many people are hesitant to believe this information. Zf the operational and safety concerns could be demonstrated and easily understood, it may increase the acceptance levels. In order for that to happen, people must better understand the problem. Zf they can be made to "feel" the issues, there is considerable likelihood that they will realize the benefits of Access Management.

A purpose of this paper is to illustrate some of the dificulties in introducing access management to a varied audience. Repaper will also identify some of the communication needs, briefly discuss methods that increase learning and explain one presentation technique that involves the participants.

PRESENTATION

Consider a scenario where community members had a concern over a proposed highway bridge replacement. The consultant's submitted design would severely restrict the sight lines of a panoramic view of the mountains. A grass roots organization was formed and proceeded to make several assaults on the city council, county commissioners, newspapers, and attached itself to environmental efforts. Several strategies were prepared that could effectively shut down the project through the court process if the project indeed made it that far. Further, the state transportation agency and the feds determined that public consensus and a win-win outcome was of utmost importance.

In a public meeting, city leaders, county commissioners and local citizens joined efforts to redesign the new interstate bridge. It was immediately apparent that the engineer had erred by proposing 12' girders when a more palatable two inches should suffice. Since the span was only a half mile in length, the necessity of the four massive columns also came into question. After a profitable 20-minute discussion it became obvious that they preferred a clear span thus eliminating the need for any columns to support the structure. While these two simple changes in design guaranteed a better view of the mountains, it also meant that tremendous cost savings would be likely. These significant design improvements were accomplished in a mere two hours. The lead agency realized the need to achieve consensus, so accepted all the modifications.

Obviously this example is preposterous. Local citizens usually accept that the engineer knows what it will take to provide a safe, strong and durable bridge.

In most engineering disciplines, the public seldom concerns itself with the exterior appearance. If they do, the engineer can often provide concessions without compromising the structural integrity. Examples might include the exterior walls of a building, perhaps changing the color or a facade over a steel infrastructure. In certain disciplines, such as those employed in bridges, dams and aircraft, the external design is essential to the structural integrity or its ability to function. The public generally leaves those design decisions to the experts.

In traffic engineering, the design and the exterior appearance of the roadway is critical. These elements determine the very function and the structural integrity, and that is where the motorist operates and behaves. However, this is one engineering discipline where the public can become very passionate and attempt to require changes that are acceptable to them.

When experts in traffic engineering list the needs and the designs necessary to provide a safe and efficient solution for a roadway, motorists, politicians, developers and private-property owners suddenly become experts.

Since the motorist is constantly and intimately involved in the roadway environment, many believe they know what works best. "I've driven on this road everyday for the past 30 years. I know what works and what doesn't". The motorist and the engineer/designer can often be at odds. There are definite opinions about issues such as where traffic signals should be placed, the optimum travel speed, proper median treatments, the number of travel lanes, and the spacing and design of driveways.

A major consideration of traffic engineering is the largely unknown and uncontrollable behavior of the motorist who operate in the design. This becomes more complex as motorists vary in age from 16 to 100, each with different reaction times, skills, experience, and willingness to adhere to the laws. They also operate a vast array of vehicles that have tremendously different performance characteristics. There are other users of the system as well, such as pedestrians and bicyclists that are from all ages, again with incredibly diverse skills and perceptions.

One of the most critical components of traffic engineering is Access Management. Access Management is a strategy and implementation of various techniques "to ensure the safe and efficient flow of traffic through the road system and access to their destination".' These techniques vary from driveway spacing to the treatment of medians and location of traffic signals. Its success lies in understanding the need for all levels of a functional hierarchy of roadways and ensuring that the roadway environment and amount of access are consistent with that function. A local road would allow numerous accesses, while the highest level road would allow only properly spaced interchanges.

These seemingly simple tools and philosophies can explode into contentious issues, especially when it may appear to violate a property owner's rights, either real or perceived.

These concerns often spiral into issues that may involve economists, business people, environmentalists, lawyers, developers, planners, transportation engineers and technicians. They encompass the spectrum from economic/land use issues and planning through transportation planning, design, safety, operation and control of facilities. The considerations are as broad as the economic health of a community or transportation corridor, and as specific as a site plan and the dimensions of a driveway. It is no wonder that presenting the access management issues to the public is such a challenge. They are being asked to understand the broad issues, benefits and consequences, while they may have a limited base of knowledge and understanding. In addition, they may have a different philosophy as to the roadway's purpose and how it should function. As if that does not make the problem confusing enough, the experts within the traffic engineering profession may contradict and disagree with one another.

A property owner may not understand the impact that one or two driveways will have on the roadway, especially if it helps to maximize the site circulation on the property. They may believe that the governing agency is simply making broad bureaucratic policies to make life more complex.

Since traffic engineering proposals, specifically access management strategies are often open to the public involvement process, it is critical that we communicate the issues as clearly as possible to achieve some level of acceptance.

Remember that the audience will likely represent many years of driving experience. During those years, many have likely developed solutions which they believe would solve all the traffic problems, some may not believe that a problem even exists. Also, they will have a strong emotional tie to the issue. That, when combined with their experience, results in a very determined audience.

The following is an example presentation of how not to convert a general audience to the benefits of access management. If you use the process described below, you assuredly will alienate the audience and may cause them to become more determined in their belief of the "proper" solution.

(Bring up a youngster and have them look at a typical poor dry map).

Here is a slightly exaggerated example of a technical explanation.

"We at the local transportation agency need to make some improvements,

Sir/Mam 'm, you are the owner of this gas station, correct? When you look at the functional hierarchy of the roadways is this area, it immediately becomes obvious that Hwy 22 is a major arterial, whereas 1st Street functions as a maj'or collector. We must ensure that traffic on the major arterial can continue to meet a required progression of a minimum speed of 22 mph with a 55% green band at a I20-second cycle length during the peak hour. The peak hour in this case is equivalent to the 30th highest hour which also incidentally will be used as the design hour.

Since the saturation flow rate is 1800 vehicles per lane per hour on the through move and 1760 for left-turning vehicles, it becomes painfully obvious that we will achieve an unacceptable Level of Service (LOS). Probably as poor as LOS E or maybe even F. Now I know that another consultant told you that they could achieve a LOS D, but that was using the Highway Capacity Manual (HCM) methodology that is based on Delay. However, we require you to evaluate this situation on a Volume to Capacity basis for a 20 year planning horizon. This will ensure sufficient capacity to optimize the signal in the future. I'm sure you can understand our need.

In addition, the traffic queues will stack up to 450', which will preven t traffic from using the turn lanes since the flare and storage area is only 250'. The turn lanes are necessary to allow the turning motorists to exit the through lanes, to provide a separate signal phase for turning motorist and to reduce the speed differential. An increase in the speed differential is a major cause of accidents. In fact, when the speed differential is 35 miles per hour (which is the same as 58 kilometers per hour under the metric system), a motorist is 180 times more likely to be involved in an accident than those motorists traveling at the same speed as the through traffic.

Motorists will not be able to access your property from the continuous two-way left turn lane (CTWLTL) since there will not be any opportunities to achieve the required acceptable gap of 6.5 seconds. It fact, it becomes self-regulating. As a result, you shouldn 't mind having a non-traversable median installed. Incidentally, national studies have clearly demonstrated that the CTWLTL become a safety concerns when the Average Daily Traffic (ADT) exceeds 24,000-28,000. Since this highway experiences an ADT of 35,000, the choice is clearly obvious. The existing traffic accident rate for this section of roadway is 6.834 per million vehicle miles (MVM) traveled, which is tremendously high. This project should reduce the accident rate to 2 or 2.5 per MFM.

Normally this would mean that your access would be limited to a right-in, right-out only condition. That will be true in this case, however we will need to remove the access closest to the signal on the upstream side of the intersection. This is necessary to allow us to build an exclusive right turn decel and storage lane.

So, this means that you cannot have the access."

Keep in mind that when we toss engineering jargon around, the listener may not be thinking the same thing. For example when we say:

250' queue, they think its something you need when you're playing on a 400' pool table.

Cycle length suggests the length of time you can sit on a mountain bike,

whereas **Stacking** is one of the benefits of Tupperware.

Acceptable gap is where a plumber should wear his blue jeans,

while **Green band** is something you experience from wearing a cheap ring.

Upstream and Downstream distance is the best place to fish.

VMT is what your father calls your favorite music video cable channel.

A **Major** arterial is an army officer responsible for weapons, whereas a

Major Collector is a serious dude with the IRS.

A **Non-traversable** median is a cross dressing clairvoyant.

Remember, if the dialogue is filled with acronyms, the audience will spend all of their energy trying to decipher the last confusing encoded string of words. The topic of Access Management has a lot of completely new terminology which can easily confuse the participants. An insightful man often said, "A wise person replaces one long word with two simple ones".[2]

The ability to quote statistics and facts relating to safety and capacity is very valuable, yet people may be hesitant to believe in numbers. The challenge is to learn new and innovative methods of presenting the access management alternatives, designs or decisions in ways that give them an appreciation for the impacts, benefits and consequences. Keep in mind that the components of access management are not clearly understood by a significant number of the technical/engineering people working in transportation, let alone the public at large.

To communicate effectively, it is desirable to select the most appropriate communication method. You must determine;

- Who is your audience? Have you considered the impacts from their perspective?

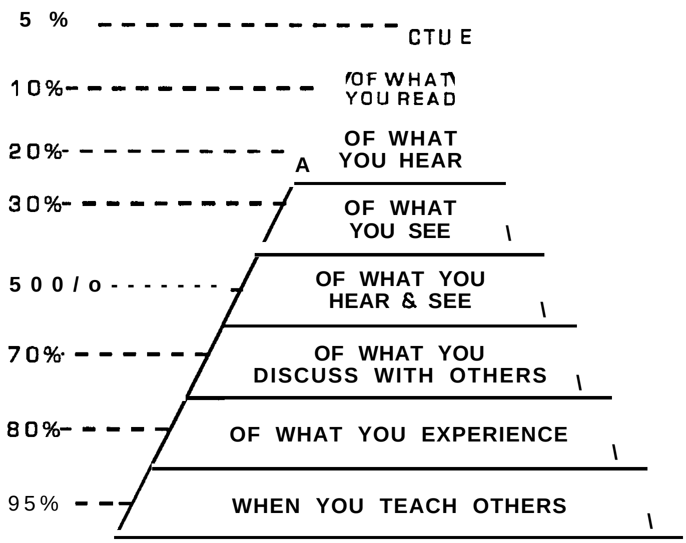
- What is the purpose of the communication? Are you trying to achieve general awareness, political buy-in, or project approval? Are you introducing new concepts or are you trying to persuade? What action do you expect or hope to achieve?

- Are you thoroughly familiar with all the important information on the issue or design? Can you answer all the questions? If not, is there someone who can?

- What general ideas, concepts, opinion or conclusions should be stressed? What are the facts that must be presented?

The next task is to determine how the information will be presented. The following graphic illustrates the effectiveness of different presentation methods.

Rate of Retention



Adapted from Control Theory in the Class,

Dr. William Glasser, 1986 [3]

Stated in another way is the proverb,

> Tell me and I forget,
>
> Show me and I remember,
>
> Involve me and I understand. [4]

Think of the potential success you might have if you could describe safety and operational concerns in an interactive environment. The goal is to relate to their experience, emotions and memories so that the audience could be made to "feel" the issues.

I will now present an example of the benefit of having people interact or work with the concepts in more simple terms.

(Now do the same demonstration with the same youngster using miniature cars on a several layouts that shows an aerial view of a highway with various highway cross sections, with and without a median barrier. Have the youngster participate in the exercise)

- a motorist using the exclusive left turn lane waiting for a gap to turn left in advance of the intersection, thus preventing other motorists from reaching the intersection in order to turn left on the left turn phase, OR developing a queue in the upstream through lane.

- show the number of potential conflict points between 5 approach roads with a CTWLTL (150) as opposed to the same Jive approach roads when there is a restricted median. (I 0)

- motorist turning left on the downstream side of the intersection, creating traffic queues through the intersection.

- show how motorists wanting to make a left turn often become frustrated and begin to gamble with unacceptable gaps in the travel stream.

- describe the problems that a pedestrian faces when attempting to cross a busy 5 lane section.

- (Rural) describe the closing distance of two oncoming vehicles in a CTWLTL on a 55 mph highway. Discuss the reaction time, and stopping distance.

Some other effective methods of communication:

Gary Sokolow from Florida DOT has developed several tremendous slide shows which he uses to communicate access management techniques. An advantage to a well prepared slide show is that it immediately increases the audience's perception of your knowledge of the topic. For controversial issues, it also helps to reduce unwanted questions during the presentation.

Describe the terminology in terms that people can identify with. An example of this is when Phil Demosthenes of Colorado DOT describes Million Vehicle Miles (MVM) and accident rates by relating to a one mile section of highway that the audience is familiar with. He states the Average Daily Traffic, and then converts that into the number of days it will take to achieve a MVM. For example a one mile section of highway with an ADT of 33,000 will achieve a MVM in 30 days. He then goes on to state how often an accident is likely to occur.

When you use examples in your communication that people can immediately relate to, they are more likely to remember and realize the benefits. This is supported by research "when subjects are able to construct their own images, greater memory or learning occurs".[5] A couple of examples are:

Explain Level Of Service and Peak Hour by comparing it to the waiting lines at a fast food restaurant during lunch time.

Describe the benefits and use of exclusive travel lanes by comparing them to the fast lines at a Supermarket, Also describe what happens when someone violates the line by writing a check instead of cash only or shows up with 30 items in the cart instead of the maximum of 10.

I believe that there are many ways that we can improve at marketing an Access Management program or strategy. This presentation is not meant to be an end but rather should be considered a stretching of your imagination to consider creative ways to communicate and involve the audience.

Remember,

Tell me and I forget,

Show me and I remember,

Involve me and I understand!

REFERENCES

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[3] Adapted from, Dr. William Glasser, Control Theory in the Class, New York Perennial Library, 1986.

[4] Chinese Proverb

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[6] Chinese Proverb

Process To Obtain Public Buy-In For A Retrofit Access Management Project

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ABSTRACT

All too often engineers design access management plans for developed roadways without gaining, or before receiving, adequate public input. Countless retrofit plans have been shelved because they did not address the affected public's concerns during conceptions.

The access management plan for a two-mile segment of Highway 99 W running through Newberg, Oregon, was developed using an integrated public involvement approach emphasizing education and consensus building. This approach proved vital in addressing Highway 99WS problems. Currently, the five-lane highway (with a two-way left-turn lane) carries 35,000 cars and trucks each day and is one of the most congested highway segments in the state. Traffic is expected to continue to grow rapidly amidst the 70 driveways per mile and high crash rate. To increase throughput and improve traffic safety, the Oregon Department of Transportation (ODOT) dedicated $5.6 million for access management and multimodal improvements.

The integrated public involvement approach entailed educating and receiving input from several different interest groups. Easy-to-understand educational tools (videos, photo and computer simulations, graphical representations of access management tools and effects, and others) were used throughout the process to gain public support and allow the different interest groups to appreciate the varied needs of all the highway users. The project depended on input from five different forums, each with its own roles and objectives:

- *A Citizens Advisory Committee, consisting of respected citizens*
- *A Technical Advisory Committee, consisting of agency representatives*
- *A Project Development Team, consisting of ODOT and consultant staff*
- *Open houses, which were heavily attended and received media attention*
- *Focus groups, consisting of residential, business, tourist, and freight interests*

The paper describes the objectives of each forum, the effective tools used to gain public consensus, how each group interacted, the methodology used to develop detailed alternatives, and challenges encountered during the project. The paper will also include some of the graphics used for the project.

PRESENTATION

All too often engineers develop access management plans for improved roadways without gaining, or before receiving, adequate public input. Countless retrofit plans have been shelved because they did not address the affected public's concerns during conception. The stakeholders need to be involved from the beginning, at the design stage, so that they can have input in the design and understand how the changes will affect them and their neighbors.

The access management plan for a two-mile stretch of Oregon Highway 99W in Newberg, Oregon, was developed using an integrated public involvement approach emphasizing education and consensus building. The real test of success is whether the proposed project actually gets built -- and that is two years in the future. However, the large turnouts for volunteer citizen committees, open houses, and focus groups, as well as the many good ideas that came from the participants, indicate that this early public involvement process was successful. This paper describes the process and the tools developed to increase public participation.

Newberg, Oregon, is a town of 14,000, located 20 miles from Portland and surrounded by scenic, rolling hills, cultivated fields, and vineyards (Figure 1). Highway 99W is a major route between Portland and the Oregon coast. Five lanes wide (with a center two-way left-turn lane), it runs directly through Newberg's downtown. In addition to carrying tourist traffic, 99W is critical to intrastate freight movement and to businesses and residential neighborhoods clustered along it. The two-mile central segment through Newberg carries 35,000 cars and trucks each weekday, more on weekends, and is one of the most congested highway segments in the state. Traffic is expected to continue to grow rapidly. The study segment of the highway has more than 70 driveways per mile and an above-average accident rate. There were 219 accidents in the two-mile project area from 1990 to 1994; the total number of people involved was 547. The accidents resulted in 356 cases of property damage, 150 injuries and 2 fatalities.

The Oregon Department of Transportation (ODOT) decided to improve traffic flow and safety concurrently with a routinely scheduled repaving project. It dedicated $5.6 million for access management and multi-modal improvements. ODOT planned to replace the highway's pavement, curbs, and sidewalks in the central two-mile segment., and also proposed to put in wider shoulders, retime the traffic signals, and add turn lanes at critical intersections.

ODOT knew public input was crucial to several actions being considered for access management. These included provision of a raised (nontraversible) center median island with limited openings for left turns; driveway treatments (consolidation, relocation, etc.); and strategies to improve vehicular and pedestrian crossings. CH2M HILL was hired as a consultant to investigate what changes to the highway would be most beneficial to the community, to develop the alternatives in greater detail according to the community's responses, and to work with the public in developing a credible retrofit plan.

The Public Involvement Process

ODOT and its consultant set up two advisory committees and a project development team that would make the critical decisions about what to build and how to interact with the general public. The Citizens Advisory Committee, led by the consultant's project manager, was made up of business owners and residents along the study corridor. The Technical Advisory Committee, also led by the consultant, included ODOT staff and representatives of the police and fire departments. Each group met monthly for six months (Figure 2); after the initial meetings, however, the meetings were frequently combined so that technical staff would be available to answer citizens' questions (Figure 3). The Project Development Team (PDT) consisted of the ODOT and consultant project managers, the community development director of the City of Newberg, and key ODOT staff -- traffic engineers, right-of-way manager, and environmental studies liaisons. The PDT met after each citizens committee meeting to discuss what had been learned and what issues had been raised, and to determine how to proceed.

Other important elements of the public involvement process were an open house and a focus group workshop to bring together groups of "stakeholders" -- people with a strong interest in the congested segment of the highway, such as nearby business owners and residents, freight haulers, and those involved in the tourism industry. The public involvement process is illustrated in Figure 4.

Open House

A public open house was scheduled to take place between the first and second committee meetings. At both the open house and the initial committee meetings, the consultant described ODOT's proposals in detail, reviewed the background conditions of Highway 99W in Newberg, and solicited public questions and comments.

The open house format was chosen to make people feel comfortable and to avoid letting anyone "grandstand' the meeting. It was held between 4 p.m. and 8 p.m. in the local college cafeteria, with plenty of cookies and coffee provided. People were encouraged to come and go as they pleased. A combination of graphics displays and ODOT and consultant staff giving talks and answering questions created a hospitable, lively atmosphere. There was a "Kids Komer" with transportation-related toys for children to play with while their parents looked at the displays. Approximately 60 citizens attended. Many more sent in written comments.

Graphics and Educational Tools

A large-scale map showed accident types on the corridor; an area headlined "What is Access Management?' displayed before-and-after conflict diagrams, explained the concept of non-traversable center medians, showed different types of driveway treatments, and listed and gave examples of various access management tools.

A 22-minute videotape explained the issues (the current and future problems on the Highway 99W corridor), the alternatives, and the benefits of access management (see Figure 2). The tape featured an interview with a business owner in a neighboring town whose driveways had been reduced as part of an access management design. His family had owned the business in that same location for 40 years, and so they had gotten used to having three driveways the way they were. Initially he felt some resistance to the change. But ot his surprise, he found that two narrower driveways actually served his customers and suppliers better and provided much safer access to and from the highway. This testimony from a near-neighbor with similar concerns was persuasive to many Newberg residents. (See Figures 6 through 12)

Capacity analysis, progression analysis, traffic signal warrant assessments, and studies of traffic diversion impacts were performed to evaluate traffic operations and attributes. An animated computer model, TRAF-NETSIM, was developed to show concerned citizens that, under each alternative, adequate gaps would be available in the traffic stream for them to make left turns into and out of driveways (Figure 2c). For instance, the model showed how the installation of a signal upstream or downstream of an individual's driveway would create safe gaps. The model also was used to test transportation system management proposals included with the project, such as the addition of turn lanes at acritical intersections, the removal of parking in certain sections, the addition of traffic signals and other details.

A slide show was developed to describe the options, define access management, explain driveway conflicts and how they can be reduced, explain the criteria used to decide which driveways to close, which to consolidate, etc., and to compare the (predicted) results of the alternatives (Figure 3). In addition, ODOT developed photo simulations to compare the various options with current conditions, and these were prominently displayed (Figure 4)

In an "Issues" area, people could use yellow Post-it notes to identify problem areas shown on aerial maps. They were encouraged to write down issues on comment forms or an easel, or to fill out and send in the return portion of a mail-out.

Publicity

Good publicity was critical for getting adequate public turnout. Over 5,000 open house notices (Figure 5) were sent out in the mail, and advertisements were placed in the two local papers. The videotape was shown on local cable television and at local organization meetings such as the Elks and the Chamber of Commerce. Several copies were made available at local video stores for free two-day use. The press was invited to attend the open house, and did attend, thanks to good followup.

The Public's Concerns

At the next citizens and technical committee meeting, the consultant distributed a list of the public concerns that were identified in the previous meetings, the mailing, and the open house. A major concern was the relationship of this project to a much-desired highway bypass for Newberg. People wanted to know if access management and other safety improvements would take the place of the proposed 12,mile-long bypass. It was necessary to address this issue directly and informatively to win public trust for the current project. ODOT and consultant staff explained, both in the public meetings and in the videotape, that the improvements would be necessary with or without the bypass. The high cost of the bypass had been a major stumbling block to its approval by the state legislature. The $5.6 million for access management would buy time for the community while it waited for the state to fund the $150 million bypass.

Other concerns related directly to the effect of access management on local businesses. Would a nontraversible median prevent access to some businesses? Newberg residents who did not own businesses on the corridor were initially more open to the idea than corridor business owners, who feared losing customers. The response to this had to be thorough and detailed, to show how good access management could actually benefit business.

The Focus Group Workshop

The focus group workshop was organized to allow detailed, intensive public scrutiny of the two access management alternatives. It proved to be extremely effective. About 50 people were invited from among those who had signed up at the open house, and other were recruited. The goal was to achieve approximately equal representation from four interest groups: business, residents, freight, and tourism. The workshop, like the open house, was held at the college, and to entice the group to stay for the three hours planned, a light buffet dinner was served.

The first 30 minutes were used to review the problems of the highway corridor, including its accident history, and to explain what access management is. The two preliminary draft alternatives were presented (Figure 17). One, using a center nontraversible median was labeled the "median alternative," and the other, preserving the existing two-way left-turn lane but consolidating or moving more of the driveways, was labeled the "driveway treatment alternative." The alternatives were illustrated in CAD format, showing in detail what driveways would be retained, removed, or consolidated. The drawings showed median openings and left-turn pockets for the nontraversible median option, and showed reconfigured parking lots, as appropriate, for both options. The plans were in color and were simple and easy to understand.

Then the groups were offered a "toolbox" of options for access management -- driveway relocation, considation, or removal; property connections; channelizing islands; center median; signal spacing; and several others (Figure 18).

The rest of the evening was divided into three parts:

- Interest group meetings to identify access management issues
- Work group meetings to identify solutions
- Reports from the individual groups to the entire gathering

Interest Groups. A technical advisory committee member facilitated each of the four groups (business, residents, freight and tourism) and made sure that each person had a chance to speak. In the first exercise, each person named at least one or two issues of concern, and these were written on large flip charts. Then the whole group got back together and went over the issues identified.

This technique allowed people to understand both the issues common to their own interests and those of others, including those that might compete or conflict. For example, while those involved in freight and tourism were concerned about moving traffic more smoothly and quickly through Newberg ("Newberg's a bottleneck"), businesspeople wanted traffic slowed down so that motorists could see the businesses better and stop to shop more easily. Neighborhood residents, on the other hand, expressed the most concern about safety for pedestrians and children, disliked truck noise and speed, and favored reduced access points.

Work Groups. The work groups were organized with a random mix of people instead of by common interest. Each group had a facilitator and a traffic engineer, and each was given a CAD plan (without the preliminary access management strategies) of a different segment of the corridor. The plan showed the existing roadway, driveways, buildings, parking lots, traffic volumes at each driveway, and accident history. Then, using the toolbox of access management options and colored markers, each group developed a conceptual access management plan of its own

When the whole group got back together, a spokesperson from each work group took about 5 minutes to present issues the group identified and plans to solve them. Some favored the nontraversible center median and some favored more driveway treatments.

Results. The results were fascinating. The interest groups identified issues ODOT and the consultant were not aware of, such as poor pedestrian areas, circulation options, and impediments to consolidating access points. The work groups came up with workable alternative plans based on their knowledge of their own places. Long-time residents were able to provide the history of the corridor, how it had been used, how the sites were developed, and why access was where it was. Some had taken advantage of the opportunity to work on alternatives for their own driveways, or had worked together with neighboring residents or businesses to figure out options acceptable to both. Some didn't like the access as it was and had come to the meeting with their own ideas for improvement. The toolbox helped them shape their ideas into usable results.

The exercise gave all the participants a better idea of how valuable access management is. It gave ODOT ideas for a plan that would be acceptable to the community.

The open house and workshops also produced feedback on the effectiveness of the various tools and graphics. People liked having the opportunity to identify issues on aerial maps. They enjoyed sketching ideas on blank plans. The videotape was praised for explaining the issues well and showing how local business could benefit. The computer simulation model also helped people understand how traffic patterns would change with the access management alternatives. The slides were helpful in explaining the benefits of access management to the citizens advisory committee, and the photo images communicated well to many people. In short, the public involvement project had all the marks of success.

Lessons Learned

What lessons came out of this process? A retrofit access management project is one of the biggest challenges a community can face. A transportation department needs as much help as it can get, and it needs a good public process to get public cooperation and input from the start. People respond both favorably and creatively to opportunities to play with alternative design.

The public meetings are not the whole story, however. To assure that this project will be built, it will be necessary to keep up public contacts, particularly in one-on-one meetings with concerned individuals, to continue to address their concerns and head off dissent.

Questions and Answers
Public Involvement and the Selling of Access Management

Public Involvement and the Politics of Access Management
A Practical Approach and the Politics of Access Management
A Process to Obtain Public Buy-In of a Retrofit Access Management Project

Question 1: What techniques are available to deal with some of the more abstract state level initiatives?

Kristine Williams: In Florida, the Conflict Resolution Consortium developed a collaborative approach for dealing with policy decisions related to the state's growth management act. The approach brings in stakeholders from a variety of interest groups. A structured agenda is developed that allows the participants to deal with policy issues through position statements. A voting process is then applied to rank the policy issues and recommend changes to the growth management act.

There are a variety of techniques for dealing with abstract state level initiatives. There is a lot going on in the collaborative process and dispute resolution that is worth observing. This includes an impressive range of techniques and guidance for the negotiation of outcomes.

Question 2: What percen tage of a budget is appropriate for a public participation process?

David Parisi: The project in Newburg, Oregon, has a construction cost of $5,800,000. Our budget for public involvement and traffic engineering was $60,000.

Question 3: What was the time frame for the public participation process?

David Parisi: The process of public involvement and preliminary design took two (2) years, and all of the public involvement took place in the first year.

Question 4: How did the ideas of the focus group compare to the final product?

David Parisi: Many ideas were taken from the focus groups. Additional problems concerning the two-way left turn lanes and their lack of consideration for pedestrians must be resolved.

Question 5: Was maintenance of access during construction addressed in the focus groups?

David Parisi: No, we did not deal with maintenance of access during construction in the focus groups.

Question 6: Were the participants constrained by an existing access code?

David Parisi: The participants could not be constrained by the Oregon Department of Transportation codes because this was a retrofit project attempting to obtain the best results possible.

Question 7: What was the final design outcome?

David Parisi: There are two (2) options which are going into environmental assessment at this time.

V Abstracts/Papers - Session 3

Legal Issues

Moderator: Richard Forester, Portland, Oregon

The Interface Of Access And Land Use - Developments In The Law

J. Richard Forester, Attorney and Mediator, Dispute Resolutions Services, Portland Oregon

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ART PICULELL GROUP v. **CLACKAMAS COUNTY**--- P.2d ----, 1996 WL 43 1685 (Or.App.- July 3 1, 1996)

Petitioner applied to the county for approval of a 19-lot subdivision bordering Summers Lane, a county maintained road. Eighteen of the lots are south of Summers Lane. Lot 19, at the west end of the proposed subdivision is north of Summers Lane. At that west end, Summers Lane traverses the proposed subdivision for approximately 130 feet. East and west of the proposed subdivision, Summers Lane is fully developed, or has been approved for full development, as a 60-foot right-of-way, with a 36-foot pavement width. Where Summers Lane borders the proposed subdivision, it is partially improved, with a 40-foot right-of-way.

The proposed subdivision is not dependent exclusively on Summers Lane for access. However, there is evidence that 8 1% of the traffic from the proposed subdivision will use Summers Lane. In addition, traffic from an adjoining subdivision will have access to Summers Lane through this subdivision development. In approving the proposed subdivision, the county hearings officer required a IO-foot property dedication and two-thirds street improvements along the eastern four- fifths of the subdivision (that portion which borders Summers Lane only on the south) and full street improvements along the western 13 0 feet of the proposed subdivision (that portion which is traversed by Summers Lane).

At issue is how to apply Dolan's legal tests. The court held that contrary to the usual purely adjudicative role of findings, Dolan effectively places the burden on the factfmder to articulate and substantiate the requisite facts and legal conclusion when, as here, findings are used as the device for the governmental demonstration and determination of rough proportionality. The Court said in Dolan that "[n]o precise mathematical calculation is required," but there must be an "individualized determination" and "some effort to quantify [the] findings." 5 12 **U.S.** at ---, --- (114 S Ct at 23 19, 2322).

It is probably impossible to formulate a universal rule concerning how "benefits" of that kind are to be factored into the rough proportionality calculus. Nonetheless, it is clear that, insofar as the facts of particular cases may indicate, conditions that in whole or in part serve the needs of the development itself should be weighed differently than pure "exactions" of the kind that serve only to mitigate an impact of the development on the public or public facilities. It also seems clear that the mix of "beneficial" and other conditions, as well as the mix of "beneficial" and other effects that may be attributable to a particular condition, can vary enormously from case to case. Given that, the absolute rule for which petitioner contends, that beneficial effects may only be considered if they are the only effects present, is not logically supportable.

Dolan states that precise mathematical calculations are not required, but it does not preclude them, and it in fact requires some quantification. Accordingly, such information, although not necessarily determinative, may be considered.

Dolan does not have the effect of uniformly limiting road improvement conditions to an extent that correlates exactly with the traffic the development will generate, that there can be other kinds of developmental impacts that residential developments can have on street systems, and that all of the impacts appropriately enter into the analysis. See J.C. Reeves Corp., 131 Or.App. at 622. It is the "government's burden," not petitioner's, to articulate the numerical and other facts necessary to demonstrate rough proportionality.

The concern under Dolan is not with the apportionment of costs for a general improvement over the general body of benefitted property owners, but with the extent to which particular property may be burdened because of impacts that are attributable to its development. We do not imply that a development cannot have impacts that could warrant improvement conditions that are system wide in scope. However,..., the determinative factor must be the relationship between the impacts of the development and the approval conditions, and not the extent of the public's need for road or other improvements that happen to exist at the time the particular development is approved.

LUXEMBOURG GROUP, INC., v. SNOHOMISH COUNTY, 76 Wash.App. 502, 887 P.2d 446) Court of Appeals of Washington, Division 1, Jan. 9, 1995.

Landowner applied to county to rezone and subdivide land, and county Hearing Commissioner denied application, because there would be no access to landlocked neighboring land, without dedication of right-of-way for this parcel. The County Council affirmed, and landowner filed certiorari action in superior court, asking that dedication requirement be found unlawful. The Superior Court, denied landowner's motion for summary judgment, and landowner appealed. The Court of Appeals, held that requirement that landowner dedicate access road to landlocked parcel as a condition to rezoning amounted to a taking without compensation.

County requirement that subdivision must provide access road to landlocked property before subdivision would be approved constituted an unconstitutional taking of property, where the landlocked property had always been landlocked from the county roads, thus the need for access was not a result of the proposed subdivision, and the dedication requirement would not remedy any problem caused by the proposed subdivision; in effect the requirement would allow neighboring landowners to take way of access without providing compensation. West's RCWA 8.24.030, 58.17.010, 58.17.110(2), 58.17.180.

Analysis of whether way of access is "necessary" for purposes of private condemnation action has no bearing on whether dedication of way of access is made necessary as result of prospective subdivision for purposes of determining whether requirement that subdivision owner provide way of access to other property constitutes a taking. West's RCWA 8.24.030, 58.17.010, 58.17.110(2), 58.17.180.

County may not condition approval of subdivision on the dedication of property unless need for dedication arises from development under review. West's RCWA 8.24.030.

PINNACLE CORPORATION, v. The VILLAGE OF LAKE IN THE HILLS, 258 Ill.App.3d 205, 630 N.E.2d 502, 196 Ill.Dec. 567, Appellate Court of Illinois, Second District, March 8, 1994.

Developer brought action against village and village officials, seeking order requiring recordation of final plat of subdivision and awarding damages, and writ of mandamus requiring village officials to execute final plat and deliver to developer. City intervened, alleging that it had jurisdiction, pursuant to intergovernmental agreement with village, over portion of road that provided means of ingress and egress to subdivision. The Circuit Court, granted summary judgment for developer, and city appealed. The Appellate Court, held that developer was entitled to recordation and execution of plat, even though city had not made decision on engineering plans.

The means of ingress and egress to the developer's subdivision is via Miller Road, over the portion within Crystal Lake's jurisdiction. Crystal Lake has a duty to evaluate safety issues on Miller Road. According to the intergovernmental agreement between the village it and Crystal Lake, it and Crystal Lake agreed to cause improvements to be made in a uniform and consistent manner to arterial roads, including Miller Road. If the parties' standards differed, the road was to be improved to the stricter standard. Under the Plat Act, LITH had the authority to approve the plat if Crystal Lake did not render a timely decision as the relevant highway authority.

CLARK v. CITY OF ALBANY, 137 Or.App. 293, 904 P.2d 185,. Oct. 18, 1995.

Petitioner proposes to locate a fast food drive-in restaurant on property zoned Heavy Commercial. Spicer Road, a county road that runs east-west and is not improved to city standards, adjoins the property to the north and intersects the Santiam Highway at a point about 200 feet from the western boundary of the property, Fescue Street, which runs north-south, ends as a public right-of-way at a point about 400 feet south of the subject property. Fescue Street continues as a private easement to the west of the property. The city's master street plan shows Fescue Street as extending either through or near the property.

Petitioner's site plan shows a strip 25 feet wide, running north-south along the western boundary of the subject property, denominated as part of the Fescue Street right-of-way. A 12-inch storm drain and a 12-inch water line run parallel to and south of Spicer Road. A 6-inch storm drain runs north-south through the subject property near the western edge of the Fescue Street right- of-way.

The city attached numerous conditions to its approval of the site plan, which were preceded with the general caveat:

> "Unless otherwise noted, all conditions and requirements must be completed to the satisfaction of the city's representative prior to final approval of the structure." (Emphasis supplied.)

The Court of Appeals, held that: (1) conditions that applicant design and construct street improvements were "exactions"; (2) condition that applicant designate an on-site area as traffic-free was not an "exaction"; (3) conditions that applicant provide storm drainage plan and construct storm drain were not "exactions"; (4) condition that applicant build sidewalk adjacent to site was an "exaction"; and (5) supplemental note to limited land use decision that infrastructure study was being conducted on proposed building site would be deleted from building permit order.

Discussion: Dolan requires that, under the Takings Clause of the Fifth Amendment, a governmental body must demonstrate a "rough proportionality" between certain conditions that it "exacts" and the "impacts" of the development that it approves subject to the conditions. The comparison of an exaction and an impact is not easily made-- and may not even be possible in some instances--when either or both have yet to assume final form and when the eventual final nature of one depends to some extent on the final form of the other.

In our view, the city's confuses the question of whether the Dolan test is applicable with the question of whether **the** conditions pass **the** test. **If, on remand, the city is able to make satisfactory findings that demonstrate that petitioner's project is the sole or principal beneficiary of the improvements that he is required to make, and that the requirements are responsive to impacts that the development will have, the city almost certainly would also succeed in demonstrating "rough proportionality."** However, neither that possible eventual success nor the city's current postulates change the fact that, on their face, conditions 4 and 5 do impose exactions that are subject to the Dolan analysis: They require petitioner, as a prerequisite to developing his property, to make road improvements on and extending beyond the affected property, and the improvements are to be available for some public use.

We recognize, and will hold in other connections in this opinion, that not all conditions of approval come within the ambit of the Dolan test. However, the fact that Dolan itself involved conditions that required a dedication of property interests does not mean that it applies only to conditions of that kind. . . . For purposes of takings analysis, we see little difference between a requirement that a developer convey title to the part of the property that is to serve a public purpose, and a requirement that the developer himself make improvements on the affected and nearby property and make it available for the same purpose. The fact that the developer retains title in, or never acquires title to, the property that he is required to improve and make available to the public, does not make the requirement any the less a burden on his use and interest than corresponding requirements that happen also to entail memorialization in the deed records.

Concerning the supplemental note. Although we agree with the city that its planners and other personnel should exercise candor in their dealings with the public, we do not agree that that laudable objective necessitates--or that quasi-judicial procedures permit--the use of decisional orders as a vehicle for announcing speculative facts and predictions about future events that have no direct connection to the issues or the decision in the case. LUBA erred by sustaining the supplemental note.

DEPARTMENT OF TRANSPORTATION, STATE OF COLORADO, v. FIRST INTERSTATE COMMERCIAL MORTGAGE COMPANY, 881 P.2d 473 Colorado Court of Appeals,Div. IV, Aug. 11, 1994.

Department of Transportation petitioned for condemnation to acquire temporary easement over property owner's land and to eliminate access point to highway. At the time of the trial court proceedings, First Interstate owned a parcel of real property in Denver situated at the northeast comer of the intersection of Sheridan Boulevard and Hampden Avenue that was in use as a shopping center known as Bear Valley Mall. Prior to the early 196Os, Hampden Avenue extended east as far as Sheridan Boulevard. In 1960, First Interstate's predecessors in interest settled a condemnation action between it and the Department in connection with the eastward development of Hampden Avenue as a freeway. The Department wished to maintain limited freeway access. First Interstate's predecessors in interest wished to have direct access to the extended Hampden Avenue.

Ultimately, First Interstate's predecessors in interest deeded to the Department all rights of access to Hampden Avenue with an exception for one 20- foot-wide opening. This deed of access rights was recorded. This opening was then used as an access ramp from westbound Hampden Avenue into the parking area of Bear Valley Mall. Other access to Bear Valley Mall exists along the northern side of the property onto Dartmouth Avenue and along the western side of the property onto Sheridan Boulevard. In June 1992, pursuant to a re-design of the Hampden Avenue/Sheridan Boulevard interchange, the Department filed a petition in condemnation to acquire a temporary easement for construction purposes over certain Bear Valley mall land and to eliminate the access point excepted from the access rights deeded to the Department in 1960.

Discussion: Any contractual right to access point in road contained in agreement between Department of Transportation and property owner's predecessor in interest did not create property interest which transferred to property owner or covenant running with land and, thus, compensation due property owner for condemnation of access point was determined under law applicable when access point was condemned, not law applicable when land was transferred to property owner; predecessor in interest's right to have access point remain open was personal and did not transfer to property owner and fact that contractual right to access point in road was included in recorded deed of access did not convert that right into covenant running with land.

Arguably, under the law as in effect at that time, First Interstate's predecessors in interest were entitled to compensation for the access rights they deeded to the Department as part of the settlement agreement. At the time of the 1960 deed, the law in Colorado was unclear as to whether a property owner who lost an access point to abutting streets or highways through condemnation could be compensated if the loss of the access point did not substantially impair ingress and egress to the property. See Boxberger v. State Highway Commission, 126 Colo. 526,533,25 1 P.2d 920,924 (1952) First Interstate concedes that the law concerning compensation for loss of access has since been clarified to require compensation for loss of access only if ingress and egress is substantially impaired. See State Department of Highways v. Interstate-Denver West, 791 P.2d 1119 (Colo. 1990)

An "exception" totally excludes from grant a specific portion of estate or interest transferred and does not create new, lesser than fee estate or interest. Under law of condemnation, payment for compensable substantial loss of access is personal to owner. Mere recording of instrument is not dispositive as to whether covenant therein will run with land.

Ingress and egress to property owner's land was not substantially impaired by condemnation of access point from highway and, thus, property owner was not entitled to compensation for loss of access point where several other access points remained. Law of condemnation requires compensation for loss of access to street or highway only if ingress and egress to property is substantially impaired.

Question of whether property owner's right of ingress and egress to his property is substantially impaired is question of law. *NOTE: but a question of fact for the jury in NJ.*

Mere circuity of route and inconvenience do not constitute compensable damages for elimination of access point. The question of whether ingress and egress is substantially impaired is a question of law. State Department of Highways v. Davis, supra; Shaklee v. Board of County Commissioners, 176 Colo. 559,491 P.2d 1366 (197 1) (the trial court must first determine if access has been subjected to unreasonable limitation). The undisputed facts before the trial court indicated that the eliminated access point provided ingress only for westerly bound traffic from Hampden Avenue and that ingress and egress existed via Sheridan Boulevard at an intersection controlled by a **traffic** signal and at numerous locations along Dartmouth Avenue. From this the trial court concluded that access was not substantially impaired by its closure. We agree. See State Department of Highways v. Davis, supra.

That some travelers who would have otherwise used the Hampden Avenue access point would now have to exit Hampden Avenue at Sheridan and enter the property either by Sheridan or Dartmouth does not create a question of fact as to the extent of the impairment of access. Mere circuity of route and inconvenience do not constitute compensable damages for the elimination of an access point. Majestic Heights Co. v. Board of County Commissioners, supra; see also Troiano v. Colorado Department of Highways, 170 Colo. 484,463 P.2d 448 (1969); Radinsky v. City & County of Denver, 159 Colo. 134,4 10 P.2d 644 (1966).

BRUZZESE v. WOOD, 674 A.2d 390, Supreme Court of Rhode Island.April 17,1996.

During the 1970s and the early 198Os, the DOT together with the Federal Railway Administration identified and eliminated several street-level-grade railroad crossings at various locations throughout Rhode Island for the stated purpose of public safety. Effective on or about November 17, 1979, the grade crossing located at Kilvert Street in Warwick was eliminated. Prior to its elimination, Kilvert Street was a two-way thoroughfare that connected two main arterial highways: Post Road and Jefferson Boulevard. Elimination of the grade crossing at Kilvert Street precluded vehicular traffic between Post Road and Jefferson Boulevard. The DOT then constructed the Coronado Street Overpass to permit traffic to resume between the Post Road and Jefferson Boulevard highways. A short, narrow roadway presently connects old Kilvert Street to the Coronado Street Overpass.

Bruzzese is the owner of a parcel of land located at 111 Kilvert Street, where he has operated a business known as Supreme Dairy since July 1969. The nature of Bruzzese's business is such that tractor-trailer trucks are frequently either delivering supplies or picking up products at two loading bays located on the premises. An expert testified that without the courtesy of a neighbor that permitted truckers to maneuver their vehicles onto its property, Hesketh indicated, the construction would have effectively precluded servicing the receiving dock at the subject property.

Landowner brought suit against State Department of Transportation (DOT) and others, seeking damages for loss of access to his cheese manufacturing facility. Bruzzese testified, after Kilvert Street was closed and the overpass was built, drivers of tractor-trailer trucks that were attempting to enter onto his property frequently had to ask employees of Supreme Dairy how to negotiate the entrance of the property with their vehicles. Bruzzese indicated that drivers were forced to trespass onto adjacent private property in order to back their vehicles onto his property.

The Court ruled in favor of landowner. Former DOT director appealed. The Supreme Court held that damages for loss of access were properly awarded.

If, in exercise of police power, right of access to land abutting upon highway is impaired or diminished, such act is not confiscatory taking requiring compensation unless impairment or diminution is so substantial as to leave property owner without reasonable access to his or her property.

Determination of whether substantial impairment has been established is question of law, while extent of such impairment is question of fact, for purposes of determining whether act is confiscatory taking requiring compensation. Proper measure of damages for destruction or impairment of access is the difference between market value of property before and immediately after destruction or impairment of access.

Damages for impairment of access were properly awarded to landowner after State Department of Transportation (DOT) closed street near landowner's cheese manufacturing business and made access for trucks difficult where DOT's actions substantially impaired landowner's right of access to the abutting roads, which had substantial and significant impact on landowner's use of and thus the fair market value of his property; before the project, landowner was enjoying the highest and best use of the property as a wholesale distribution and processing operation but afterwards the property's use was limited to warehousing and processing.

SULLIVAN v. PLANNING BOARD OF ACTON, 38 Mass.App.Ct. 918, 645 N.E.2d 703, Appeals Court of Massachusetts. Feb. 1, 1995.

This is the planning board of Acton's (the board's) appeal from a decision of a Land Court judge concerning a sixteen-acre lot at the intersection of Great Road (Route 2A) and Esterbrook Road in Acton. Route 2A is a State arterial highway, and Esterbrook Road is a town public way. On January 29, 1991, the board approved a definitive subdivision plan for the lot proposed by the owners, the DiDuca Family Trust (the trustees), subject to the four conditions contested by the trustees: (1) reservation of an easement along Esterbrook Road for the construction of an additional lane of traffic from Route 2A to the proposed subdivision road (Farm Hill Road); (2) construction of an additional travel lane on Route 2A, at its intersection with Esterbrook Road, from both directions; (3) creation of a traffic signal justification study for the intersection and, if required, payment by the trustees for installation of the signal; and (4) prohibition of "curb cuts" along Route 2A unless the net floor area of the subdivision devoted to business use is greater than 40,000 square feet, in which case only right-hand vehicle exit turns would be permitted. The first three conditions would apply only if the subdivision were to be used for business purposes.

Property owner sought judicial review of decision of local planning board conditioning its approval of subdivision plan, inter alia, on applicants' reservation of easement along adjoining road for construction of additional lane of traffic. The Land Court, held that conditions were invalid and approved defmitive subdivision plan without conditions. Planning board appealed. The Appeals Court held that: (1) planning board could not impose conditions whose performance lay entirely beyond applicants' power; (2) prohibition of curb cuts along adjoining arterial state artery was in excess of planning board's jurisdiction; but (3) board could require applicants to grant easement abutting local road for construction of additional lane of traffic.

Decision: Subdivision Control Law is comprehensive statutory scheme designed for safety, convenience and welfare of inhabitants of cities and towns. M.G.L.A. c. 41, ss 81K-81GG. Planning board's rejection of proposed subdivision must be based on particular subdivision regulations which are comprehensive, reasonably definite and carefully drafted. M.G.L.A. c. 41, ss 8 1K-8 1GG.

Planning board could not condition its approval of proposed subdivision plan upon widening of adjoining state arterial highway and property owners' payment for any traffic signal found necessary by traffic signal justification study; conditions were invalid as relating to work that was based upon governmental decision beyond property owners'control. M.G.L.A. c. 41, ss 81K-81GG.

Department of Public Works had exclusive authority to regulate excavations or driveway openings onto state

arterial highway, and **planning board could not, as condition for its approval of proposed subdivision plan, prohibit curb cuts along arterial state highway adjoining subdivision. M.G.L.A. c. 8 1, s 2** 1. *(But see the case immediately below)*

Planning board could, as condition for its approval of proposed subdivision plan, require reservation of easement, where subdivision abutted public road, for construction of additional lane of traffic; condition did not violate statutory prohibition against conditions requiring property owners to dedicate land for public use without just compensation, as statute applied only to conditions requiring that subdivision applicant grant land for public purpose unrelated to adequate access and safety of subdivision. M.G.L.A. c. 4 1, ss 8 lM, 8 1Q.

EL SHAER v. **PLANNING BOARD OF the TOWNSHIP OF LAWRENCE, 249** N.J.Super. 323, 592 A.2d 565, Superior Court of New Jersey,Appellate Division. June 27, 1991.

Plaintiff proposed to subdivide a 10.22 acre tract in Lawrence Township into ten residential lots. The property is bordered to the east by Route 206, to the north by Little Shabakunk Creek and to the south by Reeder Avenue. Four of the lots front on Route 206, and six lots are on a cul-de-sac running from Reeder Avenue. The four lots on Route 206 will have driveway curb cuts directly onto the highway. Plaintiff obtained access permits from DOT for the four driveways after the department concluded that there was "no concern that this development will have an adverse impact on the State highway."

The Superior Court, Law Division, Mercer County, which upheld denial of subdivision plan. The Appellate Division, held that the planning board could consider problems of egress and ingress from development on adjacent highway.

Planning board is duty bound to protect public and future owners of property in subdivision by requiring adequate road and drainage facilities. It was entirely proper for planning board to consider accessibility to and from development onto highway; while statute providing that subdivision ordinance must ensure suitable location of streets to accommodate traffic does not expressly provide standards with regard to ingress and egress, the requirement that a subdivision provide safe ingress and egress is logically implied from the statutory language. N.J.S.A. 40:55D-38, subd. b(2).

Planning board was entitled to give little weight to conclusion of its traffic expert that proposed development would not have significant impact on the highway where the board had requested the submission of a "gap analysis" study to enable it to gauge how much delay would be involved in getting in and out of the development and no such study was presented.

State Highway Access Management Act does not preempt planning board's decision making with respect to consideration of highway ingress and egress when considering subdivision proposal; even when state highway access permits are granted, planning board is free to consider how many driveways will be permitted, their location, and whether they conform to the overall circulation design of proposed subdivision plan. N.J.S.A. 27:7-89 to 27:7-98. In rejecting the application, the Board found that because the four driveways are "opposite a dangerous intersection with Darrah Lane [and Route 206] . . . the lots would not have safe ingress and egress."

ARKANSAS STATE HIGHWAY COMMISSION v. LEE WILSON AND COMPANY, **INC.** 43 Ark.App. 22, 858 S.W.2d 137 Court of Appeals of Arkansas,En Banc. July 7,1993.

The appellant brought this action to condemn 1.16 acres in the southeast quadrant of the appellee's property which is located at the intersection of Interstate 55 and Highway 18 1 in Mississippi County. The appellant also sought controlled access on 69 feet in the southwest quadrant and on 438 feet in the northeast quadrant which fronted Highway 18 1. The access control fence built on the northeast quadrant of the property reduced its previous highway frontage from 463 feet to a 25-foot access point. The appellee based its damages on this reduction of access. Of the 420 acres of land owned by the appellee only the 3.2 1 acres in the northeast quadrant which fronted Highway 18 1 had commercial value.

When sovereign exercises its right to take portion of tract of land in eminent domain cases, proper way to measure just compensation is by difference in fair market value of entire tract immediately before taking and fair market value immediately after taking.

State highway commission was not prejudiced by jury instructions in eminent domain action that jury should consider fair market value of entire 420 acres before and after taking to arrive at amount of just compensation, even though trial court refused to strike testimony of property owner's expert who testified only to value of 3.2 1 acres in northeast quadrant of parcel, where trial court instructed jury to determine amount of just compensation by method argued by state highway commission.

GOSS v. CITY OF LITTLE ROCK, ___ F3 ____ No. 95-4070 .U.S., Eighth Circuit, July 23, 1996.

Property owner filed suit alleging that conditioning approval of rezoning request upon dedication of strip of rezoned land for future highway expansion was unconstitutional taking. The US District Court for the Eastern District of Arkansas, dismissed complaint. Property owner appealed. In September 1971, Charles Goss purchased 3.7 acres located next to a two-lane state highway in a rural, unincorporated area outside Little Rock. Goss has operated a convenience store, gas station, laundromat, and car wash on the premises ever since. In 1985, Little Rock annexed a portion of its surrounding area that included the Goss property. In accordance with the city code, the annexed area was classified by default as an "R-2" district for single-family residences. Under the city ordinances, Goss' business activity would be limited to "C-3" general commercial district zones; nevertheless, Goss was permitted to continue his operations pursuant to a nonconforming use exception.

In April 1993, Goss petitioned Little Rock to have his property rezoned as a "C-3" zone. Little Rock's Planning Commission agreed to recommend to the Little Rock Board of Directors that the area be rezoned, but only on the condition that Goss dedicate a portion of his property to Little Rock for future expansion of the adjacent highway. The demanded dedication ran the entire length of Goss' property (63 3.68 feet) and 55 feet into the lot. The total acreage of the demanded dedication approximates eight- tenths of an acre, or twenty-two percent of the total property. Goss objected to the condition.

Decision: Rezoning decisions are vested in discretion of zoning authorities, and rezoning decisions are not subject to judicial scrutiny as to their providence, but courts must insure compliance with minimal constitutional limitations. Application of general zoning law to particular property effects a taking if ordinance does not substantially advance legitimate state interests or denies owner economically viable use of land. Whether taking resulted from conditioning approval of rezoning request on dedication of portion of property for future expansion of adjacent highway was jury question in light of absence of information in record concerning city's stated belief that different, heavy traffic-producing business could be erected on property if rezoned and whether demanded dedication was roughly proportional to projected impact of proposed rezoning.

Zoning authority has burden in suit by property owner alleging that conditioning approval of zoning application on individual parcel is taking for which compensation is required, even though in other cases property owner carries burden of proving that imposition of regulatory action violates constitutional norms.

If Little Rock had simply required the dedication of Goss' property, rather than conditioning a rezoning application on its grant, it would have been a taking. Thus, the question is whether the condition was in response to a legitimate concern regarding the proposed rezoning or whether Little Rock was using its police powers as leverage to extract the concession of a constitutional right--compensation for property taken. The record suggests that Little Rock's staff based its condition on a concern that a different, heavy traffic- producing business could be erected on the property if rezoned. The sparsity of the record, however, does not permit an inquiry by this court into the existence of the required nexus or, if a nexus exists, whether the demanded dedication bears some rough proportionality to the projected impact of the proposed rezoning. Therefore, we reverse the district court's dismissal and remand it for further proceedings consistent with this opinion.

NATIONAL ASSOCIATION OF HOME BUILDERS OF THE UNITED STATES v. CHESTER-FIELD COUNTY,--- F.Supp. ---- (1995 WL 707 164 (E.D.Va. Nov. 29, 1995).

In this case the plaintiffs assert that the cash proffer policy ("the Policy") adopted by the County's Board of Supervisors pursuant to Va.Code s 15.1-49 1.2 facially violates the Fifth Amendment to the United States Constitution's prohibition on taking of property without just compensation. The plaintiffs assert that the Policy mandates the payment of cash in exchange for favorable action on residential rezoning applications.

The County of Chesterfield has adopted an ordinance which authorizes it to accept cash proffers. Chesterfield County Code s 2 1.1-8. In order to guide its acceptance of proffers under this authority under s 2 1.1-8, the County Board of Supervisors adopted the Policy at issue in March of 1990 and subsequently as amended. The Policy states that it "is applicable to all residential rezoning requests." Through a process involving five "components" the Policy calculates "what a new home will cost the County in terms of providing public facilities such as schools, roads, parks, etc." Some of these figures are calculated based on county-wide averages and some are determined based on smaller units. Through these calculations the Policy determines a "maximum cash proffer" amount which a rezoning applicant may tender with his rezoning application. According to the Policy, currently "[r]esidential rezoning applicants are being asked to proffer a maximum of $5,083 per lot [plus an indexed amount for payments after a certain date]."

The issue before the Court is whether the Policy is, on its face, capable of application in accordance with the Fifth Amendment. The Policy establishes a maximum proffer amount based on the average cost to the County of a new home. The Policy explicitly provides, however, that this amount is a maximum. According to the language of the Policy there is no requirement that any, or any particular, amount of cash must be proffered for rezoning approval. The Court accordingly concludes that there is no reason apparent on the face of the Policy why the proffers required, if any, can not be determined in an "individualized" manner and fixed at an amount "roughly proportional" in "nature and extent to the impact of the proposed development" according to the test set out in Dolan v. Tigard. The Court concludes that the Cash Proffer Policy of the County of Chesterfield is not facially violative of the Takings Clause of the Fifth Amendment to the United States Constitution.

AMOCO OIL COMPANY v.VILLAGE OF SCHAUMBURG, 277 Ill.App.3d 926, 661 N.E.2d 380, 214 Ill.Dec. 526, First District, Fifth Division.Dec. 29, 1995.

Service station owner filed action for declaratory and injunctive relief and damages arising from village's issuance and subsequent repeal of special use permit that allowed redevelopment of station if owner dedicated twenty percent of its land for highway expansion. The Circuit Court ruled that dedication requirement did not constitute a taking but that village's attempted revocation of permit did not qualify as reasonable exercise of village's legislative authority. Parties appealed. The Appellate Court held:

Village's requirement that service station owner dedicate approximately twenty percent of its property for highway expansion in order to secure approval of zoning application to redevelop its station constituted a taking; increase in traffic due to redevelopment would have been only approximately four tenths of one percent. Matters relating to zoning lie primarily within discretion of municipality, and it is not the province of courts to interfere with that discretion unless action of municipality is shown to be unrelated to public welfare.

In order for the exaction at issue here to pass constitutional muster under the Federal Constitution, the dedication required by Schaumburg must be roughly proportionate to the razing of the current Amoco station, the erection of a "prototypical food shop", the reconfiguration of the "pump islands", the elimination of two driveways, and the addition of an overhead canopy. That dedication consists of twenty eight (28) feet of additional right-of-way along Golf Road and ten (10) feet of additional right- of-way along Roselle Road, as well as a forty (40) foot triangular section of right-of-way immediately contiguous to the intersection.

Schaumburg contends that "the nexus would have existed because the dedication requirement originally imposed related to the state interest of the highway improvement. The proportionality existed because the dedication was directly related to the land sought to be improved, by the special use." After having reviewed the evidence submitted at trial, the circuit court stated at length:

> "The Village [Schaumburg] has argued that both [the] dedication requirement and the revocation of the special use permit were necessary to protect [the] public welfare. The dedication requirement would serve to alleviate traffic problems, and the repeal of the ordinance was in order to ensure that Schaumburg had an adequate number of service stations. However, the evidence presented at trial underscored the insignificance of these so called concerns.

The issue of increasing traffic congestion and the need for additional service stations amounts [sic] to little more than pretextual excuses offered subsequent to the enactment of the repealer ordinance, and in order to insulate the Village from claims that it act[ed] in retaliation for Amoco's failure to concede to the dedication requirement and that it wielded its zoning power unreasonably.

PARKING ASSOCIATION OF GEORGIA V. CITY OF ATLANTA (1994), 264 Ga. 764,450 S.E.2d 200, cert. denied, --- U.S. ----, 115 S.Ct. 2268, 132 L.Ed.2d 273.

The city of Atlanta enacted a zoning ordinance pertaining to parking lots with 30 or more spaces in several downtown and midtown zoning districts. The ordinance required minimum barrier curbs and certain specified landscaping. The purpose of the ordinance was to improve the city's aesthetic appeal, promote public safety, and ameliorate problems with air quality and water run off. The supreme court of Georgia upheld the ordinance under state law. The court also held that the ordinance did not constitute a taking even under the "federal takings analysis. "

> "Plaintiff's reliance upon Dolan v. City of Tigard. . . is misplaced. In that case, the city required an applicant for a building permit to deed portions of her property to the city. The Supreme Court held the required dedication violated the Takings Clause because the city did not 'make some sort of individualized determination that the required dedication is related both in nature and extent to the impact of the development.' Id. at ----, 114 S.Ct. at 23 19. Here the city made a legislative determination with regard to many landowners and it simply limited the use the landowners might make of a small portion of their lands. Moreover, the city demonstrated a 'rough proportionality' between the requirements and objectives of the ordinance."

PRINGLE v.CITY OF WICHITA, 917 **P.2d 1351,** Court of Appeals of Kansas. Feb. **2, 1996.**

The City of Wichita, Sedgwick County, and the State of Kansas, are in the process of completing what is commonly known as the Northeast Expressway, a four-lane freeway running from approximately the intersection of 29th Street north and I-135 to the intersection of Kellogg east of 127th Street. The City had the responsibility for constructing the Expressway from I-135 and 29th Street to the intersection at 29th and Webb Road. The County had the responsibility for constructing the Expressway from the intersection at Webb Road to its southern terminus at Kellogg. The State has overall responsibility and upon completion of the construction will take jurisdiction of the Expressway and have the responsibility for maintenance, setting speed limits, etc...

This lawsuit arises out of a decision by the City of Wichita to close a portion of 127th Street East approximately a block north of Kellogg and to close the median on Kellogg at its intersection with 127th Street East. The plaintiffs, owners of the real estate surrounding the intersection, filed suit to enjoin the City from carrying out its plan. In the alternative, plaintiffs sought an award of money damages against the City for wrongful taking of their property rights.

The Court of Appeals, held that no compensable taking occurred in construction of expressway when city closed street and median in exercise of its police power, to limit traffic flow at intersection, thereby requiring property owners to undertake circuitous travel to go in certain directions on streets at intersection, where owners' access to streets was not eliminated.

1. A city may exercise its police power to limit and regulate traffic. A reasonable regulation imposed to protect

the public is not a taking. If a regulation is determined to be unreasonable, it then becomes a taking and is compensable.

2. An owner of land adjoining a road or highway enjoys a right of access which entitles the owner to go and return from his own land to the road or highway without unreasonable interference. The right of an abutting owner cannot be taken or materially interfered with without just compensation.

3. An abutting owner has no right to the continuation of a flow of traffic in front of his property. Regulation of traffic under the police power without liability for compensation includes prohibiting left turns, prescribing one-way traffic, prohibiting access or crossovers between separated traffic lanes, prohibiting or regulating parking, and restricting the speed, weight, size, and character of vehicles allowed on certain highways.

4. Under the facts of this case, the district court did not err in concluding that no compensable taking occurred when the city closed a street and a median.

Discussion: The plaintiffs' reliance on a claim of lost "access" is misplaced. The district court found that their "access" remained unchanged after the City's action. Plaintiffs have not challenged this finding on appeal, What the plaintiffs are really complaining about is the fact that, once they get to the highway (Kellogg or 127th Street), their routes of travel on the highway are now limited. For example, a person leaving the McMaster property has access to 127th Street but can only go north on that street. Travel to the south has been eliminated by the City's action. Similarly, a person leaving the Boone property can go north on 127th Street to Kellogg and then travel east. Travel westbound on Kellogg has been restricted by closing the median on Kellogg.

The distinction between "access" and traffic flow is important. See Teachers, 221 Kan. at 335,559 P.2d 347. "[A]n abutting owner has no right to the continuation of a flow of traffic in front of his property. The state's exercise of its police power in such situations is predominant and controlling." Brock v. State Highway Commission, 195 Kan. 361,371,404 P.2d 934 (1965). For example, the Supreme Court has commented that the regulation of traffic under the police power without liability for payment of compensation "includes, among other things, prohibiting left turns, prescribing one-way traffic, prohibiting access or crossovers between separated traffic lanes, prohibiting or regulating parking, and restricting the speed, weight, size and character of vehicles allowed on certain highways." Ray v. State Highway Commission, 196 Kan. 13, 17,410 P.2d 278, cert. denied 385 U.S. 820,87 S.Ct. 43,17 L.Ed.2d 57 (1966) (quoting Smith v. State Highway Commission, 185 Kan. 445,454,346 P.2d 259 [1959]); see Eastborough Corporation v. City of Eastborough, 201 Kan. 491,497,441 P.2d 891 (1968).

While plaintiffs latch on to the phrase "circuitous route" . . . . they ignore the district court's finding that their direct access to Kellogg and 127th Street is unchanged by the City's action in this case. That finding distinguishes this case from Teachers. Any circuity of travel faced by the plaintiffs in this case is the same circuity all drivers face when a city lays out one-way streets, creates cul-de-sacs, or closes medians to prevent left turns. Annot., Abutter's Access--Traffic Regulation, 73 A.L.R.2d 689,39 Am.Jur.2d, Highways, Streets, and Bridges s 179.

LORDAN v. FELD, 3 Mass.L.Rptr. 435,1995 WL 809480 (Mass.Super.- March 16, 1995.

On August 18, 1994, the Board approved a five-lot subdivision plan submitted by the Trust. The subdivision includes a cul-de-sac street within it named Fairway Drive. Access to Fairway Drive is to be from Ledgewood Road. At the time of approval, the Board's rules and regulations for the subdivision of land contained the following provision: If adjoining property is not subdivided but is, in the opinion of the Board, suitable for ultimate development, provision shall be made for proper protection of streets into such property by continuing appropriate streets within the subdivision to the exterior boundary thereof.

Land Subdivision Rules and Regulations s IIIB. 1 .g. Lordan owns approximately 15 acres of land adjacent to the proposed subdivision. Lordan's land is not subdivided but is suitable for ultimate development. Lordan informed the Board during the hearing process that her property is land-locked, having no access or egress by public or private way, easement, right-of-way or other legally cognizable right of access. She demanded the protection of s 1II.B. 1 .g. The Board, however, approved the Trust's plan and declined to apply s III.B. 1 .g to the Lordan property on the ground that its application would violate "the 1994 U.S. Supreme Court Decision on Land Takings."

Discussion: The principles articulated in Nollan and Dolan have recently been applied by the Florida and Washington Courts of Appeals in situations which are factually analogous to the case at bar. In Paradyne v. State, Dept. of Transportation, 528 So.2d 92 1 (1988) review denied, 536 So.2d 244 (1988) the Florida Court of Appeals disapproved a state agency's order requiring Paradyne to construct a drive on its private property for the use and benefit of the abutting landowner as an invalid exercise of the state's police power. Id. at 923. The stated purpose for the order, which was a condition imposed upon a road connection permit, was to further the safety of the traveling public. Id. at 927. The Court concluded that there was no essential nexus between the stated purpose and the condition imposed, which simply furthered the private interests of an abutting landowner. Id. at 927. As such, the condition could not withstand constitutional scrutiny as it clearly amounted to a taking without just compensation. Id. See also Schwing v. Baton Rouge, 249 So.2d 304 (La.App.), application denied, 259 La. 770,252 So.2d 667 (197 1) (refusal to approve resubdivision unless subdivider included within plan a dedication of area sufficient to accommodate extension of street to the primary benefit of the public violated constitutional prohibition against taking private property for public use without due compensation); Hylton Enterprises v. Board of Supervisors, 220 Va. 435,258 S.E.2d 577 (Va. 1979) (no implied or express authority for county to require developer to construct portions of route that abutted subdivision as prerequisite to approval of subdivision plat). In Unlimited v. Kitsap Cty., 750 P.2d 65 1 (1988), the Washington Court of Appeals came to a similar conclusion in another case involving an easement in favor of an abutting landlocked property owner. In that case, the Kitsap County Board of Commissioners conditioned the approval of Unlimited's building permit on the dedication of a public right of way across Unlimited's property to allow the abutting landowner access to public roads. The stated purpose of the condition was to allow circulation of increased traffic anticipated from the future commercial development of the abutter's land and other surrounding properties. Id. at 653. The Court held that this requirement of commercial access to the abutting property did not "even remotely satisfy" the requirements of Nollan. Id. at 653. The Court stated that the exaction of the right-of-way served "no public interest, let alone a reasonable one." Id. at 653-54. The Court said that the public had no interest in the commercial development of the abutter's property. Thus, it was clearly unreasonable for the County to require a commercial access easement to the commercially land- locked parcel as a condition to Unlimited's planned development. Id. at 654.

As a matter of law, Lordan has not met her burden to show that the Board acted improperly in approving the Trust's subdivision plan without an access easement or requiring continuation of the street. Under the guidance of Nollan, Dolan, Unlimited and Paradyne, and on the record before the Court, the plaintiff has not shown that the development has created any problem or aggravated an existing problem. In light of the foregoing analysis, Lordan's claim that the Board did not validly waive s III.B. 1.g has no merit. The Board is not required to apply its regulations in a manner which would result in an unconstitutional taking of the Trust's land.

MAGLIOCHETTI v. **STATE of** New **Jersey,** 276 N.J.Super. 361, 647 A.2d 1386 Superior Court of **New** Jersey, Law Division, Passaic County, June 3, 1994.

The State of New Jersey by the Commissioner of Transportation (the Commissioner) has determined to relocate Route 46 in Clifton to the south of its now-abutting line with the property owned by plaintiff Ralph Magliochetti (Magliochetti). In addition, as part of the highway redesign, the Commissioner will create a service road parallel to the relocated Route 46 that will be constructed partially on the existing roadbed for the westbound lanes of Route 46 and partially on a triangular piece from the southerly line of Magliochetti's property. Finally, the Commissioner will provide access to Magliochetti's restaurant, "The Lily Pond," via a street perpendicular to the service road and will revoke his current access permit.

Customers of Magliochetti's restaurant who intend to return to the location from which they travelled in reaching his property have to make one approximately 4000-foot loop on one leg of their round trip but have direct access to and from his property on the other leg. After construction, eastbound traffic on Route 46 will have to cross the Passaic River, exit on the jughandle for River Road, go north under Route 46 and take the jughandle for Route 46 West. Magliochetti's patrons will then cross the Passaic River again, take the exit for Crooks Avenue, make a left on the service road and proceed three blocks to the subject property. The Commissioner estimates that the total distance traversed on this more complicated loop will be about one mile. To return to the direction from whence they came, these patrons will have to retrace their path along the service road to Crooks Avenue and take the entrance ramp onto Route 46 East and repeat the above-described double crossing of the Passaic River, ultimately passing the subject property on the realigned highway after another mile-long, complicated loop. Thus, patrons travelling from the west of Magliochetti's establishment will, on a round trip, travel 2.65 times the distance currently required to patronize Magliochetti's restaurant.

Traffic headed west on Route 46 will have to exit the highway to the left immediately after crossing the Passaic River and take Crooks Avenue to the service road. So long as the patron knows to take this Crooks Avenue exit, access to the subject property from the east does not appear to be substantially different than it is presently, and return access to Route 46 eastbound is more direct, the customers merely retracing the path by which they arrived. However, prospective customers who remain on the realigned Route 46 and become interested in patronizing The Lily Pond as they pass the restaurant will have to proceed west on the 3800,foot loop around Lexington Avenue, pass the subject property as they head east, and then make the mile-long, complicated loop across the Passaic River and back to gain access to the service road and, ultimately, Magliochetti's property via East Fourth Street. If they miss East Fourth Street, they may have to take a trip on the Garden State Parkway.

Patrons heading south on Route 20 will not experience any significant change in their approach to the subject property, exiting onto the service road just as they now merge onto Route 46 West. They will not, however, be able to head west on Route 46 to make the Lexington Avenue 3800-foot loop. Rather, they will have to head back the way they came, on the service road, turn right on Crooks Avenue, exit onto Route 46 East, cross the Passaic River twice, take the exit for Crooks Avenue and then exit for Route 20 North. It is not clear whether this more complicated loop is longer or shorter than the Lexington Avenue loop.

Property owner brought action seeking declaration that, in state's forthcoming eminent domain action, jury should determine whether state's proposed removal of property owner's access points to highway is reasonable and, if not, amount of compensation due property owner for loss of access points. Both parties moved for summary declaration of their rights. The Superior Court, Law Division, Passaic County, held that whether state's proposed taking of property owner's highway access point would leave property owner with reasonable highway access would be determined by jury in state's forthcoming eminent domain action.

Having administrative agency determine whether state's proposed taking of property owner's highway access points would leave property owner with "reasonable" highway access would not serve goals of doctrine of exhaustion of administrative remedies and, thus, in state's forthcoming eminent domain action, whether proposed taking would leave property owner with reasonable highway access would be determined by jury; decision of administrative law judge would not obviate resort to courts, development of factual record would not be necessary, and ultimate decision would not rest on factual determinations lying within expertise of agency. N.J.S.A. 27:7-90.

Eminent Domain Act is not an enabling statute; it merely provides uniform procedure to be followed in condemnation proceedings. N. J.S.A. 20:3-l et seq. Under Eminent Domain Act, Law Division has jurisdiction of all matters in condemnation and all matters incidental thereto, including jurisdiction to determine authority to exercise power of eminent domain, to compel exercise of such power, to fix and determine compensation to be paid, to determine parties entitled to compensation, and to determine title to all property affected by action. N.J.S.A. 20:3-5.

Doctrine of exhaustion of remedies serves three primary goals: rule ensures that claims will be heard, as preliminary matter, by body possessing expertise in area; administrative exhaustion allows parties to create factual record necessary for meaningful appellate review; and agency decision may satisfy parties and thus obviate resort to courts.

Exhaustion of administrative remedies rule has limited application, and where administrative jurisdiction over subject matter is not primary and exclusive, there is no occasion for invoking rule unless essentially administrative issue involving agency expertise and discretion is involved. Where issues are especially fact sensitive and related primarily to areas of administrative expertise, then exhaustion of administrative remedies is proper.

The parties cross-move on undisputed facts for a summary declaration of their rights and obligations under the New Jersey Highway Access Management Act, N.J.S.A. 27:7-89 to -98, which provides a statutory and regulatory framework for managing access to state highways. Included among the legislative findings and declarations which form a part of the Act are the following statements:

e. Every owner of property which abuts a public road has a right of reasonable access to the general system of streets and highways in the State, but not to a particular means of access. The right of access is subject to regulation for the purpose of protecting the public health, safety and welfare.

f. Governmental entities through regulation may not eliminate all access to the general system of streets and highways without providing just compensation.

g. The access rights of an owner of property abutting a State highway must be held subordinate to the public's right and interest in a safe and efficient highway.

The gravamen of the Act and the Code is regulation of the issuance of access permits. However, the Act does authorize the Commissioner to revoke existing access permits after written notice and hearing if the Commissioner determines that alternative access is available which conforms to the Act. N.J.S.A. 27:7-94a. The criteria for determining the existence of conforming alternative access are specific to the use to which the property is put. N.J.S.A. 27:7-94c. For property used for commercial purposes, concededly the case here, the Act provides that alternative access is "assumed to exist if the property owner enjoys reasonable access to the general system of streets and highways in the State" and in addition will have

This is not a case where the ultimate decision will rest on factual determinations lying within the expertise of the agency. Those factual determinations have already been made by the agency prior to announcing the partial taking of Magliochetti's property. The only issue which will be resolved by the administrative law judge is whether the alternative access is reasonable. When the manner of access is undisputed, as is the case here, the determination of whether it is "reasonable" is a conclusion to be drawn from the undisputed facts. Lima & Sons, Inc. v. Borough of Ramsey, 269 N.J.Super. 469,478,635 A.2d 1007 (App.Div. 1994). The average juror is just as capable of deciding whether "motorists will have a convenient, direct, and well-marked means of reaching the site and returning to the State highway" as is an administrative law judge. Requiring exhaustion of administrative remedies with respect to revocation of direct access, where the loss of access is caused by a partial taking of a property owner's entire highway frontage to create a service road that will have no direct access to the highway, would be futile and interfere with a prompt judicial decision on the compensation to be paid for the taking, The reasonableness of alternative access shall be determined in the condemnation action.

LIMA v. BOROUGH OF RAMSEY 269 N.J.Super. 469, 635 A.2d 1007, Superior Court of New Jersey, Appellate Division.Decided Jan. 5, 1994.

Property owner brought action against town state Department of Transportation and others, seeking redress after town denied property owner secondary access to municipal roadway. Lima & Sons, Inc. owns real property, which is zoned for commercial use, consisting of two adjacent lots in the Boroughs of Ramsey and Upper Saddle River, commonly known as 3 19 Nottingham Road. The property is located at the northwest comer of what was formerly the intersection of State Highway Route 17 and Nottingham Road in Ramsey. Lima operates a retail boat dealership on this property. Although one side of the property abuts Nottingham Road, the main frontage is on Route 17 and the building on the property faces Route 17. The neighborhood along Nottingham Road is residential.

Prior to October 1987, Nottingham Road ran through a residential area and terminated at Route 17. Vehicles travelling on Nottingham Road could use that street for access to Route 17 south, and vehicles could exit Route 17 south at the Nottingham Road exit. When the New Jersey Department of Transportation (D.O.T.) contracted for the construction of an overpass to carry traffic on Lake Street, which is north of Nottingham Road, over Route 17 into the Borough of Ramsey a question arose whether to continue to allow access to Route 17 from Nottingham Road. After soliciting public input, Ramsey decided that Nottingham Road would end with a cul-de-sac before its intersection with Route 17, thereby discontinuing access from Nottingham Road to Route 17, and curbing would be constructed for the first time along Nottingham Road. Plaintiff has been able to continue business operations by virtue of its direct access to Route 17, but it contends that the denial of access to Nottingham Road has created significant inconvenience as well as creating an economic impact on the value of its property.

The Appellate Division held that: (1) property owner retained reasonable access to public roadways after its secondary access to municipal roadway was denied; (2) property owner's due process rights were not violated; (3) town's failure to vacate closed portion of municipal roadway did not affect property owner's rights; and (4) actions of defendants did not deprive property owner of its rights under color of state law in violation of s 1983.

Property owner is entitled only to reasonable access to system of public roadways; property owner does not have absolute right of access to all abutting highways. Town's denial of property owner's secondary access to municipal roadway was proper exercise of town's available police power since property owner still maintained reasonable access to another roadway; property owner's argument that it must make more circuitous route for ingress and egress to its property did not make such access unreasonable.

Vacating public street merely relieves land of public's right of easement and does not infringe upon private right of access of abutting landowner. Landowner did not have statutory right to move its driveway accessing municipal roadway and to continue its use of such driveway; where a property owner retains reasonable access to another abutting public road, property owner does not have absolute right to obtain alternate access to another abutting road.

Property owner's direct access onto roadway rendered its access to system of public roadways reasonable and, therefore, town's action closing property owner's access to alternate municipal roadway did not deprive property owner of its rights under color of state law in violation of s 1983. 42 U.S.C.A. s 1983

DIXIE OIL COMPANY OF FLORIDA v. STATE of Florida, DEPARTMENT OF TRANSPORTATION 657 So.2d 1258,20 Fla. L. Weekly D1623, District Court of Appeal of Florida, First District. July 13, 1995.

Appellant, Dixie Oil Company of Florida (Dixie), owns property and operates a gas station and convenience store located on the southwest comer of the intersection of Miccosukee Road and Capital Circle, N.E. (State Road 261), in Leon County, Florida. In September 1991, to facilitate the widening of a portion of Capital Circle, the Department of Transportation (the Department) commenced condemnation proceedings for temporary construction easements and to take a strip of land owned by Dixie that bordered Capital Circle. Prior to filing suit, the Department and Dixie entered into an agreement under which the Department would allow three forty-eight foot driveways to remain on Dixie's property--two driveways directly adjacent to Capital Circle, and one adjacent to Miccosukee Road. Thereafter the owner learned that department intended to reduce width of driveways and filed formal petition for administrative hearing. Department did not respond and instead proceeded with eminent domain valuation trial. After owner adduced evidence and obtained judgment in part based on reduction of size of driveways, the department dismissed owner's administrative proceeding. Owner appealed urging the applicability of the Access Management Act and to challenge the propriety of the Department's actions under the provisions of that act.

The District Court of Appeal, held that owner elected its remedies by failing to seek relief from trial court's denial of continuance of valuation trial and instead presenting evidence on size reduction and obtaining judgment based in part on such evidence.

Although property owner filed petition for administrative hearing after state transportation department purportedly reduced agreed-upon size of driveways owner could maintain in connection with road widening project, and although owner moved for continuance of eminent domain valuation trial, owner elected its remedies when it failed to seek relief to stay valuation trial and instead presented evidence on reduction as element of damages and obtained jury verdict based in part on such evidence; therefore, owner could not continue to challenge propriety of department's action in administrative proceeding. Dixie was presented with an election of remedies when the Department changed the design of the driveways. It could have pursued administrative remedies to contest the propriety of the change under administrative statutes and rules governing the Department; it could have filed suit for specific enforcement of its contract with the Department concerning the driveways; or it could have proceeded with the valuation trial to determine the amount of damages Dixie sustained by reason of this taking, including the effect of the change in design of the driveways.

SPARKS v. DOUGLAS COUNTY, 904 P.2d 738 Supreme Court of Washington, En Banc.Nov. 2,1995.

On March 29,1990, Herschel and Elizabeth Sparks (Sparkses) filed four short plat applications with the Douglas County Planning Office, designated as plats 2,3,4 and 5. Plat 2 covers 9.19 acres located East of Empire Avenue and North of 30th Street Northwest in unincorporated Douglas County near East Wenatchee (Sparks 2). Plat 3 is located immediately South of Plat 2, East of Empire Avenue and North of 29th Street Northwest, covering 9.5 acres (Sparks 3). Plat 4 consists of 6.72 acres between Empire Avenue and Fir Street Northwest, north of 32nd Street Northwest (Sparks 4). Plat 5 is located on 5.6 acres between Empire Avenue and Fir Street Northwest and adjacent to 32nd Street Northwest on the south (Sparks 5). Each of the proposed short plats contains four residential lots.

Subdivision Review Committee approved the short plat applications subject to certain conditions, which included dedication of rights of way for future improvements along the public roads bordering the plats. The committee specifically required a 10- foot right of way along the portion of plat 2 bordering Empire Avenue; a 10- foot right of way along the portion of plat 3 bordering Empire Avenue and a 5- foot right of way along the portion of that plat adjacent to 29th Street; a 25-foot right of way along the portion of plat 4 abutting Fir Street; and dedication of 25-foot rights of way along the portions of plat 5 bordering Fir Street and 32nd Street.

Property owners sought writ of review of decision of county commissioners affirming planning commission's decision to condition approval of short plat applications upon dedication of rights of way for road improvements. The Supreme Court held that: (1) county's action was neither arbitrary nor capricious, and (2) required dedication was not unconstitutional taking.

When government physically appropriates portion of person's private property, such as through easement or right-of-way, taking has occurred which requires compensation, but this rule does not necessarily apply where conveyance of property right is required as condition for issuance of land permit. U.S.C.A. Const.Amend. 5.

As prerequisite for development permission, regulation may require landowner to dedicate property rights for public use if regulatory exaction is reasonably calculated to prevent, or compensate for, adverse public impacts of proposed development. U.S.C.A. Const.Amend. 5.

County's action conditioning approval of plat applications on dedication of rights-of-way was based on well-documented findings, including information on current road widths, road standards, and current and projected road use. Approval of zoning application conditioned upon required dedication is not unconstitutional taking if government entity makes some sort of individualized determination that dedication is related both in nature and extent to proposed development's impact, but no precise mathematical calculation is required. U.S.C.A. Const.Amend. 5.

Agencies reviewing applications for subdivision approval **must consider adequacy of access** to proposed subdivision, and may condition approval on provision of adequate access. Report prepared by county planning office for each short plat documented deficiencies in right-of-way width and surfacing of adjoining streets, and county calculated increase in traffic and specific need for dedication of rights-of-way based on individual and cumulative impacts of series of short subdivisions. U.S.C.A. Const.Amend. 5.

Discussion: RCW 58.17.1 10(2) provides in relevant part: A proposed subdivision and dedication shall not be approved unless the city, town, or county legislative body makes written findings that: (a) Appropriate provisions are made for the public health, safety, and general welfare and for such open spaces, drainage ways, streets or roads, alleys, other public ways . . . and all other relevant facts . . .; and (b) the public use and interest will be served by the platting of such subdivision and dedication.. . . Dedication of land to any public body, provision of public improvements to serve the subdivision, and/or impact fees imposed under RCW 82.02.050 through 82.02.090 may be required as a condition of subdivision approval.. . . No dedication, provision of public improvements or impact fees . . . shall be allowed that constitutes an unconstitutional taking of private property.

The pivotal issue under the Dolan approach is whether the exactions demanded by Douglas County are roughly proportional to the impact of the Sparkses' proposed developments. While Dolan disregarded precise calculations in analyzing development impacts, it ruled that local government must make some effort to quantify its findings to support its permit conditions. The findings upon which the County relies reflect the required rough proportionality between the exactions and the impact of the Respondents' proposed developments. It is undisputed that the developments would generate increased traffic on adjacent roads which are not adequate for safe access under county standards. The County has, in the process of individualized analysis, satisfied the final step of the Dolan test.

Respondents argue that the substandard conditions of the roads existed even prior to the Sparkses' plat applications and cannot therefore be caused by their proposed developments. But it has been established that the increase in traffic generated by those plats on already unsafe roads would require additional right of way and reconstruction to accommodate the overflow.

J.C. REEVES v. **CLACKAMAS COUNTY,** 887 P.2d 360,131 Or.App. 615, (Or.App. 1994)

Developer sought review of Land Use Board of Appeal's (LUBA) affirmance of county hearing officer's decision approving, but imposing conditions on, developer's application to develop residential subdivision. The subject property is approximately 4.9 acres in size and is zoned Low Density Residential (R-8.5),and is essentially undeveloped and located within the Portland Metropolitan Area Urban Growth Boundary. It is located in an area developed with single family residences. Access to the proposed lots will be provided by a new east-west street (Arthur's Court) along the southern border of the subject property, via S.E. 119th Drive, which will be extended to the southern border of the subject property.

"The county planning department recommended denial of the proposal. After a public hearing, the hearings officer approved the proposal with several conditions. Of interest here is (2) construction of certain street improvements along the portion of S.E. 122nd Avenue abutting the subject property, Petitioner requested a hearing on the conditions of approval applied to the proposed development. * * *"

The Court of Appeals held that: (1) county's findings did not support imposition of development conditions concerning improvements to street bordering proposed subdivision, and (2) condition of development that subdivision commence on southern property line and that one-foot "spite strip" be eliminated complied with "rough proportionality" standard for determining whether condition survived takings challenge.

Decision: This case illustrates, the detailed analysis of traffic and other phenomena, and of the relationship of a proposed development to them' may be unlikely to appear in local orders that predated Dolan. Petitioner argues that the county "must establish that the extent of the improvements on S.E. 122nd required of Petitioner is roughly proportionate to the impact of traffic on S.E. 122nd generated by the proposed subdivision. There are no findings addressing that issue nor is there substantial evidence in the record to reflect any analysis of the relationship between the impact of petitioner's 2 10 vehicle tips per day development and the total cost of the improvements to S.E. 122nd exacted from Petitioner. Petitioner entered evidence into the record that the amount of vehicular trips per day that could be attributed to the proposed project is only 2.6% of the total traffic planned to use SE. 122nd * * *. The County did not refute that evidence. As such it is logical to conclude that the Petitioner's share of the improvements to S.E. 122nd should be only 2.6% of the cost of those improvements."

The difficulty is that the county's findings do not make the comparison at all, or at least not with the specificity that Dolan requires. They simply posit the relationship between subdivision-generated traffic and the need for the improvements. Also, the county relies on the fact that some of the improvements are required by its zoning ordinance.

SCHULTZ V. CITY OF GRANTS PASS, 884 P.2d 569,13 1 Or.App. 220,, (Or.App. 1994)

City approved landowners' application to partition parcel of property, subject to conditions. Petitioners own a 3.85-acre parcel of real property, located within the acknowledged urban growth boundary of Grants Pass. The northern boundary of the property abuts Savage Street. The eastern boundary abuts Beacon Drive. Petitioners wish to partition the parcel into two lots. The first lot would consist of a 90-foot by 20 1 -foot parcel located at the comer of Savage Street and Beacon Drive. The second lot would consist of the remaining property.

The city approved the application, subject to conditions. Among the conditions were a 1 O-foot "dedication for county right-of-way" along the length of the portion of both of the parcels that abuts Beacon Drive and

> "[a] 20,foot dedication, measuring from the street centerline, plus an additional 5-foot dedication for City right-of-way * * * along the length of the portion of the parcels abutting Savage Street, "including enough area to round the intersection

Decision: The only issue in dispute is, indeed, whether there is the "required degree of connection" between the conditions the city has imposed "and the projected impact of the proposed development." Dolan v. City of Tigard, supra, --- U.S. at ----, 114 S.Ct. at 23 17. In this case, however, the city's justification for the conditions is, in the words of the city's own supplemental findings, the impact of "potential develonment of the partitioned tract." In other words, the city imagined a worst-case scenario--assuming that petitioners would, at some undefined point in the future, attempt to develop their land to its full development potential of as many as 20 subdivided residential lots, further assuming that petitioners would obtain all the necessary permits and approvals--and on the basis of that scenario, it calculated the impacts of the development and tailored conditions to address them.

The problem with that approach is that Dolan requires that the exactions imposed be "related both in nature and extent to the impact of the proposed develonment." --- U.S. at ----, 114 S.Ct. at 2320. (Footnote omitted; emphasis supplied.) The proposed development in this case is the partitioning of a single lot into two lots and nothing more. There is absolutely nothing in the record to connect the dedication of a substantial portion of petitioners' land, for the purpose of widening city streets, with petitioners' limited application.

Even taking into account the city's data reflecting the number of vehicle trips per day that the city assumes each new household will generate, the fact that there is an increase of eight vehicle trips on Beacon Drive and Savage Street each day hardly justifies requiring petitioners to part with 20,000 square feet of their land without compensation. That does not comport with what the Supreme Court meant by "rough proportionality."

STATE v. CITY OF COLUMBUS, 667 N.E.2d 8,76 Ohio St.3d 203,1996 WL 405208 (Supreme Court of Ohio. July 3 1, 1996.)

This appeal involves two properties owned by appellant OTR. The properties in question are located directly across from each other at 355 and 400 East Campus View Boulevard, Columbus, Ohio. Both properties are zoned for commercial use. The zoning standards for this area were adopted by appellee, city of Columbus, in 1982. Under these standards, improvements to the properties are subject to certain height, setback, "curb cut," and other restrictions.

The 35 5 East Campus View Boulevard property (also referred to as Crossgate Center) is a 6.32 1 -acre parcel improved with a two-story, multi-tenant office building and parking area. The property is located on the south side of Campus View Boulevard, abutting the roadway for a distance of approximately five hundred forty feet. Access to Crossgate Center is provided by driveways onto Courtyard **and** Horizon Drives, located to the west and south of the property, respectively.

The 400 East Campus View property (also known as Campus View Plaza) is a 12.166,acre parcel improved with a one-story office building, occupied by the Ohio Rehabilitation Service Commission, and parking area. The property is located on the north side of Campus View Boulevard, abutting the roadway for a distance of approximately one thousand feet. Access to Campus View Plaza can be obtained by way of a common access driveway located at the southwest section of the property. This driveway crosses a separately designated tax parcel owned by OTR. The record further indicates that **access is also** provided via a driveway that is located at the northwest portion of the property.

When OTR acquired the properties, Campus View Boulevard dead-ended to the west of the tracks at a relatively flat grade. The grade of Campus View Boulevard was established by a 1985 city ordinance. Recently , the City constructed an overpass bridge connecting Campus View Boulevard and Worthington Woods Boulevard was constructed entirely within the city's existing right of way. The overpass design employed by the city incorporates concrete retaining walls to establish an incline at a five-percent grade. At its highest point, the overpass reaches an approximate thirty-foot elevation. The grade separation and concrete retaining walls run virtually the entire length of both the Crossgate Center and Campus View Plaza properties, creating a barrier between the properties and Campus View Boulevard. As a result, OTR is prevented from developing any access routes along the properties' frontage on Campus View Boulevard.

The Court of Appeals for Franklin County reversed the judgment of the trial court. The Court noted initially that "[a]mong the appurtenances to ownership of land is a right of access to public streets on which the land abuts." However, the court of appeals determined that the construction of the overpass did not substantially interfere with appellants' rights to access Campus View Boulevard from the abutting properties. The court of appeals stated that "[m]erely rendering access less convenient or more circuitous does not by itself constitute 'substantial interference.' " The court of appeals also noted that "the rights of access which OTR claims were 'taken' by the construction of the Campus View overpass have never been developed; the Campus View overpass does not interfere with any of the developed rights of access to OTR's properties. The driveways which provided access to the improvements on the subject properties prior to the construction of the overpass were unaffected by the overpass and remain fully accessible." In this regard' the court of appeals ultimately concluded that "[o]nly where the denial of an undeveloped right of access results in a complete loss of access to the property or improvements on the property will the denial be found to constitute a 'substantial interference.

The Supreme Court reversed Court of Appeals and held that regrading of road in manner which prevented property owner from ever having access thereto was a "taking" of owner's property rights, for which compensation was required under United States and Ohio Constitutions.

Regrading of road in manner which prevented abutting property owner from ever having access to road was "taking" of owner's property rights, such as would require compensation under the United States and Ohio Constitutions, though property owner had made no use of that particular road and had accessed its property from different thoroughfares in past; mere fact that property owner had no developed access along the graded road did not mean that there was no compensable "taking," where regrading prevented owner from ever developing access in future. U.S.C.A. ConstAmend. 5; Const. Art. 1, s 19.

Owner of real property has easement in public street on which his property abuts, as appurtenance thereto, and if substantial change of grade in street on which property abuts renders buildings thereon less convenient of access, there is appropriation pro tanto of owner's property right in easement, for which compensation may be required. U.S.C.A. ConstAmend. 5; Const. Art. 1, s 19.

STATE v. WEISWASSER 287, N.J.Super. 287, 671 A.2d 121, Superior Court of New Jersey, Appellate Division.Feb. 2, 1996.

Defendants purchased for investment purposes a tract of land measuring approximately 112.3 8 acres. The land, which is vacant, is situated in the Township of Hainesport, Burlington County, and has limited frontage on Route 38 and limited frontage on Bullshead Road. As of the date of valuation, October 15, 1987, approximately 19 acres were zoned commercial and residential and 93.3 8 acres were zoned residential.

Prior to the taking, the property included five points of road frontage, four on Route 38 and one on Bullshead Road. Although defendants had never applied for access permits, access would have been permitted at all five points of frontage. On Route 38, three of the points of frontage are narrow strips of land that lie between property owned by third parties. The fourth point of frontage is a wider area with 278.5 feet of frontage on Route 3 8. The area between the 278.5,foot frontage and a 62-foot frontage to the northeast, also on defendant's property, was owned by Ronald Firth. The condemned area totals .39 acres and includes 255 feet of frontage within the 278.5,foot frontage area.

Landowners were awarded $390,000 after a condemnation commissioners' hearing. State appealed, and landowners cross-appealed. The Superior Court, Law Division, Burlington County, entered judgment of $204,000 for landowners. State appealed. The Appellate Division held that (inter alia): (2) trial court properly permitted introduction of evidence of increased development costs to condemnees resulting from loss of visibility of their property from highway.

There are two recognized formulae, both acceptable, for determining just compensation for taking of land: the first sets the measure of damages at the market value of the land taken plus the difference before and after the taking in market value of the remainder area, and the second equates damages with the difference between the value of the entire tract before the taking and the value of the remainder after the taking. N.J.S.A. 20:3-29.

Trial court properly permitted condemnees to introduce, for purposes of calculating damages, increased development costs from the loss of visibility of the remainder of their property from the highway, where condemnees planned to develop the remainder into single-family residential home-building lots, where loss of frontage on highway deprived condemnees of opportunity to market this property by building sample home next to highway, and where condemnees would incur increased advertising costs to overcome absence of visibility. N.J.S.A. 20:3-29.

Property owner is not entitled to access to his land at every point between it and the highway, but only to free and convenient access to his property and the improvements on it. But, in condemnation proceedings, condemnees may be awarded damages to the remainder by way of increased development costs attributable to a loss of visibility.

THREE GUYS REAL ESTATE v. HARNETT COUNTY, 469 S.E.2d 578, Court of Appeals of North Carolina. May 7, 1996.

Plaintiff is the owner of an undeveloped tract of real property containing approximately 23 1.37 acres located in Harnett County, North Carolina. In late 1993, plaintiff submitted a plat map of the property, dated 27 April 1993, to the Hamett County Planning Department. This map showed a proposed subdivision entitled "Weswood 4" containing twenty-three parcels, each of which was in excess of ten acres. Plaintiff requested that the Planning Department certify the map as exempt from Hamett County's Subdivision Regulations so that the map could be recorded with the Harnett County Register of Deeds. The map was denied exemption by County's Subdivision Administrator; the Harnett County Planning Board; and the Hamett County Board of Commissioners. The reason given for the denial was that the map showed no road access to the parcels.

Developer brought action against county seeking declaration that map was exempt and a writ of mandamus directing county to certify exemption. The Superior Court denied relief. Developer appealed. The Court of Appeals held that: (1) developer's plat map did not fall within definition of "subdivision" contained in county's subdivision regulations, but (2) county properly refused to approve map for plat recordation based on danger to health, safety, and welfare of community.

Plat map which divides tract of land into parcels consisting of ten or more acres and which specifically appropriates for the public, access to proposed parcels is subject to county's subdivision regulations. Hamett County, N.C., Subdivision Regulations s 3.0(l), as amended, 1 l-l-82, 1 l-15-82,4-16-90.

Developer's plat map which showed series of private driveway easements but did not show dedicated rights of way from only marked road located near, but not providing access to, 22 of 23 parcels did not fall within definition of "subdivision" contained in county's subdivision regulations. Hamett County, N. C., Subdivision Regulations s 3.0(l), as amended, 1 l-l-82, ll-15-82,4-16-90.

Municipal planning board is not obliged to approve subdivision merely because it is exempt from local subdivision ordinance. County is not required to approve developer's plat map for recordation even though map may not fall within definition of "subdivision" contained in county's subdivision regulations if developer's proposed use of its land as shown thereon would be danger to health, safety and welfare of community. Hamett County, N.C., Subdivision Regulations s 3.0(l), as amended, 1 l-l-82, 11-15-82,4-16-90.

County properly refused to approve developer's plat map for recordation based on danger to health, safety, and welfare of community where development had inadequate access to subdivision lots for such county services as law enforcement, fire, or rescue operations; any access to various lots was dirt roadway branching out into series of unimproved timber cart paths which did not service each and every lot. Harnett County, N.C., Subdivision Regulations s 3.0(l), as amended, 1 l-l-82, 1 l-15-82,4-16-90.

EVANSTON v. CITY OF CHICAGO, 279 Ill.App.3d 255, 664 N.E.2d 291, 215 Ill.Dec. 894 Appellate Court of Illinois,First District, Fifth Division. March 29, 1996.

Evanston and Chicago are home-rule units. They are divided by Howard Street with Evanston lying to the north and Chicago lying to the south. In February 199 1, developers approached Evanston city officials regarding construction of a shopping center on a 23-acre site then owned by Bell & Howell. This site was bordered by Kedzie on the west, Hartrey on the east, and Howard on the south. It was originally improved with a building of 780,000 square feet and used as a manufacturing and distribution facility. The residential development on the south side of Howard Street in Chicago was constructed after the development of the property and consists almost entirely of single-family homes. The area to the east of the site in Evanston is also zoned for residential use.

Between February and November 199 1, the developers and Evanston city officials conducted negotiations about the development of the site. In November 199 1, the Evanston city council gave conceptual approval to a proposed shopping center on the Bell & Howell site. The assistant city manager of Evanston notified the commissioner of planning and development of Chicago of the proposed development. Numerous community meetings were held in Evanston and Chicago, including three meetings with the North Boundary Homeowners Association, representing the residents in Chicago lying south of the site. Alderman Bernard Stone of the 50th ward also attended the meetings.

On March 13, 1992, the committee on transportation and public way of the Chicago city council submitted a report recommending that the city council pass an amended order directing the commissioner of the Department of Transportation to erect a center divider at a minimum of nine inches to a maximum of three feet in height south of the center line of west Howard from 100 feet east from north Francisco to north Kedzie without any openings.

Evanston sued Chicago and its Commissioner of Transportation, seeking injunction mandating removal of guardrail median installed by defendant city in center of street marking boundary between two cities. The Circuit Court, Cook County, The Appellate Court held that: (1) trial court used appropriate standard, in its determination that defendant city had abused its exercise of police power; (2) plaintiff city proved by clear and affirmative evidence that resolution of defendant city to construct guardrail median was unreasonable and that it would not promote safety and welfare of public; (3) Commissioner of Transportation of defendant city did not have authority to construct guardrail median without express approval of city council expressed in ordinance; and (4) testimony of witnesses for defendant city as to concerns of area residents regarding increased traffic, noise, pollution, litter and crime was purely speculative and constituted inadmissible hearsay.

Access Management And Highway Improvement Projects

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Lorinda Lasus is a Deputy Attorney General assigned to provide legal representation to the New Jersey Department of Transportation. The views expressed in this publication are Ms. Lasus' and do not necessarily reflect the views of the State of New Jersey, Department of Law and Public Safety or the Department of Transportation.

ABSTRACT

New Jersey's State Highway Access Management Act and Code have brought many changes to access management in the state, both in the permitting context and in how the Department of Transportation addresses access changes on high way improvement projects.

The paperpresent the goals and some features ofNew Jersey s access management program. It explain the difference types of impacts to property that result from highway improvement projects, project impacts, access impacts and right of way impacts. Finally, it provides three examples of why access regulation and property acquisition on these projects must be coordinated.

INTRODUCTION

Until 1989, New Jersey treated access permuting and the design of highway projects as two separate areas within the Department of Transportation. Those seeking to develop properties on State highways needed highway access permits to authorize driveway construction. Although these permits were required by law and were revocable, there was no procedure to follow for revoking them.

When advancing its highway improvement projects, the Department frequently altered driveway geometry and reduced the number of driveways. However, there were no design guidelines for changing driveways to improve highway efficiency. The Department did change driveway locations where there were clear accident histories or in limited, specific locations where the Department concluded that access was unsafe, for example, on acceleration or deceleration lanes. Otherwise, access changes were generally limited to overall project changes. Examples of these types of changes include the installation of a center median, which might make access to a property more circuitous from one travel direction, or construction of a frontage road, which rernoved the main line highway traffic from in front of a property. New Jersey developed a large body of this type of access law.'

In 1989, the State Highway Access Management Act, N.J.S.A. 27:7-89 et seq., became law. Although the Act primarily focuses on access management in the permitting context, it has also resulted in changes in how New Jersey handles access management on highway improvement projects. Most importantly, it led to the coordination of access management and right of way acquisition activities on Department projects.

This paper presents the goals and some features of New Jersey's access management program, explains the different types of impacts to property that result from highway improvement projects and provides three examples of why access regulation and property acquisition on these projects must be coordinated.

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lTubular Service Corp. v. Comm. State Hiahwav Dept, 77 N.J. Super. 556 (App. Div. 1963), aff'd 40 N.J. 331 (1963); State v. Monmouth Hills, Inc., 110 N.J. Super. 449 (App. Div. 1970) certif. den. 57 N.J. 133 (1970); State v. Stulman, 136 N.J. Super. 148 (App. Div. 1975); State v. Charles Investment Corporation, 143 N.J. Super. 541 (Law Div. 1976) aff'd 151 N.J. Super. 14 (App. Div. 1977) aff'd 76 N.J. 86 (1978).

HISTORY

The New Jersey State Highway Access Management Act became law in 1989. Among other things, the Act recognizes that the State highway system is an irreplaceable public asset that was constructed at great public expense. It notes the danger of unrestricted access and cites the common law principle that an abutting owner is entitled to reasonable access to the general highway system, but not to a particular form of access. It further recognizes that the access rights of abutting owners must be subordinate to the public's right and interest in a safe and efficient **highway**.[2]

The Act mandated that the Department of Transportation adopt comprehensive access management regulations. Earlier regulations addressed the permitting process and contained geometric standards for driveways, but they did not embody an overall philosophy of access management, like the principles set forth in the Act.

Department staff, using consultant assistance, worked for one year developing proposed regulations. The proposal generated substantial public comment and debate. A second proposal was published one year later, which also received considerable feedback. After another year of addressing the comments, the State Highway Access Management Code, N.J.A.C. 16:47-l. 1 et seq., was adopted, in April of 1992. Certain provisions took effect immediately, while others were delayed for five months. This provided an opportunity for the Department to train its staff and for the public to have advanced notice of the requirements of the new Code.

ACCESS MANAGEMENT PROGRAM GOALS

The Department established the following four goals for its regulations:

1. **Consistency:** The application of the Code should achieve the same result every time the same set of facts arises. The outcome should not vary based on the personnel performing the analysis or the geographical location of the property. Similar outcomes should also result from work performed by applicants through the permitting process and the Department through its projects.

2. **Predictability:** The public should be able to anticipate the likely response to an access question. The universe of potential responses should be readily apparent.

3. **Timeliness:** The public should receive a response to an inquiry or a State highway access permit in a reasonable period of time. At the time a question is asked, the Department should be able to indicate when a response should be expected.

4. **Simplicity:** The Code should be easy to understand. Department should be able to read and apply the requirements.

ACCESS MANAGEMENT PROGRAM HIGHLIGHTS

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[2] High Horizons Dev. v. Dent. of Transn., 120 N.J. 40 (1990). High Horizons was a pre-Act case in which the New Jersey Supreme Court stated, in dicta, that the Access Act confirms common law access principles (120 N.J at 48-49). Comm'r of Transn. v. Nat. Amusements, 244 N. J. Super. 2 19 (App. Div. 1990), certif. den. 127 N.J. 327 (1991). National Amusements was also a pre-Act case . Nevertheless, the appellate court held that the Access Act standard for reasonable alternative access should be used to determine the compensability of the closure of a State highway driveway, where all remaining access would be from a local street (244 N.J. Super. at 225).

The following are some of the features of New Jersey's Access Act and Code:

1. **Grandfathered Drivewavs:** All driveways in existence as of July 1, 1976 are presumed to be "grandfathered". This means only that such driveways are presumed to be authorized by access permits. Many people incorrectly believe that this authorizes the driveways in perpetuity. However, "grandfathered" driveways are subject to the same regulations as driveways authorized by actual permits.

2. **Permit Standards:** There are criteria for when an access permit is needed and when an existing permit expires. A standard is provided for when an expansion or change in use results in a "significant increase in traffic" requiring a new permit.

3. **Design Standards:** There is a classification system for highways based on the posted speed limit, function, anticipated highway cross-section and urban or rural character of the area. There are also driveway design and spacing criteria.

4. **Penalties:** There are penalties for the use of unpermitted driveways.

5. **Fair Share Contributions:** As part of the permit process for some proposed major developments, the Department may require "fair share" financial contributions towards the construction of public improvements, based on the added traffic to be generated by the development.

6. **Procedures for Driveway Changes:** There are procedures for adjustments, modifications and revocations of access.

7. **Endorsement of Alternative Access:** The Department may revoke a permit granting direct access and provide alternative access or deny a permit for direct access where alternative access is available or require that a lot have both direct access and alternative access.

8. **Alternative Access Involving the Department and Local Government:** When the Department requires alternative access on a local street, the local government must abide by the Department's decision. The local government may require additions or changes to the development plan consistent with local ordinances, but these requirements may not be inconsistent with the alternative access required by the Department. In the permitting context, the local government may require that the developer mitigate the impacts of the traffic using the alternative access. On Department projects, the Department must ensure that alternative access roadways are of sufficient design for the use(s) that they serve.

HOW ACCESS MANAGEMENT RELATES TO HIGHWAY IMPROVEMENT PROJECTS

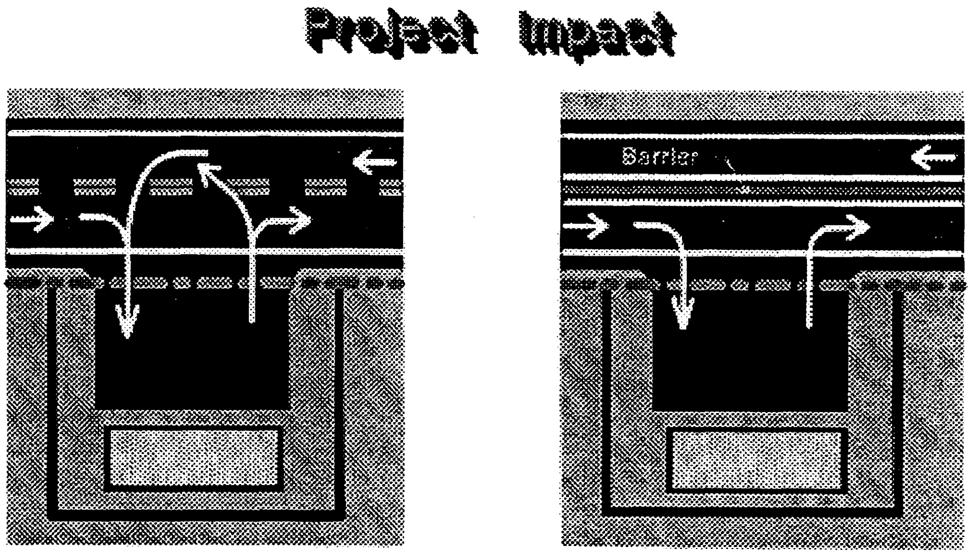
The Access Code contains specific criteria for driveways. Examples of these criteria include spacing, width, number and clearance to intersections and other driveways. Every Department project undergoes access review and every attempt is made to bring existing driveways into conformity with the Code. If the Department determines that this is not reasonably possible, then it may make changes to driveways that improve existing conditions, although not to the extent set forth in the Code. The Department may issue waivers for these driveways.

IMPACTS ON PROPERTY AND COMPENSABILITY

The impacts of a highway improvement project fit into the following three categories:

1. *PROJECT* Project impacts result from changes to the traffic pattern in the vicinity of a property.

Examples include dividing an undivided highway, relocating a highway and converting the existing highway to a service road, or constructing a bypass. When the Department divides an undivided highway, it is not required to pay compensation to the owners of property along the highway. Constructing a bypass is also not compensable, since the property still has access to the same highway before and after the project. Although under the common law relocating a highway or creating a frontage road was not compensable, under the Access Act and Code, these changes are revocations and are subject to a reasonable alternative access standard for compensability. Thus, in the absence of direct access, the Access Act and Code place limits on permissible circuity.

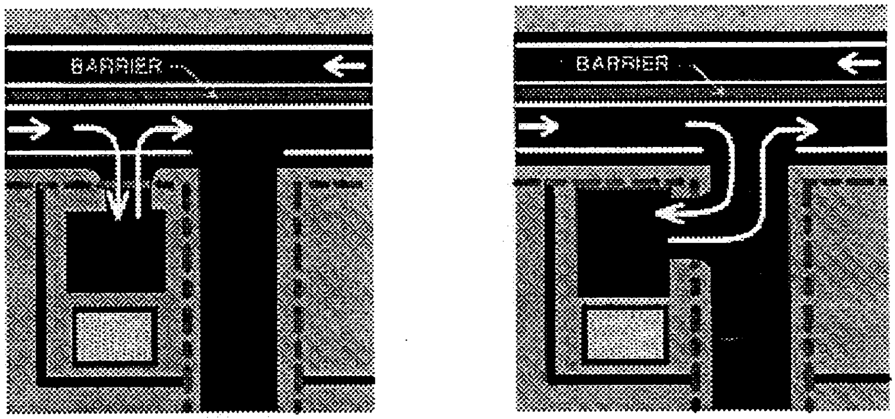


Before After

2. *ACCESS* Access impacts relate to the ability to have ingress to a property and egress back to a highway. Examples include replacing multiple driveways with a single driveway or revoking direct highway access and replacing it with alternative access from another road. Revocation is subject to a reasonable alternative access standard for compensability. Other property-specific access changes are subject to a reasonability standard.[3]

Mueller v. New Jersev Highway Authority, 59 N.J. Suner. 583 (App. Div. 1960). Mueller was a pre-Act inverse condemnation case, in which the court stated that there must be access for each "reasonable independent economic use unit" (59 N.J. Suner. at 595). State Highwav Commissioner v. Kendall, 107 N.J. Super. 248 (App. Div 1969). Kendall was a pre-Act case in which the court noted that a property could not be denied all access, but that the right of access "must be consonant with traffic conditions and reasonable and uniform police requirements" (107 N.J. Suner. at State, by Com'r of Transn. v. Van Nortwick, 260 N.J. Super. 555 (App. Div. 1992); State v. Van Nortwick, 287 N.J. Suner. 59 (App. Div. 1995), certif den. 143 N.J. 320 (1995). Van Nortwick was a pre-Act case. After the first trial, the appellate court reversed the jury verdict and remanded the case for a new trial, because the trial court admitted testimony regarding damages attributable to what both parties agreed was a reasonable access restriction. At the second trial, the trial court accepted the same damage testimony, reasoning that the access limitation had an impact on the development potential of the property, if vacant. Essentially, the court applied a condemnation standard rather than a police power standard in judging the compensability of the access restriction. The appellate court affirmed and the Supreme Court denied certification.

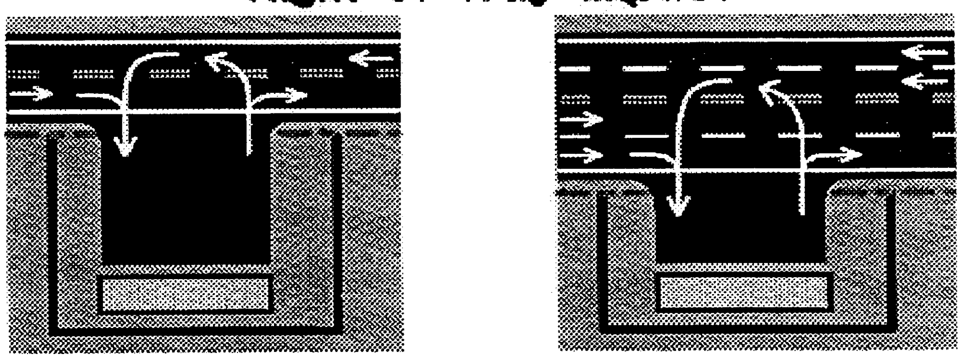
Access Impact



Before **After**

3. *RIGHT* OF *WAY* Right of way impacts result from the acquisition of land in fee or easement. Examples include acquiring a strip of land across the highway frontage of a property to widen the highway or acquiring a slope easement to raise the grade of the highway. The Department always pays for property acquisition.

Right of Way Impact



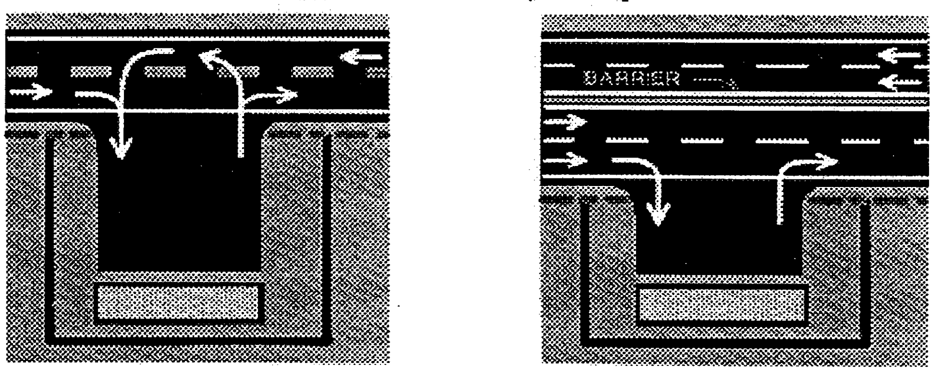
Before **After**

It is prudent to evaluate each property within the limits of a project in terms of each of these components. This is particularly important when more than one of these factors impacts the same property. Each of these factors can then be considered for potential compensability. The two examples that follow demonstrate the necessary analysis.

Consider a property on an undivided highway, with right and left turns permitted in and out of the property in the before project condition, as illustrated below. Then consider the impacts on this property from a highway improvement project that divides and widens the highway by 15 feet across the frontage of the property. The installation of the center median precludes left turns. The property retains direct State highway ingress and egress, although certain traffic movements are more circuitous. The driveway remains the same size and in the same location, in terms of distance from the side lines of the property, but is further back from the centerline of the highway, due to the 15 foot right of way acquisition.

The owner is not entitled to compensation due to project changes in the highway design and highway operation or access change. The Department pays for the 15 foot strip acquired along the frontage only. These changes are readily separable into project, property-specific access and right of way changes.

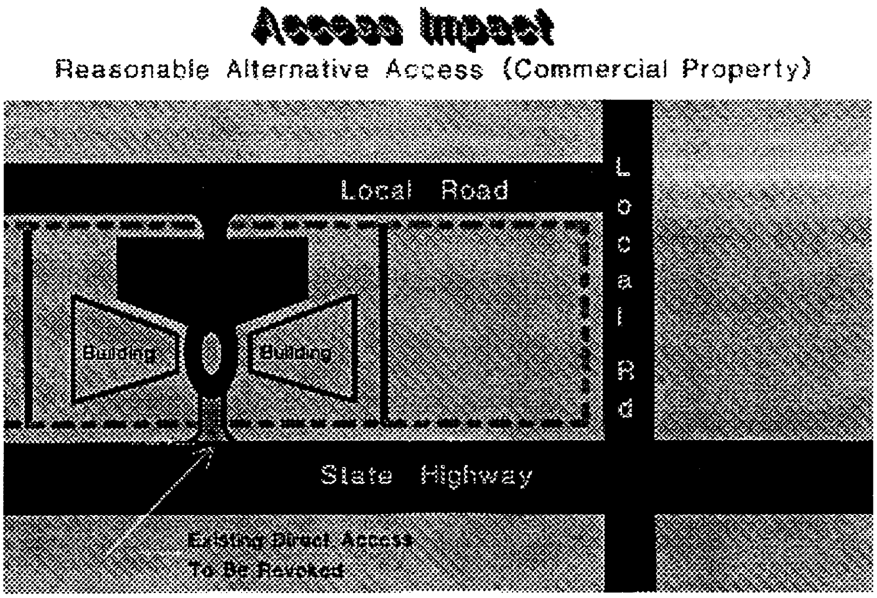
Project and Right of Way Impacts



Before   After

Now consider a property that has direct access to a State highway in the before project condition, as illustrated below. If that direct access is revoked and alternative access exists or will be provided by the Department, the Access Act and Code provide specific standards for determining whether the alternative access is reasonable or unreasonable. These standards depend on whether the affected property is commercial, industrial or residential. The commercial standards are the most stringent. They require that the alternative access be on a street that is parallel or perpendicular to the State highway, convenient, direct, well-marked and of sufficient design to enable motorists to reach the site and return to the highway.

When direct access is revoked and the alternative access meets the reasonability standards of the Act and Code, the change in access is not compensable. If the standards are not met, then damages, if any, that are demonstrated in the market are compensable. In all cases, the Department pays for right of way, if any is acquired from the affected property. In access revocation cases, access changes may be project-related (for example, creation of a frontage road), property-specific (for example, correction of an existing comer clearance violation) or a combination of both (see Example 3 which follows).



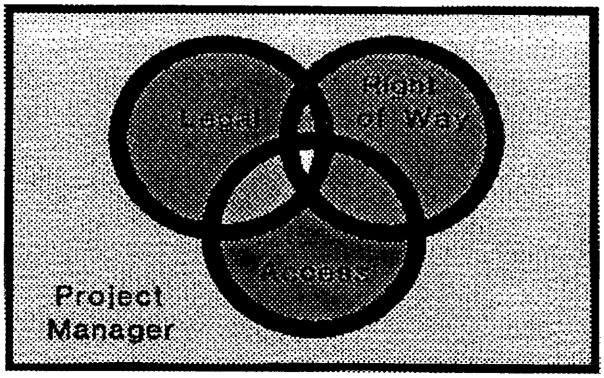
PROJECT COORDINATION AND TEAMWORK

In the not too distant past, the Department's design staff made most of the project decisions, including access changes, and established right of way parcels for acquisition. Once these decisions were made, the right of way staff became involved in the acquisition process. Finally, if the necessary property could not be acquired amicably, legal counsel instituted a condemnation action. The participation of each specialization was more sequential than collaborative. Examples 1 and 2 which follow illustrate the shortcomings of this methodology.

The Access Act and Code provided a catalyst for a change in this process and marked the beginning of a team approach to project development. With the adoption of the Access Code, a unit of access specialists was created. They began consulting with the design staff about access changes early in the project planning process. The access unit and legal counsel worked together in the permitting area and recognized the value of early input on the legal implications of access decisions. The right of way staff and legal counsel worked together in the condemnation area, but this was nearly always after the significant project decisions had been made. In time, all of the specialists realized that early consultation and coordination on Department projects would be the way to avoid the repetition of experiences like those in Examples 1 and 2 which follow.

In addition, the Department moved to a Project Management System. The project manager has the ultimate responsibility for each project from start to finish. The project manager is also the most knowledgeable about overall project costs, scope and schedule, all of which are significant considerations when project decisions are made. Thus, the project manager has emerged as the coordinator of the multi-disciplined, decision making team.

Project Decisions



CASE STUDIES

Following are three instructive examples of properties where access was to be changed and right of way was to be acquired. The first two illustrate the need for close and early coordination between the access and right of way processes. The third illustrates the benefits of such coordination. Aspects of these examples have been simplified for ease of presentation.

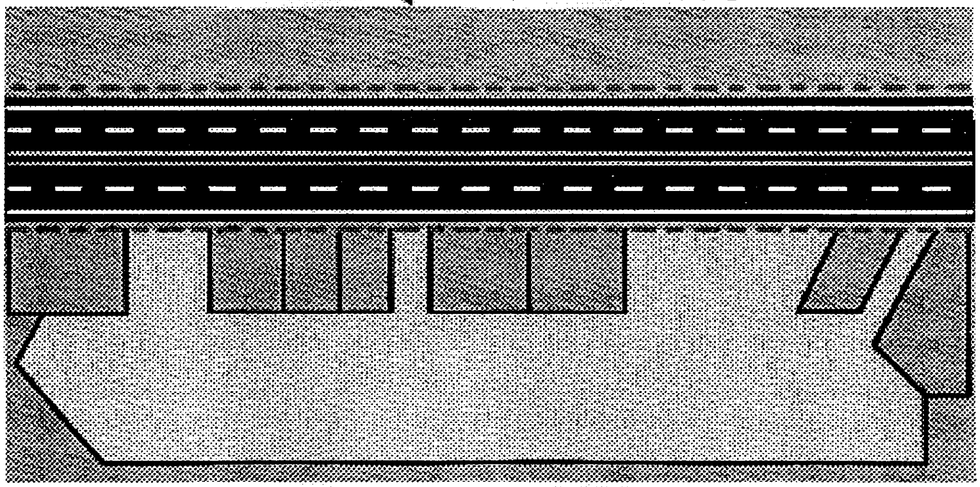
Example 1

There was a large, undeveloped property having several frontages along a State highway (see illustration on next page). A Department project was proposed to divide the highway. There was a right of way acquisition from the property for the construction of a jughandle, with all future access denied around the proposed jughandle. The denial of access encumbered the longest frontage, leaving several narrow frontages that were not capable of providing access for a high volume of traffic.

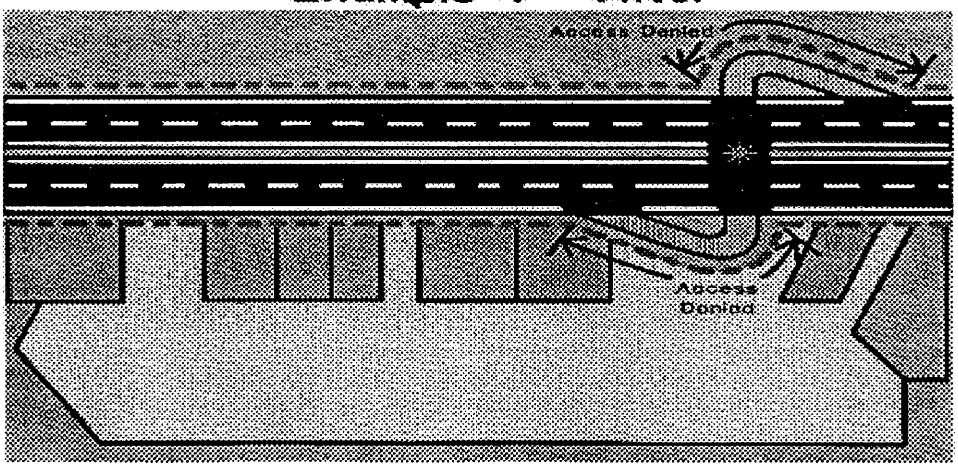
In the condemnation case, the Department paid a very high cost to acquire the land necessary for the jughandle. Although the amount of property acquired for the jughandle was small, the associated denial of access around the jughandle caused substantial damages to the remainder of the property.

Early coordination of the access and right of way aspects of this case would have resulted in a different access restriction, which in turn would have saved substantial right of way costs. The Department learned from its experience in this case that it should not generally draw denial of access lines around entire jughandles. Instead, there should be a window left in the denial of access line, toward the middle of the jughandle. This would permit conversion of the traditional jughandle design to a street intersection jughandle at some point in the future, if the adjacent property owner elected to undertake such construction. Not only does this plan benefit the adjacent property owner, but, by allowing traffic exiting the property to make turns at the jughandle, it reduces the volume of traffic on the State highway system.

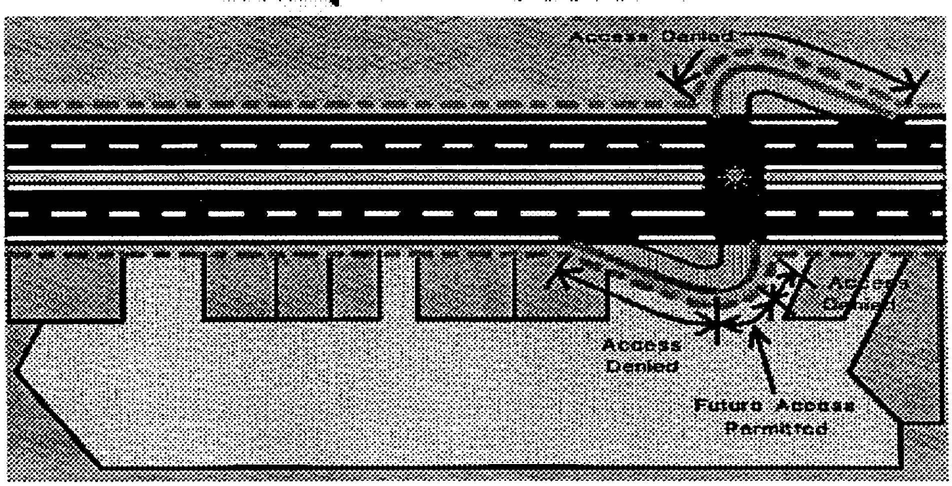
Example 1 - Before



Example 1 - After



Example 1 - Preferred



Example 2

There was a large tract of property with mixed commercial and industrial zoning (see illustration on next page). The property was located at the intersection of a State highway and a municipal street. The commercially-zoned portion was located on the State highway, while the industrial portion was located along the municipal street. The Department acquired property along the State highway frontage for the construction of a forward jughandle and the deceleration lane leading to the jughandle.

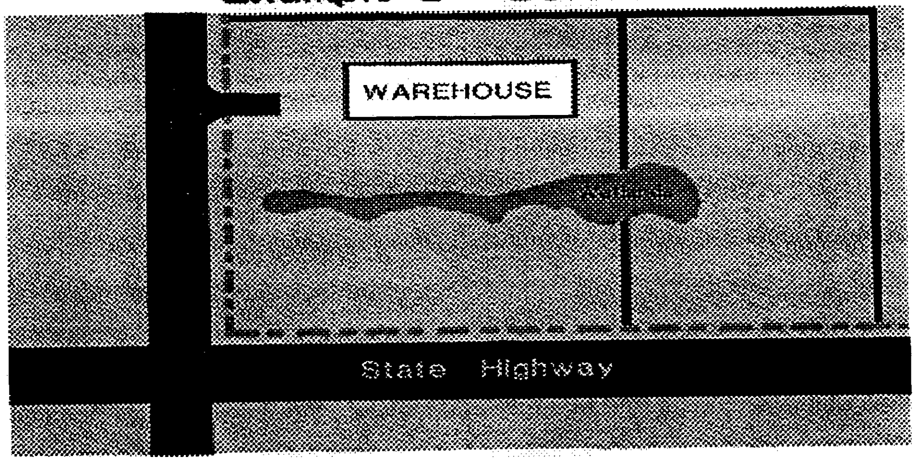
The Department believed that the driveway to the property from the municipal street would provide reasonable access for the entire remainder.[4] However, it was later discovered that wetlands precluded access from the industrial portion to the commercial portion of the remainder. The Department's standards precluded access along the deceleration lane. The Department recognized that this standard would require that it acquire the commercial remainder. However, the owner wanted to keep this remainder and asked the Department to consider granting an access waiver. In response, the Department stopped the denial of access line sufficiently east of the westerly property line to enable a driveway to be constructed to the State highway, when the commercial portion of the property was developed.

In the condemnation case, the owner pointed to the Department's access standards and claimed that he could only obtain a permit for direct access to the State highway, if the Department violated its own standard prohibiting access points on deceleration lanes. The owner sought considerable monetary damages as a result of the substandard access that would have been permitted.

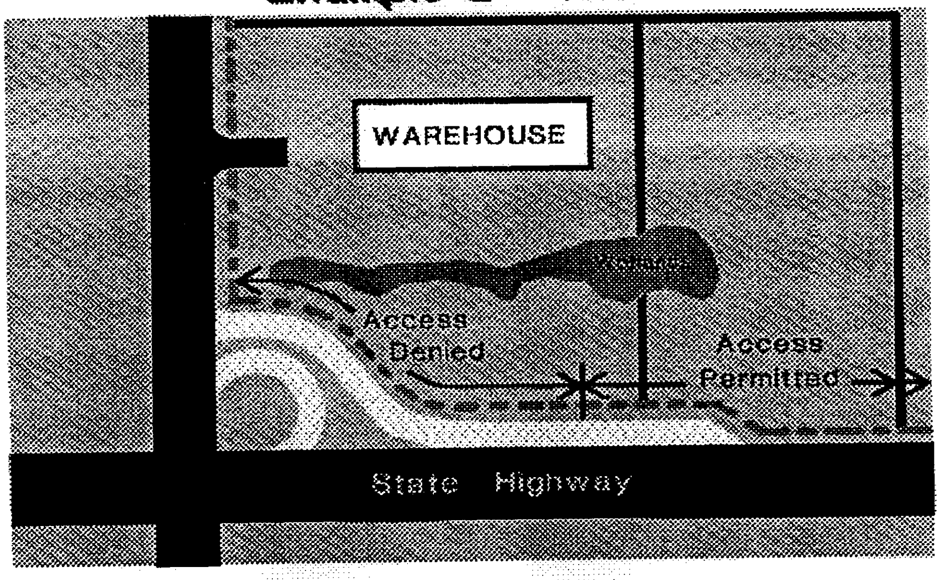
Early coordination of the access and right of way aspects of this case may have led the Department to conclude that the potential future access was so substandard as to be inadvisable. Based on the owner's substantial damage claim, acquisition of the commercial remainder would not have been significantly more expensive. Other options could also have been explored, such as the installation of a frontage road beginning in advance of the deceleration lane or shared access with the adjacent property. Using a coordinated approach to decision making, the specialists would have jointly assessed the likely cost, benefits and exposure associated with each concept and arrived at a well-researched conclusion.

[4] This was a pre-Act case. However, the alternative access via the perpendicular municipal street would even meet the stringent Act standard for commercial property.

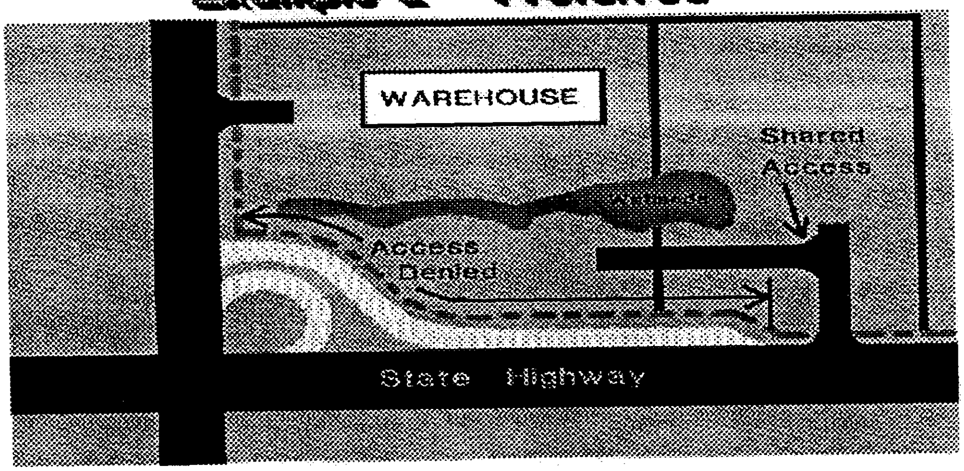
Example 2 - Before



Example 2 - After



Example 2 - Preferred



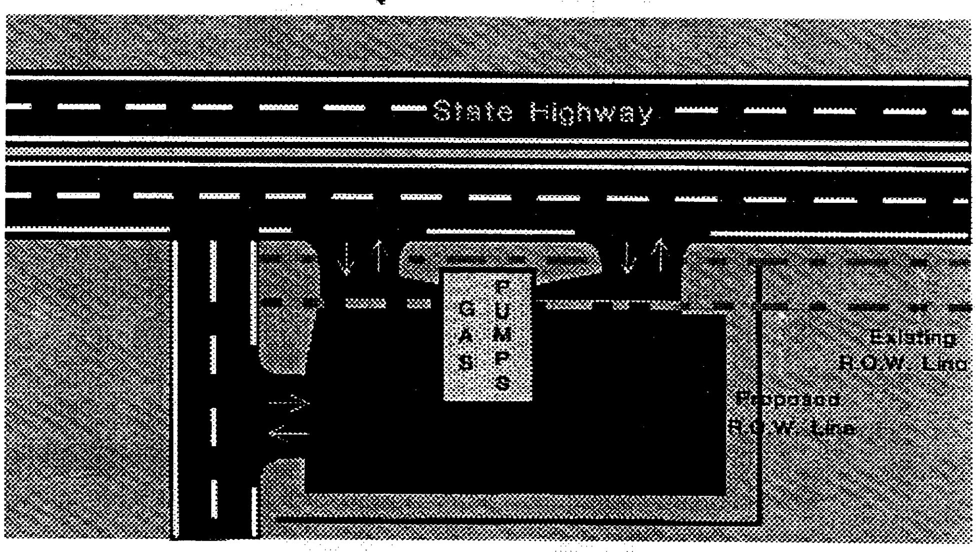
Example 3

There is a gas station located at the comer of a State highway and a local street. The gas station has two driveways on the State highway and a driveway on the local street. The Department has a project that will convert the existing highway area along the frontage of the property into a service road, which will exit from the main line of the highway in advance of the property and reconnect shortly after. In addition, the Department will close the driveway on the service road closest to the intersection with the local street, since the driveway violates comer clearance standards, and limit the other driveway on the service road to egress only, since there are potential conflict problems with converging traffic from the main line of the new highway. Thus, all traffic will enter the property from the local street driveway and exit by either the driveway on the local street or the service road driveway. There will also be an acquisition in fee along the property's frontage. This acquisition will run through the pump islands on the site.

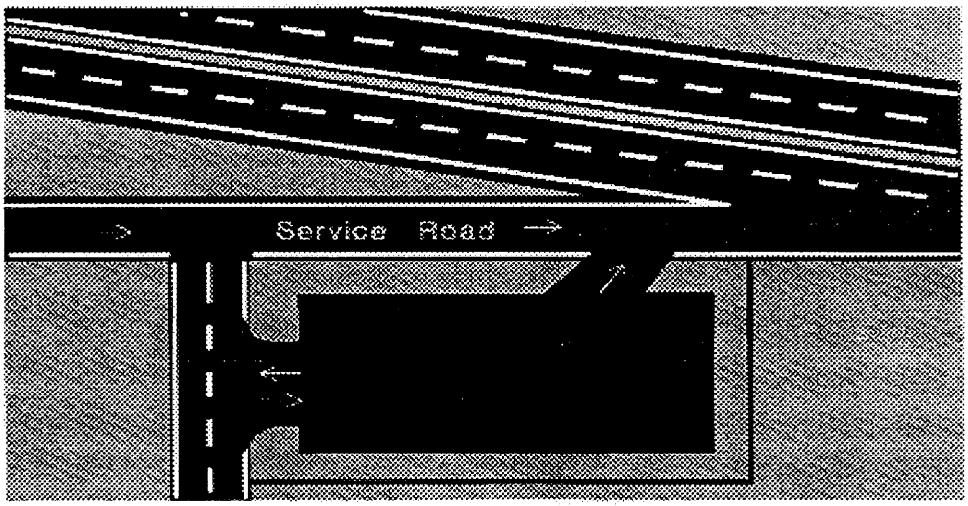
The Access Act and Code classify the Department's access activities here as a revocation (both project-related and property-specific). The owner is entitled to a hearing before an Administrative Law Judge. This would be a separate proceeding from the one for the acquisition of the land along the frontage. In this case, one of the owner's main concerns is site circulation. However, since the existing pump islands are within the right of way acquisition area, site circulation would become a non-issue after the acquisition.

Viewing these issues in the usual sequence, the Department would have litigated potential access impacts on site circulation in one proceeding, only to have the pump islands eliminated in the subsequent acquisition. However, when this property was viewed from the dual perspectives of access and right of way, it was decided that both issues should be addressed in the same proceeding. This is more economical from the Department's prospective, in terms of both time and money. It is also what the owner preferred.

Example 3 - Before



Example 3 - After



CONCLUSION

The 1989 Access Act and the 1992 Access Code brought dramatic changes to access management in New Jersey. However, neither the Act nor the Code associated access changes on highway improvement projects with right of way impacts on the same project. The Department always recognized that access management and right of way activities have the potential for significantly impacting properties adjacent to State highways. However, until the Access Act and Code, it did not fully appreciate that the impacts of these activities are often interrelated.

This recognition has resulted in a change in the way that the Department handles its projects. Project managers now coordinate pertinent project decisions with access, right of way and legal specialists. This approach has enabled the agency to operate more efficiently, reach better solutions in a shorter period of time, expend less public funds and involve affected property owners in fewer adversarial proceedings.

Property Rights May Not Be Ignored

Robert Duncan, Colorado

ABSTRACT

(No Abstract Submitted)

PRESENTATION

(No Formal Paper Submitted)

Questions and Answers
Legal Issues - Discussion Session

Question I: What exists in case law that shows how much distance is reasonable in circuity of access to get to a site?

Richard Forester: Cases have permitted over a mile of circuity of access. The amount of circuity that is allowable depends on the state. A New York case, which is about 10 years old, allowed 4 miles of circuity of access.

Lorinda Lasus: There is not any case law in New Jersey that limits the distance of circuity of access.

Gary Sokolow: Florida has found that it is impossible to define a reasonable distance in terms of circuity of access. There is no 'magic' definition of distance to put into the codes.

Herb Levinson: Surveys showed in Indiana about 1.5 miles was considered excess circuity and compensable.

Question 2: What types of parameters may courts look at for determining circuity of access?

Robert Duncan: Circuity of access is rare in Colorado. There has to practically be a denial of all access to the property. There is a differentiation between property on which there is no existing use and situations where there are existing businesses. There has to be a substantial impairment of access to be considered compensable. Circuity of access does not exist for the most part in Colorado.

Question 3: What procedures work best for coordination among various departments and jurisdictions to make sure that all access restrictions are understood?

Arthur Eisdorfer: New Jersey has developed a computerized system for entering all access management permit applications. It is set up as a route and milepost system. There is a key which identifies areas covered by access management plans. This system has the ability to cover areas which previously have been denied access.

Gary Sokolow: The Florida Department of Transportation will not give a final access permit until the land development approval is given for the property. This assures that the DOT does not do something that goes against the comprehensive plan of the local government.

Del Huntington: Some critical access management decisions are left to lower level employees in Oregon. As issues are becoming more complex, people with skills and abilities are needed to perform in these roles. There also needs to be more coordination between the permit decision makers and planners.

Question 4: How much public input do you get at the start of developing a successful access management policy?

Lorinda Lasus: The State Highway Access Management Act in New Jersey required the DOT to convene a group of outsiders (planners, attorneys, developers, etc.) to offer input on the development of the access management code. This proved to be so useful in the development of the code that this group continues to meet when issues confront the DOT and input is desired from the regulated community. When the code was up for readoption, this group was given a draft of the proposed regulation and many of the group's comments were incorporated into the proposed readoption.

Arthur Eisdorfer: When the access management code was originally developed in New Jersey, the law required that five public hearings be held concerning the proposed regulation. The DOT received approximately 600 public comments the first time it published the proposed regulations. A second proposal, which was published one year later generated approximately another 600 public comments. These comments helped form the basis for the regulations which were adopted in 1992.

Del Huntington: The whole access management development process is open in Oregon, and all stakeholders are involved. In addition, a web site has been developed to receive public comments.

Question 5: What are disadvantages of an open house forum for developing access management processes?

Gary Sokolow: One major drawback is an organized opposition may be reluctant to attend, and the opposition may feel they have lost a strategy if there is an absence of public hearings. A whole range of options needs to be employed, including face-to-face meetings with leaders of opposition groups.

Question 6: In Colorado, do situations arise where the local government does not play by the rules and allows a property to be subdivided without an access permit?

Robert Duncan: These type of situations do occur and they pit the local government against the DOT. There are cases where the only access point of a subdivision is to a state highway. One safeguard is a referral, which requires that a permit application pending before a local government entity be submitted to the DOT for comment.

Philip Demosthenes: This situation happens quite often. Although it can be fought legally, it is often difficult to fight local government politically. This also can create a difficult situation for a private party which is trying to circumvent the law.

Arthur Eisdorfer: New Jersey's law is similar to Colorado's law in this regard. Similar problems are also often encountered.

Richard Forester: One system that is used in Washington requires preliminary plat approval for any subdivision. A typical condition is that recording of the final plat is not allowed without a letter from the state transportation agency confirming that the access point meets regulations.

Question 7: How do you separate land use issues for access management issues?

Robert Duncan: It is difficult to balance the public needs of using state facilities paid for by public funds against a landowner's right to develop property and have access. This issue will always be a continuous cause of tension, and there is no one solution. State legislatures tell DOTs to stay out of the land use business.

Herb Levinson: Iowa wants to encourage agricultural development, and does not want to inhibit developers in terms of charging permit fees. From an engineering perspective this is rural land and there is more flexibility in the choice of access point. A constant cause of concern is a lack of coordination between people making access decisions and people making permit decisions, and the state is exploring ways to improve this working relationship.

Lorinda Lasus: The access management code in New Jersey says that municipalities and counties must conform with the access code. In a sense this puts the DOT in the land use business.

Del Huntington: In Oregon, the governor has told the DOT that they will be leaders in transportation growth management and that the DOT will work closely with the Department of Land Conservation and Development.

By regulation the DOT can not construct a highway through rural or farm lands unless it is established that the highway is consistent with rural or farm uses. This means that there often will be no intersections or access to the highway for long stretches

Question 8: How can the development of access management regulations be related to primarily rural areas?

Del **Huntington:** In Oregon there is roughly 7,600 miles of state highways. Approximately 600 miles if these highways are interstate and less than 1,000 miles are urban highways. Most of these highways are two lane highways, and conservatively estimated, 33% of accidents on these rural state highways are directly related to an access point or approach road. These accidents cost the state $80,000,000 annually. Roughly half of all fatalities in Oregon are related to access conditions in rural areas.

An approach to developing access management procedures has been to accomplish things such as improving sight distance requirements. Another technique has been to increase requirements for deceleration lanes for right turning vehicles and to add paved shoulder areas. Another aim has been to reduce the number of conflict points where it is possible.

Philip Demosthenes: Colorado is looking to make changes to the state highway access code for rural highways. Rural highways are often really long distance high speed collectors. They may split the rural highways into two categories. Major highways in terms of classification by the national highway system will continue to be protected strictly. Rural secondary roads will be allowed more access with techniques such as greater shoulder widths to allow correction of errors.

Gary Sokolow: Florida has developed a restrictive median policy which no longer allows 5- lane sections. This approach is causing the state to become more concerned with median width requirements as they relate to safety.

Question 9: Do access management plans in New Jersey set up a system where the actual location of driveways on undeveloped parcels can be enforced?

Arthur Eisdorfer: Access management plans in New Jersey must be a joint venture between a municipality and the DOT. These plans are intended to show the specific locations where access will be permitted for every property (developed or undeveloped). A primary aim of these plans is to provide predictability and make development easier in the future.

V Abstracts/Papers - Session 4

4A - The Management Of Access Management

Moderator: Del Huntington, Oregon Department Of Transportation

Access Management Program Development In Oregon

Access Management In Michigan, The Good, The Bad And The Ugly

An Australian Review Of Access Management And The Land Planning Connection

Road Corridor Management And Access Control In Quebec

4T - Signal Spacing

Moderator: Vergil Stover, S/K Consultants, Texas

Signal Spacing - A Key To Access Management

Access Management Warrant In Traffic Signal Justification

Spacing, Timing And Operational Interference Between Signalized Intersections

The Access Management Program Development In Oregon

Del Huntington, Access Management Coordinator, Oregon Department of Transportation
Transportation Development Branch, 555 13th St. N.E., Salem OR., 973 10

ABSTRACT

Oregon Department of Transportation 's challenge is to develop an Access Management Program while under tremendous pressure to accommodate and encourage growth and development. This becomes more difficult as the rights of private property owners appear to be increasing while governments are being asked to deregulate and reduce their interference.

Over the last several years, Oregon Department of Transportation was developing a state of the art Administrative Rule on Access Management. It included the best from the experience of Colorado, New Jersey and Florida. Oregon 's pioneering, statewide land-use laws also provided increased opportunity to assist a successful program.

There was some hesitancy within ODOT to pursue approximately 100 pages of rulemaking in light ofpresent political realities. One year ago, the Management Team decided to have policies and standards developed that support Access Management. This was to be accomplished in a collaborative process with local agencies and stakeholders.

The process is under way, but will not be completedfor at least another year. The policies and standards will be presented to the Oregon Transportation Commission for approval. Following their approval, amendments, additions or deletions will be made to the existing rules as needed to ensure consistency. An education element for ODOT staff stakeholders andpoliticians is an importantpart of the strategy.

The paper will describe the successes and pitfalls that occur in the process. The Oregon experience may prove beneficial to other state and local agencies that are considering an Access Management Program.

INTRODUCTION

While access management holds many of the keys to successfully manage roadways for long term safety and capacity benefits, it is becoming increasingly difficult to initiate a comprehensive program that addresses those needs. Some of the impediments to a program may include a lack of political resolve, an aggressive desire to encourage and promote development and increasing property owners' rights either real or perceived. The process being used in Oregon should prove to be successful and may serve as a model for other state or local agencies that desire to develop an access management program.

Background

There are roughly 100,000 miles of roadways in Oregon, that consist of private, Forest Service, Bureau of Land Management, city, county, and state ownership. These roads are as diverse as the Oregon terrain and weather.

Since 1947, Oregon has had statute that lays out a system of "Throughways" that are a high level system of highways that link areas of the state together. The language of the law that created the throughway system speaks of the need to save lives, minimize property damage, safeguard highway travel and protect the highways from roadside uses.

In the early 1990's, the Oregon Department of Transportation (ODOT) contracted with an attorney and a Professional Engineer to evaluate the "Throughway" law. Their task was to advise the agency on how to administer the law, principally in the area of acquiring access rights. In addition, the consultant collected the "State of the Art" in Access Management from across the US. The object was to develop a system in Oregon that would combine the best methods available combined with opportunities unique to Oregon due to the Land Use laws that exist in the state.

The consultants developed the "Oregon Throughway Study, 1989," then subsequently developed a draft "Oregon Highway Plan Policy, Proposed Draft Administrative Rule, 1993." This was approximately 100 pages of the best access management practices and included a large component from Colorado, New Jersey, and Florida. The recommendation was to bring the draft to closure, and then initiate administrative rulemaking. Administrative rules are a layer of authority that do not have the full strength of statute, but have more power than guidelines or policies. State agencies may develop rules as a means to clarify or provide direction to the existing statute, but cannot exceed the limits established by the statute.

Simultaneously, ODOT worked in-house to develop an Access Management Classification System for all of its approximately 7600 miles of highways that it maintains and operates. These highways were assigned into one of four "Level of Importance" based on their function and importance to the state. These vary from the Interstate system, (whose function is to provide connections and links between major cities, regions of the state and other states), to District highways with a primary function to serve local traffic and land uses.

The highways thus categorized by Level of Importance could then be temporarily assigned to one of six access categories based on the amount and type of access that would be allowed, median controls, and traffic signals. These categories also made allowances for urban or rural conditions. Final assignments will be made as corridor plans are developed for each highway across the state over the next five years.

ODOT was then faced with a critical decision as to advancing 100 pages of standards, procedures and policies into administrative rules. In reality, ODOT was not always consistent in implementing the current standards, which include 5-6 pages of statutes and 11 pages of administrative rules. There was no logical reason to conclude that the agency would be more consistent with 100 pages of rules. In addition to these concerns there were and are,

- ODOT already had considerable ability to control access with the existing statute and rule. A permit has been required for all new road approaches since 1949. (Approach roads are commonly referred to as "driveways")

  a lack of understanding throughout all layers of people in private and public agencies of the tremendous safety and capacity benefits of wise access management.
- a perception that proposing additional rules might dampen Oregon's much desired economic surge.
- increased property owners initiatives
- the awareness that there is an exposure during the Administrative rulemaking process where an agency may not gain all that was intended and may even lose some of'the existing authority
- realization that successful rulemaking would require considerable work and closure on many standards and polices.

  political pressure to reduce the amount of rules.
- the lack of a champion that believed in Access Management who would ensure that ODOT succeeded in spite of political or development opposition.

Work plan

The ODOT Management Team adopted a work plan in September 1994 which provided authority to pursue policies, set standards, and devise a manual for field personnel, all of which would support a comprehensive Access Management program. The proposed completion date of September 1995 was too optimistic. The issues have proven very controversial, and adding to the complexity was a reorganization and then a Re-engineering process within the agency.

The work plan consisted of;

#1 Bring polices and design issues to closure that are necessary for a comprehensive access management program.

#2. Better understanding of existing statute and rule

#3. Develop consistency within the agency

#4. Build internal and external support

#5. Monitor program

#6. Partner with local governments

ODOT immediately entered into a contract with the two major engineering universities in the state. The benefit of this relationship has been immense. Having local expertise can assist in brush fires such as testifying to the legislature. Increasing the awareness of access management in the school will help the students become more familiar with its importance and benefits.

Portland State University is working on research, while Oregon State University is working on the policy development. Dr. Vergil Stover is an expert advisor to the process.

#l Bring polices and design issues to closure that are necessary for a comprehensive access management program.

The draft administrative rule quickly pointed out those policies and standards where ODOT is currently weak and has unresolved issues.

The first step for Oregon State, is to develop background papers on several issues. These will support the policies and standards that will be developed as the second step. A core team of ODOT staff from across the state was assembled to give direction to the project. As papers, draft polices and standards are developed, there is an opportunity for other ODOT staff and outside stakeholders to participate. In an effort to support this process, a site on the World Wide Web has been established to allow interested parties to access the information. (The Web site can be accessed at http://www.odot.state.or.us). We may not always reach consensus on these issues, but the hope is to reach consent. The list of policy papers follow.

A) Philosophy Statement and Policy on the Functional Integrity of the Highway System

ODOT was challenged with two bills in the last legislature that would have had devastating impacts on our ability to manage access. They were the outcome of following the spacing guidelines in the Classification System on some District level highways. The recommendation is to put the emphasis on those highways that are critical to the state and national interests. Consider allowing more accesses or variances on those facilities that are local in nature and if congested will not impact interstate economic interests.

B) Interchange Management Policy.

A concise policy that includes: the identification of the function of the existing interchange clearly stated and the needs that must be preserved; standards addressing the functional area of the interchange; distances to nearest public/private accesses and traffic signals and the appropriate Level of Service at those locations.

Are there specific movements through the intersection that are more critical for the safety and capacity needs of the state highway, and how should they be quantified?

C) Variance Procedures

Develop a paper that recommends a variance procedure to use when considering variances on access issues that relate to but are not limited to:

- Sight distance at approach roads
- Approach road spacing

Median treatments

- Median Openings
- Signal spacing

Describe the benefits of a two- step process that would allow variances of a limited nature to be made by the District Manager or equivalent. Recommend a process for variances that require substantial deviation from the standard.

D) Median Treatments.

A policy to describe when medians are appropriate for both rural and urban applications, and how they are designed i.e., continuous two-way left turn lanes versus non-traversable medians, barrier versus mountable curb, the use of landscaping in medians.

When non-traversable medians are installed, determine median opening spacing, the appropriate design of the median opening, and the directional move(s) that will be accommodated.

E) Evaluation of ODOT Access Classification and Spacing Standards.

Review the current guidelines and incorporate the necessary changes to ensure a more consistent and usable Access Management Classification System. The goal is to develop the access classification and spacing standards into a form that can be easily understood by the public. This component will be adopted into administrative rule.

F) Volume/Capacity versus Delay based methodology

Describe data necessary for each, their benefits and deficiencies, and their usefulness in operations as well as for planning purposes.

G) Functional Intersection Area.

Describe the functional area of an intersection and how it relates to access management.

H) Sight Distance Requirements.

A policy paper that defines the sight distance requirements for public and private accesses, for both signalized and unsignalized conditions, i.e., should stopping sight distance be used? Is intersection sight distance a better solution?

I) Signalized Intersection Spacing.

Since most of the population growth is occurring in the Urban Growth Boundaries where many of the public street connections have already been established, a realistic process is required that considers the existing infrastructure. Identify the necessary progression speed, green band and cycle length of the traffic signal.

J) Left and Right Turn Deceleration and Storage Lanes.

Define clear traffic warrants for left and right turn deceleration and storage lanes.

K) Design Standards for accesses.

Determine if ODOT approved dustpan (drop curb) designs are adequate for private road connections, or if curb returns should be used more often in order to provide a safer and more efficient system.

L) Policy of when ODOT will allow a Right-in/Right-out Only access

Develop a policy that defines design requirements that accommodate a right-in/right-out only access.

M) Thresholds for "Traffic Impact Studies".

Establish realistic and appropriate thresholds that trigger the need for a traffic impact study when applicants request a road approach permit.

N) Level of Service.

A position paper to solve the confusion on the definition of level of service (LOS) with recommendations on how to solve the apparent contractions within ODOT standards. Are the desired LOS realistic? Do they support the Transportation Planning Rule and ODOT's mandate to pursue Transportation Growth Management, and decreased reliance on the single occupant vehicle?

0) Development Review Guidelines

Evaluate the current draft Development Review Guidelines and complete.

#2. Better understanding of existing statute and rule

One area where ODOT appeared to be most inconsistent was when we decided to close an existing approach road/driveway. It seemed that each of the 16 Districts had a different impression of our legal authority. In an effort to develop consistency with the current statute and administrative rule, a "White Paper" was produced on the issue with the assistance of the Attorney Generals (AG's) office and the Right of Way section. The purpose of the paper was to describe how to determine the "legality" of the road approach, identify safety and capacity concerns that would support closing the approach and the necessary administrative process.

The benefits of this type of procedure are considerable. It requires a lot of communication between the staff, and produces a interpretation of the law that has the support of the AG's office. Another sizable benefit is that it helps to expose those statutes or rules that may need to be revised.

The Access Management program will develop additional position papers as time allows and issues are raised such as; "What are the steps you need to consider when issuing an approach road permit where the spacing criteria cannot be met

#3. Develop Consistency

There was a realization that there needed to be considerably more training on access management. Regardless of the amount of rules and policies, there will be inconsistency if the people in the field are unsure how to apply them. In an effort to fill that need, we have pursued extensive training. As a result, we have had approximately 200 people attend training sessions over the past two years.

Each of the five regions across the state has recognized the need to assign/develop a position for access management and development review and has taken steps to staff such a position.

ODOT is evaluating the existing permit process for road approaches. At this time, the application and permit is one sheet of paper with the same form used regardless if the applicant is building a single family residence, or a 500,000 sq. ft. shopping center. This can lead to very different response times in different Regions and inconsistencies as they may impose different thresholds for **a** Traffic Impact Study and subsequent mitigation.

Hopefully, there will be many changes in the process. Ideally, these will include a pre-application meeting to ensure that ODOT and local agencies concerns will be considered. This will allow for the identification of the function of all adjacent roadways, safety concerns, other land uses in the area, transportation needs, median control, and the relationship of the access to the other access in the corridor. The developer can be informed of where access is possible and what designs would be acceptable.

In an improved process, the developer would receive an application that corresponds to the size of development. The developer requirements and timelines would be clearly stated, as well as ODOT obligations and timelines. When the application is satisfied, permission would be granted to build the approach road.

#4. Build support internally and externally

Regular meetings with ODOT Commissioners and upper management are critical to keep them informed of the progress and educate them on the issues. There is also a need to communicate the benefits of access management to the politicians.

We have involved the consultant community, local agencies, developers, American Automobile Association, Oregon Truckers Association, and other stakeholders in the policy development.

Training is also a very successful method to develop support. Another is to gather and assemble findings of national research. In addition, we have initiated research with Portland State University to find the Oregon experience to counter arguments such as "I don't care if it works in Florida, this is Oregon!" The data and conclusions have proven very beneficial when discussing "access" with the public. Some of the past research has centered on safety as it relates to the functional area of the intersection and parkway designs.

ODOT has initiated a long term project (5- 10 years) that will attempt to compare some of the impacts of a five-lane highway with strip development to a portion of four lane highway that has a restricted median. Some of the considerations will be property values, development turn over, economic impacts, accident experience, multi-modal issues, and air quality.

The research will include surveying motorists and other users of the corridor for their perceptions as well as the use of current resources such as accident data, highway traffic volumes, and roadway inventory. The hope is to involve many experts both within and outside of the Department.

#5. Monitor Program

We plan to identity problems, omissions or those areas where we might be too zealous in the policy and standard implementation. Where there are obvious errors, strategies will be developed to correct the situation. ODOT will continue to develop expertise and consistency in the Region and District offices with training and experience.

#6. Partner with Local Governments

The ultimate goal is to have the local governments more involved in the road approach permitting process, based on an adopted transportation and comprehensive plan, access spacing guidelines, and clear understanding of the function and purpose of the state highway.

Conclusion

Oregon is a state in which aggressive land use laws, planning requirements and environmental concerns are broadly accepted There is also an expectation that stakeholders will be allowed to participate in a public process when government agencies develop new policies. Over time, these trends could easily become the standard across the nation. The model that ODOT is using may be an example that other agencies may choose to follow.

Access Management In Michigan
"The Good, The Bad, And The Ugly"

David Geiger, Michigan Department Of Transportation, Lansing, MI
Jerome Gluck, Urbitran Associates, Inc, New York
Mark Wyckoff, Planning & Zoning Center, Inc., Lansing, MI

ABSTRACT

This paper will present the findings of an access management study that is being preformed to review the driveway permit process of the Michigan Department of Transportation (MDOT) and identify areas of potential improvement. This study objective is to evaluate MDOT's existing access control policies as they pertain to state trunklines. This evaluation is being done to assist in the development of a systematic, overall approach to access management that provides a sound legal basis for access control decisions. The approach must be tailored to Michigan's particular needs -- it's broad range of road types, development patterns, geography, and political jurisdictions.

This paper will presen t the approach used to assess current practices, the principal findings of the assessment, and the recommended options for improving the process and guidelines used in driveway permit reviews.

PRESENTATION

INTRODUCTION

This paper presents the approach and findings of an access management study that is being performed to review the driveway permit process of the Michigan Department of Transportation (MDOT) and identify areas of potential improvement. The study objective is to evaluate MDOT's existing access management policies as they pertain to the nearly 9,600 miles of State trunklines. This evaluation is being done to assist in the development of a comprehensive approach to access management that provides a sound legal basis for access control decisions.

1. Study Overview

This study of access management is being performed to review the driveway permit process of the Michigan Department of Transportation (MDOT) and identify areas of potential improvement. The study objective is to evaluate MDOT's existing access control policies as they pertain to site development, driveway control, and the State/local review process in addressing access along State trunklines. This evaluation is being done to assist in the development of an improved comprehensive approach to access management. As urban and suburban land use densities increase and as traffic volumes and trip generation increase, the influence of the frequency, location and design of driveways and intersections has become a critical factor in the performance and safety of the arterial system. Access movements have been clearly identified as a significant element in accident rates and causes of congestion.

In Michigan there were nearly 390,000 accidents in the 3-year study period from January 1, 1992 to December 3 1, 1994. With accidents on limited access facilities excluded, there were nearly 3 18,000 accidents in the 3-year period. Almost 68 percent of these accidents are access-related, having occurred at intersections or driveways (including driveways in interchange areas). More than 33,000 accidents were definitively recorded as driveway related, accounting for 69 fatalities and more than 13,900 injuries. The average annual cost associated with these driveway-related accidents, based on National Safety Council 1994 cost factors is more than $220 million.

As shown in Table A- 1, the nine MDOT district offices (see Figure A- 1) issued nearly 4,300 driveway permits in the 3-year period between January 1,1992 and December 3 1,1994. This represents an average of about 1,430 permits per year. In the 3 years, about 63 percent of the permits were issued for residential driveways and 37 percent for commercial driveways.

Over 1,800 units of local government can exercise planning and zoning authority with few requirements for coordinated decision making. Over 1,320 jurisdictions are estimated to currently be exercising local zoning authority and site plan review.

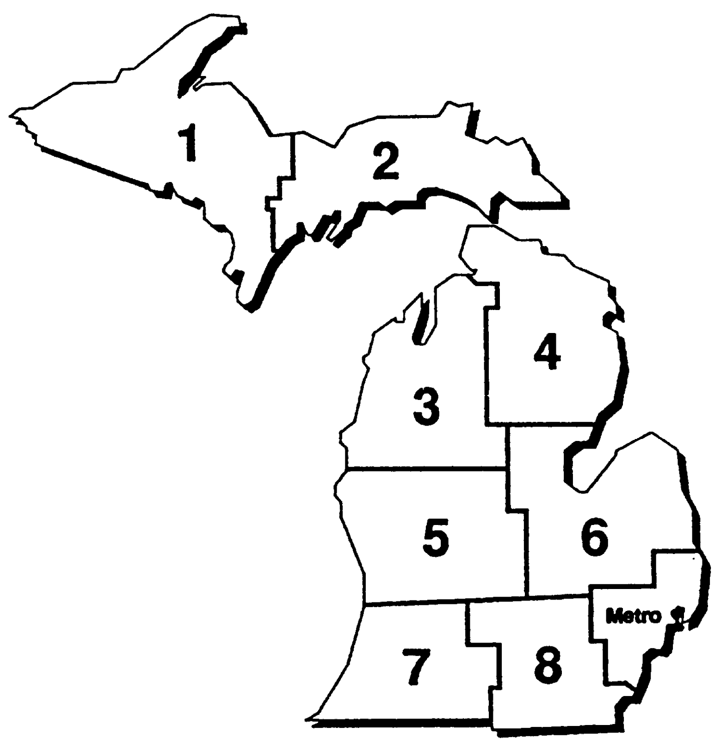
TABLE A-l

Summary of the Number of Driveway Permits Issued in 1992,1993 and 1994

District		NUMBER OF PERMITS							
		Residential Driveways				Commercial Driveways			
		1992	1993	1994	Total	1992	1993	1994	Total
Crystal Falls	1	62	50	76	188	25	15	20	60
Newberry	2	73	69	77	219	24	22	28	74
Cadillac	3	107	111	105	323	20	32	35	87
Alpena	4	127	130	123	380	55	49	57	161
Grand Rapids	5	93	91	98	282	68	72	88	228
Saginaw	6	170	172	174	516	67	71	77	215
Kalamazoo	7	103	99	112	314	61	66	69	196
Jackson	8	126	94	128	348	74	74	77	225
Metro Detroit		46	51	48	145	102	108	115	325
Total		907	867	941	2715	496	509	566	1571

Figure A-l

MDOT District Boundaries



Sometimes access management problems begin with the agency that is responsible for local land use planning, zoning, and site plan review This can easily occur because site plans are often approved locally without requesting review by MDOT. Thus, the number and spacing of driveways, and the placement of buildings and parking areas become fixed, leaving MDOT little recourse. Without a definitive access policy, and coordinated procedures with local governments, MDOT is hindered in its attempts to manage access.

The conflict between traffic movement and land access will increase as development continues in urban, suburban, and rural areas. The challenge is how best to coordinate access with land development in a way that encourages economic activity while simultaneously preserving mobility. A systematic approach to access management is needed -- one that provides a sound legal basis for access control decisions. This approach must be tailored to Michigan's particular needs -- its broad range of road types, development patterns, geography, and large number of political jurisdictions. This need underlies this study.

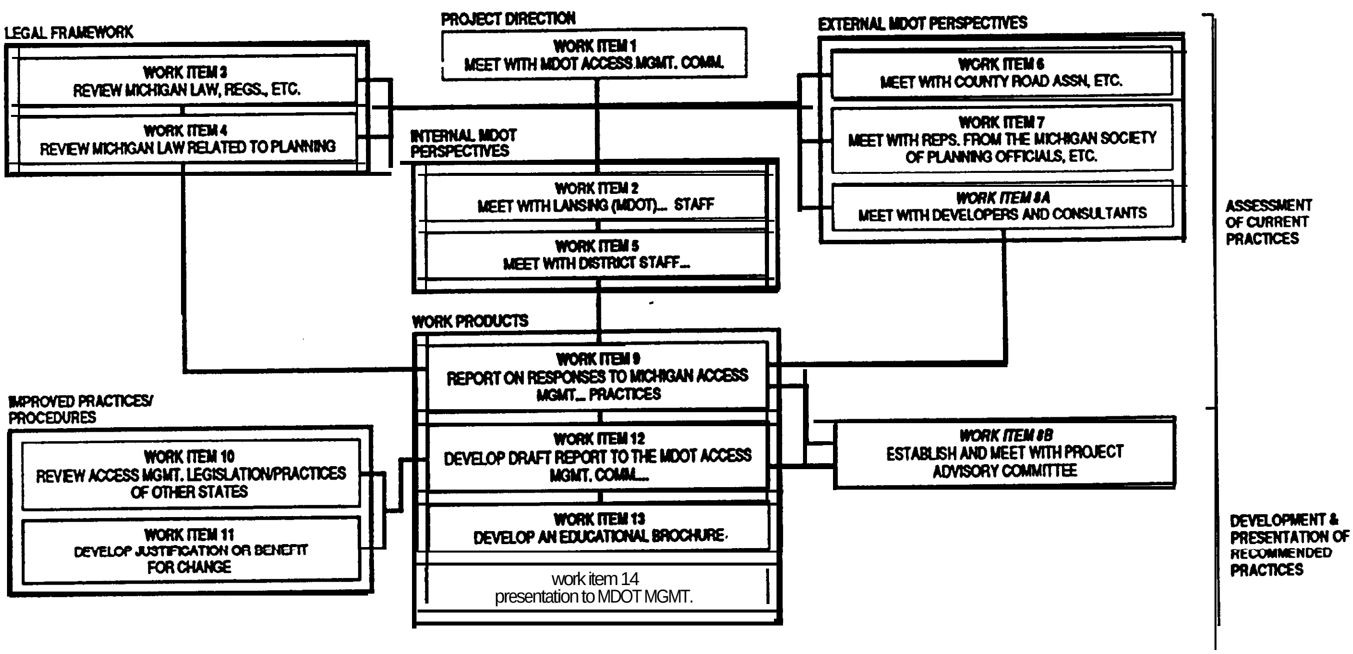
2. Study Approach

There were 15 specific study tasks or work items, shown in Figure A-2 to develop an improved comprehensive approach to access management. These tasks may be grouped as follows:

1. Obtaining **project direction** from the MDOT Access Management Committee.
2. Establishing **the** current **legal framework** that governs access management by investigating the pertinent statutes, regulations, and case law.
3. Obtaining **MDOT perspectives** from staff in Lansing and due to the decentralized permit review process from the district offices.
4. Obtaining perspectives, through a series of facilitated workshop discussions from **agencies and groups outside of MDOT,** that are involved in some manner with access management.
5. Establishing a **project advisory committee** of interests external to MDOT to review key work products and meet at critical milestones.
6. **Identifying improvements** to the current practices and procedures and the associated benefits.
7. Preparing **the work products.**

Figure A-2

Access Management Study Work Program

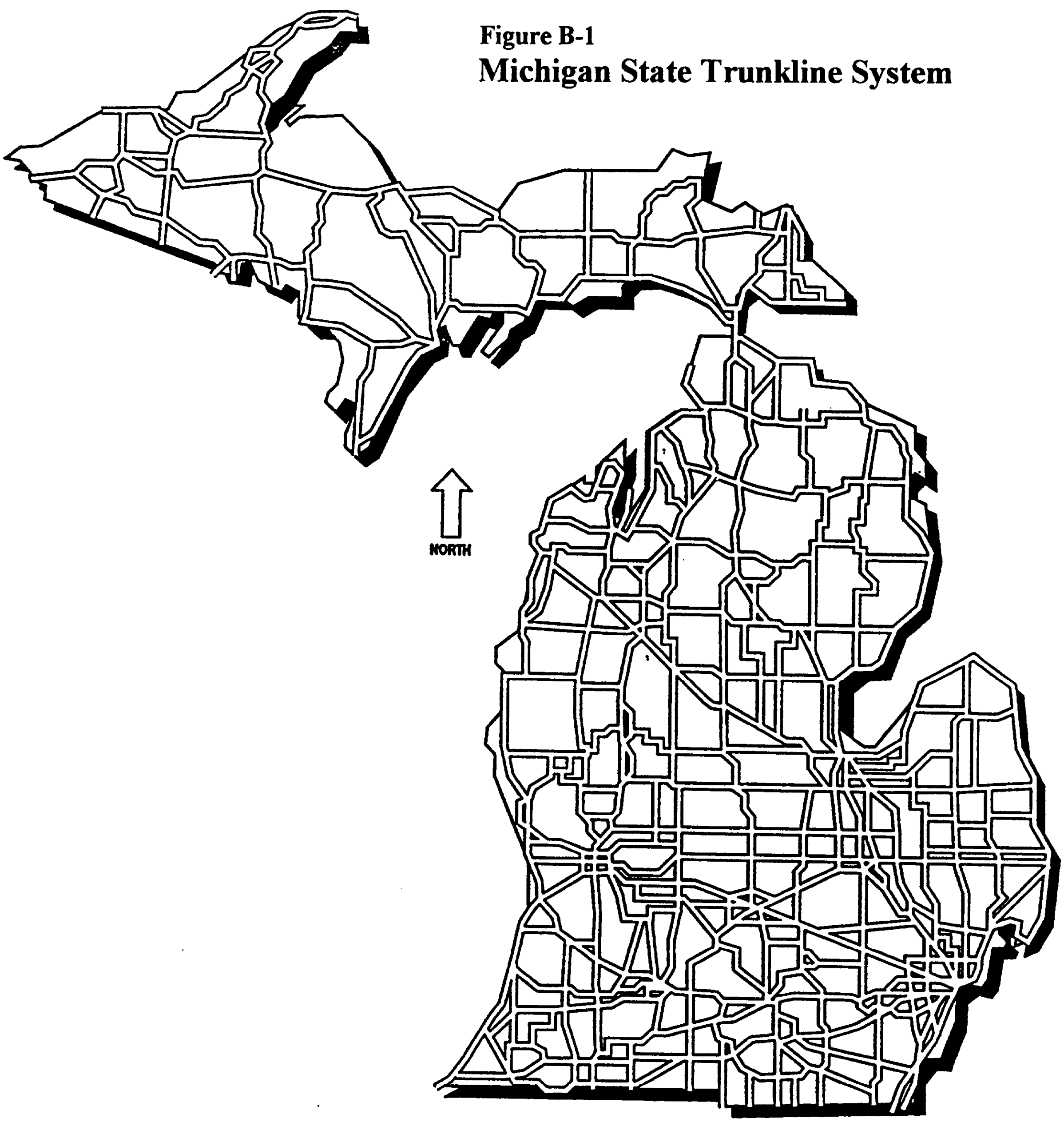


An assessment was performed of current access management practices based on completing the tasks associated with the first four items; the meetings with MDOT, the meetings with agencies and groups from outside MDOT, and the legal review. The results of the assessment were used as the basis for discussions to formulate future recommendations concerning MDOT's access management process.

B. STATUS OF MDOT DRIVEWAY PERMIT PRACTICES

The legal basis for the administrative rules that govern the driveway permitting process in Michigan is found in Act 200 of the Public Acts of 1969, as amended. The act's preamble states; *'An Act to regulate driveways, banners, events, andparades upon and over high ways; to provide for the promulgation of rules; to prescribe requirements for the issuance ofpermits, and to provide for the issuance of those permits.* " The administrative rules adopted pursuant to the Act serve to further ensure maximum protection for the public through "reasonable" control of driveway access on State trunkline highways. A trunkline is any highway or road under the jurisdiction of MDOT (see Figure B-l). State trunklines represent about 9,600 miles of highways, including Interstate freeways and business routes, U.S. routes, and State "M" routes.

Figure B-1
Michigan State Trunkline System



The following section summarizes the MDOT driveway permit process.

1. MDOT Responsibility

a. Current Permit Procedures

Michigan State laws require the public to have permission from the governmental unit having jurisdiction over a street or highway to construct inside of the right-of-way (ROW) line. MDOT has jurisdiction over the State trunkline system and has established a driveway permit process to be followed by all applicants.

Permit Application - Business or private parties and utility companies wishing to use the highway right-of-way for operations other than normal vehicular travel and including land access are required to obtain a permit from MDOT. The permit form is entitled "Individual Application and Permit" (Form 2205). This form is used for all routine requests for construction and/or occupying State trunkline highways (or the airspace above them) by individuals and corporations for residential and commercial driveways. Forms are obtained from the appropriate district offices of MDOT and must be accompanied by a drawing or plan of a proposed driveway with its location, dimensions, and type of surface indicated. Drainage design is also an integral part of the driveway design and, therefore, must be addressed as part of the driveway permit application. Typical layouts of various types of driveways that conform to MDOT rules are included in the application package to help ensure consistency in the design.

Processing of Permits - Construction of a new driveway or reconstruction of a driveway connecting to a State trunkline is allowed only after a permit has been issued by MDOT. The Department may authorize local governmental agencies to review or process applications and to perform necessary site inspections on its behalf. However, none of the local agencies have petitioned MDOT to take on this responsibility.

MDOT's review process is dependent upon the type of permit requested and the nature of the permit request. The more complicated the request the longer the review process. A set time period under which a review must take place is not defined, but the procedure to be followed by the applicant for a driveway permit is described in information from the MDOT Engineering Services Division. MDOT encourages the use of the report "Evaluating Traffic Impact Studies", produced by the Tri-County Regional Planning Commission, Southeast Michigan Council of Governments and MDOT (1994), in projecting trip generation.

Enforcement - MDOT may halt any activity if the provisions of a permit are not satisfied or if an individual fails to obtain the appropriate permit. Any costs incurred by MDOT in correcting a failure to comply with terms of a permit, or a failure to obtain a permit are borne by the individual.

b. Rules, Regulations and Guidelines

Application of the rules and regulations set forth in the Administrative Rules manual is supported by a series of criteria, guidelines and details established by MDOT's Engineering Services Division. The objective of this information, is to further define and clarify the intent of the administrative rules. This information is intended to aid the applicant in understanding the desired outcome of the driveway permit process, but serves only as a guide and may be varied, depending on actual conditions. Because these are only guidelines and are administered by nine district offices, their actual application may vary widely throughout the State, depending on specific circumstances.

c. MDOT Players and Participants

MDOT has nine district offices throughout the State. The district offices are responsible for accepting, reviewing and issuing driveway permits when in compliance with the administrative rules and regulations of MDOT.

MDOT's central office staff set policies; establish standards and guidelines relating to the permitting process; and, when needed, support district offices with more complex projects. The responsibilities of the central and district offices are shown in Table B- 1.

TABLE B-l

BUREAU OF HIGHWAYS

Model of

District-Lansing Operations

A Lansing Responsibility	B Joint District Lansing Involvement	C District Responsibility
1. Establish policy recommendations. 2. Establish and publish statewide procedures. 3. Establish and publish statewide standards and guidelines. 4. Establish preconstruction program assignments and priorities. 5. Establish master schedule priorities. 6. Approve and publish budget. 7. Establish Bureau goals and objectives. 8. Establish and approve training needs to meet Department goals. 9. Assure statewide compliance and/or uniformity with all of the above.	Participate in developing recommendations with respect to all items in Column A.	In accordance with items specified in Column A, fully responsible for district operations and administration, including accepting applications and reviewing and issuing driveway permits.

In instances where the scope of the project necessitates involvement of central office staff, final decisions regarding design and permit issuance reside jointly in Lansing and with the district offices. Central office staff involvement in the process, however, is generally the exception, and not the rule. Permit enforcement, while typically the responsibility of district offices, may also require the involvement of the State Attorney General's office. The AG assesses court action and the best means of addressing violations.

2. Responsibilities and Roles of Local Government and Developers

a. Local Government Role and Practice

An important component of the access control process exists outside the confines of MDOT. While the primary responsibility for most of the roads and streets in Michigan resides either with county road authorities or MDOT, the land use decision making authority resides with local jurisdictions.

Within Michigan, local government officials are the land use decision-makers. Their primary responsibility is to ensure new development is consistent with the goals of local plans, requirements of local regulations, and compatible with other land uses in the community. Each community is responsible for assessing the implications of land use decisions within its borders, but not beyond. The development review process of individual communities is often segregated, with local officials reviewing site plans and the road agency, whether city, county or state, addressing access.

In Michigan, over 1,800 units of local government have authority to exercise local zoning if they choose. Currently, it is estimated that over 1,320 jurisdictions exercise local zoning authority, including 866 townships, 32 counties and 423 cities and villages. An average state has between 300 and 500 local governments exercising zoning authority according to the American Planning Association. Because local land use decisions (especially zoning) have significant transportation impacts on the State's highway system, and are often uncoordinated with driveway decisions of local road authorities, the ability to direct and manage the driveway permit process by district offices is significantly more difficult and complicated.

Local land use decision bodies may not be well informed of MDOT's requirements for driveway permits, or the impact that development may have on the safety and function of State highways. Moreover, driveway permits are generally secured after the land use decision is made. This often results in little road agency input into decisions. Therefore, potential mitigation measures are identified too late in the process, resulting in frustration among all participants.

Local governments through zoning, subdivision regulations, condominium regulations, private road regulations, lot split regulations, and building codes have the ability to authorize new land development with or without consideration of access impacts. Due to the multiple jurisdictions that are involved, intergovernmental cooperation and coordination are needed for a successful access management program.

b. Perspectives of Developers

Easy and convenient access is important to the development community. As the key player in real estate activity, developers have long understood that households and businesses desire locations with convenient access to employment centers, shopping, and recreational and cultural centers. The necessity of access dictates its importance, and the importance of transportation, as a determinant of real estate decision-making. Therefore, the developer seeks to maximize access opportunities and the local communities (who often do not have the responsibility of maintaining the roadway system) generally support these desires. Road agencies like MDOT, who have the responsibility for road integrity, safety, and management, are generally expected to issue the access permit under the general interpretation of "reasonable access" and also make required improvements to accommodate new development as necessary.

C. PERCEPTIONS OF MDOT STAFF AND OTHER INVOLVED PARTIES AT WORKSHOPS

Understanding the perceptions of those directly involved with or impacted by the current driveway permit process and procedures is critical to fully evaluating its strengths and limitations. The future shape of MDOT's access management program is largely dependent on these perceptions.

Representatives of MDOT central and district offices, county and local road agencies, local planning agencies, private developers, and transportation consultants were asked to participate in the evaluation process.

1. Identification of Issues, Opportunities and Options

As part of an effort to gain a perspective on the current access management practices, procedures and experiences in Michigan, a series of workshops were conducted, beginning with MDOT staff. The MDOT Lansing staff provided an overall statewide perspective while district offices discussed current standards and procedures applied on a regional basis.

Due to the decentralized nature of the driveway permit process in Michigan, input from the District staff, who deal with the issue on a day-to-day basis, was crucial. At the same time, input from county road agencies, local government officials and private developers about their perception of key problems was also important to more fully understanding the current system.

Each workshop focused on three basic questions regarding access management within the State:

1. What concerns and issues do you have with the present driveway permitting system?
2. Are there ways to do things better than they have been done in the past?
3. How should positive changes take place?

The input received varied with the backgrounds of participants involved in each workshop. The outcome was a comprehensive list of issues and opportunities which reflected the principal concerns of a broad cross section of stakeholders. The discussion that follows begins with input received from MDOT staff.

2. Evaluation of Feedback Received

a. MDOT Staff

Over 50 issues and opportunities were identified by MDOT staff during the workshops, ranging from the need to enhance relationships with local jurisdictions, to formalizing procedures and policies. The staff felt that improvement to the current system of issuing driveway permits was necessary from the perspective of both MDOT and applicants. Primary concerns focused upon: 1) the lack of consistent submission standards for application review; 2) the lack of consistent policies dealing with local jurisdictions; 3) the lack of enforcement regarding the issuance of permits; 4) the fundamental philosophy that direct access to any State highway is a property right; 5) the lack of adequate substantive design standards; and 6) the lack of a consistent set of procedures within MDOT.

All nine district offices that issue driveway permits participated in the process. It quickly became apparent that, while the responsibilities of each district office relating to permit review and approval are uniform throughout the State, numerous factors influence the approach each uses to administer the program. Staffing levels, demands on time, coordination with central MDOT offices, individual administrative methods and operational policies vary from one district to another and consequently, influence the way the permitting process currently operates. In addition, each district is responsible for coordinating its efforts with local government jurisdictions. These methods of coordination are not uniform.

b. Other Involved Parties

MDOT invited outside organizations, agencies and developers to a series of facilitated workshops. The objective was to encourage discussion among participants, with a particular focus upon interaction between participants who influence, or are influenced by the driveway permit process. Discussion was also directed at procedures, standards and administration of current regulations. The participants involved in the process included representatives from both the public and private sectors.

Each participant was given an opportunity to share perceptions regarding existing regulations, procedures and processes, as well as opportunities for improvement. Over 200 comments were shared, ranging from the need to work more closely together, to the lack of uniformity in the application of standards on a statewide basis. Overall, many of the concerns and issues identified by MDOT district and Lansing staff were also voiced by community participants.

Following an open discussion, each participant was asked to fill out a survey to ensure substantive input was received on 28 key issues relating to access control. Issues were organized into three general categories, administration, statutory or education, for ease of review and consistency with presentation. Participants were given a choice of responses, ranging from strongly agree to strongly disagree.

Fundamentally, participants valued highways as a State resource, and desired to preserve the function of that resource over time. They also recognized the need to balance private right to access, with public responsibilities for safe and efficient roads. The need for improved coordination between governmental agencies also received strong support, as well as the need for greater emphasis by both local jurisdictions and MDOT on access management as a strategy. It is apparent, based upon the responses, that participants saw a strong role in the approval process by both local and State government and that by enhancing education, standards and communication, the objectives of access management can be achieved.

D. ANALYSIS OF ACCESS MANAGEMENT AUTHORITY FROM A LEGAL PERSPECTIVE

MDOT, pursuant to its power in Act 200 to make rules, adopted Administrative Rules Regulating Driveways.. ., effective June 30,197O. The key feature of the existing regulatory framework under this authority is the necessity of obtaining a permit from MDOT for a driveway on a State trunkline. The Act and the Administrative Rules require a permit for all driveways connected to the State trunkline highway system except for driveways which predated the effective date of the Act, i.e., August 6, 1969.

The object of regulation pursuant to Act 200 is limited to driveways. "No driveway.. . is lawful except pursuant to a permit issued in accordance with this act unless otherwise provided." A driveway is defined as the linkage "providing vehicular access between a highway and property adjoining the highway."

1. Need for Driveway Permit

Once the physical improvement has been determined to be a regulated driveway, the next question is what activities with respect to the driveway precipitate the need for a permit. Act 200 defines the following actions as triggering events:

- Construct, reconstruct, surface, or resurface a driveway;
- Make a change or expansion of the use served by the driveway when the change or expansion causes the existing drive to be a safety hazard;
- Operate, use, or maintain a new driveway.

2. Access Rights

The management of driveway access to the State trunkline highway system involves the interplay between the adjoining landowners' property rights and the State's interest in a safe and efficient highway system. The general rule is that the owner of land abutting a road has "right of access" which is the nature of a property right.

Under Michigan case law dating back to 1910 (Goodfellow Tire Co. v. Commissioner of Parks and Recreation, 163 Mich. 249, 128 N.W. 410), it has been recognized that an abutting owner's access cannot be completely denied, but it can be made subject to reasonable conditions. The court has determined that a business loss suffered as a result of diversion of traffic would only be compensable if there was an entire or material cutting off of access to the highway system.

3. Interpreting Standards

Act 200 authorized rules "consistent with the public safety" to be promulgated for the granting of driveway permits. The polestar of the regulation is the public safety element of the police power. The police power is the power of the State to protect its citizens by preventing activities which are detrimental to the general public health or safety. It is clear that the power to regulate driveways is a proper exercise of the State's police power.

E. ANALYSIS OF ACCESS MANAGEMENT AUTHORITY FROM A PLANNING PERSPECTIVE

There is a wide variety of statutes giving local governments the principal authority over most land use decisions. In addition, local governments can adopt focused regulations -- including access management -- through a general police power ordinance. This authority is derived from the State constitution as a means to protect or advance the public health, safety, or general welfare.

F. ANALYSIS OF TRAFFIC ACCIDENTS IN MICHIGAN

The benefits of access control and management have been long recognized. Access control reduces the number, variety, and spacing of events and conflicts to which drivers must respond. This translates into savings in travel times, and reductions in accidents. A growing body of information documents these benefits. These secondary sources were reviewed to quantify the safety benefits of access management associated with:

(1) fully controlling access,

(2) increasing intersection and driveway spacing, and

(3) installing medians and turning lanes.

Table F-l summarizes statewide statistics for reported driveway-related accidents in Michigan over a three-year period, January 1,1992 to December 3 1, 1994. The average annual cost associated with these driveway-related accidents, based on National Safety Council 1994 Cost Factors, is more than $220 million.

For analyzing MDOT's accident database, the average number of intersections per mile and the number of lanes were used for stratification purposes.

Figure F-l illustrates the relationship in Michigan between urban and rural two-lane facilities and mid-block accident rates. The accident rate increases directly with the average number of intersections per mile, since the closer the intersections are the greater the friction among vehicles. Furthermore, for the same number of intersections per mile, urban facilities exhibit a higher accident rate reflecting the higher probability of an accident due to increasing level of activity.

TABLE F-l

STATEWIDE SUMMARY OF REPORTED ACCIDENTS

DRIVEWAY RELATED

YEAR/SEVERITY	FATAL	INJURY	PROPERTY DAMAGE	TOTAL
January 1,1992 To December 3 1, 1992	13	2,014	5,634	7,661
January 1,1993 To December 3 1, 1993	23	3,664	9,223	12,910
January 1,1994 To December 3 1, 1994	30	3,478	9,23 1	12,739
TOTAL	**66**	9,156	24,088	332310

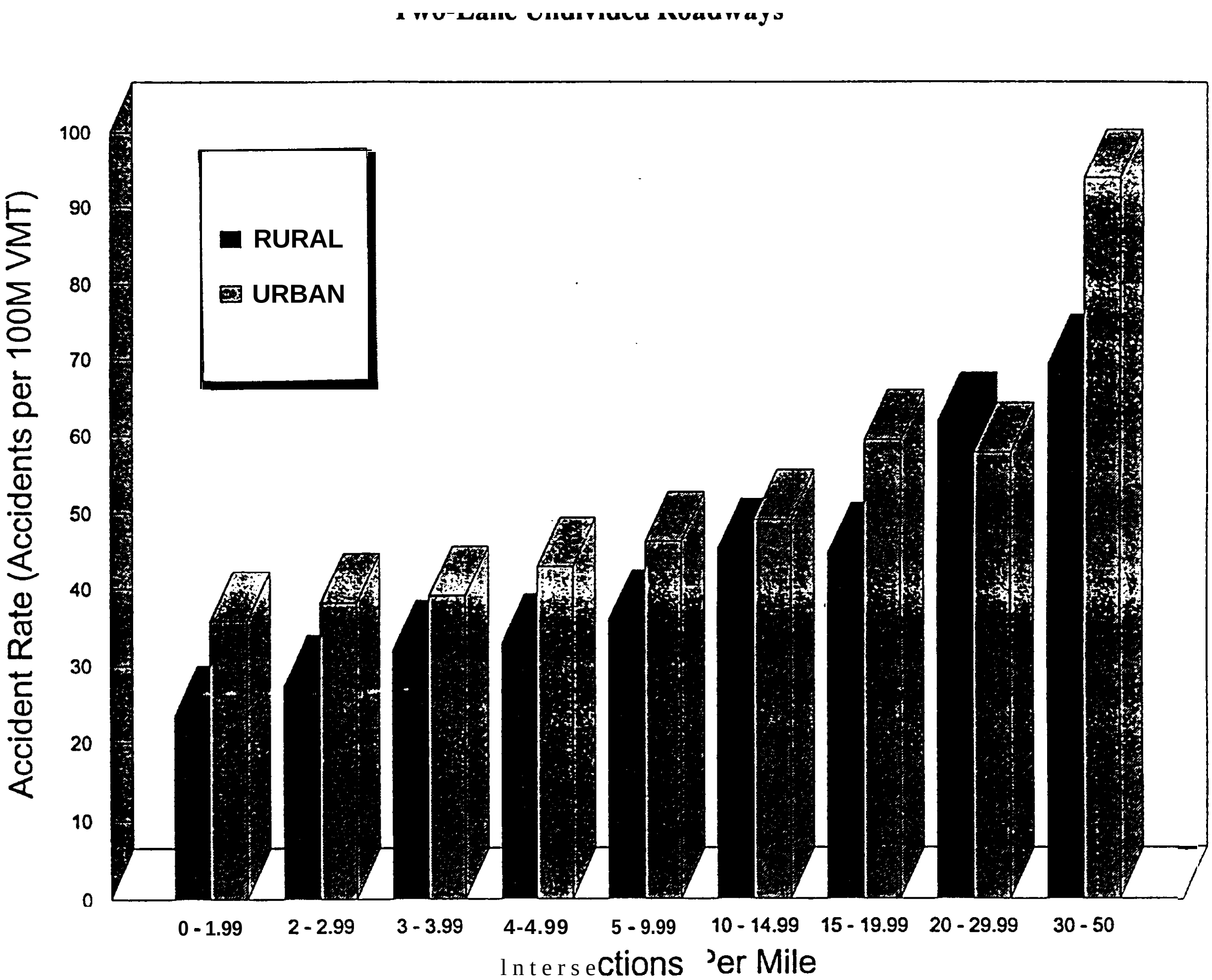
Notes:

1) Table data reflect the total number of accidents resulting in fatalities, injuries and property damage. Actual number of persons affected is as follows:

   Total number of persons killed = 69

   Total number of persons injured = 13,855

2) Intersection or interchange area accidents occurred on trunklines or crossroads within 15 0 feet of a trunkline intersection.



G. PRACTICES IN OTHER STATES AND THE LOCAL/COUNTY/MPO LEVELS

1. Practices in Other States

Surveys of access management programs in other states were conducted to summarize key information for use in reviewing MDOT access management practices and for identifying improvement options. A detailed questionnaire was developed to elicit information from key people in each of the selected states. The survey highlights are being presented in a separate paper for the conference.

2. Practices at the Local/County/MPO Levels in Michigan

In an effort to identify what has been initiated at the local level regarding access management, the corridor plans (and related access management techniques) of six Michigan communities, four counties, and one metropolitan planning organization were examined. Each plan was measured against a set of twenty-six criteria that are characteristic of access management. Although the specific design standards (spacing between driveways, etc.) varied from one community to the next as it relates to these criteria, the importance of each issue to individual communities is obvious.

The criteria that were found to be more commonly addressed include:

- Joint access
- Maximum number of commercial driveways

- Maximum number of residential driveways
- Driveway spacing standards
- Consistency with the local comprehensive plan
- Proximity to cross streets
- Adjoining parking lots
- Coordination of access points
- Acceleration/deceleration lanes

In addition, model access management guidelines, prepared by several other states for the benefit of local communities, were reviewed. Florida has a statewide access management program in place and its model guidelines were found to be the most comprehensive.

H. POTENTIAL IMPROVEMENT AREAS

Drawing upon comments received during the workshops, practices identified in other states, and information obtained from county and local government agencies in Michigan, about 60 improvement options were identified for MDOT consideration and discussion purposes. The presented improvement areas and options reflected an attempt to match areas of similar interest and focus between MDOT and other workshop participants.

The improvement areas were classified as follows into four general areas:

1) Administration, including:

    Organizational Structure

    Management Support

2) Procedures, including:

    Local Coordination

    Overall Permit Process

    Development Impacts

3) Access Standards/Guidelines, including:

    Trunkline Access

    MDOT Standards

    Highway Interchanges

4) Enforcement

The range of improvement options was included for discussion and consideration by both the MDOT internal committee and the external advisory panel comprised of interested agencies and groups. Each option was identified along with an indication of whether the option could be implemented within the existing regulatory framework or whether a change in statute or administrative rules would be required.

The options were first prioritized and ranked by those who will be involved in their approval and implementation. Higher priority options were ranked in order of importance by each member of the MDOT Access Management Committee. The Project Advisory Committee, consisting of members of groups external to MDOT, performed a similar prioritization of the improvement options. The two resultant sets of rankings -- one from MDOT and one from the external group -- were analyzed to identify any correlation in the priorities that were assigned.

The higher priority options were compared with the MDOT's Mission Statement and the goals and objectives that were published in the State Transportation Plan (adopted December 1994). The consultant team reviewed the rankings and, based on their experience, further ranked each option as “High”, “Medium”, or “Low” priority for implementation. In addition to prioritizing each option, the consultant team identified a range of implementation categories, from doing nothing, to making modest changes to the current driveway permit process, to making significant changes to move toward a comprehensive access management program. Following are the four implementation categories that were identified:

- "0" -- Do Nothing
- “I" -- Guidelines/Improvements within Existing Framework
- "II" -- Improvements Requiring Statutory Rule Changes
- "III" -- Combination of Selected Statute/Rule Changes and Improvements within Existing Framework

I. RECOMMENDATIONS AND CONCLUSION

In formulating its recommendation, the consultant team assigned each of the improvement options to one or more of the four implementation categories. The context, pros, and cons for each of the four implementation categories were drafted along with a summary that presents the priority and implementation category for each of the options. This process and the results were reviewed with the MDOT Access Management committee for their comment.

The MDOT management team recommended that the consultant along with the MDOT Access Management Committee proceed with Implementation Categories I and II, involving improvement options that can be done within the existing framework as well as those that would require statutory or rule changes, as described above. If this was not feasible, it was recommended that Category III be pursued. Category I options represent the minimum changes that should be pursued; they should be pursued independently only if Categories I and II together or Category III alone are not feasible. The “Do Nothing” alternative was not viewed as a viable option.

MDOT upper management favored seeking legislative actions, where needed, to enable the implementation of an enhanced access management program. Efforts are underway to formulate an implementation plan to progress improvement options included in Implementation Categories I and II.

An Australian Review of Access Management and the Land Planning Connection.

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ABSTRACT

During 1995, the State Government of Victoria (Australia) conducted a review of arterial road access managementpractices. Australian access managementpractice is long established and derives as much from traditional planning objectives and processes as from traffic engineering. Driveway controls and service (frontage) roads have been common treatments on arterials since the I95Os, but in the past twenty years or so developers have preferred to turn sites away from the arterial to face onto local streets. The Review revealed some strong opinions against these established practices among developers and some planners which are likely to be relevant to American practice. This is particularly so as "traditional neighborhood" design and permeable local networks become more widespread. The paper notes some key issues that have arisen, and present in summary the Review's conclusions about them. These issues include: questioning of the traffic basis of access management; "defensible space" and crime; amenity of sites adjacent to arterial boundaries; adapting practices to accommodate the needs of "new urbanism"; and the safety and efficiency trade-offs (e.g. resulting from more frequent local street connections in traditional neighborhoods). The outcome was that two different policy directions were offered: to continue with (improved) practices based on separation of arterial traffic from local activities, or to move towards greater integration of traffic into urban activities, in response to urban design and "traffic calming" trends. An approach based on Access Management Categories administered by the local planning authority, supported by documentation covering engineering design of access management measures and the amenity and urban design of adjacent development, was recommended. A suggested basic prescription of traffic fundamentals and requirements is offered in the paper.

Keywords: access management; traffic management; urban development; driveway; Australia.

PREAMBLE

This paper reflects on some issues which have arisen from a review of arterial road access management in Australia. It takes as read the well-established traffic reasons for access management and its techniques, which others at this Conference will no doubt discuss and illustrate. Following a brief overview of Australian access management and its place in urban planning practice, several key issues are discussed. These issues typify increasing critical scrutiny of established highway-based requirements and their underlying assumptions. They are raised here to sound a caution against focussing exclusively on traffic objectives as the rationale for access management. US practice may also be called upon in the near future to respond to urban design imperatives and community concerns about whether or not access management supports visions of "sustainable cities".

THE AUSTRALIAN SCENE

Australian arterial road access management is long-established. Current practice reflects its origins, which owe as much to British land use planning influences as to highway and traffic engineering. Consequently, there is an implicit understanding in various Australian State policies and practices that access management tries to provide for adequate interaction between a road and adjacent land, while protecting the utility and amenity of both. In addition to their responsibility for protecting arterial efficiency and safety, road and traffic authorities have also acknowledged their role in protecting the amenity of land which abuts traffic routes. "Amenity" of adjacent land refers to its quality of enjoyment, undisturbed by the presence of traffic (including minimization of noise intrusion, protecting the residential territory, and reducing the effects of the passing traffic on activities associated with the site.) It is accepted by implication that this may sometimes involve compromises with the objectives of traffic efficiency, as this paper later notes. Skills and experience in the art of managing the negative impacts of traffic on the amenity of adjacent land are commonly found in Australia among traffic professionals rather than land use planners and urban designers. Current moves to reduce the influence of road authorities on land development along arterials could therefore have the effect of diminishing rather than enhancing the quality of the non-traffic spaces.

In addition to various levels of control over the details of traffic design, the Australian States and New Zealand vary in the degree to which they specify access management policies and the way in which they are implemented. In general, however, there is a common understanding of the care needed in defining the level and nature of vehicular access to sites abutting arterial roads, in order to preserve the traffic function of those roads. Most commonly, rules and procedures involving State transport bodies relate only to higher-order arterials. Jurisdictions vary in the way in which they define "arterials"; the "declared" State road system does not generally fully describe the arterial system, although there is clearly an understanding that roads of major importance in the transport network have, or ought to have, access management controls applied to them under the auspices of the State road or transport agency.

Another characteristic, not universal in Australia and New Zealand but clearly recognized as a desirable practice in most places, is to obtain cooperation between local government (as a responsible planning and road authority) and the State transport and planning agencies; to clarify the roles of each of these parties in access management (or at least access control); and to delegate as much of the decision making as practicable down to the local level through the development control process. It is through the processes of planning scheme preparation, rezoning and site development applications (including subdivisions) that access management requirements are imposed.

To varying degrees, road authorities are typically referral authorities (meaning that applications are referred to them to check that their requirements have been accommodated). Decisions on site development, access and supporting street works are therefore typically made by local government with varying degrees of involvement by the State road authority. Access planning and design regulations or guidance are not available in most jurisdictions. These two factors are the major causes of inconsistency and delay in the approvals process.

Legislation and powers and duties seem to focus largely on *access control* (i.e. the specific control of vehicular and sometimes pedestrian movement to the site across the arterial boundary). The many other tools of access management are implemented through a variety of specific and general traffic sources. These are typically administered by the State road agency or by local government, depending on the status of the road.

On highways and other primary arterials, the frequency of access points is typically managed by the use of service (frontage) roads (fig. 1). Also common in areas developed over the past two decades is the orientation of sites, buildings and their access away from the arterial and onto a local access street on another boundary. These "back-up" lots usually present a continuous fenced or walled boundary to the arterial, most often with a 10m or more "access control strip" (usually provided by the developer) to provide roadside landscaping (fig. 2).

Service road junctions with crossing streets have presented the usual problems. Treatments which deviate the service roads away from the arterial (fig. 3) to separate the intersection points are rare in Australia. More common is the avoidance of intersections between service roads and at least the more important local streets, by taking service road entries and exits (usually one-way) off the nearside lane of the arterial. National traffic engineering practice guidelines assist in the design of such treatments (fig. 4). Given that service roads are, in effect., local access streets pushed to the edge of the neighborhood, this practice increases the number of access points onto the arterial compared with the treatment in fig. 3.

AUSTROADS, the national association of State and territory road departments, is currently considering the possible content and status of national access management guidelines to help reduce the delays and inconsistencies currently experienced, while reaffirming the safety and efficiency benefits of access management.

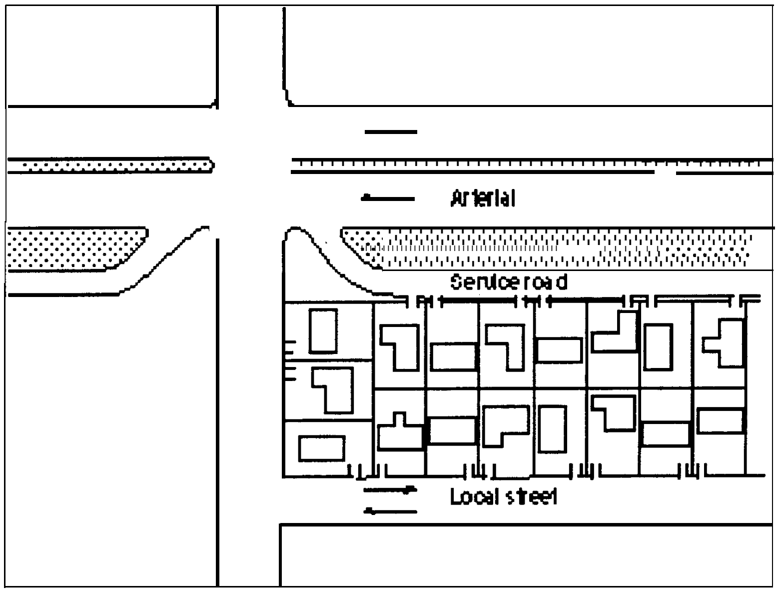

Fig. 1 Service (frontage) road treatments are common in Australia.
(Note: Australians drive on the left)

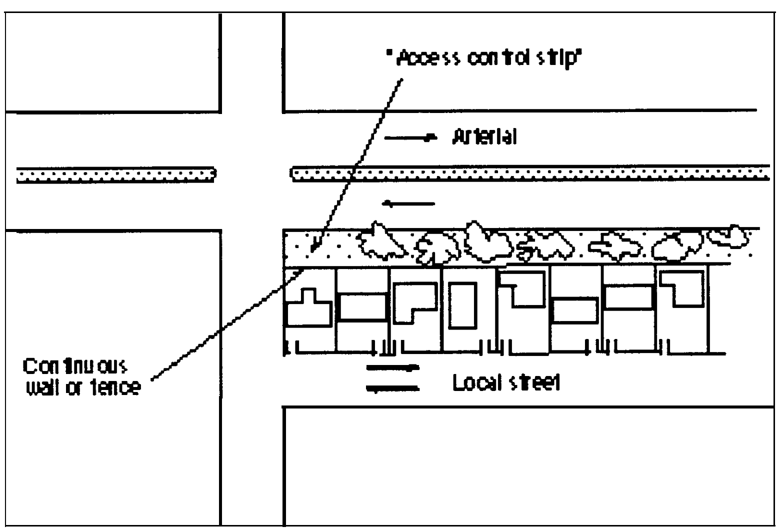

Fig. 2 In new areas, "back-up" lots with landscaped access control strips along the arterial boundary are also common in Australia.

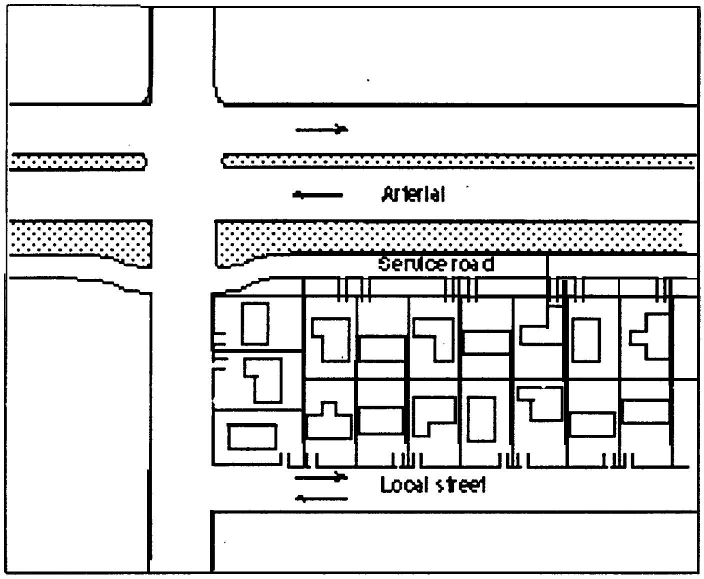

Fig. 3 Deviation of service roads to form separate intersections on the crossing road is not common practice in Australia.

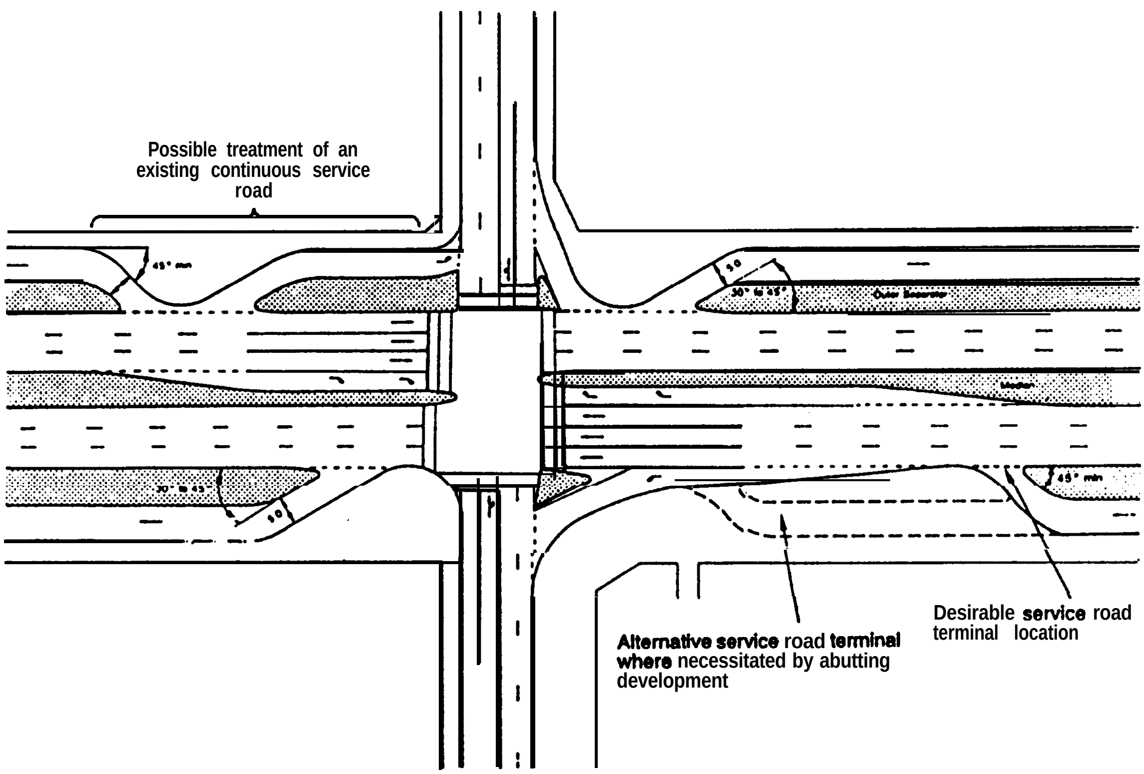

Fig. 4 Treatment of service road entries and exits, as recommended in the Australian national guide to traffic engineering practice.

THE VICTORIAN REVIEW

Through 1995, the Victorian State Government reviewed access management procedures, rationale and implications. The author was engaged as a consultant to this process, out of which two reports arose (1,2). A final report on findings and recommendations was in the course of preparation at the time of writing this paper.

Of interest to the wider audience are the motives for the Review, and the issues that emerged. The Review was requested by the State Minister for Roads in response to a series of cases which reflected what was seen to be inconsistency and unreasonableness by the State road authority in its decisions and the conditions it imposed on land development applications affecting State ("declared") roads. The solution to that sort of problem is reasonably straightforward: introduce clear guidelines and standard requirements (both of which were lacking). However, two impediments to that simple solution became apparent. Firstly, governments in Australia are attempting to move development control from a prescriptive to a performance-based process. The idea of a set of absolute standards for design and process was seen by some as giving the road authority too much directive control over building and site matters which are outside their mandate. Secondly, the assumptions upon which road-based requirements are based were beginning to be questioned. Some land development groups were asking for greater freedom and fewer constraints in the development planning and approvals process, to improve productivity and reduce costs. Others were keen to challenge long-standing (if inconsistent) practices which favored traffic needs at the expense of what were promoted as community and urban design values.

The nature of these values, and some reflections on them, form the following major part of this paper

ISSUES ARISING FROM THE REVIEW

"Proving" the Need for Access Management

Incremental change and gradual deterioration of the quality of traffic service is a major issue for road managers. The extent to which any access management measure - or its absence - affects the safety and efficiency of a road is impossible to estimate for the purposes of individual evaluation and justification. But the data clearly demonstrate the cumulative effect of planning policies which either permit or restrain frequent access movements. This was given judicial status by an Access Appeal decision in Colorado which recognized the concept of cumulative effect in finding that "the relative safety of a single access point [being requested] is not the controlling factor" *(3).* Access management guidelines allow individual cases to be assessed within the context of their cumulative effect, so that incremental change does not compromise strategic objectives.

Nevertheless, critics of the influence of traffic engineering and safety requirements on land uses along arterial roads have pointed to this imprecision as "evidence" of a weakness in the conventional basis for access management. In a growing climate of deregulation and land efficiency, protagonists have drawn attention to a number of real and claimed trade-offs, such as:

- safety vs commercial interests
- traffic safety vs personal safety
- noise exposure vs urban design objectives
- traffic efficiency vs directness of traffic access
- safety and efficiency vs land development costs
- safety and efficiency vs parking
- authority pays or road user pays vs developer pays
- acceptance of traffic interruptions vs economic growth
- commercial interests vs aesthetics.

How well prepared are we to answer such arguments?

The conventional and longstanding traffic engineering basis of access management is well-documented. It is a fundamental precept of traffic engineering that the "elimination of unexpected events and the separation of decision points simplifies the driving task" (4). A summary of US experience (5) has noted:

> "One thing is very clear, the most important geometric design element in reducing accidents is access control."

Australian road safety practice has long recognized the importance of access management (6). The Australian guidelines "Planning for Road Safety" (7) are based on the widely-accepted principle of separation of the traffic movement and land access functions of roads as much as possible. This "segregation" philosophy underpins most access management practice around the world.

The large body of information available to support this experience will not be reviewed here (2, 4). This abundance of data is not easy to collate systematically in order to derive reliable models of the benefits and other consequences of various measures. Australian practitioners are hopeful that the NCHRP study on Impacts of Access Management Techniques may provide a more rigorous and systematic presentation of the data. However, the Victorian Review observed that the body of data already available constitutes a solid case for continued regulation of the traffic conflicts related to access movements to and from land adjacent to arterials. This is evidence not to be discounted lightly. As Australian suburban development takes on a more "urban" character, with great mix of land uses and higher densities in a context of a slow-down in the expansion of the road system, the European experience becomes more relevant to us and the safety rationale for access management will take on greater rather than less importance.

There is clear evidence that access management - particularly access control, through limitation of the number of driveways and intersections - can contribute either to road efficiency (measured in travel times, delays, fuel consumption and emissions) or to minimization of the scale of road construction required for a given traffic task. There are many reports, as well as traffic theory, to demonstrate that fewer interruptions in the traffic stream converts to more appropriate arterial free flow speeds and hence to "level of service" improvements.
So are there points of trade-off against road safety, and can they be rationally discussed and defined? Some participants in the discussions on this subject have expressed the view that road safety is not something which should be demanded "at any price". On the other hand, traffic authorities generally place highest priority on road safety, even at the expense of traffic service if necessary (e.g. turn phases at signalized intersections). It is most likely that popular opinion would support this implied priority.

Even so, while road safety may be a key objective for access management, every permitted interruption to traffic flow constitutes a "compromise". As noted previously, marginal changes in accident propensity can rarely be precisely specified for marginal changes in access condition. The inability to give a precise, direct answer to questions about the effect of a specific access proposal has been used to play down the safety argument in site decisions. The "cumulative effect" principle is very important in such cases.

This makes better data more, rather than less, necessary. When there is uncertainty about the traffic safety consequences, most practitioners would tend towards a "precautionary" position - if there is doubt about the safety consequences, do not do it. However, this does not remove the need to reduce uncertainty as much as possible. Failure to do so weakens the role of road and traffic authorities in development planning along arterials.

Even if a traffic authority is not currently seriously challenged on such grounds, it would be prudent for it to anticipate broader assessment criteria, such as the following, in addition to the more familiar traffic impact and safety assessments:

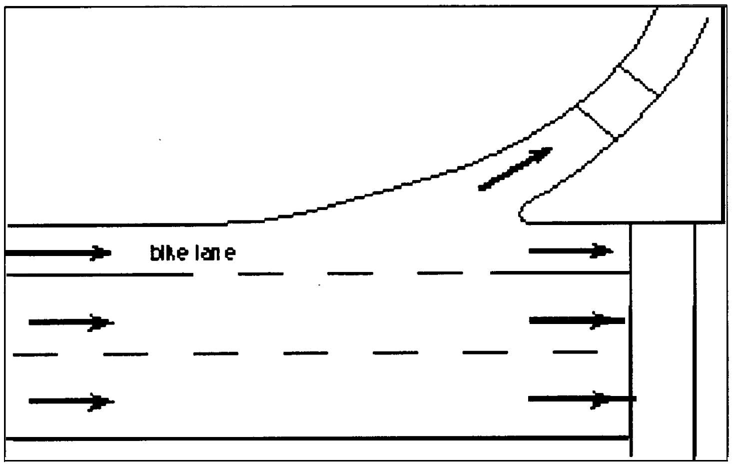

Fig. 5 Fast exits across bike lanes create problems for cyclists.

- *Pedestrian and bicycle* effects - both for access to the site and for movement along the road corridor (particularly in relation to provisions for higher vehicle exit speeds across the paths of pedestrians and cyclists - fig. 5).
- *Impact on the streetscape* - how the buildings relate to the street and the areas around the site. This is only partly a consequence of access provisions; there are many examples of buildings with traffic access to the frontage, but which are poorly related to the street and surrounding built form. Such developments may thus be doubly negative in their impacts.
- *Conformity of the proposal with non-traffic guidelines and policies* which might be in conflict with traffic objectives. For example, the Australian residential design model code contains a number of implied recommendations which could result in developments which are contrary to traffic and safety objectives.
- *Possible compromises* in order to achieve even more important planning outcomes. Care would need to be taken to differentiate between real compared with claimed outcomes, and between genuine long-term gains compared with short-run advantage for specific groups.
- *In summary, the total effect of the development* on the land use-transport system - and vice versa.

Access Management as a Tool of Land Use Planning

Managing the road-land interface has always involved close cooperation between road and planning practitioners, and frequent participation by local or State road authority staff in the planning and development permit processes. However, there are two planning-related topics which are of particular relevance at the current time and which have been found necessary to consider in framing an approach to access management.
Firstly, planning for access management - for example, agreeing on sets of rules for different levels of access management and then allocating an agreed set of rules to each segment of the network - requires application of an integrated approach to planning. Urban land uses and activities interact with the transport system - particularly the traffic system - in many ways. The interaction is two-way: roads and their traffic can affect (positively and negatively) the use of adjacent land, and vice versa. One of the principle objectives of land use-transport planning is to create and regulate the road-land system so that problems are rninimized and benefit is maximized. Access management plays a key role in this process.

Secondly, the word "integrated" comes up in another planning sense in reference to "integrated spaces".

In essence, the philosophy of access management has been that, where traffic and people must mix (as in local access streets and activity centers), the traffic must operate in a way which is compatible with the human activities in that same space - its speed and the expectations of drivers must be subordinate to the needs of the living environment through which the traffic moves. On the other hand, where traffic volumes and required levels of traffic service are incompatible with safe and pleasant living conditions, some degree of separation between the traffic and "living spaces" is introduced.

These concepts, and the rationale behind them, were clarified in Australian work some time ago (8). Attention was drawn to the fact that, far from being "in balance", the traffic functions of a road are in reality in *conflict* with the living and other functions.

Thus, the concept of *segregation* of busy traffic from sensitive activities and land uses under-pins current international and Australian practice.

However, a different concept of the interaction between movement and human enjoyment of the city has recently emerged, from one approach to urban design and some understandings of the term "traffic calming". This approach is based on *integration* rather than segregation of movement and living activities on all parts of the road network other than freeways. It encourages greater rather than less exposure of urban dwellers to traffic, on the grounds that to do otherwise relegates non-vehicular movement and activities to subordinate importance. Some have argued, for example, that road safety gains in recent years have been illusory because they have been achieved at the expense of restrictions on individual freedoms of movement and choices of activity (9). Likewise, traditional separation of adjacent land from higher-volume roads has been described as divisive in the urban fabric, creating non-interacting "enclaves" and even removing urban dwellers from the excitement and stimulus of movement activity.

Some of the consequences of this philosophy are becoming embodied in Australian national and State codes of practice. While most of these perspectives do not directly constrain access management, some (which will be familiar to North American readers) do impinge on it e.g. :

- Recommended mixture of local land uses to increase accessibility and reduce travel, which could lead to mixed-activity frontages to arterials.
- Pressure for more connective (grid) local street systems with more outlets to the arterial network (10).
- Suggestions that the segregation of arterial traffic from "living" activities is not good urban design, and may in fact encourage more traffic.
- Objections to "inward looking" residential areas, on the grounds that they are elitist, isolationist and not in the interests of community.
- Growing emphasis on surveillance of public spaces for increased personal safety. (See next heading.)

Taken to practical extreme, such views would generally run counter to access management measures which might be considered for safety, efficiency or even amenity reasons. The review of practice revealed no example of current practice based on the concept of deliberate integration of street uses and frontage activity on arterial roads in new areas, other than in town centers. Even so, Australian authorities are being advised to be aware of these developments in current planning thought, and consider the extent to which guidelines should either resist or accommodate such concepts. Policy decisions will demand careful attention to the safety, amenity and efficiency evidence in order to demonstrate that traffic functions of a heavily-trafficked arterial cannot be compatible with pleasant use of the adjacent spaces, and that segregation of traffic from other activities is sometimes (if not always) desirable.

The choice between integration or segregation was offered in the Victorian Review as the key question for public debate on access management. This debate is ongoing.

Another urban design influence on arterial performance is likely to come from the growing influence of the concept of "neo-traditionalism", or the "new urbanism". This will occur through the preference being given to "permeable networks", i.e. local street systems that are internally and externally connective, and are not collector-based. The primary effect of such concepts on arterial access management is to increase the number of minor streets forming junctions and intersections on the traffic routes, and to resist favoring one local street over another when nominating access points into the local street system. That implies that most, if not all, local street-arterial intersections will have to permit all turns, and few should be signalized. The implications of this are worrying to Australian traffic practitioners.

To what extent are the implications of "integration" of land uses and traffic compatible with the demands for efficient and safe operation of the traffic network? And to what extent do the techniques of access management really compromise the objectives of urban design and community building? Are there fundamental absolutes at work here, or is it only a matter of *how* things are done rather *than what* is done?

It is also relevant to ask "Who is to be the guardian of consistency and variety, visual quality and urban image, road functional quality and quality of the built environment?" At the very least, such questions imply a role for road authorities and local government as "champions of the road corridor", i.e. *including the non-transport aspects,* when they participate in the integrated planning process. It is important that adequate skills for this role reside in road authorities, suggesting they need a somewhat broader professional base than at present.

The Nature of the Boundary and Frontages

The treatment of the interface between the road and adjacent development - both the nature of the access control and the physical relationship between road, buildings and the spaces between them - was the source of adverse criticism in the Victorian review. The boundary treatment has obvious relevance to the level of traffic interaction, but it also has implications for the level of non-traffic interaction that can be achieved and the way the road and its traffic impact on the amenity of adjacent sites.

Some have claimed that there is a significant trade-off between personal safety and traffic safety in access management, pointing to the requirement now appearing in some design codes that there should be surveillance of the roadside area from adjacent buildings.

The argument that spaces are less safe if they are not overseen by buildings comes from a form of physical determinism sometimes called "defensible space" (II). This holds that personal safety is maximized if the physical spaces are designed and built in a way which provides (or leads potential assailants to assume will provide) opportunities for other parties to observe an assault.

Road authorities will need to be informed about this subject since debate will no doubt continue on it in the wider planning sphere and in specific cases. Arguments about whether such concerns arise from perceived rather than actual threats to personal safety may take some time to resolve. It may be more constructive to consider ways to respond to the urban design desire for "surveillance" (and "urban" frontages) without compromising the need to control vehicle access movements. This depends in part on the nature of the arterial road boundary. It transpires that the desire for different forms of building presentation to an arterial need not compromise traffic requirements.

There are four generic types of traffic access condition:

- Indirect access (traffic access from another boundary).

- Service roads
- Auxiliary lanes
- Direct access to through lanes.

Service roads are merely a way to reduce the number of minor junctions on an arterial - a means by which manoeuvres into and out of many minor access streets and driveways can be separated from through traffic. A no-vehicle-access boundary clearly results in fewer traffic conflicts at arterial speeds and avoids the design and operational problems that often arise with service roads, especially where service road entries and exits are close to intersections or where intensification of site activity renders the service road less able to meet its task. Service roads are less common in Europe (reportedly because of the land inefficiencies that result) and planning guidelines in Europe clearly express a preference for alternative frontages. A study for Alberta (Canada) Transportation in 1987 compared service roads with alternative forms of access control and tended to favor "alternative access"/back-up lot treatments (I 2).

But a distinction needs to be drawn between "frontage" and the boundary across which vehicular access is gained. Particularly in more urban environments, frontages without vehicular access (including continuous frontage row housing, apartments and mixed use buildings) offer many design attractions (fig. 6). However, while most traffic and safety requirements could be met by frontages with alternative vehicular access, such forms of development may still generate curbside parking demands and pedestrian movements across the arterial road. Furthermore, as Appleyard found (13), residential development which is oriented towards an arterial road experiences lower levels of amenity and social quality with increasing traffic levels, even when vehicular access is gained from another boundary. This raises the issue of what has been termed "environmental capacity" - the level of traffic above which various measures of amenity are unacceptably infringed. While quantification of this phenomenon is still inadequate, it cannot be ignored in the planning and design of development adjacent to traffic routes. An indication of its significance can be found in the effects of arterial traffic on property values. It is often found that compensation paid to owners of acquired houses on arterials is inadequate to buy comparable properties on local streets nearby. Real estate sources in Australia estimate the difference currently at around 15 per cent.

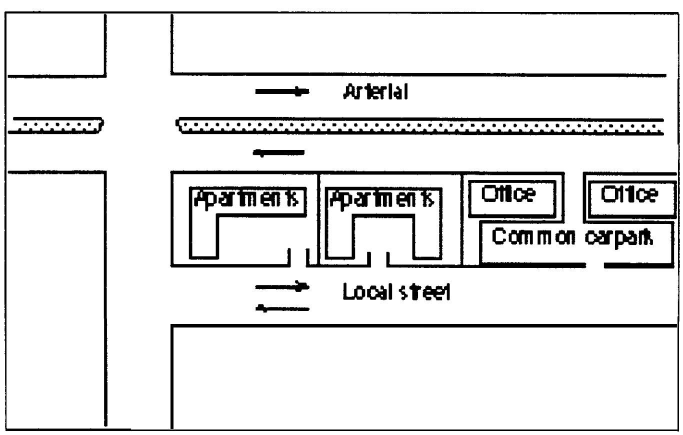

Fig. 6 Frontages with alternative vehicular access may satisfy urban design objectives without compromising access management requirements.

Some contributors to the Review disputed the assertion that lower levels of amenity for sites fronting arterial traffic routes were undesirable, saying that in fact this should be tolerated since it provides "starter housing" for low-income households. It would be fair to say that such views are not widely supported, and are contradicted by emerging information about the health impacts of traffic noise, data on the effects of traffic on community, and so on. Nevertheless, does evidence of "tolerance" of traffic noise and disturbance justify perpetuating such conditions in new development? Alternatively, should people be protected from themselves? Is it good that arterial frontages provide lower cost (and lower quality) housing? Is there scope for building other methods of protecting amenity (siting, building design etc) into development controls? Such questions need to be resolved if "frontages without vehicular access" are to be acceptable measures in the access management toolkit. This is an area requiring a good deal more research and other information if it is to be adequately resolved.

The Review concluded that, provided the number and design of connections with local streets (including service roads) can satisfy traffic and safety requirements, *traffic objectives can be met without distinguishing between service road frontages and back-up lots*. The further planning and design measures that might be contemplated are not central to access management or access control.

Some Observations Arising from the Review

Best practice

A synthesis of Australian and overseas practice suggests that planners and highway authorities would regard the following as key elements of "best practice":

- Access management is understood, planned and managed most readily in a land planning context, working within planning and development processes and philosophies.
- Access is controlled through planning instruments and the development approvals process, Thus, changing community values and needs can be accommodated. (This assumes that the planning process is in fact responsive both to community values and technical requirements.)
- Traffic safety is acknowledged as a major objective of access management, and is protected by established technical guidelines and criteria in the planning and design process.
- Amenity (for users of adjacent land, non-vehicular road users and vehicle occupants) is also a primary objective. This might have implications for planning requirements for sensitive (e.g. detached residential) land uses abutting more heavily-trafficked arterials.
- An agreed and widely-understood access categorization scheme is adopted and applied to all roads as a basis for the different degrees of control that may be required on each road. Decisions on access points in new developments are then linked to the strategic function of the road and the types of traffic and trips that it serves, as well as the type of environment intended to result. The system of access management types is not identical to a "road classification" system, but may supplement it. Specific decisions on access-related design and management are subject to access management categories, not "road classification".
- The engineering (traffic service and safety) aspects of access control standards are the responsibility of the highway and traffic bodies. The full specification of access control conditions should be an integrated process involving traffic and planning input.
- Direct vehicular access to individual sites is not normally permitted on more important traffic routes, but this does not preclude various forms of non-vehicular access and building orientation to the arterial.
- The use of the road reserve for utilities and other purposes is also subject to access management controls, including "rental" or fees for costs imposed on other road users.
- Engineering and design standards are consistent nationally. This is not to say that variations to meet local conditions and requirements are not sometimes permissible. The *principles* and the general effect of the standards, however, are consistent.
- An "access management plan" is used in "retrofit" (existing development) situations. This is a local plan which aims to enhance the higher functional routes through access removal, control over signal spacing

and careful design, while checking the local roads in the corridor for their ability to absorb the local traffic.

A possible basic prescription for traffic objectives

On the basis of current practice, and recent re-examination of access management requirements in the context of today's attitudes, it is possible to identify some basic characteristics for the traffic system. These help to suggest criteria by which appropriate levels and forms of access management can be developed for each road.

1. Fundamentals:

   1.1. Not all "traffic routes" require the same levels of access management.

   1.2. Control over turns and the minimi zation of speed differentials within the traffic stream are the two primary traffic objectives of access management.

   1.3. The speed environment on the arterial road is a major factor in determining the appropriate forms of access management (and vice versa).

   1.4. Lower-speed environments are sometimes appropriate on traffic routes, especially through linear centers and other pedestrian-oriented areas. The road design and speed environment must be in tune with the nature of the non-traffic environment.

   1.5. Traffic considerations generally focus on the demand and provisions for parking, and the number, location and design of minor intersections and driveways.

   1.6. Building setbacks and orientation, landscaped access control strips, and the types of adjacent land use *are* not *directly* of concern to the traffic function of an arterial. The nature (frequency and design) of the vehicular access points to adjacent land is the key factor.

   1.7. However, traffic planning *should* concern itself with the impacts of the traffic stream on the use and enjoyment of adjacent land. The design and treatment of the margins of the road and adjacent land development are relevant to such a concern.

   1.8. Single-household residences impose less impedance on the traffic stream than do commercial and other land uses - but **traffic** streams impose greater safety and environmental burdens on adjacent residential uses than on most other uses.

2. Basic requirements

   2.1. Parking on any arterial should preferably be clear of through lanes. Parking should not be permitted on through lanes where a speed above 60 km/h is expected or desired.

   2.2. Unprotected frontages of sensitive land uses are not compatible with higher volumes of traffic or with speeds above 60 km/h.

   2.3. Direct connections from private driveways to the through lanes should not be permitted where a speed above 60 km/h is expected or desired unless they are treated as intersections. In any case, the spacing of direct private driveways to residential or commercial sites should meet or exceed prescribed minimum standards.

   2.4. Controls over turns across the road centerline (frequency and location) are generally required on traffic routes where a speed above 60 km/h is expected or desired, either by controls over breaks in solid medians or, where the traffic volumes are lower, by controls over the spacing of driveway and service road entries.

2.5. Driveways, service road entries and exits, and minor intersections should be minimized along arterial bicycle routes and designated bicycle paths or ways. Higher-speed vehicular exits and entries are difficult for cyclists and need special design attention with their needs in mind.

2.6. Standard engineering design requirements covering the location and design of entries and exits should continue to apply (as modified and updated) where it is agreed that safety and traffic service are relevant determining factors.

Outline ofpossible procedures

The practical ideas that emerged from this Review were based on the following broad conclusions:

1. Access management does have clear benefits, but some familiar measures of control may inhibit preferred design and other outcomes.

2. There was a clear desire to make the development approvals process speedier and more consistent. The State road authority was anxious to simplify its involvement in what is seen essentially as a planning approvals process. The State road authority's interests can be met if adequate ground rules and regulations are established. It does not need to be involved in issuing permits for every site or access.

3. The local (municipal) authority, acting as the planning authority (i.e. responsible for the planning scheme, zoning and development approvals) is the appropriate body to administer site permits and access conditions.

4. The access conditions pertaining to each road section, and any technical design or other requirements, need to be clearly established up front.

The Review suggested that a process based on Access Management Categories (AMCs), similar in some ways to the access classification system used in some US States, be considered. These categories and their specifications need cover only a few critical elements, such as the spacing and control of off-side turns (across the road center-line), the frequency and management of near-side turns, the spacing of cross-intersections and signals, treatment of parking, and the anticipated operating speed (to match the Speed Zoning methodology in use in Australia). Once an AMC is allocated to each road section (through the planning process), a development proposal could be assessed on that basis. Conformity to design guidelines to cover the engineering treatment of the access details, and the amenity and urban design of sites and buildings, would also be required. This can be done under our planning processes by calling up the relevant documents in the planning instruments. The guidelines for amenity and urban design would introduce forms of development which satisfy concerns about streetscape and security, and specify the conditions under which they could be appropriate (such as frontages without vehicular access).

On the State road system, the State road authority would have the right of consultation and objection if the requirements were not met. The only other times it would be involved in the process would be for larger developments (say, more than a certain number of parking spaces). This does not mean that the road authority is marginalised in the process; it would play a major role in establishing the AMC definitions, their allocation to the State road elements in the network (the local authority would decide the rest), and the development and updating of the road design guidelines for access management.

SUMMARY AND CONCLUSION

This description of an Australian review of arterial road access management raises a number of matters of wider interest. While the body of evidence confirms the validity of access management to enhance traffic flow and safety, developers and planners are pressing traffic authorities to be more specific about the impacts of changes in access conditions, both in general and in particular cases. There appears to be a lot more research that could be usefully done.

Not all traffic routes need to have the same level of access protection. A system of "Access Management Categories" is being considered. Many existing and future roads, particularly under the influence of "new urbanism", may be nominated for greater levels of frontage activity. Where lower speed limits are acceptable, this combination of functions should generally be acceptable. On higher-order arterials, particularly those operating at higher speeds (above 60 km/h), design options include "frontages without vehicular access". Whether or not site development is oriented towards the arterial boundary, design guidelines and amenity standards have been proposed to protect the safe and pleasant use of those sites, and to guide the design of the built form along the frontage. Such possibilities meet traffic requirements while putting responsibility for urban design matters such as personal security and the activity of frontages back to the site designers rather than highway engineering standards.

If the specification of the access category is appropriate, the design requirements are in place, the appropriate speed environment is applied and enforced, and the development approvals machinery is working properly at the local level, then the State road authority does not need to be routinely involved in access permits and management related to individual sites. It is interesting to note that the trend in the US appears to be in the opposite direction. Readers might like to speculate on the reasons for this, and on the possibility of pressure for a change in planning and design controls (and who administers them) if there is a shift in urban design values in North America. Ultimately, the question is this: Is access management a land planning or a traffic engineering matter? It seems clearly to be both.

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Road Corridor Management And Access Control

**Initiative proposed by the ministere des Transports du Quebec
and review of the approach adopted with respect to the municipalities**

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ABSTRACT

Faced with increasing difficulties in maintaining a safe, efficient highway system, the Ministere des Transports du Quebec (MTQ) identified measures targeting improved access management and a better balance between local and through traffic.

In its efforts, the MTQ was able to learn from extensive U.S. roadway access experience. However, it had to take the following major pan-Canadian and North American public management trends into account : the declining role of government, deregulation, and public service regionalization and decentralization. These trends pose significant problems for the MTQ since it has no regulatory power over road accesses.

The MTQ's strategy is based on having the regional bodies join in implementing access management systems. Working groups of urban planning and transportation specialists were set up in 1994 of Quebec's 16 administrative regions. Apart from access-related conflicts, regional analyses highlighted specific land use priorities which are incompatible with the requirements of provincial highways and the lack of efficient local highway systems that complement the arterial highway system.

The distrust marking relations between local and provincial government representatives, the fear of having new responsibilities imposed without the attendant fiscal transfers, and various professional concerns led local participants to propose conservative measures stressing the procedure to be adopted by the MTQ rather than the access management objective.

Although past experience in the field shows that the MTQ must gain full regulatory jurisdiction over roadway access and play a leadership role province-wide, such a role must also take into account the government's decentralization projects, which are aimed at empowering citizens, while increasing their accountability, enhancing the role played by municipal authorities, and redefining the links between the government and local communities.

Key words : Quebec, access, road corridor management

I OVERVIEW OF QUEBEC AND THE MINISTÈRE DES TRANSPORTS

Quebec is located in the northeastern part of North America. It is the biggest of the 10 provinces in Canada and accounts for 16 percent of Canadian territory. It is three times the size of France and seven times bigger than Great Britain.

However, most of this immense territory is sparsely settled. Most activity and the majority of Quebecers are concentrated in the Saint Lawrence valley. Nearly half of the population lives in three urban areas. Montreal, with a population of 3 million, is the province's most important city from an economic, demographic and cultural standpoint.

The main challenge facing the ministere des Transports is unquestionably winter. Quebec experiences harsh winters, with temperatures in the -10°C to -30°C range. Road maintenance during the winter makes special demands from the standpoint of logistics and funding.

The ministere des Transports and management of the road network

The responsibilities of the ministere des Transports du Quebec are defined by the division of powers between the federal and provincial governments. Road transport falls, for all intents and purposes, under provincial control, while maritime, air and rail transport are by and large under federal authority.

The ministere des Transports ensures the movement of individuals and goods throughout Quebec by means of the development, implementation and operation of transportation infrastructures and systems.

In order to guide its initiatives, the department has adopted three strategic policy directions:

- the repair and maintenance of the road network and transportation facilities;
- the development and integration of various modes and systems in the realm of transportation;
- support for Quebec's economic development.

The Quebec road network totals approximately 164 000 km of roads. The ministire des Transports oversees 27 000 km of freeways and main, regional and collector roads, including 2 000 bridges and viaducts.

Increasingly, the ministere des Transports is focusing on the reduction in the use of existing roads. The department has included in its program the elaboration of a policy pertaining to the management of road corridors, the main objective of which is to establish a plan of action aimed at enhancing control over access roads, and to its partnership with the municipalities responsible for land use planning.

However, the approach adopted by the department must take into account the absence of legal and administrative links between land use planning and the management of the main highway network, and the absence of regulatory power over access roads.

Moreover, the department's initiative must reflect three broad trends in public management in Canada and North America, i.e. the reduction of the role played by government, the reduction in regulation, and the regionalization and decentralization of public services.

It THE SEARCH FOR A SOLUTION AND THE APPROACH ADOPTED

Bearing in mind the foregoing constraints and the importance of ensuring harmonization between urbanization and road network management policies, a plan of action has been implemented to deal with the problem of access centered on an integrated approach, i.e. road corridors, in order to:

- ensure sustained interaction between the department and its partners responsible for land use planning;
- maintain constant receptiveness to the road environment, i.e. to be able to adapt at all times and in all places to the needs of each of the intervening parties concerned;
- ascertain the differences between the notions of urbanization and road transport and better coordinate the two;
- examine urbanization in conjunction with the road network, not as an isolated notion, but as an integral part of road transport.

The plan of action is made up of three stages:

(1) an information and awareness campaign conducted in the regions, with particular emphasis on an integrated approach called "road corridor management"(') (December 1992 to August 1993);

(2) the elaboration of preventive measures and the establishment of task forces in the regions (October 1993 to September 1994);

(3) the drafting of a departmental policy on road corridor management and access control (October 1994 to November 1995).

III REGIONAL TASK FORCES AND ROAD CORRIDOR MANAGEMENT

In order to heighten awareness among interveners at the municipal level and clarify the factors related to the loss of use of roads, in 1993 the ministere des Transports established 14 task forces throughout Quebec, made up of from three to six members specializing in land use planning, urban planning and transportation.

This chapter focuses on a summary of the reports submitted by the regional task forces. First, it outlines the mandate assigned to the task forces and the methodology used. It lists the problems noted by each regional task force and the solutions adopted to enhance the management of road corridors.

(A) Mandate assigned to the regional task forces

The task forces were asked to submit, by May 1994, technical measures pertaining to the protection and management of road corridors adapted to the specific needs of their regions. Under the mandate, the task forces were called upon to:

- ascertain the main causes of the loss of serviceability of the main highway network;
- draw up various intervention plans designed to enhance the management of road corridors;
- indicate the division of responsibilities between the MTQ and its partners in respect of the management of road corridors;
- pinpoint a procedure to enable the MTQ and its partners to jointly integrate the management of road corridors into land use planning.

(B) Methodology used by the regional task forces

The regional task forces analysed the organization of urban activities along roads from the standpoint of traffic problems. They were then asked to propose preventive measures that could be implemented to preserve the function of the main highway network.

The analyses were effected using representative samples of the network from the region, according to three types of ribbon development, i.e. repetitive, multidirectional or superimposed. The task forces first examined each sample using analytical grids proposed by the ministère des Transports. The diagnosis centered on the urbanization process in the sectors from which the samples were drawn and the problems specific to the road corridor. This study enabled the task forces to shed light on the factors that explain the corridor's dysfunction and, subsequently, to propose preventive solutions of a prescriptive and administrative nature and pertaining to planning needed to maintain the serviceability of the road network. The task forces analysed 52 samples of the main highway network totalling 122.97 km.

(C) Problems noted by the regional task forces[2]

(1) Urban planning that encourages ribbon development and the proliferation of private driveways and intersections

Large numbers of private driveways and intersections

The short distance between private driveways, driveways located too close to or directly at intersections, driveways that do not meet standards respecting sight distances, and the high number of driveways per kilometre are the main problems noted. The task forces also noted high numbers of intersections directly linked to the main highway network. The short distances between each of the intersections and the influx of local traffic on the main highway network increase the number of conflict points that motorists experience.

The proliferation of private driveways and intersections is partly attributable to urbanization policies that encourage ribbon development along roads and which do not take into account the latter's function.

The installation of public services such as waterworks, sewers, gas, cable and so on, along the main highway network significantly encourages ribbon development along the road.

Making proper use of the main highway network instead of building local roads

The existing taxation system encourages individuals to purchase lots along the main highway network instead of along local roads and discourages the owners of big lots from proposing residential development in the concentration perimeter.

Municipalities tend to promote development along the main highway network instead of building local roads, as they are thus able to avoid road construction and maintenance costs.

This problem is especially acute in small municipalities. In particular, it has been noted that in rural population centres most construction occurs outside concentration perimeters along existing roads.

(2) Poorly designed, unsafe private driveways

Private driveways that span the entire width of the lot and poorly backfilled ditches

Commercial driveways are usually built across the entire width of lots, especially in rural areas. They allow several vehicles to simultaneously enter or leave the lot and occasionally prevent motorists from clearly seeing the edges of the road.

Moreover, backfilled ditches running the width of a property and sloping toward the road frequently result in the deterioration of the road structure, given that the road becomes slippery during freeze-up.

Analysis conducted in this respect in 1986 reveal that there were over 90 000 driveways whose width exceeded departmental guidelines. The total cost of remedial measures to bring the driveways into line with departmental standards throughout the main highway network was estimated at $67 million. This figure rose to $100 million when account was taken of various structures that did not comply with standards inside the right-of-way, e.g. stationary objects, signs and so on.[3]

TABLE 1. Proportion of non-standard driveways in relation to the prescribed width in peri urban and rural areas

Type of area	Non-standard commercial driveways	non-standard residential driveways
Peri-urban	**27%**	**26%**
Rural	**70%**	**22%**

Source: Service des politiques d'exploitation, ***Inventaire et analyse des accès sur les routes 175, 173, et 367,*** July 1995

Moreover, it is estimated that more than 150 accidents a year in Québec are caused directly or indirectly by the presence of stationary objects in the right-of-way.

Poorly organized off-street parking lots

Shortcomings are often observed with respect to off-street parking lots, i.e. badly defined lanes, parking spaces that directly abut entrance lanes, or the absence of parking lots adjacent to a number of commercial premises.

When a commercial building is too close to the road, it is hard to build a parking lot from which vehicles can drive forward onto the road. The necessary manoeuvring slows traffic and frequently causes accidents.

The presence of vehicles on display in the right-of-way and excessive commercial billposting can also reduce visibility, make it hard to read road signs and distract motorists.

A poorly informed public

In light of the procedure that municipalities now follow to grant building permits, it is hard for the ministere des Transports to adequately inform the public about access to roads

before a construction project has been completed. In the existing legal framework, a municipality may issue a building permit without the owner's having first obtained the necessary information from the department concerning the location and construction of his driveway.

Moreover, individuals may purchase and have subdivided a lot adjacent to the main highway network without first ascertaining whether it is possible to build a safe access road.

(3) The ministère des Transports disposes of inadequate means to engage in access control and must contend with political interference, the absence of penalties and so on

Shortcomings of access control

An analysis of the various factors that explain the proliferation and presence of numerous non-standard access roads reveals the shortcomings of existing control methods and the discrepancy between the current situation and departmental standards.

Pressure from elected officials and ordinary individuals all too often means that departmental officials allow exemptions. The number of exempted driveways and the easygoing attitude of the department make it virtually impossible to apply departmental standards to existing non-standard driveways.

Consequently, departmental officials tend to close their eyes and attach greater importance to the other tasks assigned to them. The number of non-standard driveways and encroachments in rights-of-way continues to rise. Departmental representatives enjoy less and less credibility among roadside owners.[4]

(4) Road use planning that engenders heavy traffic that overlooks road capacity

The main highway network, a growth centre

The analysis of the problems that explain the reduction in the serviceability of the main highway network confirms the importance of roads as a growth centre.

One phenomenon that has become more widespread since the establishment in the 1960s of the main highway network is the development of a new urban configuration in which the growth centre is an intersection or simply a fast lane connected to or circumventing the traditional central metropolitan area.

Recent decades have witnessed the establishment and development of "corridor cities" and "corridor towns".[5] In some instances, mention can even be made of "corridor regions".

Economic activity develops close to the road network rather than in relation to the existing urban environment, in a way that enhances advantages pertaining to transportation and visibility.

A cursory analysis of the operating conditions of the main highway network was conducted in each of the regions in 1993 and 1994. The information compiled reveals that significant operating problems are found on nearly 10 percent of the main highway network. Failure to take action in the short and medium term could push this figure to 20 percent.

TABLE **2. Analysis of the serviceability of the main highway network**

Administrative region	Road sections on which significant operational problems are found (km)	Road sections that recently required special attention to remain serviceable (km)	Proportion of main highway system affected (both categories)
Québec	205	200	35%
Estrie	310	465	43%
Outaouais	155	235	28%
Montérégie	885	720	53%
Gaspésie	15	80	The two regions
Bas-Saint-Larent	130	160	combined: 15%
Laurentides	110	215	The two regions
Lanaudiére	46	50	combined: 18%
Saguenay-Lac-Saint-Jean	190	155	24%
Abitibi-Témiscamingue	9 5	140	8%
Chaudike-Appalaches	125	210	14%
Côte-Nord	80	100	9%
Mauricie-Bois-Francs	145	140	12%
Total	2491km	**2 870 km**	22%

Source: MTQ, Service des politiques d'exploitation, compilation of data collected during consultations conducted in 1993 and 1994.

(5) Absence of efficient local road networks that complement the main highway network

The increase in local traffic on the main highway network is attributable to the consolidation of commercial and residential uses along the main highway network, the inefficiency of the local road network, which is wholly dependent on the main highway network, and the high number of intersections on the main highway network.

These problems in turn result from the failure to integrate land use planning into road transport planning. As a result, residential and commercial lots are dispersed along the main highway network, with direct access to the road. Moreover, the local road network has been stratified and uses have been adopted that generate heavy traffic, without taking into account the impact on the function of the main highway network.

(6) Conflicting modes of transportation (trucks, automobiles, school buses, pedestrians, cyclists, skidoos, ORVs)

The analysis carried out by the regional task forces on road sections in urban and peri-urban areas revealed major conflicts between different road users, i.e. cars, trucks, pedestrians, cyclists, school buses, skidoos and all-terrain vehicles on rights-of-way.

The foregoing problems have arisen because road development in urban and per-i-urban areas does not always satisfy the needs of pedestrians and cyclists and threatens their safety. In the absence of cycle paths, sidewalks and crosswalks in these areas, cyclists and pedestrians must share the main highway network with an array of vehicles. The problem is more acute when trucking is extensive.

Moreover, the dispersal of residential and commercial activities along a road increases school transport services and garbage collection on the main highway network. Such services create new conflicts for users and reduce mobility and safety on the roads.

(7) Absence of a broad perspective and cooperation concerning urbanization at the regional and provincial levels

Urban development affected by the presence of a main highway network

Bearing in mind the reduction in the size of households, population growth does not explain space consumption. It is the enhancement or the presence of readily accessible means of transportation that will continue to explain the extension of urban and suburban boundaries. The ministere des Affaires municipales has noted that we are a long way from mastering urbanization.

A lack of consistency between the initiatives of different government departments

Different government departments and agencies make decisions that affect urbanization and, indirectly, the function of the main highway network, without taking into account the concerns of the ministere des Transports. Mention should be made, among other things, of the location of public facilities and industrial sites, the exclusion of certain agricultural land, and grants in respect of the establishment of waterworks and sewers.

Such initiatives promote ribbon development along major transportation arteries and encourage corridor urbanization.

This problem is attributable to the absence of cooperation in urban centres and the regions, and the absence of a coherent, broad perspective of urbanization.

(8) Homes located too close to the main highway network

The proximity of homes to roads means that residents are exposed to bothersome problems such as dust, vibrations and noise. Such problems are more acute on roads where trucking is allowed.

Residents live in an unsafe environment

Individuals living beside the main highway network, especially families with children living along heavily used, high-speed freeways, feel very unsafe.

This situation is one of the major problems inherent in road corridors. The safety of children is the main source of complaints from residents and of political pressure to encourage the ministère des Transports to intervene in order to enhance the safety of residents living along roads.

The problems are attributable, among other things, to the direct access accorded residents to the main highway network, which is intended for through traffic and the transportation of goods. Moreover, the distance between homes and the main highway network is often too short or a buffer zone is lacking between major residential areas and the main highway network. Such problems are also engendered by urbanization policies which, instead of consolidating the existing urban environment, tend to encourage residential development along the main highway network.

As a result, residents living along the main highway network feel unsafe, due to conflicts between school buses and through traffic or the need for pedestrians and cyclists to share thoroughfares with automobiles and trucks.

(9) Commercial billposting policies that do not take into account the impact of billposting on road safety and visibility

Urban roads that are poorly integrated into the natural environment

During consultations on road corridor management, excessive commercial billposting was a constant concern in each region. Such billposting makes it harder for motorists to find their way and read road signs. When it appears over a long distance, it is irritating for motorists.

Furthermore, it has been noted that the gradual transformation of major traffic arteries into industrial and commercial roads has pushed into rural areas the landscape of the peripheral areas of cities and produced a new landscape that is usually poorly integrated into the natural environment.[(6)] This problem is especially apparent on peripheral roads in major urban centres and at the exits of highway exchanges.

Stopgap measures that overlook the quality of the environment

The deterioration of the environment has occurred, among other things, because of stopgap measures that are lacking in a broad overview of the quality of the environment and in which short-term considerations take precedence over long-term concerns. Economic arguments often serve as a pretext for neglect, improvisation and expediency. This attitude is not only apparent in private-sector commercial and residential projects but in major government projects such as road construction.

Rights-of-way are being used increasingly for the installation of public utilities, e.g. cable and power lines. These installations often proceed without taking into account their impact on the environment, thus contributing to the further deterioration of the environment from an aesthetic standpoint.

Moreover, the minister-e des Transports must assume the cost of moving such equipment when road improvements are carried out, at an estimated cost of $10 million.

(D) Measures proposed by the regional task forces

The summary of the problems noted and the solutions proposed by the regional task forces confirm the importance of ensuring that urbanization policies are closely geared to road transportation policies. As the majority of task forces noted, this objective can be achieved through the consolidation of the partnership between the ministere des Transports and municipal governments and the establishment of common objectives pertaining to the road network. Briefly, two measures emerge from the recommendations of the task forces:

(1) The **first** measure calls for a departmental policy accompanied by minimal standards concerning land use along roads that are included in government regulations under the authority of the ministere des Transports. However, the standards should achieve a consensus at the regional level. The restrictive nature of this measure is warranted by the urgent need to act and is intended to avoid interference by municipal and provincial politicians and discretionary decisions made by public servants, and to ensure that all Quebecers are treated fairly.

(2) The second measure also calls for a departmental policy on road corridor management, but a policy centered on access control that is closely geared to land use planning. Here, the emphasis is on broadening the responsibility of the regions. The task forces stress that a consensus should be reached at the regional level concerning the standards adopted.

The task forces are aware that individual and collective rights must be reconciled. For this reason, they recommend that the procedure for administering the departmental policy be flexible and that such a policy can be adapted to each region's needs and priorities.

Furthermore, the task forces have suggested that joint departmental-municipal committees ensure follow-up with respect to the policy, both from the standpoint of the policy's implementation and the issuing of permits governing access, construction and land subdivision.

In order to ensure that all Quebecers are treated fairly, the task forces in the Monterigie administrative region have recommended the adoption of a specific plan of action to rectify existing access roads that do not comply with highway safety standards.

FIGURE 1. ILLUSTRATION OF PROBLEMS NOTED IN RURAL AND PERI-URBAN AREAS

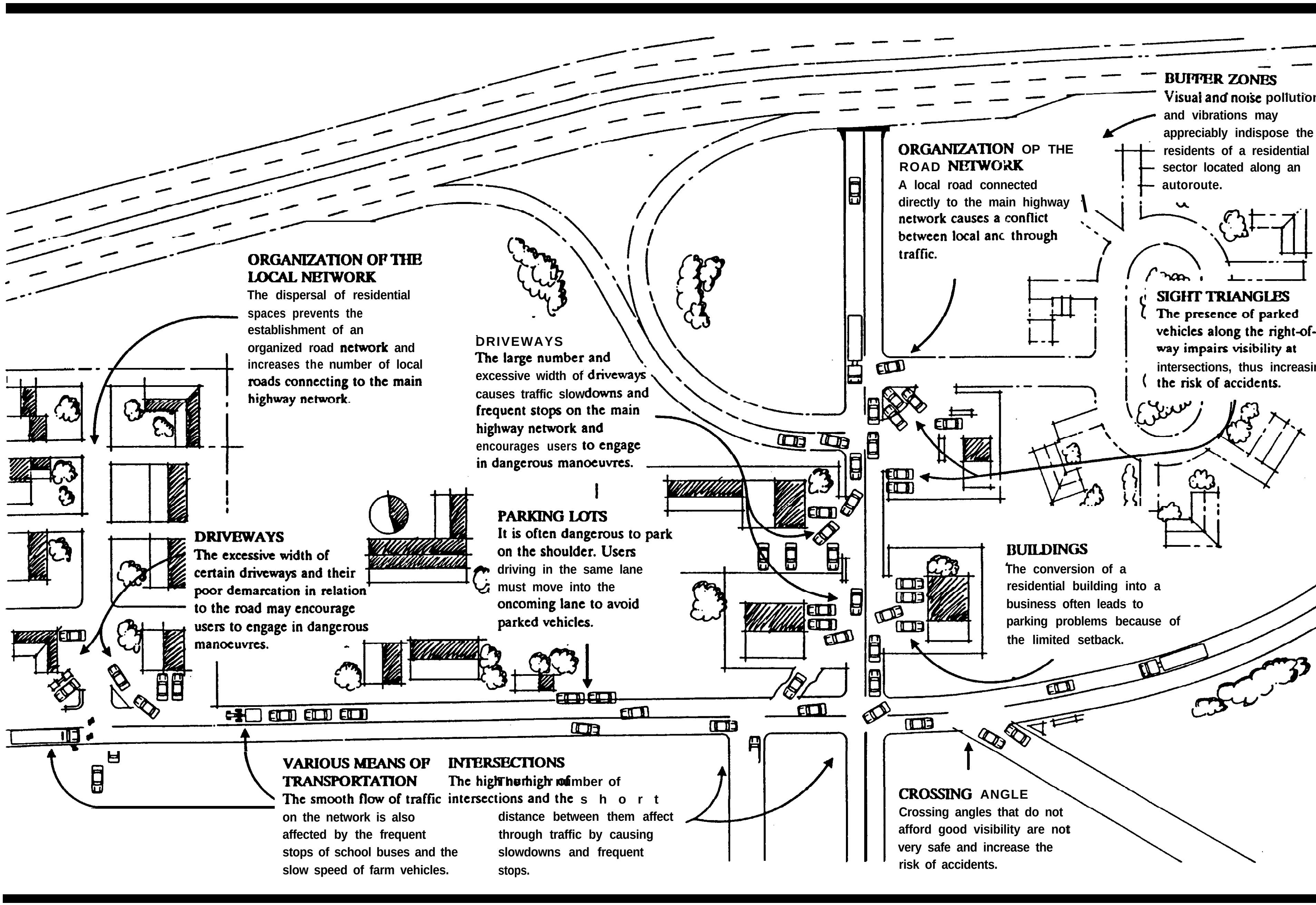
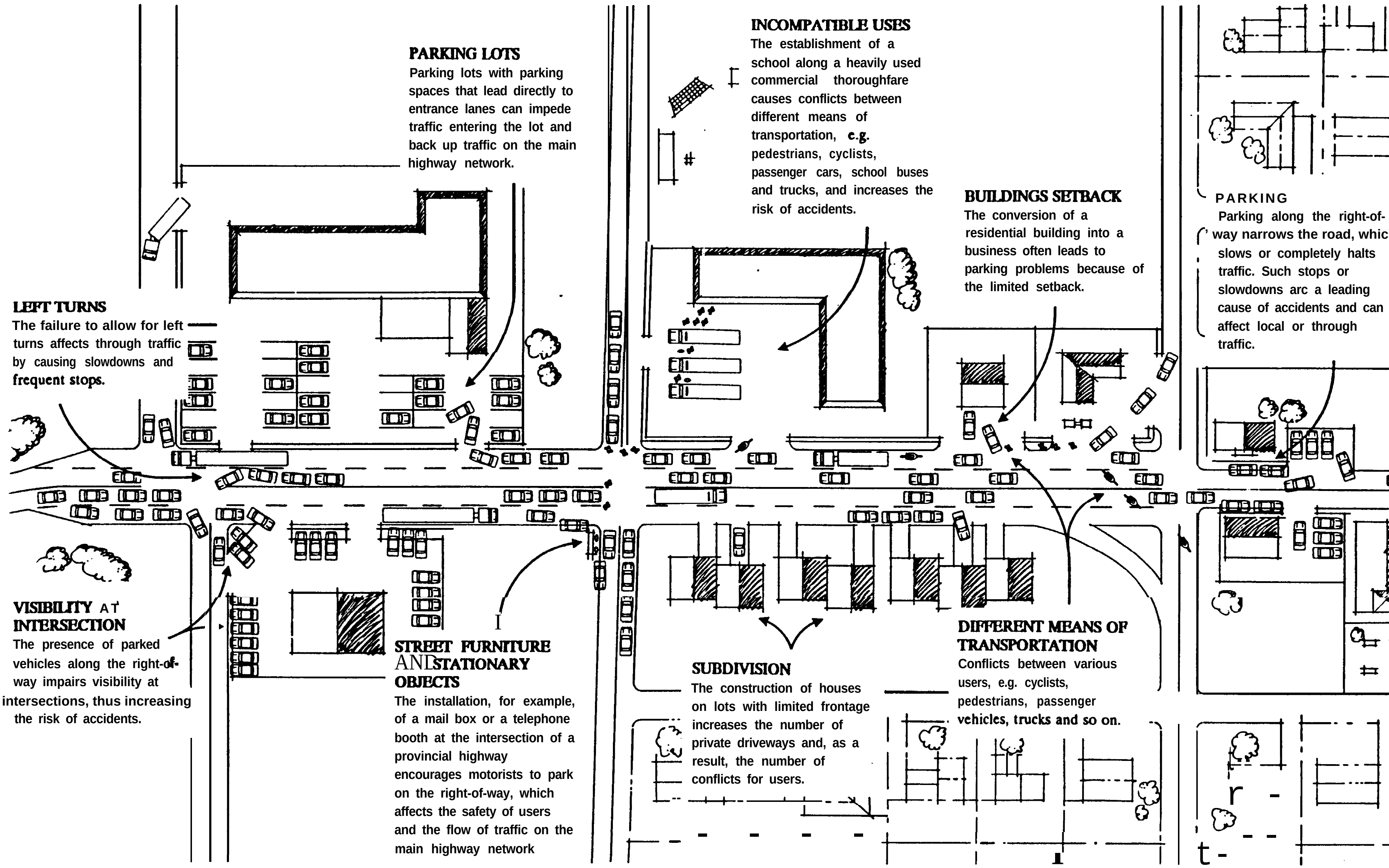


FIGURE 2. ILLUSTRATION OF PROBLEMS NOTED IN PERI-URBAN AND URBAN AREAS



IV OVERVIEW AND MAJOR TRENDS

(A) Concerns of various interveners

This chapter briefly summarizes the steps taken by the ministere des Transports since December 1992, as shown in Table 3. It reviews internal and external constraints and the concerns of various interveners with respect to the problem of access roads.

A sectorial, fragmented perspective of problems and solutions

Administrative and political officials in the ministere des Transports unreservedly support the process now under way. Indeed, the question has been part of the department's priorities since 1993. However, decision-makers in the department must take into account government policy directions with respect to the transfer of responsibilities from the government to the municipalities. The constraints mean that they are acting cautiously and that they apprehend the reaction of municipal representatives.

Road transportation specialists in the department are divided on the issue. Two trends are emerging, one in favour of the department's direct participation in the everyday process of land use planning, and the other focusing on indirect intervention by means of departmental policy directions and standards, bearing in mind that the field is the responsibility of the municipalities.

Planners in the regional county municipalities who have taken an interest in the problems raised by the ministère des Transports have been asked to submit their recommendations on the matter. Their concerns have centered primarily on the links to be established between land use planning and road transportation, and on the scope of their contribution. It should be noted that the planners' participation largely exceeded the department's expectations.

However, the representatives of these agencies clearly indicated that they were prepared to collaborate in this respect provided that the ministere des Transports clarifies its intentions and obtains the support of elected municipal officials.

Municipal engineers and urban planners are fully aware of the problem raised by the ministere des Transports. They propose what are often radical solutions and emphasize the urgency of acting because they are directly involved in urban planning. However, they are aware of the problem's technical and political complexity and tend to put responsibility on the department's shoulders and demand that the latter propose solutions as province-wide transportation falls under its jurisdiction. The municipalities will react to the solutions proposed at a later date.

Individual Quebecers are aware of factors related to development along roads and highways. A survey conducted by the ministere des Transports in 1993 reveals that Quebecers are highly receptive to the notion of control over access roads and stationary objects along roads. However, they are willing to contribute insofar as their personal interests are protected and the application of departmental standards does not affect property values or their existing privileges.

The same survey shows that **elected municipal officials** are aware of problems pertaining to access roads. However, given the difficulty of discussing the issue with residents and property developers and the importance of maintaining good relations with taxpayers, such officials tend to opt for the status quo or the adoption of low-key measures.

TABLE 3. Summary of the procedure followed since December 1992

Stage	Initiatives and proposals	Trends and attitudes
(1) **Before the department decided to act**	. With respect to **access,** the department **intervened** on a case by case basis, displayed tolerance and never concluded legal proceedings	. **Ministère des** Transports officials adopted a **sectorial** approach and regarded land use planning as an entirely municipal concern . Elected **officials were** hardly receptive to the department's concerns regarding road access and **intervened** frequently
(2) Beginning of the process (December 1992)	. The **MTQ** organized information sessions for **non-elected** municipal representatives	• Road corridor access control is a departmental priority . A province-wide process of deregulation and **regionalization** was launched . Emphasis was placed on the enhancement of the **role** of the municipalities and the consolidation of municipal autonomy
(3) **Period of reflection** (19921993)	. The **MTQ** established task forces in each administrative region	. The **ministère des Affaires** municipales made a proposal concerning decentralization . **There** was a clear determination to reduce the government's **role and** draw Quebecers closer to the decision-making process . Municipal representatives cooperated fully, to a greater extent than the department **expected**
(4) Proposals submitted by the regional task forces (1994)	**Two measures were proposed:** (1) Provincial regulation governing various facets of access roads, to be administered by the **ministère des** Transports (2) An **initiative** focusing on road corridors that gives priority to access control, implemented jointly with the municipalities	. Departmental representatives in the outlying regions recommended restrictive control over access roads and land use along main **highways** . The representatives of urban areas advocate extensive participation by the municipalities . **Central** bodies deemed it important to ensure the consistent application of standards and to establish regional guidelines in this **respect**
(5) Measure submitted to the ministère des Transports steering committee (fall of 1995)	. Provincial regulation **centred** on access control by means **of:** - the application of general **rules governing** the entire main highway network. - the elaboration of **road** corridor development plans in order to **encourage** the integration of access control into land **use** planning - the establishment of agreements **with those** municipalities wishing to assume responsibility for access control within **their** territories - **the** application of **access road fees** **Recommendation of the steering committee:** - Draw **Quebecers** closer to the **decision-**making process (single information outlet) and propose a measure that ensures broader participation by the municipalities	. The Auditor General has harshly criticized the access control effected by the **ministère des** Transports . Numerous professionals in the department and in other government departments are reluctant to change

(B) Presentation of a draft policy on road corridor access control

In order to satisfy the expectations of officials in the ministère des Transports and the department's partners, a draft policy on road corridor access control was submitted to decision-makers in the MTQ in November 1995. The twofold draft policy focuses on:

(1) province-wide regulations governing access roads applied to the main highway network and accepted by all interveners;

(2) the formulation of road corridor development plans at strategic sites in order to encourage the integration of the management of the road network into land use planning.

Many non-elected representatives of municipal bodies were disappointed by the proposal. They wanted the department to propose a broad road corridor management policy, i.e. a planning and control process centered on access roads and on all measures pertaining to rights-of-way and adjacent land.

Decision-makers in the MTQ agreed in principle to the regulation of control over access roads. However, account had to be taken of government withdrawal, in keeping with broad North American trends toward decentralization, regionalization, deregulation and the liberalization of public services.

Bearing in mind these constraints, departmental representatives requested adjustments designed to involve residents more extensively in decision-making and further involve municipal agencies, especially as regards subdivision and the use of land adjacent to the main highway network, and that regional bodies be consulted on the matter.

(C) Establishment of a province-wide consensus

(1) Symposia on road corridor access control

The ministère des Transports, in collaboration with the Association québécoise du transport et des routes (AQTR), held two symposia on road corridor management and access control in January 1996, one in Quebec City (eastern portion of the province) and the other one in Montreal (western portion of the province).

The symposia were intended for individuals and agencies concerned with the efficiency of major road transportation arteries, i.e. elected municipal officials, engineers, urban planners, regional planners, economic development agents and transportation specialists.

They were aimed at sparking debate on the question of the protection of the integrity of road infrastructures that are essential to the economic development of each region of Quebec.

Very few elected municipal officials took part in the symposia. The participants included public servants from the ministere des Transports (50%), land use planning specialists (30%) and engineers from private-sector firms (20%). Participants' comments focused on the role that the department should assume, collaboration by the municipalities, and the strategy that the department should adopt to implement the measures proposed. More specifically, the comments are summarized below.

Measures to be adopted by the ministère des Transports

- Display province-wide leadership in the realm of road transportation and obtain the powers necessary to assume its responsibilities in this respect;
- Clarify its intentions by presenting clear policy directions pertaining to road corridor access control;
- Engage in an awareness campaign aimed at elected municipal officials;
- Give priority to measures aimed at ensuring road safety, notably to the rectification of existing access roads that are deemed to be dangerous;
- Ensure that the control over access roads is exercised by a level of government that is as close as possible to

residents;

- Propose an initiative that would lead to the adoption of a government policy that integrates urban planning, the environment and road transportation.

Collaboration by regional and municipal bodies

- Consider the main highway network as a strategic tool for economic development.
- Establish road and highway safety committees in each region.
- Adapt subdivision standards to criteria governing the spacing of private driveways.
- Ensure that the issuing of construction and subdivision permits is subject to the issuing by the ministere des Transports of an access permit.

Implementation strategy proposed by symposia participants

Bearing in mind the political constraints related to control over access roads, the participants recommended that control measures pertaining to access roads be implemented step by step. Specifically, they suggested that:

- the ministere des Transports oversee the overall access road control process, i.e. planning, location, development and construction;
- awareness be increased in the municipalities by means of pilot projects;
- municipal bodies alone exercise control over access roads on the main highway network, at the request of the municipalities or the regional county municipalities.

(2) Consultation with the 14 regional task forces

The members of the 14 regional task forces were asked to submit their comments on the proposed policy presented in November 1995. The regional representatives emphasized:

(a) the importance of closely linking restrictive control over access roads and land use planning;

(b) the need to act quickly in order to ensure better planning of future access roads and to rectify existing private driveways that pose a threat to highway safety;

(c) the need to formulate access road development plans at strategic sites;

(d) the need to regulate provisions governing the development and construction of access roads;

(e) the urgent need to inform elected municipal officials and quickly involve them in the initiative under way.

V CONCLUSION

Initiatives carried out since 1993 by municipal bodies and departmental officials and research on Canadian and American practices in the realm of road corridor access control provide a clear picture of the initiatives required to achieve greater efficiency and safety on the main highway network.

An analysis of the problem has led all of the interveners to conclude that rigorous management of access roads will significantly contribute to the maintaining of an efficient, safe main highway network. However, strictly sectorial intervention may have only a limited effect as it does not allow for the harmonization of urban planning and the management of the main highway network.

Moreover, in light of the government's withdrawal, the liberalization of public services and the short-term concerns of elected municipal officials, control over access roads will quickly be perceived as an obstacle to economic development. Such a perception will be all the more acute unless the municipalities integrate the question of road transportation into the management of their territory.

Given the issue's complexity and the constraints enumerated earlier, it should be noted that many decision-makers are tending to opt for cautious, gradual measures. Our analysis also reveals that decision-makers will first take account of the entire range of constraints facing them, not just prescriptive or technical factors, before they accept or reject the measures proposed with respect to access roads.

Such constraints will be more important than we anticipated. For this reason, we have indicated nine conditions to ensure the support of decision-makers regarding control over access roads and to encourage the municipalities to take into account road transportation in conjunction with the management of their territory. Five of the conditions focus on control over access roads, and four on the implementation strategy to be adopted.

TABLE 4. Conditions for the success of the initiative under way

(A) Control over access roads

1. The adoption of an approach that avoids blanket standards and which allows for each situation to be taken into account;
2. The clarification of departmental objectives to ensure that the anticipated results are fully understood and to prevent the objectives from being interpreted as so much wishful thinking.
3. The support of departmental management to ensure the necessary leadership and obtain a mandate that encompasses the entire organization;
4. The simplification of the process and the measures proposed to encourage concerned parties to focus on the essential elements and quickly achieve results;
5. Emphasis on minimal standards centered on road safety.

(B) Implementation strategy

6. The implementation of measures in stages to allow each of the agencies involved, i.e. elected officials and public servants, to adapt to change;
7. The exchange of information, the sharing of tips and successful initiatives to bolster staff confidence as regards the measures to be adopted (municipalities assistance and the anticipated support,
8. The training of employees to enable them to offer the municipalities assistance and the anticipated support;
9. An awareness of the attendant costs, bearing in mind that th return on investment is very high.

Technical standards pertaining to the managing of access roads should be subject to a consensus among traffic and road safety specialists, not elected officials. Ultimately, it would not be necessary to regulate such standards, which could be compared with standards *in the National Building Code* in that they are essentially intended to ensure public safety.

Management of urban planning

In light of the government's withdrawal and the search for greater autonomy by the regions and the municipalities, reflection on the question of the management of urban planning can hardly be initiated by an agency devoted to road transportation, at least in the short term. However, rigorous management of access to the main highway network is a concrete step, one that will encourage municipal elected officials to better understand the consequences of their decisions on province-wide road transportation.

This awareness should lead all of the agencies concerned to devise a broader perspective of the development of their territory and to understand the need to incorporate the management of urban planning into the management of access roads linked to the main highway network.

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3. Gouvemement du Quebec, ministère des Transports, *Protection de l 'intégrité des infrastructures routières, document sommaire, 1986, page* iv.

4. Gouvemement du Québec, ministère des Transports, *Gestion des demandes de fermeture de fossés et infractions,* Comité sur les entrées privies, February 1992, p. 5.

5. These terms refer to ribbon development that follows the axis of one or more main highway networks.

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Signal Spacing - A Key To Access Management

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ABSTRACT

The spacing of traffic signals in terms offrequency and uniformity governs the performance of urban and suburban highways. This paper shows how traffic signal spacing impacts speeds and sets forth the salient access management implications. It illustrates how speeds decrease as signal density (signals per mile) increases for various levels of traffic flow. It analyses time-space relationships that further underscore the need for uniform and widely spaced signals. Finally, it emphasizes the need to incorporate signal spacing (or bandwidth) requirements in to access management programs and procedures.

INTRODUCTION

The spacing of traffic signals-in terms of their frequency and uniformity-governs the performance of urban and suburban highways. Signals account for most of the delay that is experienced by motorists. They constrain capacity during peak travel periods with attendant queuing and spill back. They delay vehicles during both peak and off-peak periods wherever they are randomly located, ineffectively coordinated or improperly timed.

This paper quantifies the travel time impacts of traffic signals on arterial traffic flow and describes the resulting access management implications. It shows how traffic signal densities and traffic volumes influence speeds. It describes how time-space patterns and through-bandwidths are reduced by improperly placed signals. Finally, it sets forth the salient access management planning and design implications.

Signal Density and Speeds

The reductive effects of traffic signal density on travel speeds have been explored in a number of studies over the past 30 years.

New York State. A 1967 study of 77 street sections in New York State by Guinn (1) found that signal density was the most important parameter affecting speeds on urban streets. Three parameters were suggested for inclusion in subsequent analyses: posted speed limit, traffic signal density, and traffic volume per lane.

Seminole Countv. Florida. A 1992 study of 17 two-lane roads in Seminole County, Florida by Ewing (2) suggested a simple linear model for average travel speed based on two independent variables, peak hour traffic volume and signal density (Equation 1). The model included 68 observations of morning and evening peak hour conditions in both directions of travel and produced an R^2 of 0.55. (Thus, the model explained about half of the variation). The resulting equation was:

$$\begin{matrix}\text{Average}\\ \text{Travel Speed}\\ \text{(mph)}\end{matrix} = 44.7 - \left(0.0087 \times \begin{matrix}\text{Peak-Hour}\\ \text{Traffic Volume}\end{matrix}\right) - \left[7.74 \times \begin{matrix}\text{Signal Density}\\ \text{(Signals per mile)}\end{matrix}\right] \quad (1)$$

Ewing believed that a better predictive model could be developed using more variables like the green-per-cycle ratio, arrival type, and percentage of turns from exclusive lanes.

New Haven. Connecticut. A 1982 study of travel times in the New Haven, Connecticut area found that signal density had a major influence on speeds (3). Signal density alone explained 50 percent of the variance while the number of vehicles per lane per hour alone explained only 4 percent of the variance. The multiple correlation coefficient between speed and these variables was 0.7 1, the resulting equation was:

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$$\begin{array}{c}\textit{Peak-Hour}\\ \textit{Travel Speed}\\ \textit{(mph)}\end{array} - 34.35 - \left(0.006 \times \begin{array}{c}\textit{Peak-Hour}\\ \textit{Lane Volume}\end{array}\right) - 2.265 \left(\begin{array}{c}\textit{Signal Density}\\ \textit{(Signals per mile)}\end{array}\right) \qquad (2)$$

Assuming that 8 percent of the daily traffic per lane travels in the peak-hour results in the following equation.

$$\begin{array}{c}\textit{Peak-Hour}\\ \textit{Travel Speed}\\ \textit{(mph)}\end{array} = 34.35 - 0.48\ (ADT/Lane\ (000's)) - 2.265 \left(\begin{array}{c}\textit{Signal Density}\\ \textit{(Signals per Mile)}\end{array}\right) \qquad \mathbf{(3)}$$

Multi-City Analysis. Linear regression equations were also derived as part of the NCHRP 7- 13 project, Quantifying Congestion (4) (1995) for Class I and Class II and III arterials. The 1994 Highway Capacity Manual (5) defines arterial class based on street design characteristics, free-flow speed, speed limit, access frequency, and signal density. Class I arterials are typically high-speed suburban arterials, while Class II and III arterials are intermediate- to low-speed facilities in downtown or urban fringe areas.

The resulting equations were:

Class I Arterials

$$\begin{array}{c}\textit{Average Peak}\\ \textit{our Speed (kph)}\end{array} = 65.4 - 0.32\ (ADT/Lane,\ 1000s) - 6.92 \left[\begin{array}{c}\textit{Signal Density}\\ \textit{(signals per km}\end{array}\right. \qquad \mathbf{(4a)}$$

$$\begin{array}{c}\textit{Average Peak}\\ \textit{our Speed (mph)}\end{array} = 40.6 - 0.20\ (ADT/Lane,\ 1000s) - 2.67 \left|\begin{array}{c}\textit{Signal Density}\\ \textit{(signals per mile}\end{array}\right. \qquad \mathbf{(4b)}$$

Statistics: n = 300 segments, R^2 = 0.35, root mean square error = 6.59, c.v. = 20%

Class II and III Arterials

$$\begin{array}{c}\textit{Average Peak}\\ \textit{Hour Speed (kph)}\end{array} = 58.6 - 0.48\ (ADT/Lane,\ 1000s) - 4.04 \left[\begin{array}{c}\textit{Signal Density}\\ \textit{(signals per km)}\end{array}\right] \qquad \mathbf{(5a)}$$

$$\begin{array}{c}\textit{Average Peak}\\ \textit{our Speed (mph)}\end{array} = 36.4 - 0.30\ (ADT/Lane,\ 1000s) - 1.56 \left[\begin{array}{c}\textit{Signal Density}\\ \textit{(signals per mile}\end{array}\right. \qquad \mathbf{(5b)}$$

Statistics: n = 618 segments, R^2 = 0.28, root mean square error = 7.39, c.v. = 25%

The New Haven and NCHRP data suggest a 2 to 2.5 mph drop in speeds for every traffic signal added to a mile of street, and up to a 0.5 mile drop in speeds for every 1000 vehicles per lane per day increase in daily of street, and up to a 0.5 mile drop in speeds for every 1000 vehicles per lane per day increase in daily traffic. The low R^2 in the NCHRP data limits their use as a predictive tool and suggests that a non-linear model may be more appropriate.

Simulation Studies. Recent simulation studies indicate that average travel speeds decline in a non-linear manner as the spacing between traffic signals decreases and as the traffic volume per lane increases. Margiotta et al. (6), for example, used NETSIM to simulate the effects of traffic signal density and volume-to-capacity ratios on average travel speed. Figure 1 shows the simulation results for a 50 mph (83 kph) free-flow speed, fixed-time signals and left turn bays. Signal density has the greatest effect on travel speed, with a sharp drop from 0.5 to 3 signals per mile. The simulations show a growing effect of traffic volumes as the volume-to-capacity ratio approaches 1.0.

Suggested Relationships. Curves for estimating peak hour speeds on arterial streets at different daily traffic volume levels and signal densities are shown in Figures 2 and 3 for Class I and Class II-III arterials respectively. The Class I arterials assume a capacity of 10,000 vehicles per lane per day and the Class II-III curves assume a capacity of 8,000 vehicles per day.

These curves represent a synthesis of the NCHRP, New Haven, and Margiotta relationships and, therefore, differ from the individual curves or equations. They provide results that are intuitively correct and that remove some of the anomalies in the individual data sets or the constraints posed by linear regression analysis. They indicate the following:

- Traffic signal density has a greater effect than traffic volumes on reducing speeds when traffic volumes are less than capacity (i.e., 8,000 vehicles per lane per day on Class II-III arterials and 10,000 vehicles per lane per day on Class I arterials).
- When traffic volumes approach, or exceed capacity, there is a considerable drop in speeds at all traffic signal densities.
- Signals have their greatest reductive effect when they are introduced into free-flowing or lightly-interrupted traffic (from 0 to 3 signals per mile)(0 to 2 signals per kilometer).
- Signal progression can be taken into account by viewing the signal density in terms of "effective" signals per mile. The effective signals per mile equals the product of (1 -bandwidth/cycle length) and the signals per mile. For example, a 40 percent through band would result in 60 percent of the signal density associated with little or no progression.

A further analysis, in process, suggests that travel times and speeds obtained from the curves can be estimated by the following equation:

$$T = T_o[1+e]^a[1+(v/c)^4]^b \quad (6)$$

where:

T_o = freeflow travel time in minutes per mile

T = actual travel time in minutes per mile

e = effective signals per mile

v/c = volume-to-capacity ratio

$a = 0.3$

$b = 0.7$

The actual speed in miles per hour is $\frac{60}{T}$.

The curves and equation provide reasonable approximations for planning and policy purposes. They can be used to assess the impact of adding traffic volumes and/or traffic signals to a given roadway. Where existing travel time data is available, the curves can be used in conjunction with the actual observations as shown in Equation 7.

$$\text{Future Estimate} = \text{Existing Measurement} \times \frac{\text{Future Surrogate (from curves)}}{\text{Existing Surrogate (from curves)}} \tag{7}$$

Time-Space Analyses

Time-space analyses clearly indicate the desirability of long and uniform signal spacings in achieving efficient traffic signal progression at desired travel speeds. The effects of signal cycle length and spacing on progressive speeds in both directions of travel have been well established. Speeds increase directly as signal spacing increases and inversely as cycle length increases. Thus, long cycle lengths combined with high speeds require long distances between signals while shorter cycle lengths and lower speeds allow closer spacing of signals.

Basic Relationships. The basic equations are as follows:

$$V = \frac{0.681S}{C} \text{ for simultaneous signals} \tag{8a}$$

and

$$V = \frac{1.362S}{C} \text{ for alternating signals} \tag{8b}$$

where S = signal spacing in feet

C = cycle length in seconds

V = speed in mph

$$V' = \frac{3.6M}{C} \text{ for simultaneous signals} \tag{9a}$$

In metric units these formulas become

$$V' = \frac{7.2M}{C} \text{ for alternating signals} \tag{9b}$$

where M = spacing in meters

C = cycle length in seconds

V' = speed in km/hr

Table 1 presents required spacings for various speeds and cycle lengths. The following findings are relevant.

Table 1. Optimum Signal Spacing as a Function of Speed and Cycle Length

Cycle Length (seconds)	Speed, mph						
	25	30	35	40	45	50	55
	Feet						
60	1,100	1,320	1,540	1,760	1,980	2,200	2,420
70	1,280	1,540	1,800	2,060	2,310	2,590	2,830
80	1,470	1,760	2,060	2,350	2,640	2,940	3,230
90	1,650	1,980	2,310	2,640	2,970	3,300	3,630
100	1,840	2,200	2,570	2,940	3,300	3,670	4,040
110	2,020	2,420	2,830	3,230	3,630	4,040	4,440
120	2,200	2,640	3,080	3,520	3,960	4,400	4,840
Cycle Length (seconds)	Speed k/hr						
	40	48	56	64	72	80	88
	Meters						
60	330	400	470	530	600	670	730
70	390	470	540	620	700	780	860
80	440	530	620	710	800	890	980
90	500	600	700	800	900	1,000	1,100
100	560	670	780	890	1,000	1,110	1,220
110	610	730	860	980	1,100	1,220	1,340
120	670	800	930	1,070	1,200	1,330	1,470

- Spacings that are less than l/4 mile (400 m)-i.e., more than four signals per mile-result in progressive speeds that are too low for urban conditions (except perhaps for central business districts).
- Signals spaced at about l/4 mile (1,320 feet or 400 m) can provide progressive speeds from 26 to 30 mph at cycle lengths from 60 to 70 seconds. These speeds and cycle lengths are acceptable in cities where traffic volumes are spread over several streets and where two-phase signal operations dominate.
- Longer signal spacings are necessary along many suburban highways where both traffic volumes and speeds increase. Longer cycle lengths are commonly used to increase capacity and to provide protected phases for left turns. Cycle lengths of 80 to 120 seconds are common, especially during peak periods, they require half mile signal spacings (800 m)-i.e., 2 signals per mile-to maintain progressive speeds of up to 45 mph (7).
- Cycle lengths that exceed 120 seconds should be avoided since they result in progressive speeds under 25 mph, even with half-mile spacings between signals. Moreover, when green times exceed 60 seconds, there is a 10% decline in saturation flows.

Through-Band Impacts Uniform or near uniform spacing of signals is essential. A uniform spacing, with signals placed at optimum locations from a time-space perspective, allows through bands that are equal to the green time. As signals are placed away from the optimum locations, there is a corresponding reduction in the through bandwidth-the time during which progression is maintained. This is apparent from the time space diagram shown in Figure 4 (8). Placing a signal at point "C"-midway between signals at points "A" and "B"-allows a full through band in both travel directions. If the signals are located elsewhere, the through band is reduced. If the signals are located at point "X" or "Y," there is a corresponding reduction in the bandwidth. When the signals are located midway between the optimum location and an existing signal (point "Y"), the bandwidth is cut in half Some, but not all, of the loss in bandwidth can be regained by increasing the green time at locations XandY.

Figure 5 shows how the through bandwidth reduces when signals are placed irregularly. (It assumes the same green time at each location). The application of this chart is straightforward. For example, an 80-second cycle might allow a through band of 40 seconds-about 20 vehicles per lane per cycle or 900 vplph. A signal at location "X" would result in a through band of 30 seconds-about 15 vehicles per lane per cycle or 675 vplph. Similarly, a signal at location "Y" would result in a through band of 20 seconds-about 10 vehicles per lane per cycle or 450 vehicles per lane per hour. Thus, if the actual traffic volume is 700 vehicles per lane per hour, these vehicles would be easily accommodated within the through band with properly spaced signals. However, at location "X", 25 vehicles (4 percent) would travel outside of the band, at location "Y", 250 vehicles (36 percent) would travel outside of the band resulting in a breakdown in the overall progression.

A further analyses of the delays resulting from reducing the through band is summarized in Table 2 (9). The delays were estimated by Staniewicz (9) based upon a 30 mph progressive speed, an unimpeded arrival by the first vehicle in the platoon, and 2.1 second arrival and departure headways.

Table 2. Illustrative Delays when Traffic Demand Exceeds Bandwidth Capacity

Volume Veh/Cycle/Lane	Volume-to-Capacity Ratio	Capacity of Through Band Veh/Cycle/Lane			
		3	6	9	12
3	.25	0	0	0	0
6	.50	I7	0	0	0
9	.75	23	12	0	0
12"	1.00	26	17	9	0

* Capacity assumed at 12 vehicles per cycle based on 29 seconds green per 60 second cycle. First vehicle arrives unimpeded. 2.1 arrival and departure headways. Base progressive speed, 30 mph.

Source: Staniewicz, J. M. and Levinson, H. S. "Signal Delay with Platoon Arrivals." *Transportation Research Board 1005.* Transportation Research Board, National Research Council, 1995.

The table indicates that delays would result whenever the approach volumes exceed the number of vehicles that can be accommodated in the through band. The volume-to-band capacity ratio appears more significant than the actual v/c ratio in influencing delays. For example, a volume of 9 vehicles per cycle would result in a 12 second delay when the band capacity is 6, while a volume of 6 vehicles per cycle would result in a 17 second delay when the through band is 3 vehicles per cycle. Thus, the data underscore the need for preserving the through band, since its reduction would increase delays even at moderate traffic volumes.

Access Management Implications

Traffic signal spacing is indeed an important key to effective access management. Wide and uniform spacings ensure continuous progressive movement at desired speeds thereby preserving both the quality of flow and safety along streets and highways.

This is why signal spacing requirements are an integral part of access management codes. The Colorado State Highway Access Code, for example, calls for a standard l/2 mile (approximately 0.8 km) spacing between signalized intersections, and where this cannot be achieved, the bandwidth for through traffic becomes the criteria for allowing signals. The Florida Code specifies minimum signal spacings of l/4 to l/2 mile (approximately 0.4 to 0.8 km) depending upon the designated highway access class. The New Jersey Code establishes minimum bandwidths for each type of highway. Similar guidelines could be established by states and other public agencies that are planning to establish codes.

States, counties, and cities that do not have comprehensive access management codes should set signal spacing criteria. A half-mile signal spacing along major suburban arterials is a desirable objective. Signals could be provided at closer intervals where only one direction of travel is involved. The half-mile spacing criteria also adapts well to suburban road spacing requirements-since wider spacings of major roads unduly concentrate turning movements and may adversely affect capacity.

Obviously, there are many situations where closer signal spacings may be necessary. In such cases, progression could be preserved by establishing minimum "through-band" width requirements for various types of arterials. Where signals must be provided at locations that do not "fit" in the time space patterns, additional green time is necessary to ensure adequate through band width. This leaves less green time for the intersecting street or driveway. Longer cycles usually provide better band-width efficiency than shorter cycles for these situations.

Through-band width requirements should be incorporated into traffic impact study procedures. In this way, traffic signal progression would become as significant a factor as volume-to-capacity ratios and service levels in assessing land development access along public highways.

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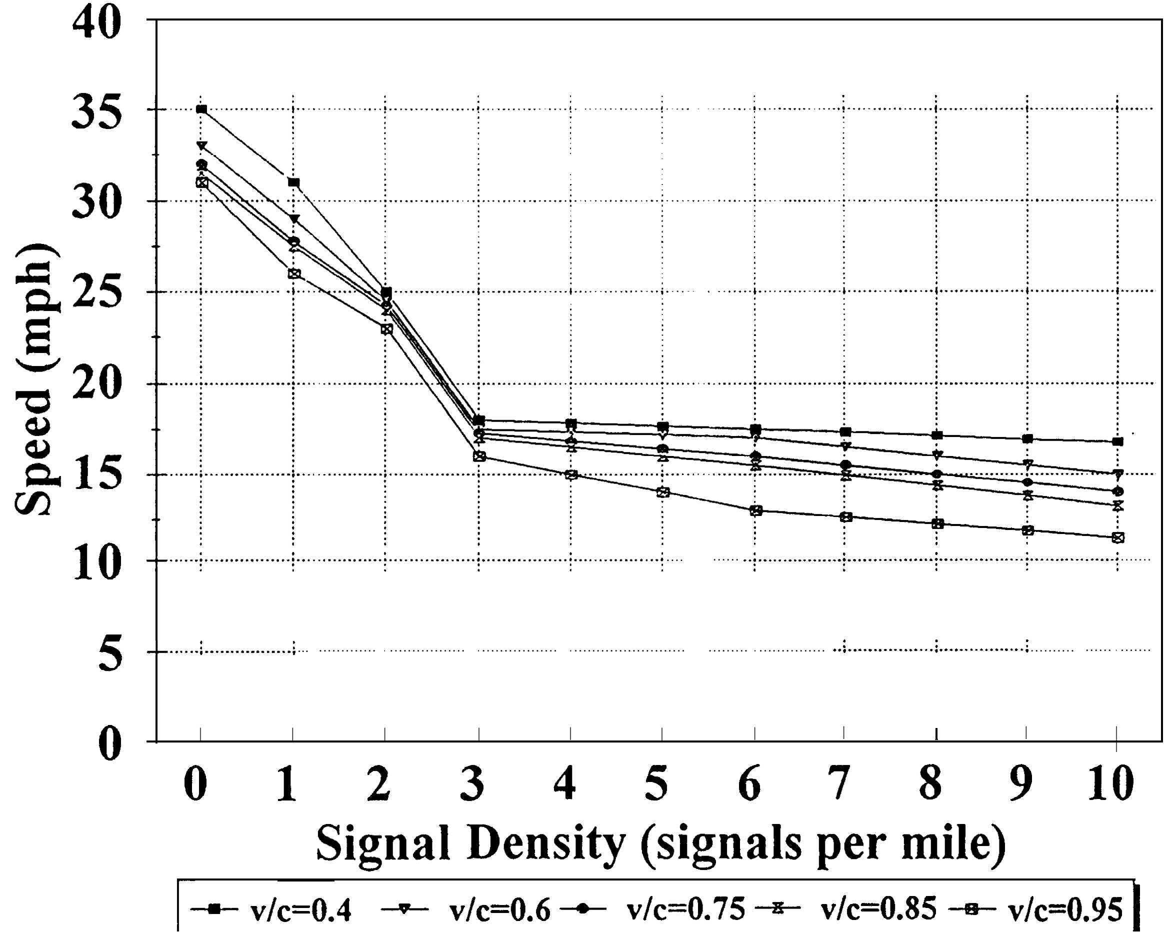
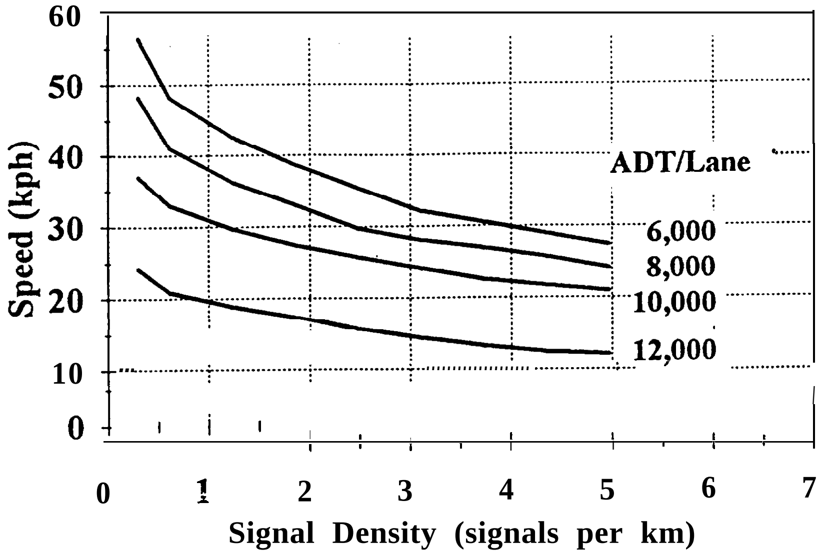


Figure 1. Simulated Effects (TRAF-NETSIM) of Signal Density and Traffic Volumes on Arterial Speeds



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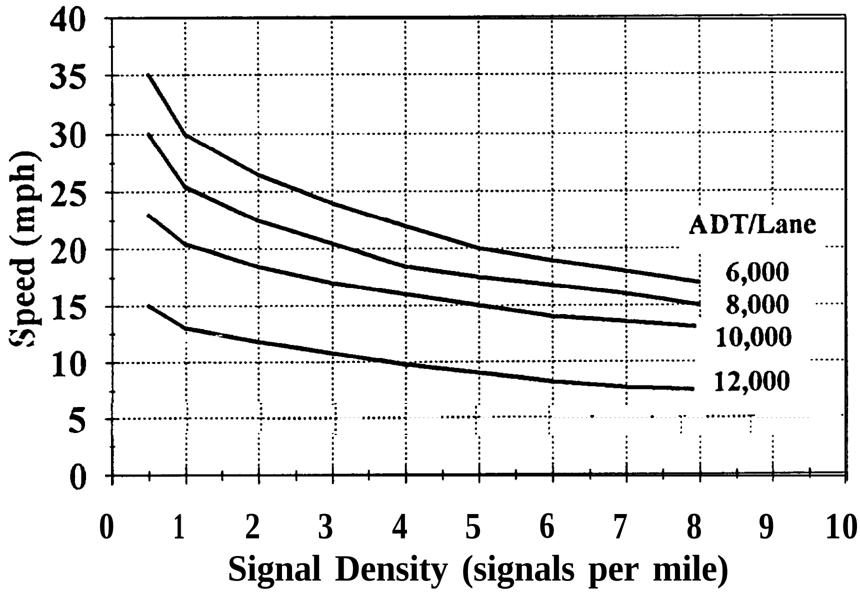
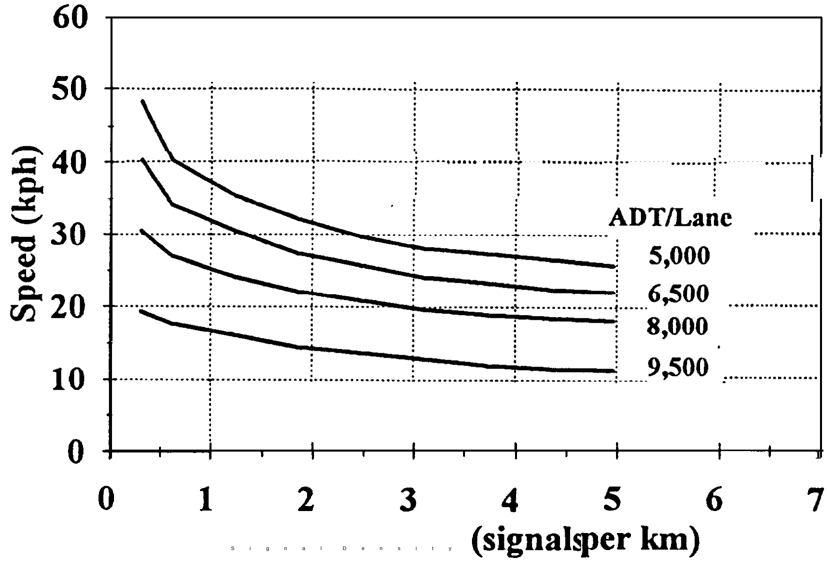


U.S. Customary Units

Figure 2. Suggested Speed Estimation Curves for Class I Arterials



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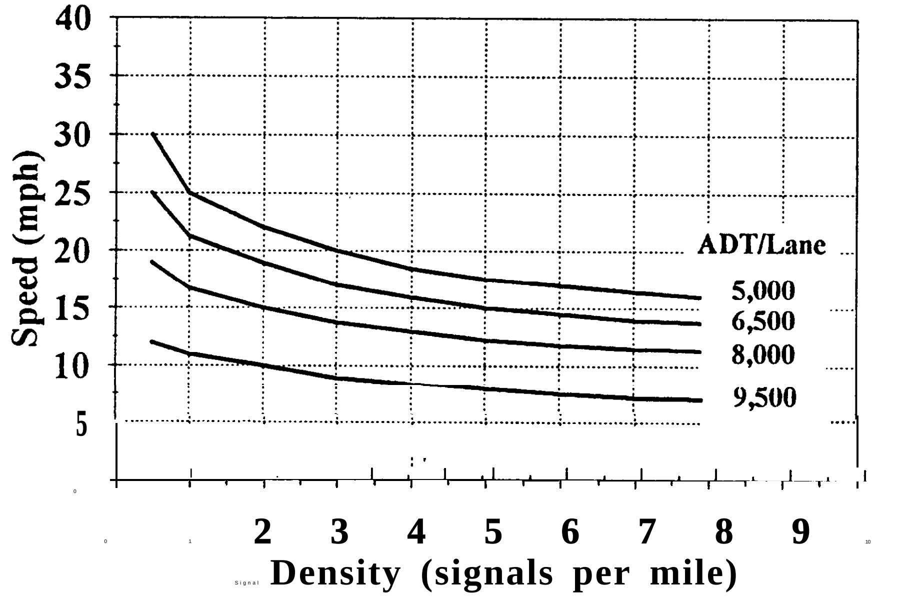
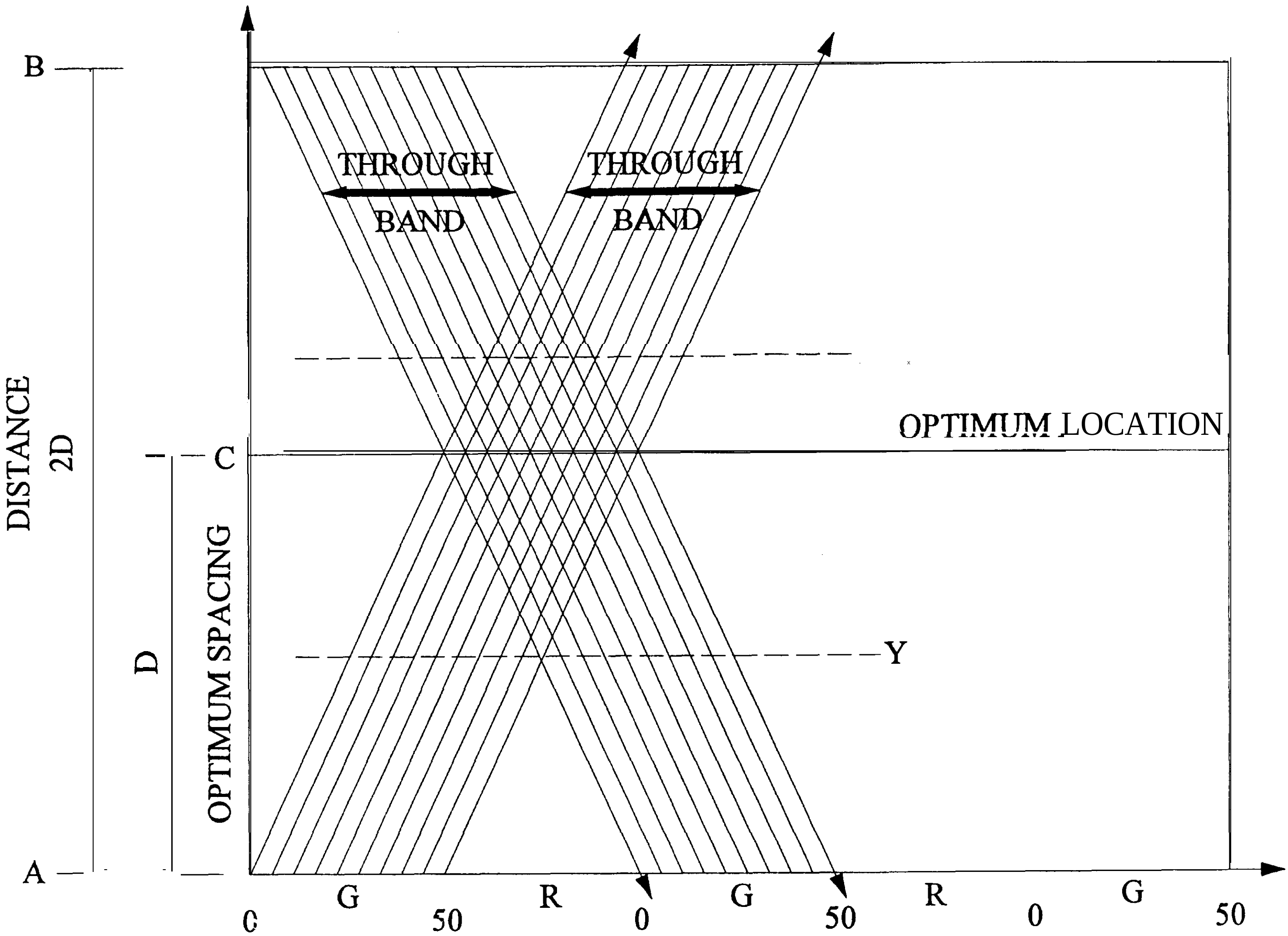


U.S. Customary Units

Figure 3. Suggested Speed Estimation Curves for Class II and III Arterials



Source: Reference 8

Figure 4. Time - Space Pattern

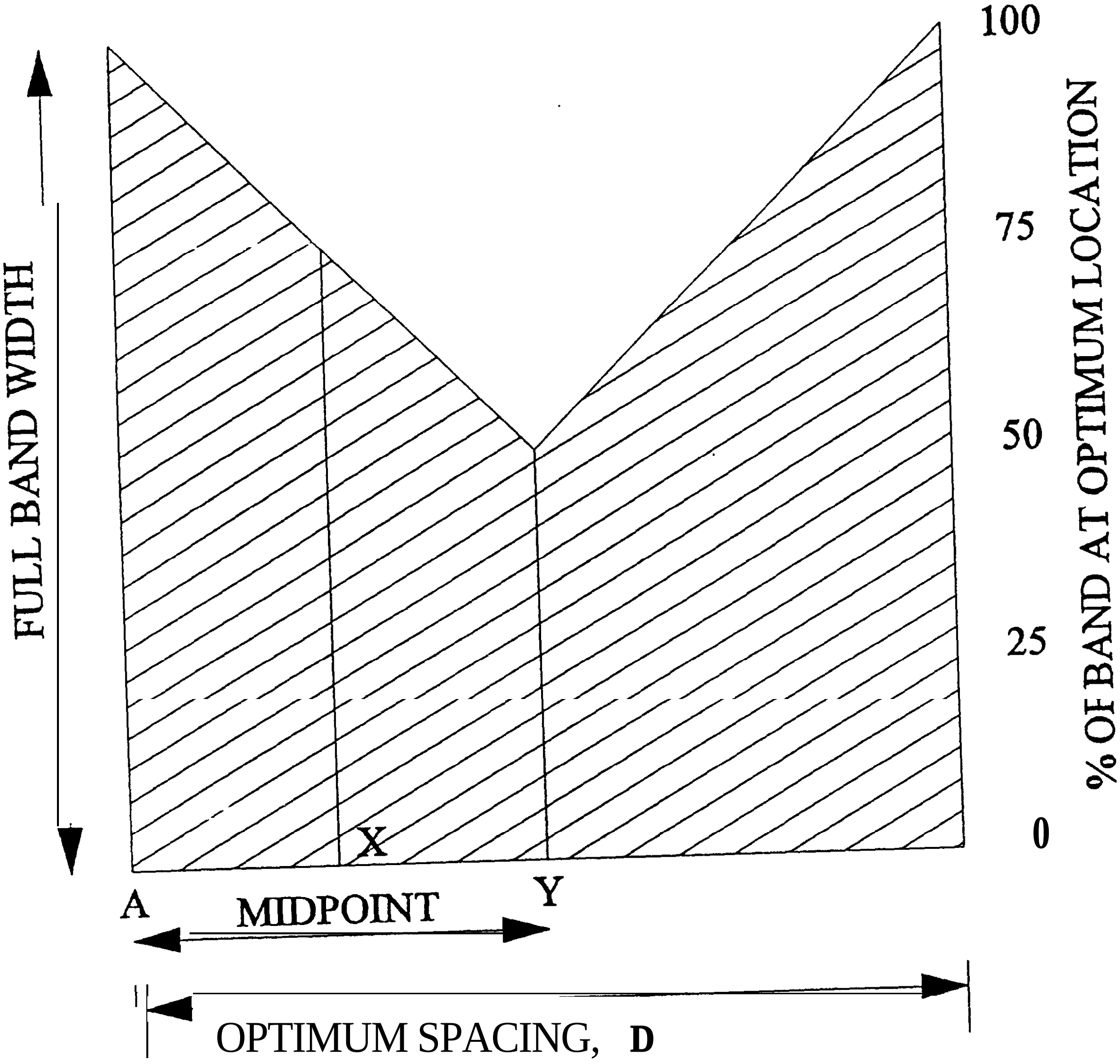


Figure 5. Effect of Non Optimum Spacing
on Through Band Width

Access Management Warrant In Traffic Signal Justification

Jan Thakker, Florida Department of Transportation, Fort Lauderdale
Freddie Vargas, Florida Department of Transportation, Fort Lauderdale

ABSTRACT

The purpose of this paper is to advance consideration of access management issues right at the time of conducting signal warrant analysis to determine the need for a traffic signal. Specifically, while it may be premature, this paper attempts to propose a signal warrant that would require fulfillment of certain access management quidelines for establishing the need for, or more importantly, against the installation of a traffic signal at an intersection on a given (access management) class of roadway. Various real-world situations are examined and discussed along with case studies to illustrate the need for considering access management issues as part of the signal warrant analysis.

In urban areas where traffic volumes are increasing rapidly, it is becoming easier to satisfy one or more traffic signal warrants. As a result, the number ofpotential traffic signals has been increasing at a substantial rate. This increase in the number of traffic signals has a negative impact on the arterial's operation. As the number of traffic signals increases, the speeds and capacity of the highway decrease, congestion develops , and accident rate of the arterial increases.

This functional deterioration of the arterial resulting from installation of too many signals must be monitored and checked. Application of appropriate access management principles and guidelines, may provide opportunities for improving the operation , and thereby maintaining the functional integrity of the arterial. For example, the spacing of intersections, signalized or unsignalized, may be controlled. Once the decision is made to signalize an intersection, an effort may be made to identify the signal parameters, such as effective green band width, that would maintain virtually the same operation speeds.

As possible signal warrant form access management point of view, considerations may be given to whether other access management measures, such as directional median opening that many restrict through and left left turn movement, were tried. Once signals, and the resulting band width and the operating speed of the corridor is acceptable from the standpoint of maintaining its operation at the original level.

In retrospect, when the operation of an arterial corridor is reviewed, the location of signalized intersections and the resulting band width and operation speed become "givens". Considering the large number of signalized intersections and their close spacing on many urban arterials, the application of access management guidelines at the early stage of determination for signal installation would have made a difference that may result in improved arterial operation. This paper makes an effort, among other things, in emphasizing that point.

INTRODUCTION

(No Formal Paper Submitted)

Spacing, Timing and Operational Interference Between Signalized Intersections

Lee Han, University of Tennessee, Knoxville

ABSTRACT

(No Abstract Submitted)

PRESENTATION

(No Formal Paper Presented)

Questions and Answers
Signal Spacing

Signal Density - A Key to Access Development
Access Management Warrant in Traffic Signal Justification
Spacing, Timing, and Operational Interference Between Signalized Intersections

Question 1: Did your analysis consider eliminating left turns at intersections so that all conflicting movements would be U-Turns?

Freddie Vargas: The analysis did not consider this as an option for one main reason. There is heavy residential traffic on both sides of the road, and all the neighborhoods feel that they are entitled to direct access.

Question 2: Does the state take into account the different types of accidents that may occur?

Freddie Vargas: Yes, our studies look mainly at rear-end crashes because these types of accidents are often caused by a lack of progression or synchronization, or by the improper location of signals. We attempt to isolate correctable crashes, in order to establish correlations.

Question 3: What can be done in situations where the minimum cycle length is limited by pedestrian crossings?

Lee Han: In these situations the minimum cycle length is limited by the minimum walking time required by pedestrians, but it is possible to alter the offset.

Question 4: Do you make the assumption that the cycle lengths are changed at various times during the day?

Lee Han: You may not have to change the cycle length under congested and non-congested conditions, but you may have to change the offset.

V Abstracts/Papers - Session 5

5A - Access Planning And Development

Moderator: Jerry Cluck, Urbitran Associates, New York

Development And Administration Of An Access Management Program For Local Government

The Challenges (And Early Successes) Of A Town Initiated Access Management Retrofit Program On Two State Highways

Access Management By Consensus, A Success Story

5T - Access Spacing

TRB Committee On Operations Effects Of Geometrics
Moderator: John Mason, Pennsylvania State University

Guidelines For Commercial Driveway Spacing On Urban And Suburban Arterial Roads

Accidents And Access Density In Oregon

Comparison Of Delay And Accidents On Three Roadway Access Designs In A Small City

Development and Administration of an Access Management Program for a Local Government

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A B S T R A C T

The Town of Parker, Colorado, is a rapidly grqwing residential community south of the Denver Metropolitan Area. Residents of Parker enjoys a rural atmosphere with a IO minute commute to the Denver Technological Center and a 30-40 minute commute to downtown Denver. This combination has made Parker a very desirable place to live resulting in extraordinary growth in population, land area, annexation requests, building permit applications, and infrastructure needs.

In order to ***manage*** *this growth with a vision, the Town's Planning and Public Works staff have developed several documents which form a comprehensive access management program. A process has been developed to administrate the access management program through review of* ***all development*** *proposals and negotiation of variance requests.*

The guiding elements of the program ***include:***

- *The Transportation Element of the Master Plan*
- *The Mainstreet Access Plan*
- *Functional classifications for streets*
- *Access standards for each functional classification*
- *Traffic Study Guidelines*
- *Subdivision Agreement standards which define access and financial commitments for each development*

The cornerstone of the administrative process is regular coordination between the Town's Planning Department, Public Works Department, the Parker Water and Sanitation District, the Parker Fire District, and consultants hired to supplement the Town 's staff. The process includes:

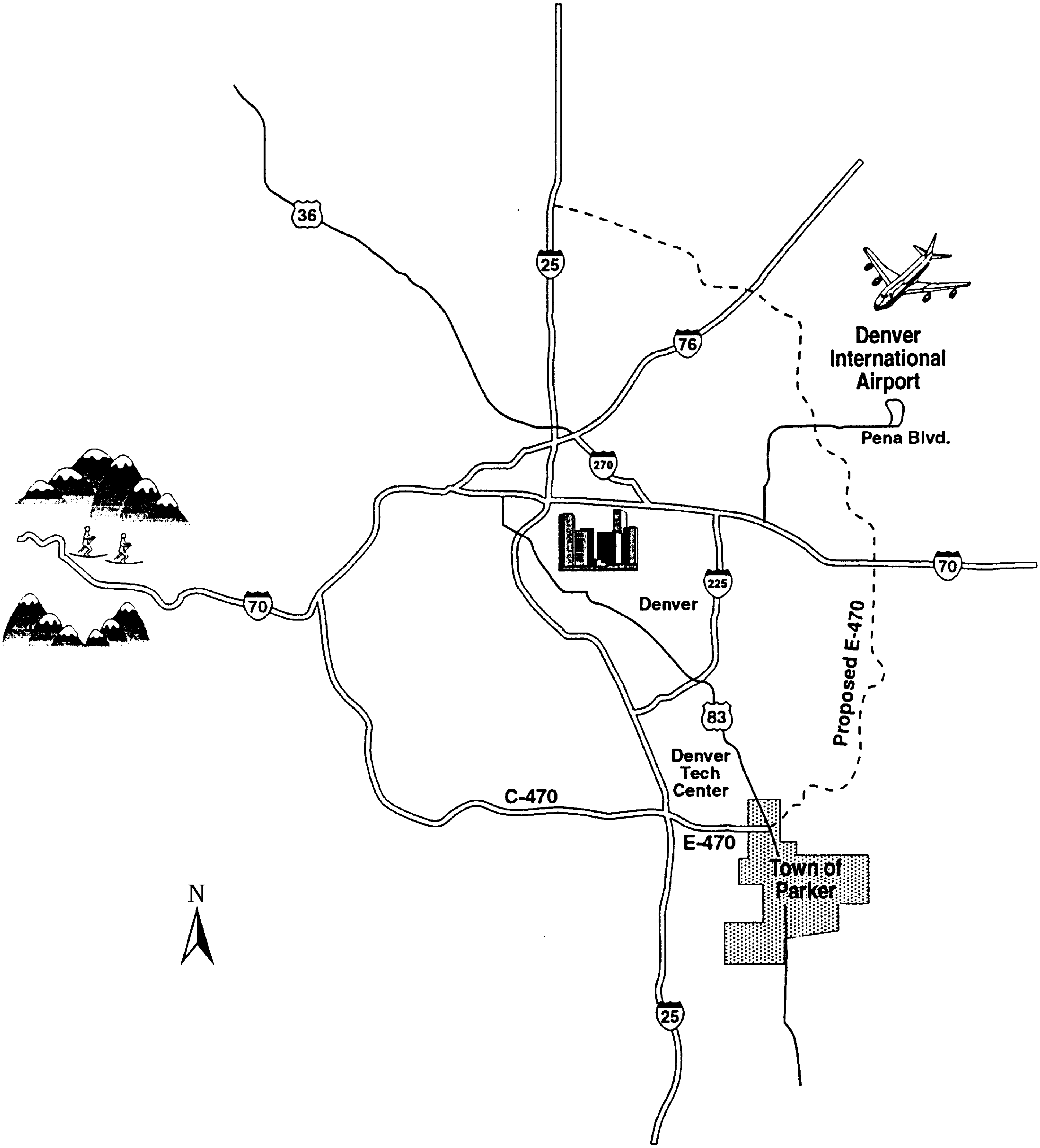
- *Meetings with developers to discuss their concepts* ***and the Town 's goals***
- *Review of development sketch plans, plats, and construction documents*
- *Review coordination by staff agencies and consultants*
- *Negotiation with developers on variance* ***requests***
- *PIanning Commission and Town Council approvals*

Over the past 7 years, the program has gained strength and definition. ***The Town*** *'s vision for its future is being protected and through this focused program, opportunities have been created for developers, residents, and the Town.*

PRESENTATION

The Town of Parker, Colorado, is a rapidly growing residential community south of the metropolitan area of Denver. Parker is approximately 12 miles (a 15 minute commute) from the Denver Technology Center, 20 miles (a 30 to 40 minute commute from Downtown Denver, **and** 40 miles from the Denver International Airport (DIA).

Built along a state highway, Parker can be accessed from the major employment areas by Interstate 25; E-470 (Denver's partia1 beltway); Lincoln Avenue, a major east/west arterial; and SH83, a major north/south highway. Exhibit 1 shows the Town in relationship to the Denver Metropolitan Area.


36
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Proposed E-470
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Tech
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E-470
Town of
Parker
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Exhibit 1

This area of Colorado is a high prairie with rolling hills, deep gulches and dry land vegetation. The Town was built up around a Pony Express Station and has maintained it's rural atmosphcrc with a focus on open spaces and equestrian activities. The Town's vision as stated in the Masterplan is 'A community with wide open spaces, country living and hometown friendliness.' Surrounded by county residential development of 5 to 35 acre lots, Parker is the "center of town". Commercial and retail development has been concentratcd along the major roadways bisecting the Town.

Parker was incorporated in 198 1 and is a home rule town with a 1995 population of 11,500. The population in 1985 was 1,794. Over the past 10 years the annexed area of Parker has increased from 4,260 to 7,5 10 acres. The land area which is served by the retail development of Parker is 175 acres. Building permits increased to a high of 680 in 1994. This explosive growth is a result of the rural atmosphcrc and the reasonable commute times to the major employment areas of the Denver Metro Area.

In order to most efficiently manage it's resources, the Town of Parker has chosen to privatize the rcvicw of development plans, the observation of construction and the warranty reviews prior to final acceptance of infrastructure. As a part of the review of all new development plans, the proposed access is reviewed by a private consultant. This review follows the process and criteria discussed in this **paper.**

Comprehensive Approach

Over the past 10 years a program of comprehensive planning and town management has been refined, this program includes access management. The program is the result of vision and experience on the part of the Town's staff as well as some lessons from the "school of the hard knocks". The program now gives consideration to the Town's vision and issues such as long term maintenance, operations for the 20 year forecasts, installation and progression of signal systems and identification of offsite impacts with financial commitments to mitigation measures.

The program has 2 major elements which impact the access management planning within the Town, **the planning documents and the process.**

The documents have been written and updated over the **past** 10 years. Many are adopted by the Town Council. The most critical documents to access management, in approximate order of development, are:

Town of Parker Land Development Ordinance
Mainstreet Access Plan
Town of Parker Roadway Design and Construction Criteria
Town of Parker Master Plan

Within these documents are included criteria and guidance on the Town's vision of its transportation facilities, zoning, site plan regulations, subdivision regulations, **traffic study guidelines,** functional classifications for streets, and design and access standards for streets by functional classification.

The Land Development Ordinance was developed to **facilitate the orderly growth and expansion of the** Town. This document defines the review processes for **all** types and stages of development, thus providing a more efficient system. Within this process are the steps developers takes to determine traffic study criteria, define access points, functional classifications for streets and identify impacts and mitigation measures.

Specifically to address the access along the main 'downtown' street, Mainstreet, the *Mainstreet Access Plan* was completed. This document is used to inform developers of parcels along Mainstreet as to the access that will be granted, as well as to support the Town's design of street improvements on Mainstreet.

The documents and sections of documents most commonly used in the determination of access for the residential subdivisions are *the Roadway Design and Construction Criteria Manual* **and** *the Transportation Element of the Town 's Master Plan.*

Planning and Design Documents

The Town of Parker Roadway Design and-Construction Criteria ManuaI were first assembled in 1984 in response to construction of public facilities. The building of residential subdivisions was booming and the Town had no design criteria or specifications for construction of improvements that would become publicly owned. The first drafts of the criteria dealt with construction specifications. However before the first Manual was adopted, design criteria were included. These criteria described three functional classifications of roadways; arterials, collectors, and local streets, with horizontal and vertical alignment standards.

This was the beginning of access control within the Town. As developments continued to annex into the Town and present site plans for review, access issues were raised earlier in the process and became critical to the development of many parcels.

A variance request process was a part of the first Manual. This variance process gives flexibility to the Town and, over the years, has pointed out the criteria which are the weakest and most difficult to implement.

The Manual was updated in 1995 to help better define the Town's goals with additional standards for access type and locations by functional roadway classifications. The variance request process has remained a part of the updated Manual. It continues to maintain flexibility in the application of the criteria. The new updates to the Manual in the area of access have decreased the number of variance requests regarding access.

The section on Traffic Study Guidelines was added to the Manual, thus requiring a traffic study for all developments. Also added to the Manual was Article 6 "Roadway Access", this section details the access principles used within the Town and gives design criteria for acel/decel lanes, driveway spacing, etc.

Another refinement to the Manual is the expansion of functional roadway classifications from 3 to 5. A distinction in functional use was identified by staff between roadways within residential subdivisions and nonresidential areas. Therefore, greater definition was developed in criteria addressing access, right-of-way, street cross section and parking with these new classifications.

The Transportation Element of the Town 's Master Plan is another critical document in the administration of the access management program. The Transportation Element defines the arterials and non-residential collectors planned within the Town for the 2015 forecast. Using the arterial network and the criteria for intersecting roadways, the planning for the collector system begins the access management process. The major Roadway Plan is shown in Exhibit 2.

Specific Design Criteria that Impact Access Management

- Functional Classifications for the Street System- These criteria define the purpose of the classification, the intersection street type(s), the location/spacing of intersection streets, the type of traffic control allowed, the right-of-way required, the posted and design speed, the range of projected volumes, and the parking restrictions. See the Appendix for *Article 2 Functional CIassification for the Town of Parker Street System.*

- Sight distance criteria- Although a variance process exists, no variances are permitted from the sight distance criteria, therefore, access points may be affected. The sight distance criteria is based on design speed and functional classification.

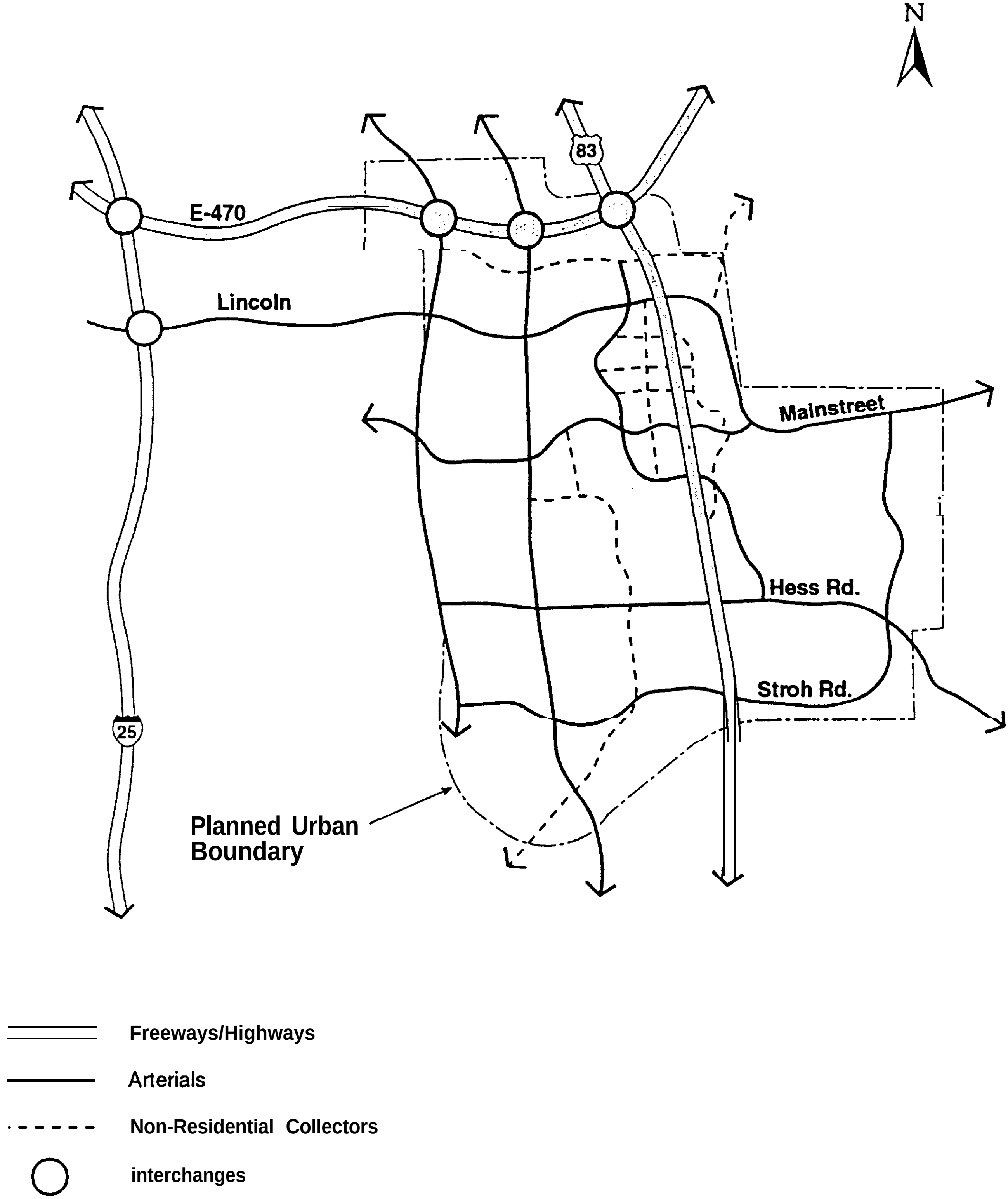

Exhibit 2
Major Roadway Plan

The table below ties the design criteria together.

Minimum Horizontal Curve Design Criteria

Design Criteria	Local	Residential Collector	NonResidential Collector	Arterial
Minimum Design Speed (mph)	30	35	40	45
Minimum Centerline Radius (ft)			See Table 3-2	
Minimum Horizontal Sight Distance (ft)	200	225	275	325
Minimum Reverse Curve Tangent (ft)	50	100[b]	150[b]	200[b]
Minimum Approach Tangent at Intersections[a] (ft)	50	220	280	350

[a]Because these tangent sections provide adequate sight distance for traffic control divides on curved approaches to intersections, no variances will be considered for "Minimum Approach Tangent at Intersections". The tangent distance shall be measured from the flowline of the intersected street.

[b]The tangent length between reverse curves must accommodate superelevation runouts.

Specific Access Criteria

1. Access Plan-This plan must be submitted with the sketch plan and detail the type and location of the access points. The plan must address the traffic control devices planned.
2. Traffic Study-This study must generate and distribute trips, address the access points with appropriate analysis, identify offsite impacts and mitigation measures. See the appendix of this paper for *Minimum Requirements for Traffic Studies.*
3. Access Criteria-The access criteria are stated in *Article 6 Roadway Access.* The article discusses the process, the goals of access management, and states specific access policies. Some of the most important policies are discussed below and Article 6 is included in the appendix.
   - Number of access points-The policy allows a single access point to each property, additional access must be proven necessary in the traffic study based on volume or operations.
   - Corner Distance Criteria-A table is given which states the comer distance required for access/driveways. This table gives the comer distance based on the functional classification of the two roadways. See Article 6 in the Appendix.
   - Driveway Criteria for Local Streets-The location of the driveway for comer lots has been set at a 50 foot minimum from the comer and must be on the upstream side of the lot. This is an example of a criteria which has been set to protect the uses of local streets and to result in larger comer lots, a Town value.

The Process

Over time 2 lessons learned by the Town's staff and assisting consultants have been the importance of process and coordination. *The Land Development Ordinance* defines the planning process and a flow chart that illustrates the process has been developed. A regular coordination meeting, between the Town staff and the consultants reviewing the development plans, has been established to implement the process efficiently and consistently.

The coordination meetings are held every other week and include representatives from the planning department, public works, the fire district, drainage consultants and roadway consultants.

Through the coordination meetings a link is established between the planning process and the requirements of the *Roadway Design and Construction Criteria.* This link has made the defined process consistent in its review comments to developers and the regular coordination meeting has established the defined process as the quickest way to get comments and approvals. Described briefly below are the planning steps and the Manual requirements regarding access at each of these steps:

Sketch Plan/ Access Plan	Traffic Study completion Conceptual location of access points Number of access points finalized Functional classification of all roadways Identification of impacts and mitigation measures
Preliminary Plan	Finalize location of access points Review of horizontal and vertical alignments Commitments to mitigation on- and offsite
Final Plat	Review of final construction plans

The process and coordination continue into the construction of the improvements through the preconstruction meeting and a program of regular construction observation. Probationary and final acceptance of improvements represent the completion of the process. Even these steps require coordination due to the financial securities held on each project.

The Lessons Learned

The development of this program has taken 10 years. It has not been a linear development. Over the 10 years, the first 2 years represented the foundation of the access principles and criteria. Thcsc wcrc implemented over 5 to 6 years. The last 2 years have again been an intense assessment of the principles and criteria used in the access management program. New criteria which better define the Town's goals have been included in the updated Manual.

Through this development the planning and public works staff and the consultants who assist the Town have learned about each others responsibilities and goals. This respect for the needs of the other departments has been important in the overall strength of the criteria and the commitment to implement them.

A new lesson we are learning is the importance of an adequate paper trail as a part of the process. This may seem obvious, but in a small town it has been possible to do a minimum of forms and maintain control. As the number of developments increase, with requests for phasing of the improvements, an access request form has been developed. This is now completed by the applicant and must be onsite during construction to ensure that the proper approvals have been given prior to start of construction.

The most important lessons learned are that a fair process with continuing coordination is critical to the success of any access management program. With this in mind the principles that this access managcmcnt program uses to thrive are:

Maintain quality criteria and standards which reflect the community's values.

Remember the long term goals of the standards when reviewing access requests.

Make the standard process the fastest way to acquire approvals.

Look for the win-win solutions when applying the criteria and standards.

Appendix A

Article 2
Functional Classification of Town of Parker Street System

The Town of Parker intends to organize a roadway hierarchy to provide for safe and continuous travel and access. A functional classification of roadways provides the hierarchy necessary to accomplish the Town's mobility goals. Streets are divided into three primary classifications: arterial, collector, and local.

- Arterials are roadways whose primary purpose is the efficient continuous movement of through traffic.
- Collectors collect traffic from local streets and channel it to arterials.
- Local streets provide for direct access to abutting properties and channel traffic to collectors. Cul-de-sac streets are open at one end only and provide for the turning around of vehicular traffic.

Each classification has design criteria which maintains and protects the primary purpose of the roadway. Functional classification is determined by the Town staff using several criteria. A roadway, once functionally classified, maintains that classification over its entire length. These functional classifications are described below.

1. Arterial

An arterial street is a general term denoting a roadway designed or operated with the following characteristics:

A. The primary purpose of arterial streets is the efficient continuous movement of through-traffic. To facilitate this purpose, access to arterial streets will only be from collector streets. The location of intersecting streets will be evaluated to provide the desirable signal spacing.

B. Direct **access onto** arterials through curb cuts of driveways will be prohibited. Full turning access locations will be prohibited when alternative access is possible.

C. The posted speed limit will be 40 mph or greater with a minimum design speed 5 mph greater than the posted speed limit. The desirable posted speed limit will be 45 mph.

D. A minimum right-of-way (ROW) width of 110 feet and a typical section as shown in Standard Detail No. 1. Additional ROW may be required should projected **traffic volumes** warrant. The need for additional ROW will be determined by the Town at the time the traffic study is reviewed. Arterial-arterial intersections will reserve an additional 30 feet of ROW (15 feet on each side of the arterial) for 200 feet in all approach directions for future additional lanes (see Standard Detail No. 4).

E. A 12,000-vehicle-per-day projected traffic volume when the land that the arterial serves is fully developed.

F. No direct access will be permitted to adjacent parcels of land.

G. No parking will be allowed on arterials.

H. **Traffic control is provided by traffic signals at l/2-mile spacing. Closer spacing** will be considered only if **a traffic study for** the length of the arterial shows that signal **progression at the desired speed can be accomplished.**

2. Collectors

Collectors function to direct traffic from local streets to arterials. Two types of collectors exist within the Town and are described below. Both types of collectors must meet design standards for horizontal and vertical alignments as described in Article 3 under Collectors.

Residential Collector

A residential collector will provide for the need within residential communities for trips from local streets to the arterials and for access to parks and schools. For sight distance requirements, pavement design, and vertical and horizontal alignment, a residential collector will meet collector standards.

A. Residential collector will be allowed only within residential subdivisions. Their primary purpose is to move traffic to arterials and provide access to parks, schools, and shopping centers serving residential neighborhoods.

B. The posted speed limit will be 30 mph with a minimum design speed of 35 mph.

C. A minimum ROW of 70 feet and a typical section as shown in Standard Detail No. 1.

D. A 3,500-vehicle-per-day projected traffic volume when the land that the collector serves is fully developed.

E. Access to single properties is discouraged and will be disallowed in most cases. Driveway access to residential units will not be allowed. Parking may be allowed on residential collectors. No parking will be allowed within 100 feet of intersections.

F. Traffic control is provided by intersection signing or traffic signals at l/4-mile spacing.

Non-Residential Collector

A non-residential collector will provide for direct access in non-residential areas to adjacent properties along collector roadways. For pavement design, sight distance requirements, design, or other non-access designs, non-residential collectors will meet collector standards. Non-residential collectors will have the following characteristics:

A. The primary purpose will be to channel traffic to arterials with the secondary purpose to provide access to large sections of adjacent properties. Individual access points will be granted by the Town at its sole discretion.

B. A posted speed limit between 30 and 40 mph with a minimum design speed of 40 mph.

C. A minimum ROW of 80 feet and a typical section as shown in Standard Detail No. 1.

D. A 3,500 vehicle-per-day projected traffic volume when the land that is served is fully developed.

E. Access to single properties is discouraged; joint access to multiple properties will be allowed. Parking will not be permitted on non-residential collectors.

F. Traffic control is provided by traffic signals at l/4-mile spacing. Direct access points will be controlled by stop signs on the access as a minimum. Access points may be restricted to right in/right out movements at any time as determined by the Town. Reasons for such restriction will include, but not be limited to, through traffic operations or potential safety improvement.

G. Non-residential collectors will not be permitted within residential subdivisions or local commercial areas within residential developments.

3. Local Street

Both non-residential and residential local streets have the following characteristics:

A. The primary purpose of local streets is to provide vehicular access to abutting land.

B. Posted speed limit of 25 or 30 mph with a minimum design speed of 30 mph.

C. Projected traffic volumes of less than 3,500 vehicles per day.

D. A minimum ROW width and typical section as shown in Standard Detail No. 2.

E. Local roads are designed for the safety of pedestrians and bicyclists and ease of access to adjacent parcels of land.

F Traffic control is by stop signs, yield signs, or right-of-way rules for uncontrolled intersections.

Cul-de-sac Street

A cul-de-sac has the following characteristics:

A. It is open only at one end and provides for the turning around of vehicular traffic at the other end.

B. It is designed as a local street with a 11 O-foot ROW and 45-foot center point to flowline dimension at the bulb-out. See Standard Detail No. 3.

C. A cul-de-sac will not exceed 700 feet in length.

D. Modified cul-de-sac streets, such as shown in Standard Detail No. 3 and commonly referred to as knuckles, shall not be permitted along residential nor nonresidential collectors. Cul-de-sac streets which intersect with residential or nonresidential collector shall not be less than 145 feet along the centerline. This distance shall be measured from the flowline of the collector to the centerpoint of the cul-de-sac.

Appendix B

Article 6
Roadway Access

1. General Policy

An access plan will be submitted with all sketch plans. The access plan will detail the type and location of the access and will address all of the design policies stated in Section 2 of this article, The access plan will also address the traffic control devices and will have sufficient detail to analyze the design for compliance with the criteria.

An access permit shall be acquired and approved by Public Works Department for each access point.

Any changes to the information given on the original access plan will require review of the access.

A traffic study (see Appendix B for minimum requirements) will accompany all requests for access on arterial and collector streets when the development is expected to generate 100 or more vehicle trips per day. Driveway location and design will be related to the traffic volume and type. Offsite impacts shall bc analyzed in all traffic studies.

Where access to one site is possible from two or more streets, access will be given onto the street where all applicable access criteria can be met and as directed by the Town.

Roadways which provide access to residential subdivisions with 70 or more dwelling units shall be served by two access points. These access points shall be from the collector/ arterial network. A variance request may be made when a single access point is divided by a median that extends to the next adjacent intersection and the single access does not utilize a bridge to span topographic features impacted by weather.

This variance will be granted at the sole discretion of the Director of Public Works and the Fire District.

Any adjustments to existing infrastructure caused by construction of access improvements will be the responsibility of the owners.

One access point per property owner will be approved unless the traffic volumes developed in the traffic report show a demand for additional access points.

No backout driveways will be allowed except on local streets.

No backout driveways for trucks nor truck maneuvering within the roadway right-of-way will be allowed.

Truck loading areas fronting on local streets may use the street for maneuvering when all of the following criteria are met:

- The local street has no through traffic to other destinations.
- The local street has no other types of traffic generators.

Parked trucks may not overhang into the right-of-way at any time.

Traffic control signalization systems will include a pre-emption device controlled remotely by police/fire units.

2. Design Policies

Width

The width of driveways and curb cuts will be adequate to accommodate the type of traffic expected (see Table 6- 1).

Table 6-1
Driveway and Curb Cut Widths

	Residential	Commercial	Industrial
Width	*10* to *30* ft	*15* to *35* ft	*20* to *40* ft

The need for oversized driveways will be justified in the traffic study. Oversized driveways will not exceed 75 feet in width.

Spacing

The minimum spacing between driveways will be 50 feet. This will apply to the distance between driveways on the same property and driveways on adjoining properties. Joint entrances will be required whenever the 50-foot minimum spacing cannot be met.

The distance from the street comer to the near side of right in/right out driveways or curb cuts will be as shown in Table 6-2. The distance will be measured from the intersection of the right-of-way lines to the driveway curb return.

The distance between full movement intersections shall be l/2 mile on arterials and l/4 mile on collectors.

Driveways and curb cuts will meet the street at an angle of 90 degrees whenever possible. The minimum entrance angle allowed will be 70 degrees.

Table 6-2
Distance from Comer Flowline to Right In/Right Out Access/Driveway

	Classification of Street with Access			
Classification of Intersecting Street	Arterial	Non-Residential Collector	Residential Collector	Non-Residential and Residential Local
Arterial	500 ft	250 ft	250 ft	NA
Non-Residential Collector	250 ft	100 ft	100 ft	100 ft
Residential Collector	250 ft	100 ft	100 ft	44.5 ft
Non-Residential and Residential Local	NA	100 ft	100 ft	44.5 ft

Driveway Locations on Local Streets

Driveways on the comer lot of a residential local street shall be placed on the upstream side of the lot. See Standard Detail No. 3.

Acceleration/Deceleration Lanes

Need for acceleration/deceleration lanes will be determined and presented in the traffic study. A right-turn acceleration lane will be required where the posted speed is 40 mph or greater.

If the design hourly volume (DHV) for an access is 25 with **a** posted speed of 20 mph to **40** mph, or 20 DHV for a posted speed above 40, a right-turn deceleration lane will be required.

The need for left-turn acceleration lanes will be determined on a site-specific basis.

Left-turn lanes will be required for any access with left-turn design hour volumes of 30 or more and posted speeds of 25 to 45 mph or for a DHV of 25 and posted speeds greater than 45 mph.

The required lane lengths and taper lengths for acceleration/deceleration will be **as** shown in Table 6-3.

Table 6-3
Required Lane Lengths and Taper Lengths

	Stop Condition		15-mph Turn		
Posted Speed (mph)	A (ft)	D (ft)	A (ft)	D (ft)	Ratio for Straight Taper for A&D
20		160		100	7.5:1
25	100	200	90	150	7.5:1
30	190	235	190	185	10:1
35	270	275	240	235	12.5:1
40	380	315	320	295	15:1
45	550	375	480	350	15:1
50	760	435	700	405	20:1
55	960	485	910	450	22.5:1

Appendix C
Minimum Requirements for Traffic Studies

Traffic consultants are required to discuss projects with the Town engineer prior to start of the study. A meeting will be scheduled for large projects to identify the study area and specific roads and intersections impacted.

Study Requirements

All traffic studies will contain, as a minimum, the following information:

1. A summary table listing each type of land use, the units involved, the general rates used (daily and AM/PM peaks), the source of the rates used, and the resultant trip generation.
2. A map that shows the location of each type of land use within the site.
3. Traffic study graphics will show the following for current year and design (current +20) year:

   A. AM Peak-Hour Site Traffic (in and out)
   B. PM Peak-Hour Site Traffic (in and out)
   C. AM Peak-Hour Background Traffic
   D. PM Peak-Hour Background Traffic
   E. AM Peak-Hour Total Traffic (in and out)
   F. PM Peak-Hour Total Traffic (in and out)
   G. Total Daily Traffic

All project-generated traffic will be assigned to existing and planned facilities in a manner consistent with accepted traffic patterns and approved by the Town engineer.

I. An operational analysis will be conducted for all major driveways that intersect collector or arterial streets and at all adjacent arterial-arterial, arterial-collector, or collector-collector intersections. Both peak hours will be tested to determine the critical movements. Pedestrian movements will also be considered in the evaluation.

   The 1985 Highway Capacity Manual methods for operational analysis will be used to evaluate signalized intersections.

   The operational analysis will show impacts on the existing roadway system, the expected future roadway system, and any interim roadway system phases that may correspond to expected development phases.

II. Traffic progression on Town streets is of paramount importance. Consequently, potential signalized intersections should be placed at l/2-mile intervals on arterials and at l/4-mile intervals on collectors. Other locations will be considered based on the following criteria:

   A. Progression band width will be 50-second minimum in both directions.

   B. Cycle length will be 100 seconds.

   C. Progression speed will be from 35 to 40 mph.

   D. Remaining time for side street traffic must be sufficient for side street volumes.

III. Level of service C will be the highway and intersection design objective and level of service D will be the minimum for site and nonsite traffic operations. The design year will be approximately 20 years following construction.

N. Trip generation will be based on average rates contained within the most recent Institute of Transportation Engineers' *Trip Generation Guide.* The Town Engineer will approve any estimated rates in the event that data is not available for the proposed land use.

V. Internal trips will not exceed 10 percent. Nongenerated passerby traffic reductions in generation volumes may be considered, if applicable. All estimates of trip distribution, assignment, and modal split are subject to review and approval by the Town engineer.

VI. An analysis will be completed that identifies where speed change lanes arc ncedcd. Findings will be included in the traffic study report.

VII. The study will summarize expected project traffic impacts on existing and future (20-year) traffic conditions and state improvements proposed to mitigate those impacts. The developer shall be responsible for the cost of any mitigation plan for that development's onsite and offsite impacts. All mitigation plans shall be approved by the Town of Parker.

The Challenges and (Early Successes)of a Town Initiated Access Management "Retrofit" Program on Two State Highways

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Geoff Benway, P.E., Project Manager, MRB Group, P.C., Rochester, New York

ABSTRACT

The Town of Penfield a suburban town adjacent to Rochester, New York, is experiencing a substantial growth in development and resulting traffic cpressures along Routes 441& 250, two arterial State highways that traverse the town. Prompted by these pressures, and coupled with an upcoming 1997 New York State DOT improvement project for these roadways, the Town, in cooperation with NYSDOT, developed and adopted an Access Management Overlay district that incorporates a Land Use and Access Management Plan (LUAMP) for Routes 441 and 250. The primary purpose of the LUAMP is to provide a comprehensive and coordinated managementplan for access control to improve the capacity and safety along these roadways. The LUAMP equips the Town Planning Board with the basic framework or planning tool for accommodating future growth along these two corridors.

The Penfield LUAMP is largely a "retrofit"plan that includes numerous access management supportive elements. Without any formal access classification system in place in New York State, development of the plan represented one of the first formalized attempts at implementing a complete access management system that includes driveway consolidation and spacing, access roads, medians, consideration of future signal spacing, as well as the adoption of access management supportive language in the existing town land use ordinances.

The process and support for the plan were key elements that have resulted in two early successes. First, medians proposed as part of the access plan at the intersection of Routes 441 and 250 affected three convenience/gas stations and a fast food restaurant. Although initially unpopular to the merchants, the concept and need for medians was eventually acknowledged and accepted by all affected parties. Secondly, construction, in part, of a strategic link in a planned access road network has already begun, and is being funded by the developer with town incentives added.

Coordination of the town's plan with the NYSDOT improvement project was essential. The NYSDOT recognizes the potential cost savings, and operational and safety benefits associated with implementation of the LUAMP. In exchange, NYSDOT is now considering additional highway project betterments to Routes 441 and 250, that may accelerate andfurther the implementation of the LUAMP

I. INTRODUCTION

The Town of Penfield, a suburban town (pop.32,OOO) adjacent to Rochester, New York, is experiencing a substantial growth in development and resulting traffic pressures along Routes 441 & 250, two arterial State highways that traverse the town. With growth, comes the inevitable challenges of balancing the needs for access versus mobility on these travel corridors.

The Route 44 l/250 corridors are a primary commercial center for the Town of Penfield. The commercial area stretches approximately a mile in each direction from the intersection of these two arterials, and contains approximately 450,000 s.f. of retail space and 40,000 s.f. of office uses. Overall, the potential build-out of the area currently yields a total 1.4 million square feet of retail and commercial uses.

In January 1994, a Route 44 1 corridor quality management team, representing a partnership of State, County, Town, Citizen, and Business officials charged with identifying methods to make Route 44 1 a safer and more efficient transportation corridor, focused their attention on the growth corridor surrounding the Route 44 l/250 intersection. The corridor task force team, in conjunction with the Penfield Town Board and Planning Board members recognized that the standard project-by-project reviews were inadequate, and that an overall plan that treated land use and transportation as a system was needed for the area.

In early 1994, the Town officials reacted to a rush of development applications in the study area, by declaring an informal moratorium on development. Prompted by these pressures, and coupled with an upcoming New York State DOT improvement project for the Route 44 l/250 intersection, the Town initiated a Land Use and Access Management study. The Town and consultants jointly developed in cooperation with NYSDOT, a plan to address the potential development for the area and to coordinate local land use decisions and access management strategies in concert with the proposed intersection improvement project.

The intent of the Land Use and Access Management Plan (LUAMP) is to provide a comprehensive and coordinated management plan for development and access control within these two high growth corridors.

II. BACKGROUND

The project area centers around on the intersection of Routes 44 1 and 250, two minor arterial highways primarily serving morning commuter traffic, and conflicting retail and commuter afternoon traffic. Route 44 1 is a four lane east-west travel route that connects the major employment centers located in the City of Rochester with suburban residential communities located in Penfield and easterly into the fastest residential growth areas of Wayne County. Currently, Route 44 1 carries 25,900 vehicles per day on the study section.

Route 250 is primarily a two-lane north-south travel route that services a major suburban employment center located at the northern terminus; and a regional retail center located at the southern terminus. The roadway accommodates approximately 16,200 vehicles per day through the study area. The posted speed limit on Route 441 is 40 mph, and 45 mph on Route 250.

The competing demands to service both the through traffic component and the access needs of businesses located along these corridors presently creates significant turning conflicts and capacity conditions (Level of Service E) over several highway segments within the plan area. As growth continues, the absence of a well-defined policy on access will further exacerbate the overall travel condition.

III. GOALS

In 1989, the Town of Penfield chose a proactive stance in its transportation policy by completing a Town-wide Strategic Traffic Study. The recommendations presented in this study became the basis for the Towns' 1990 Master Plan highway goals and objectives. The Master Plan established the policy framework that supports the access management initiative. Development of the LUAMP is consistent with the goals and objectives set forth in the Town of Penfield's Master Plan.

The primary goal of the LUAMP is to preserve the regional and local flow of traffic in terms of capacity, safety, and travel speed, and to provide reasonable access to land development within the plan boundaries. The underlying intent is to address the access issues and restraints in the most cost effective manner, while achieving the most safety and capacity benefits from both the public and private investment.

Traditional methods of designing access generally lacked a comprehensive and coordinated approach to land use and transportation. The LUAMP strives to achieve a better balance and integration between the roadway design elements and the land use and site planning features embodied in both existing and future developments.

IV. STUDY PROCESS

A comprehensive survey performed initially as part of the study, revealed that the majority of town residents were strongly supportive of the Towns' initiative to better manage the land use demands with the available transportation resources. A number of public information meetings were held early in the process to update business and residential owners on the plan and to garner input and support for the access management concepts. Efforts were also made to review the progress of the plan with local business owners.

Several workshops with the Town Board and Planning Board were held to determine, reinforce, and adjust if necessary, the desired course of action, based upon various growth scenarios.

An initial step in the study process investigated lot conformance with minimum width and depth dimensions. Lot widths less than the recommended 245 ft. minimum driveway spacing, delineated locations with potentially the greatest need for cross access and shared access arrangements. Parcels with lot depth greater than 400 feet were considered locations offering the opportunity for development of a secondary access road network.

Existing adjoining land uses with a high degree of compatibility were categorized as potential candidates for unified parking and circulation between parcels.

"Micro-level" planning on a parcel-by-parcel basis and visioning procedures were performed to identify the actual development potential within the Route 44 l/250 corridors. The developable build-out potential for lands within the study area, as prescribed under the current zoning were mapped and quantified. Historical lot coverage trends were analyzed and then used to estimate the future build-out scenario and site-generated trips. Under the present zoning conditions, it was determined that an additional l,OOO,OOO s.f. of commercial and retail uses could occur within the plan boundaries.

Traffic simulation and analysis methods were used to assess future intersection operations and queue conditions. Future traffic conditions under the full build-out scenario were evaluated and intersection levels of service and queuing conditions identified. The equivalent of operational "contour" maps were developed to highlight the functional limits of the study intersections, and to identify areas of potential conflict between driveways and these functional areas.

As part of the study process, probable future signal locations were identified that maintained to the extent possible, a minimum 30% future bandwidth along each corridor.

V. PLAN ELEMENTS

Access Management Design Guidelines and Recommendations

No longer are access management techniques focused solely on an individual development application, with a limited range of access techniques applicable to the development site. Instead, management plans include an array of access management related What's new in New York State, and already established in other states, is the degree to which access management principals are being applied. measures aimed at addressing access conditions on a sub-area, corridor, or larger transportation system base.

The Penfield LUAMP includes a package of strategies and techniques that provide for total system management and integration within the Routes 44 1 and 250 plan limits. The plan, as shown in part in Figure 1, involves the development of a plan tailored specifically to the needs and environmental conditions of the study corridors, including, but not limited to the following elements:

- driveway consolidation
- driveway spacing guidelines
- comer clearances
- shared driveway access, cross access and unified parking plans
- use of raised medians
- access road plans with new design standards
- driveway throat length standards
- probable location of future signals with bandwidth recommendations
- additional right-turn lane treatments

The plan focused on limiting the number and location of driveway curb-cuts along both roadways. Figures 2 and 3 show for Routes 44 1 and 250, the existing and future number of driveways conforming to the minimum 245' driveway spacing recommended in the plan. While a greater driveway spacing distance is desirable, it was recognized early in the plan process that a realistic, and workable separation distance was needed that was sensitive to the existing developments and compatible with the existing environmental setting.

Full implementation of the LUAMP results in a 3 7% reduction in total driveways along Route 44 1, and a 17% reduction in curb-cuts along Route 250. Under the LUAMP, the reduction in the number of non-conforming driveways with driveway spacing less than 245 ft. is even more significant along both roadways.

The plan calls for the creation of a integrated traffic circulation system that includes a system of access roads, cross access arrangements, unified site parking and circulation. Separate design, driveway spacing and setback requirements were developed for the access roads. The planned access road network provides greater integration and connectivity among developments, thus minimizing vehicular trips onto the arterials.

As part of the study, accident clusters were identified on Route 441 at access locations closest to the Route 441/250 intersection. In response, a raised median extending no less than 500 feet in either direction on Route 44 1 is proposed under the LUAMP plan.

Land Use Recommendations

The plan also recommends the adoption of an Overlay District that establishes land use language and ordinances that support access management and promotes transit, bicycle, and pedestrian friendly features.

An overlay zone is a growing method used for managing access along commercial corridors. The technique is used to overlay access management supportive language onto an existing zoning district, while retaining the underlying zoning and its associated requirements. These include transit friendly land use planning that encourages a mix, and proximity of uses necessary to facilitate greater transit and walking or bicycling. Providing for transit, pedestrian, and bicycle transportation is essential to a well balanced transportation system.

Consistent with the 1990 Master Plan goals and objectives, the LUAMP encourages strategies aimed at shifting demand away from single occupant vehicle travel, and helping offset the need for new highway lane miles. The establishment of a safe and efficient pedestrian walkway system is a key component of the LUAMP. The inclusion of pedestrian and bikeway improvements, as part of site development plans, are required to make walking and bicycling more pleasant, and convenient in the study area.

As part of the LUAMP, transit friendly community design concepts, a permanent Park-and-Ride station, and a second transit shelter are recommended for the study area.

The plan also outlines specific land use recommendations related to:

- “Conditional Uses” only in the business zones within the Overlay District
- Use Limitations for Comer Parcels
- Front Setback Reductions (reduced from 80’ to 50’)
- Density/Intensity Incentives as Prescribed in the Town’s Incentive Zoning Law
- Buffers(Allow greater flexibility to promote plan elements)
- Coverage (building, lot coverage)
- Special Dimensional Requirements
- General Signage and Directional Signing Modifications
- Alternative Parking Requirements
- Landscaping

VI. IMPLEMENTATION STRATEGIES

The project team investigated several financial and administrative measures necessary to implement the plan recommendations. These include the need to obtain developer agreements for temporary access to the state highway system pending the creation of internal access roadways or shared access arrangements. The plan includes recommendations for use of Incentive Zoning laws to offer benefits to the developers for compliance to the plan.

The funding of the plan and recommended betterments to the NYSDOT plan included the Town support in obtaining additional right-of-way for the improvements, and developing an Overlay District with a Transportation Improvement Fee component. The fees are based upon peak hour trip generation for the proposed developments, and are paid to the Town to offset costs for the study, SEQR compliance, and the cost for betterments beyond those proposed by the NYSDOT. These funds could be partially waived for developers that instead, complete improvements to the state highway for access considerations and plan advancement.

VII. KEY ATTRIBUTES FOR PLAN ACTUALIZATION

Many factors contributed to the overall advancement of plan, but those most important and consequential to its progress include the following:

Vision - An essential link in the plan process is a vision of the desired future. ***Vision is essential to achieving consistency between land use and transportation.*** Although visionary plans are often impeded by the politics of land development, without vision, there is no plan. [1]

A clear long term view of the desired development pattern for the future was a crucial element exhibited by both the Town Council and Planning Board early in the process. The town recognized the need for a policy driven plan versus reactive decision-making that lacked direction and cohesion.

Town officials had the foresight and vision to establish in their 1990 Master Plan, a policy framework that supports more detailed access management initiatives.

Local support - Local governments are charged with managing land use - land use pattern, intensity of use, subdivision and zoning regulations, site plan approval, and access roads. ***Local support is one of the most crucial ingredients for the formulation and success of a plan.***

Officials and staff from the Town of Penfield recognize that land use decisions cannot be made apart from transportation decisions. Transportation and land use problems are interdependent and require coordinated solutions, such as the LUAMP. Corridor preservation requires involvement at the local level where land use decision are made.[2] The Town of Penfield translated the public goals and objectives as stated in its Master Plan, into a coordinated arterial management program for the Routes 44 1 and 250 study corridors.

Education - ***Plan acceptance and approval depends largely on the education of all involved parties.*** Comprehensive access management represents a new approach to mobility protection that oftentimes includes new ideas and concepts, unfamiliar to residents and business owners. Generally, property owners affected by the new LUAMP concepts, were initially resistive to change. Throughout the study process, the project team emphasized that the State, Town and land owners all share a common goal for improved mobility and safety. The benefits gained under the LUAMP serve the community as well as the affected landowners, in terms of improved safety, operations, planning and corridor preservation.

A review of the three year accident history in the Routes 441/250 study area revealed that 43% of the total accidents occurred at uncontrolled access locations. Accident clusters were identified at access drives located immediately adjacent to the Route 44 1/250 intersection.

The property owners associated with these driveways were apprised of these conditions, and through subsequent informational meetings, the owners realized the need for improved safety for their customers, and expressed a willingness to support the proposed safety enhancements proposed in the plan.

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[1] Center for Urban Transportation Research, "Executive Summary - StateTransportation Policy Initiative", University of South Florida, June, 1995.

[2]. Ibid.

Both motorists and merchants are the recipients of the potential operational benefits achieved through the LUAMP. Travel times are reduced for commuters as well as shoppers, thus preserving market areas for existing retail centers. Educating merchants to the intrinsic benefits of sharing the common goal of increased mobility, proved highly effective in promoting the overall plan.

The LUAMP is designed to achieve better long range planning for highway access, and to simplify future planning efforts. The LUAMP aims to streamline the process for new development application review by defining the conditions under which access permits will be issued. The LUAMP equips the Town Planning Board with the basic framework or planning tool for accommodating future growth in a more efficient and effective manner along these two study arterials.

The LUAMP stretches both taxpayers dollars and the useful life of the facility. dors such as Route 44 1 and 250 must be protected and improved to assure the continued mobility and economic stability of the area. How realistic is the traditional 20 year design life when in most cases, major highway improvement time lines are being extended to 30, or 40 years before another major reinvestment in highway is made, given current capital funding trends?

Consistent and Equitable - ***Consistency in application and use of medians, cross access agreements, corner clearances and other access management related techniques is imperative.*** Challenges and potential litigation regarding plan elements precipitate without consistent and equitable design and administration of the plan. A staff training process is necessary for uniformity in decision, prior to any plan implementation. While the concepts of access management are not new to traffic engineers, most local municipalities seldom have trained technical staff to assist in the implementation process. Oftentimes the application of the access management principles requires interpretation and engineering judgement related to site specific conditions and limitations. Sufficient efforts must be made to educate the practitioners responsible for plan implementation.

Coordination with Planned Highway Improvements - ***One of the most effective means of instituting access management is with new roads, widenings, and intersection upgrades.*** Development of the LUAMP, in advance of the NYSDOT improvement project offered the town an opportunity for greater input in the design process.

The earlier access management strategies and techniques are considered in the planning phase — the more effective the program will be. Access management should start at the local level and compliment future roadway improvement projects. Public support must be obtained well in advance of the plan.

VIII. EARLY SUCCESS ELEMENTS OF THE LAND USE AND ACCESS MANAGEMENT PLAN

Acceptance and approval of Medians - Raised medians proposed as part of the access plan at the Routes 44 1 and 250 intersection affected three convenience/gas stations and a fast food restaurant. Although initially unpopular to the merchants, the concept and need for the medians was eventually accepted by all affected parties, after highlighting the existing accident frequency and operational deficiencies at these locations.

Development of an Access Road Network - Construction, in part, of a strategic link in a planned access road network has begun and is being funded privately, as development continues. The Town, in an effort to advance the access road plan and the LUAMP objectives, modified the existing buffer requirements between the access road and near-by residential units. Further implementation of the planned access road network will progress as development occurs.

Adoption of Land Use and Access Management Supportive Overlay District - After minor plan refinement, the Town of Penfield formally adopted the establishment of the Overlay District within the Routes 44 1 and 250 area. The overlay district regulations superimpose on the primary zoning districts and provide additional standards and design criteria to achieve the development objectives of the Routes 441 and 250 LUAMP.

IX. SUMMARY

Land use decisions are predominantly local determinations, while access to arterial corridors such as Route 44 1 and 250 is primarily a State function. In the past, the two areas evolved mostly independent of one another. However, what is clear, as exhibited in the Town of Penfield's Land Use and Access Management Plan, is that much can be done by towns, and local jurisdictions to improve the mobility, as well as the desired development outcomes along major corridors.

The Town of Penfield, through development of a Land Use and Access Management Plan, established a plan that supports corridor preservation and access management, as envisioned in the Town's Master Plan. The plan, initiated and developed by the Town, in partnership with the State Department of Transportation, identified an appropriate access system to accommodate future growth along two State arterial corridors within the town.

Local communities such as Penfield are recognizing that they can and must take more proactive roles in the delivery of transportation system improvements and in the entire transportation planning process. A truly integrated and coordinated system of land use and access, demands greater participation and support by local communities to enhance the overall efficiencies of the transportation system.

A strategic approach to transportation planning recognizes that capital improvements are not enough. State Departments of Transportation, County's and local municipalities must also look for better ways to manage the existing transportation system.[3] Effective corridor preservation requires involvement at all levels, particularly the local community level where land development decisions are made.

Lastly, access management requires the cooperation, creativity and coexistence among all participants to insure that our transportation system meets the needs of the users, our customers.

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[3] Ibid.

Figure 1

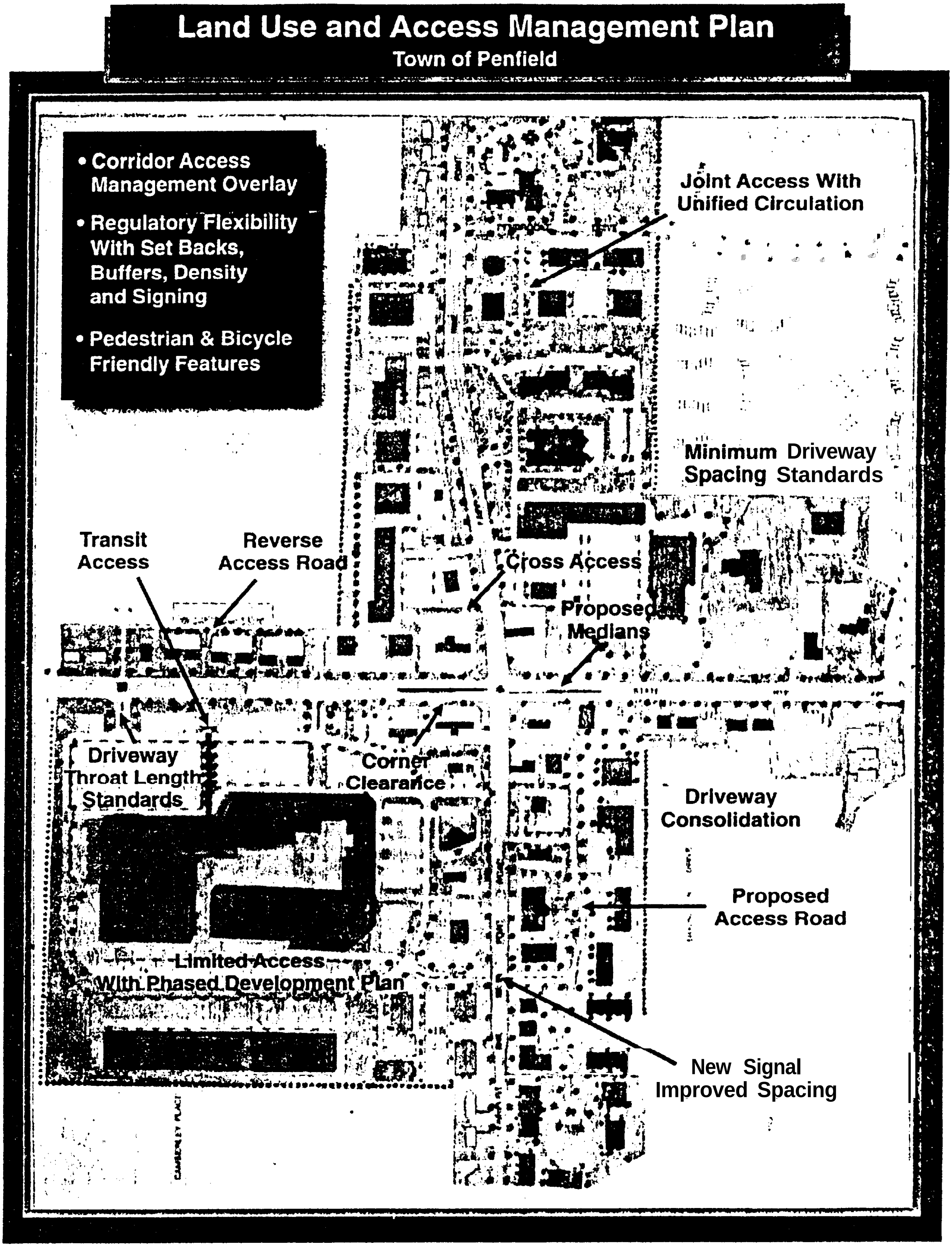
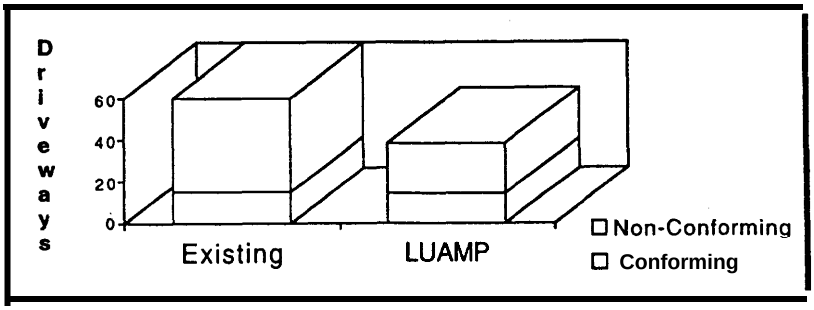

Land Use and Access Management Plan
Town of Penfield
• Corridor Access Management Overlay
• Regulatory Flexibility With Set Backs, Buffers, Density and Signing
• Pedestrian & Bicycle Friendly Features
Joint Access With Unified Circulation
Minimum Driveway Spacing Standards
Transit Access
Reverse Access Road
Cross Access
Proposed Medians
Driveway Throat Length Standards
Corner Clearance
Driveway Consolidation
Proposed Access Road
Limited Access With Phased Development Plan
New Signal Improved Spacing

Figure 2
Driveway Spacing Conformance

NYS ROUTE 441



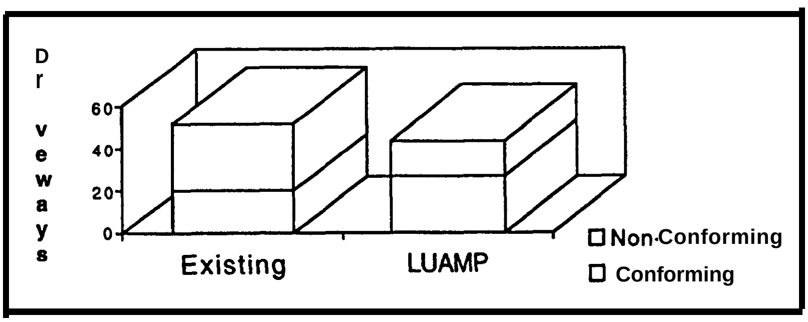
	Existing	LUAMP
Conforming	15	14
Non-Conforming	45	24
Total Number of Driveways	60	36

Reduction in Number of Driveways — 37%

23/24 or 96% Non Conforming Driveways to Existing Residences

Figure 3
Driveway Spacing Conformance

NYS ROUTE 250



	Existina	LUAMP
Conforming	20	27
Non-Conforming	32	16
Total Number of Driveways	52	43

Reduction in Number of Driveways -117%

11116 or 69% Non Conforming Driveways to Existing Residences

Access Management by Consensus. . . A Success Story

Freddie Vargas, P.E., Assistant District Traffic Operations Engineer, Florida Department of Transportation
Jonathan M. Overton, P.E., District Access Management Engineer, Florida Department of Transportation,

ABSTRACT

(No Abstract Submitted)

PRESENTATION

From the early 1980's the Florida Department of Transportation (FDOT) District IV has been managing access similar to the state's current access management standards. As the district developed rapidly, safety and congestion problems started to emerge. The district engineers anticipated a need to manage access as a counter measure for such problems. In response, the Florida Access Management Act was passed in 1988 and in 1990 the Administrative Rule 14-96 was developed and approved as mandated.

Each district devised its own access management process governed by the statute. Due to decentralization, it was assumed that the districts could have different processes. The rule would ensure consistent application statewide. We, in District IV, handle most access management issues in the Office of Traffic Operations. Our office reviews all of the Department's roadway design and safety upgrade projects, including all major connection permit requests. Sometimes, the petitioners claim that their development cannot and/or should not have to comply with access management. The petitioner may request a deviation from the spacing standards. If the request has merits based on safety and operational benefit(s) and, would not degrade the system, an Access Management Variance Review Comrnittee(AMVC) meeting is scheduled by the Access Management Engineer(AME) to review the merits. The committee consists of the District Roadway Design Engineer, the District Traffic Operations Engineer, and the District Maintenance Engineer. All access management variance decisions have been delegated to these engineers by the District Secretary. Meetings occur once a month in which the petitioners have at least one hour to present their case. On each case, the committee usually arrives at a consensus by the end of the meeting. This decision is made, recorded in writing, and given to the petitioner the same day, which is important at the bureaucratic level. The petitioners, usually, are satisfied as they had their "day in court" despite the outcome.

As first thought, the rule alone did not provide consistency. The application of access management was inconsistent statewide because each district was using their own access management process. Many consultant firms work in multiple districts and were receiving conflicting findings for similar access issues. The problem prompted the Department Secretary, Ben G. Watts to instruct the development of a common process that all districts would have to abide. During this development, District IV's process was evaluated against other district methods in an attempt to consistently apply the access management concepts uniformly throughout the state. An evaluation was conducted by The Center for Urban Transportation Research at the University of South Florida that revealed that our process provides the most consistent results and was recommended as the model for all other districts within the Florida Department of Transportation. The process was reviewed and refined by key-people throughout the state with the sole purpose of ensuring consistency when reviewing median opening requests. In September 1995 Mr. Watts approved the process as a Directive. The directive known as the "Median Opening Decision Process" has been a useful and successful document and is expected to become Procedure in September 1996.

This process, as indicated earlier, has been in use for at least ten years in our district. However, until recently, no data was collected to determine its effectiveness or consistency. In July 1994, we began tracking the decisions made by the AMVC. Statistics were collected during fiscal year '94/'95 (year one) and fiscal year '95/'96 (year two). This was done specifically to evaluate the degree of deviation approved and the impact of those decisions to the process. Our results have revealed totals and averages that will be used to compare to the future years' rulings and consistency trends.

Several areas were identified for data collection such as the percent variance granted for all access control features, how often the AMVC agreed with the AME, how often specific consultants are granted variances, and what state roads and/or counties received the most variances. A few important and measurable variables were selected for evaluation purposes. The Variance Committee Tracking Chart **(Table 1, year** one and **Table 2, year** two) depicts the format in which data is recorded. Access management variance requests are tabulated for all access classifications monthly. These requests are coded under Driveways, Median Openings, and Traffic Signals as appropriate. Actual percent deviation is recorded for each individual issue even if no variance is granted. Our process for deviation evaluations also includes the recommendations from the AME. This information is critical in obtaining substantial compliance and consistency with the access management regulations. By tracking how often the AME's recommendation is sustained, the engineer is provided with an indication of review thoroughness, team opinion and criteria used in the decision process.

The results show that the AMVC agreed with the recommendations of the AME much less often in the first year when compared to the second. The AME was sustained in only 47 percent of the driveway reviews in year one but the statistics jump to a staggering 76 percent in year two. There was also an increase of 5 percent in year two with respect to how often the AMVC agreed with the AME on median opening decisions.

Discrepancies with driveways in year one can be attributed to the fact that only one person was reviewing driveway connection requests and did not have the advantage of a multi-disciplinary group consensus. In June 1995, the FDOT issued the rewrite for the administrative process for the Rule 14-96. The new rewrite encourages petitioners to come to a pre-application meeting with the Department's officials for a review of the access plans of a proposed project. The officials include: the AME, the permits engineer, and the petitioner's consultant. Pre-applications provide the opportunity for a more thorough review with more than one engineer. Therefore, the pre-application meetings had a positive affect in year two on how often the decision of the AME is sustained on variance recommendations. Agreement on median opening issues was improved in year two by using the newly developed "Median Opening Decision Process." The AMVC and the AME must abide by this criterion that results in a more uniform team opinion. As our district has matured in the process, we have found that flexibility is a valuable tool that can be used when managing access without undermining Administrative Rule 14-96. Flexibility must be an integral part of access management if its intent is to weather political storms.

Referring to the pie chart on Requests for Variances **(Figure 1)** we can see that in year one, 54 percent of variances involved median opening requests for all classes. Median opening requests have been subdivided into Access Class 3 and Access Class 5 facilities **in Figures** 2 and 3. We can see that 6 1 percent of variances dealt with median openings for Access Class 3 and 50 percent for Access Class 5. An Access Class 3 facility allows full median openings every 2640 feet while an Access Class 5 facility allows full median openings every 1320 feet. With a greater distance between median openings, there is an opportunity to design standard left turn lanes, but the median openings may not necessarily meet access management standards. An Access Class 5 roadway does not offer the same tolerance when compared to an Access Class 3 roadway in strict terms of design. From the data we can see how the AMVC was more flexible with driveways than median openings and that driveway deviations can be expected to be granted with a higher percent deviation. The AMVC sustained the AME recommendation in 47 percent of the cases for driveways and 68 percent for median opening deviations. Another interesting finding is the percent deviation granted. As anticipated, we found that the average percent deviation did not exceed 2 1 percent for median openings and 23 percent for driveways. During the study period, there were only four traffic signal variance requests, each with a high degree of spacing deviation. Intensive traffic, operational, and warranting analysis were conducted for each case. Many other parameters besides spacing were studied and considered when reviewing traffic signal requests. **Figures 4,5,** and 6 depict data regarding the percent of variances granted by roadway classification and type of variance requested. The results show that, for all roadway classes, 74 percent of median opening petitions were approved with an average variance of 28 percent and 60 percent of driveway deviations were approved with an average variance of 40 percent. **Figure 7** displays the average variance percentage for year one. Frequently, if petitioners are granted a variance, they are required to upgrade the total system. For example, a permittee may be required to channelize or even close an adjacent median opening as a condition to the request. The result is a roadway segment in conformance with its access classification. This is a mutually beneficial situation. The permittee obtains a variance to use a median opening or driveway and the motoring public gets a safer, more efficient corridor. Therefore, variances are given not merely by how close they come to the spacing standard.

As with year one, the pie chart on Reauests for Variances **(Figure 8)**, we can see that in year two, 34 percent of variances involved median opening requests for all classes. **Figures** 9 and **10** subdivide these requests into Access Class 3 and Access Class 5. Of these, 27 percent of variances dealt with median openings for Access Class 3 and 42 percent for Access Class 5. During this fiscal year, the AMVC sustained the AME recommendation in 76 percent of the cases for driveways and 73 percent for median deviations. The average deviation never exceeded 2 1 percent for median openings and 3 8 percent for driveways. **Figures 11,12,** and 13 depict data regarding the percent of variances granted by roadway classification and type of variance requested. The results for year two show that, for all classes, 50 percent of median opening petitions were approved with an average variance of 23 percent and 75 percent of driveway deviations were approved with an average variance of 33 percent. **Figure 14** displays the average variance percentage for year two. We did not expect much change in the average percent deviations for median openings or driveways. However, driveways received a sightly greater percent deviation than in year one. Variables such as the specific details of each request were not tracked to adequately explain this. The deviation reiterates that the variance committee is more flexible with driveways than with median openings. This can be explained by the fact that property owners have rights to access the State Highway System. The same is not true with median openings. Median openings are traffic control devices that lie within the Department's right-of-way and are at the Department's exclusive control. Driveway deviations can also be explained by the variety of abutting property land use, and their varying frontage lengths that can prohibit the property's ability to conform to the spacing criteria. Specific land uses such as drive-through banks and restaurants make the problem more complex. Often their lot size and site plan offer few possible driveway locations. With these limitations, we consider that the 37 percent deviation is a great accomplishment.

After the first year of tracking access management procedures, we were interested in the number of petitions handled annually. More specifically, the number of cases settled by the AME. The object was and is to keep the variance requests to a minimum and to resolve as many access petitions as possible without going to the variance committee level. As stated earlier, Florida's Access Management Rule encourages the petitioner to come to a pre-application meeting. District IV conducts these meetings weekly. Most issues are resolved at this level and the petitioner can continue with the permitting process. Those that cannot be settled here have the option of appealing to the AMVC. By more thorough reviews in the pre-application process, the outcome of most potential variance requests can be predicted. This is important because the petitioner may ask about the odds of a variance being granted. The pre-application meeting process improves the permitting process by significantly reducing review time in at least three ways: 1) the petitioner receives more consistent reviews, 2) helps prevent unreasonable (menial) issues from reaching the level of the AMVC, 3) helps to educate consultants on the type of variance requests that may be considered reasonable. Each case is reviewed on a "case-by-case" basis and there is no "cookbook recipe" for what a reasonable variance request is. Evidently certain characteristics of various access issues are common to many reasonable variances, but that is another paper.

By tracking the number of pre-applications and the number of variance committee meetings we have determined **the** efficiency of the system. **Figure 15** shows that of all the petitions handled, only 20 percent were settled by the variance committee. The remaining 80 percent were settled by the AME. Keeping the number of variance requests to a minimum reduced the frequency of the AMVC meetings. The committee members are usually in upper management status so it makes sense that these meetings are costly both in terms of money and time. Perhaps even more important, this fact fortifies the committee members' confidence that the AME has exhausted all possible options before a variance is sought.

Another opportunity to carry out access management is by the Department's roadway resurfacing program. In fiscal year '93/'94 and fiscal year '94/'95, our District let 5 1 road resurfacing projects. Of these, only twenty projects were possible candidates for access management retrofit. The other roadway resurfacing projects were undivided facilities. During the study period, the AME filed twelve access management recommendation reports.

However, only three were placed in the contract design plans and built for an overall 15 percent accomplishment rate. The results **are** shown **in Figures 16 through 19.** Several constraints deter access management on such resurfacing jobs. Some possible reasons are public perception of a negative economic impact, ineffective public involvement, lack of local government interest, and conflicting goals between the local and the state governrnent. If the design engineer and the AME coordinate the work together from the beginning, appropriate access management changes can be made without delaying the project letting. Access management may cause inconvenience to some motorists in terms of travel distance. This inconvenience is a cause for several groups to oppose its application. We have recognized such problems and are aggressively working to reduce the negative effects on access management achievement in Florida. Public information workshops are essential to the success of carrying out access changes in these type of projects. It has been our experience that if public workshops are well conducted and valid, reasonable concerns are addressed, then the job can be built on time while maintaining the design schedule and adhering to the intent of access management.

District IV, of the FDOT has clearly embraced the access management ideals. Management continues to realize the potential benefits and has been consistently supporting our efforts, findings, and recommendations. We have shown that the Access Management Rule has had little negative affect in the permitting process and that most petitions can comply with or without plan modifications. A tracking procedure, such as ours, can be used to ensure that the intent of access management is preserved and that it can consistently be applied throughout the state. There are, however, cases that merit flexibility to the rule. Sometimes projects cannot follow the "letter of the law" and if public officials review petitions with this idea in mind access management will not be in jeopardy. We have shown that with strong public involvement, consistent application, flexibility to the rule, common sense and practical procedures that are meaningful to the public, a government agency can employ access management and retain its integrity. Access management can be successfully achieved; District IV did it and continues to do it.

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Table 1
F.D.O.T. District 4
VARIANCE COMMITTEE TRACKING CHART

FISCAL 94/95				VARIANCE REVIEW COMMITTEE RESULTS					
MONTH	CLASS	COUNTY	SR	ACCESS MANAGEMENT RECOMMENDATIONS SUSTAINED?			PERCENT VARIANCE ACTUALLY GRANTED		
VARIANCE TYPE →				DRIVEWAY	MEDIAN	SIGNAL	DRIVEWAY	MEDIAN	SIGNAL
July	3	BROWARD	820	YES			0		
July	5	BROWARD	816	YES	YES		0	17	
July	3	PALM BEACH	804	NO			32		
August	5	PALM BEACH	704				NO SIG. CHANGE		
August	5	BROWARD	810		YES			0	
August	5	BROWARD	817		YES			19	
August	5	PALM BEACH	704		YES			0	
September	3	PALM BEACH	706		YES			28	
September	3	ST. LUCIE	614		YES			13	
September	4	ST. LUCIE	A1A	NO			36		
September	5	INDIAN RIVER	5	NO			59		
September	3	BROWARD	7	NO			30		
September	3	BROWARD	820		YES			0	
October	5	PALM BEACH	804		YES			17	
October	3	MARTIN	5		YES			0	
November	5	PALM BEACH	807	YES	NO		0	17	
November	5	MARTIN	5	NO			95		
November	3	BROWARD	848	NO			63		
November	3	BROWARD	7		NO			38	
November	5	PALM BEACH	805	NO			17		
December	5	INDIAN RIVER	60	NO			15		
January	3	INDIAN RIVER	5		NO			30	
January	3	BROWARD	823		NO			47	
January	3	BROWARD	820	YES	YES		0	32	
February	5	PALM BEACH	808		YES			6	
March		NO CASES							
April	5	BROWARD	A1A	YES	YES		0	20	
April	5	BROWARD	817	YES			0		
May	3	BROWARD	817		YES			0	
May	3	PALM BEACH	80			NO			66
June	3	BROWARD	820		NO			60	
June	3	PALM BEACH	7	YES			14		
June	3	BROWARD	820		NO			47	
PERCENT AVERAGE:				46.67	68.42	0.00	22.56	20.58	66.00

Table 2
F.D.O.T. District 4
VARIANCE COMMITTEE TRACKING CHART

FISCAL 95/96				VARIANCE REVIEW COMMITTEE RESULTS					
MONTH	CLASS	COUNTY	SR	ACCESS MANAGEMENT RECOMMENDATIONS SUSTAINED?			PERCENT VARIANCE ACTUALLY GRANTED		
VARIANCE TYPE ▶				DRIVEWAY	MEDIAN	SIGNAL	DRIVEWAY	MEDIAN	SIGNAL
July	5	BROWARD	858	NO			13		
July	5	BROWARD	817		YES			39	
July	3	MARTIN	5	NO			50		
August	5	PALM BEACH	811	NO	YES		3	0	
August	5	PALM BEACH	706	NO	YES		20	0	
August	3	BROWARD	820	NO			47		
September	3	INDIAN RIVER	5	YES			15		
Scptcmbcr	3	BROWARD	816		YES			0	
October	5	BROWARD	A1A	YES			47		
October	5	BROWARD	838	YES			49		
Octobei	5	PALM BEACH	802		YES			20	
October	5	PALM BEACH	704	YES			78		
Octobei	5	BROWARD	5	YES			0		
November	5	BROWARD	845	YES				0	
December	3	PALM BEACH	811		YES			13	
December	5	PALM BEACH	786		YES			0	
December	3	PALM BEACH	7		YES	YES		36	51
December	3	MARTIN	5	YES			59		
December	3	BROWARD	7	YES			17		
December	3	BROWARD	820	YES			0		
January	3	BROWARD	817	YES			0		
January	5	BROWARD	7	YES			10		
January	3	INDIAN RIVER	5	YKS			83		
January	3	INDIAN RIVER	5	NO			44		
February	5	BROWARD	7		YES			0	
February	INTERIM	PALM BEACH	882	YES			92		
February	3	INDIAN RIVER	A1A	YES			73		
March	3	MARTIN	5	YES			73		
March	5	BROWARD	817	YES			13		
March	3	PALM BEACH	7		NO			55	
April	5	BROWARD	858		NO			37	
April	3	BROWARD	820		YES	YES		37	34
April	INTERIM	PALM BEACH	809		NO			14	
April	3	BROWARD	838	YES			40		
April	5	BROWARD	5		YES	NO		46	51
PENDING	5	PALM BEACH	802						
May	3	BROWARD	823	YES			39		
PENDING	3	MARTIN	5						
June	3	PALM BEACH	804		NO			31	
June	3	BROWARD	870	YES			24		
PERCENT AVERAGE:				76.00	73.33	66.67	37.04	20.50	45.33

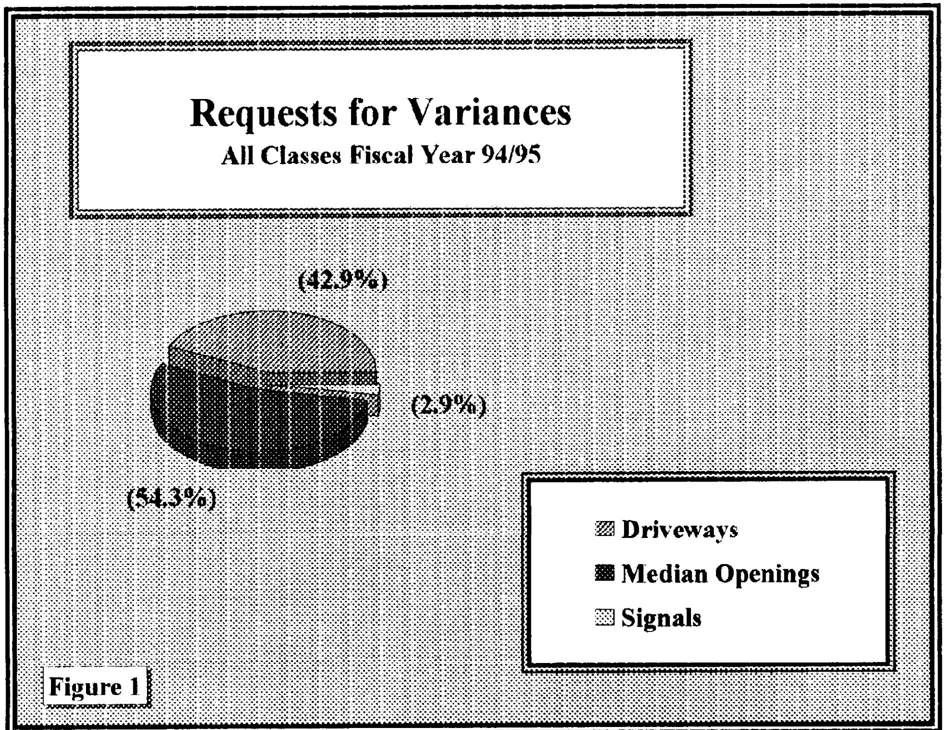
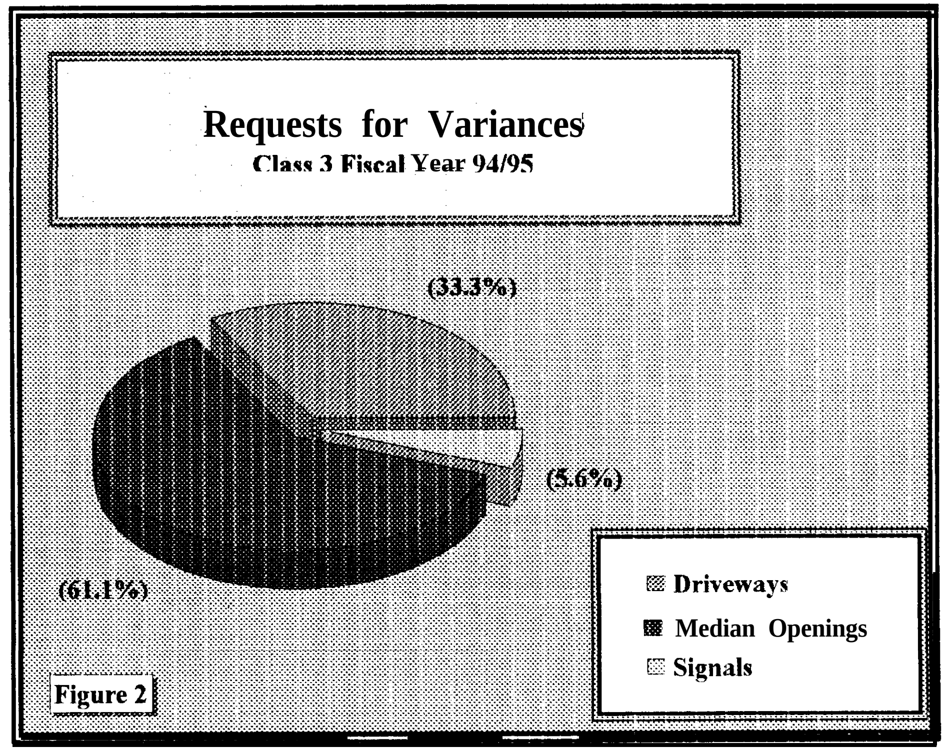


Figure 1



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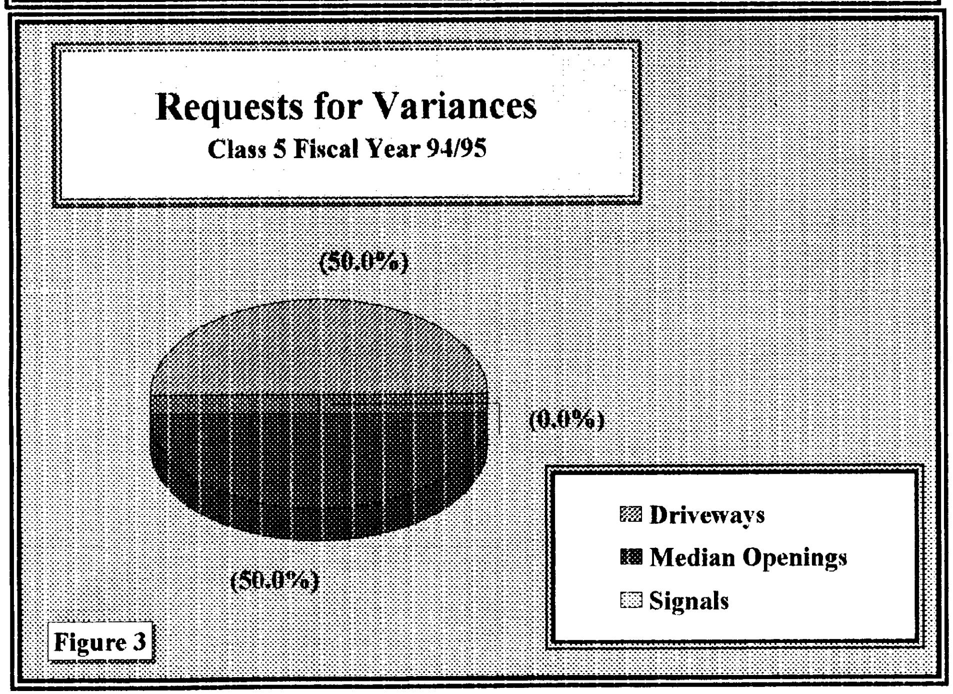

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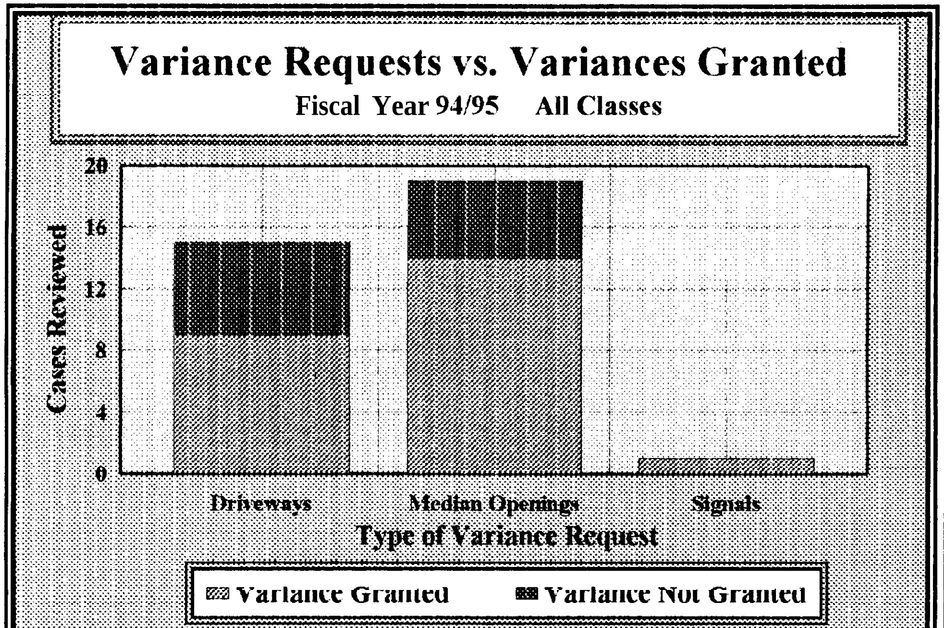

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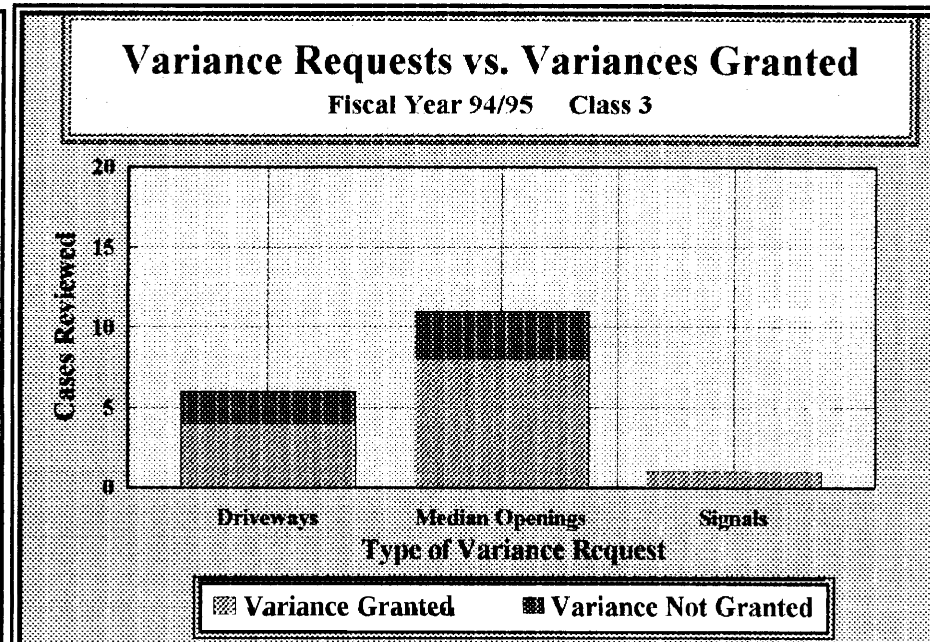

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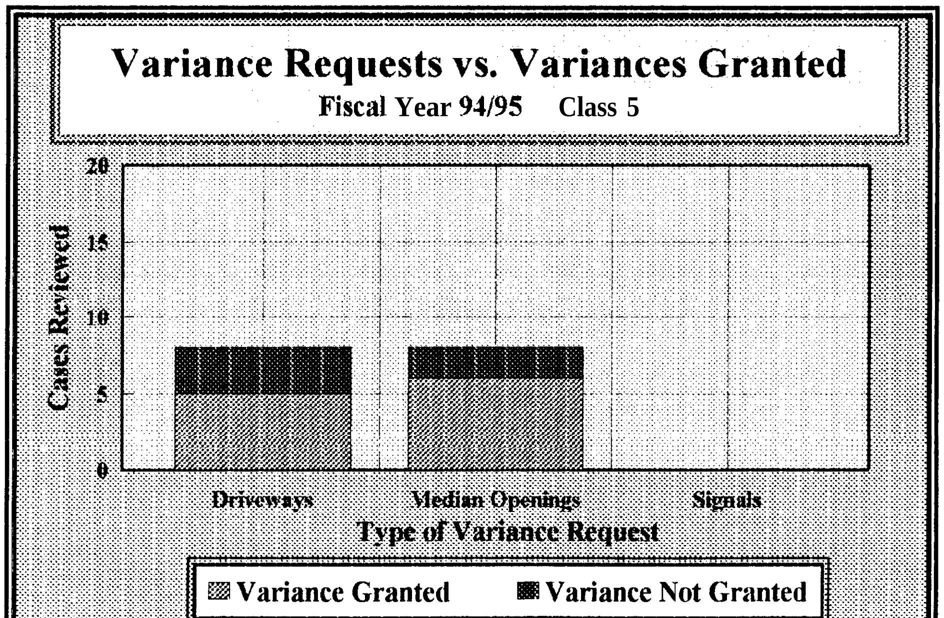

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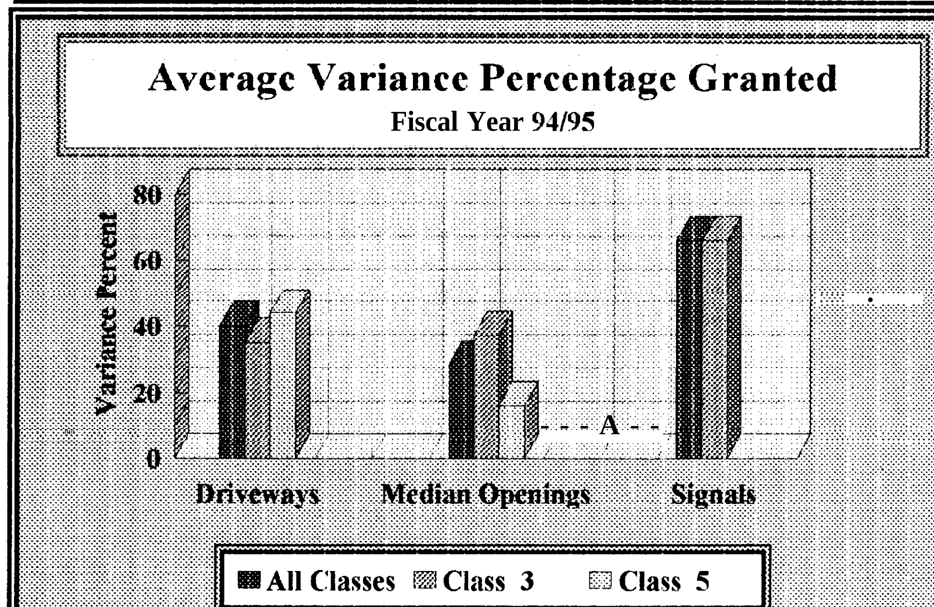

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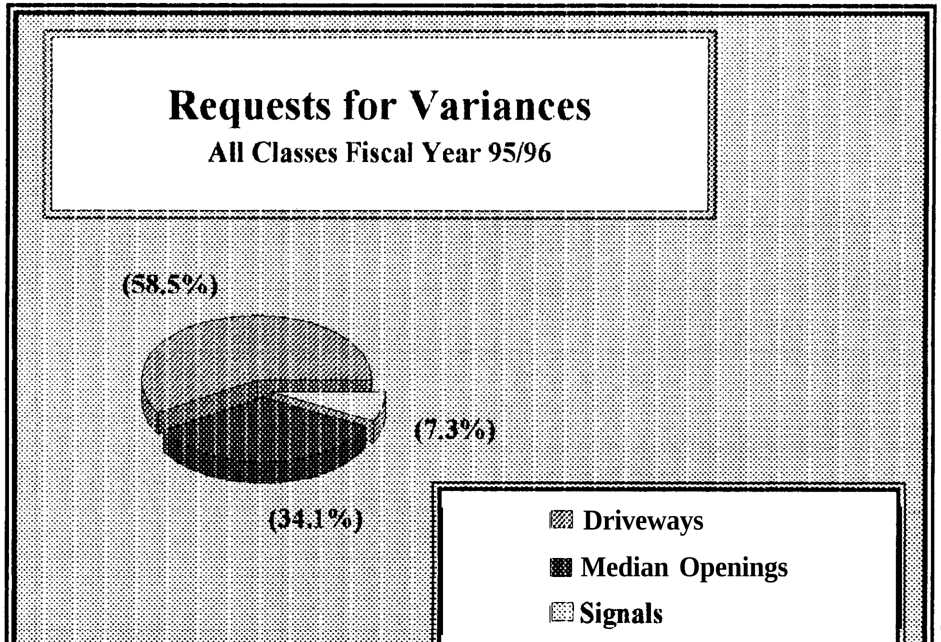

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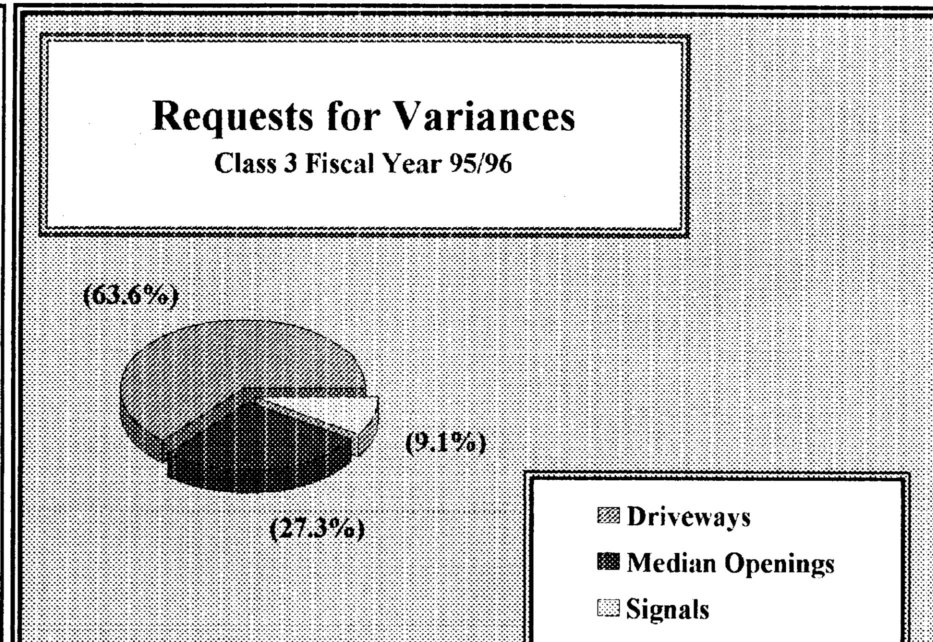

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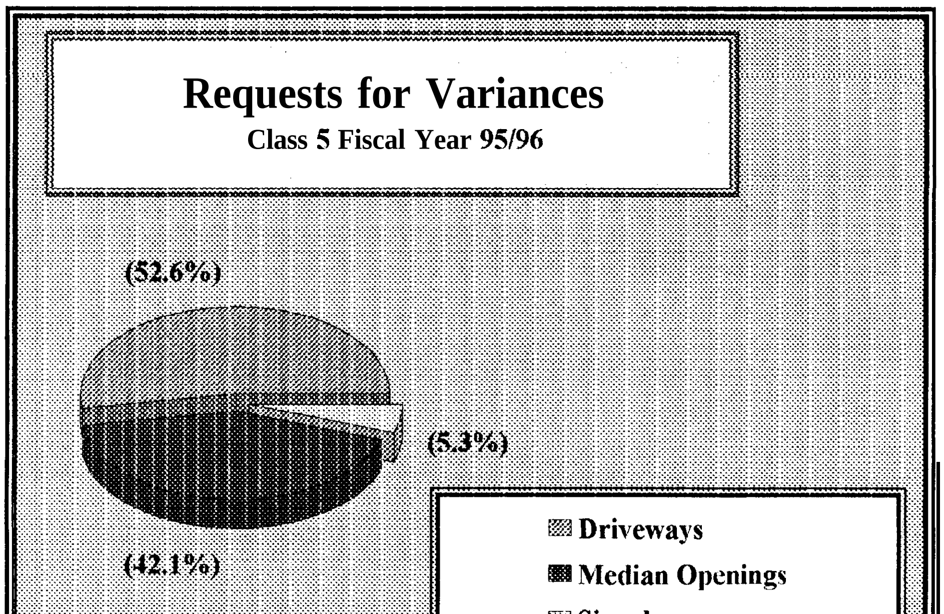

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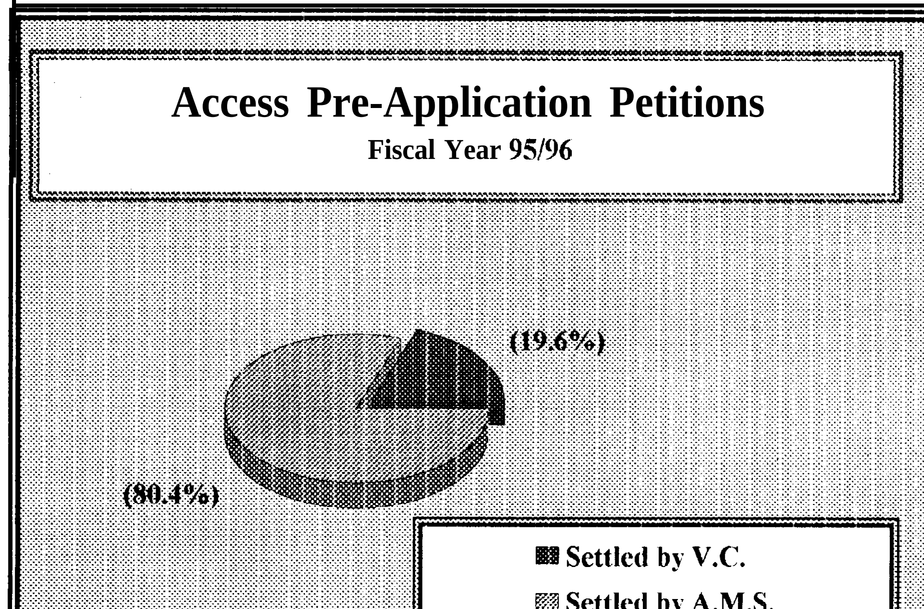

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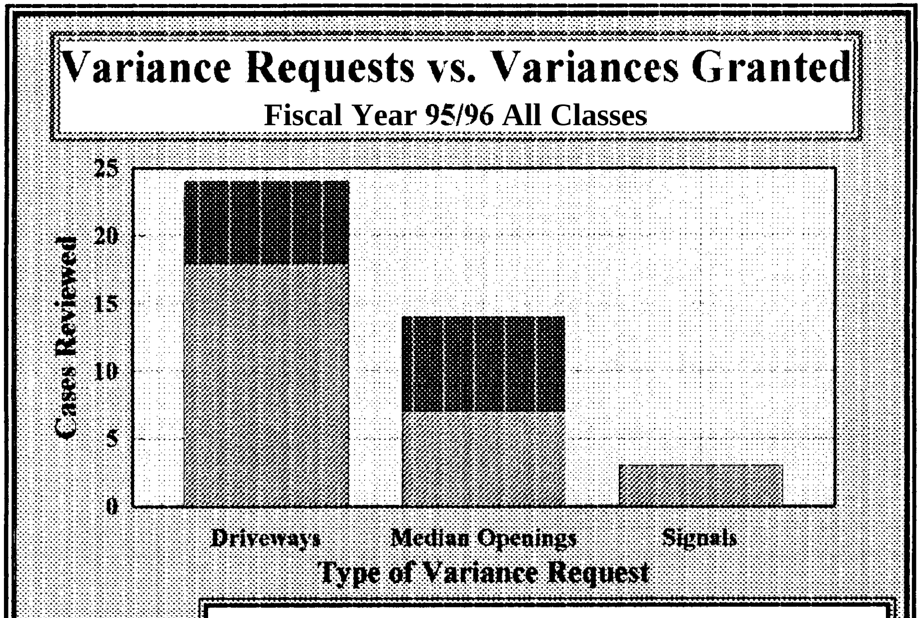

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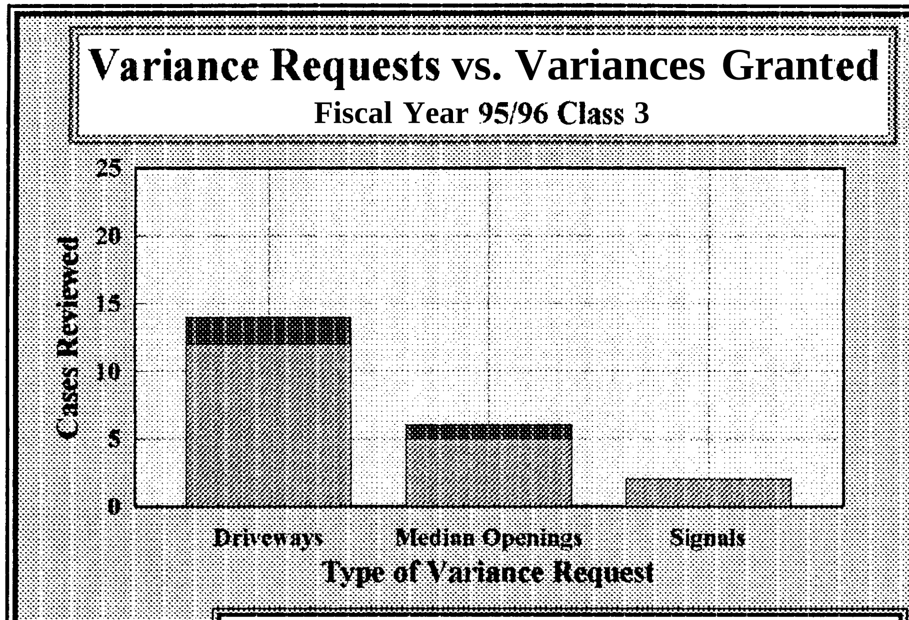

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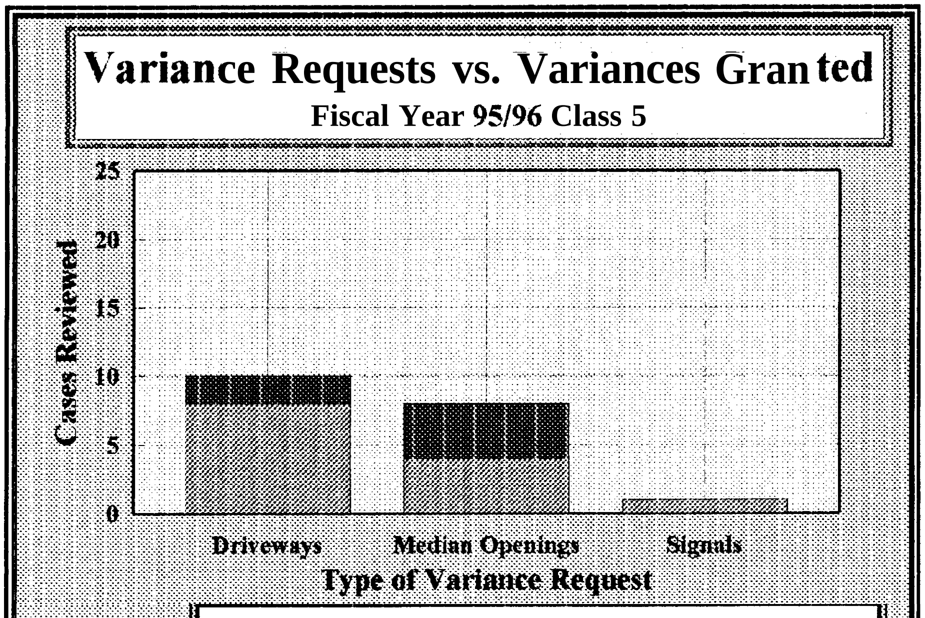

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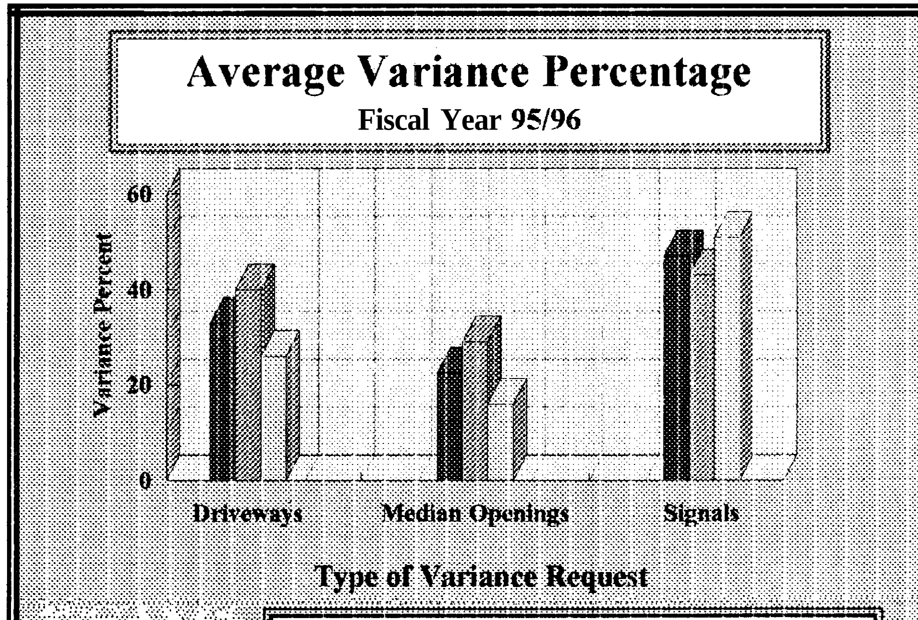

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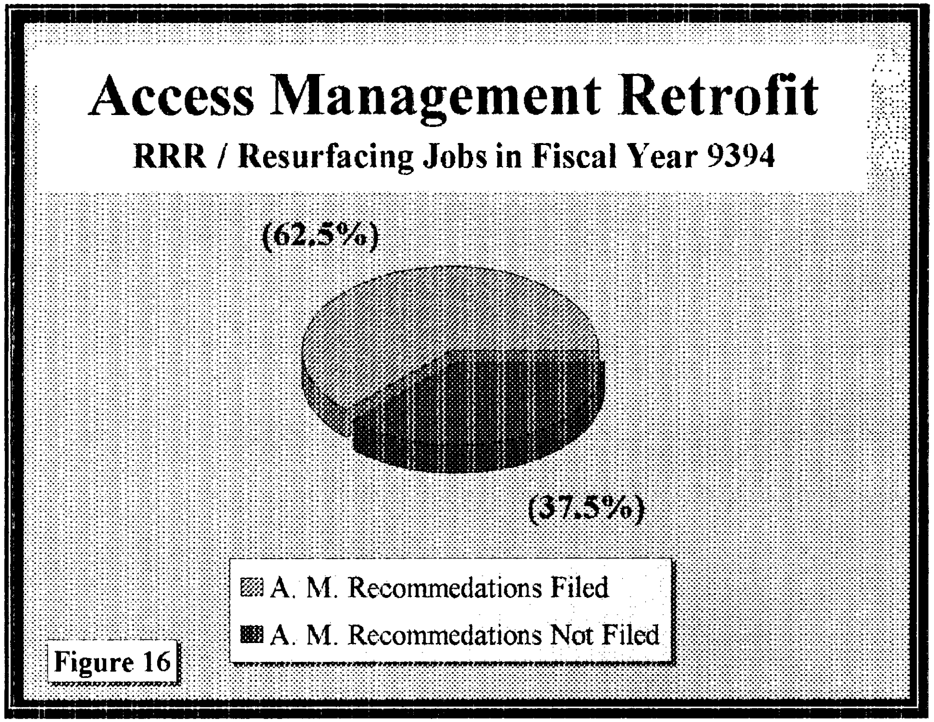

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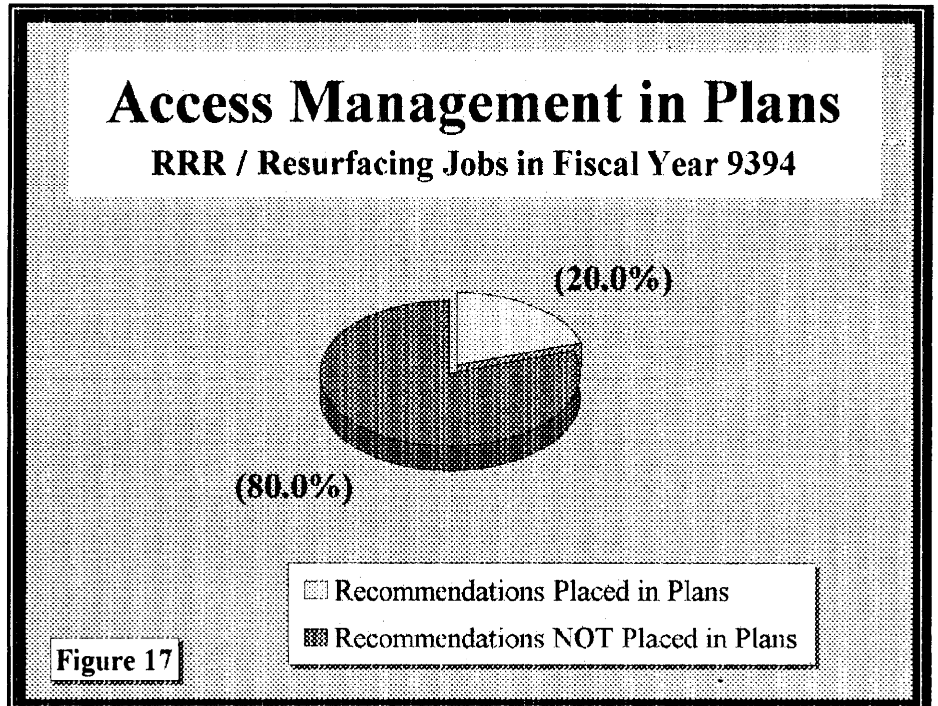

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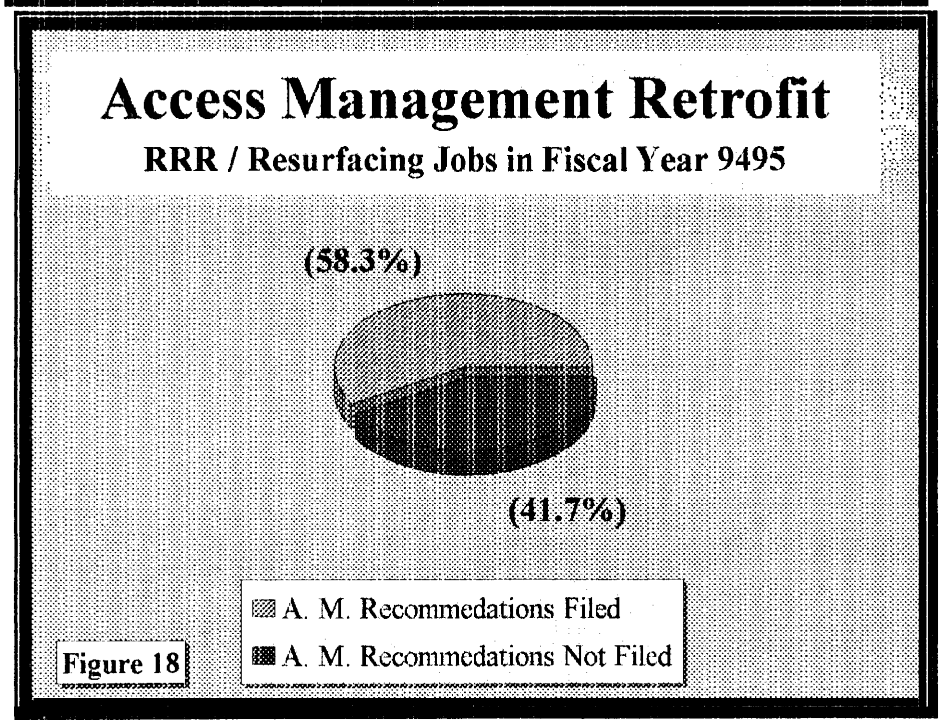

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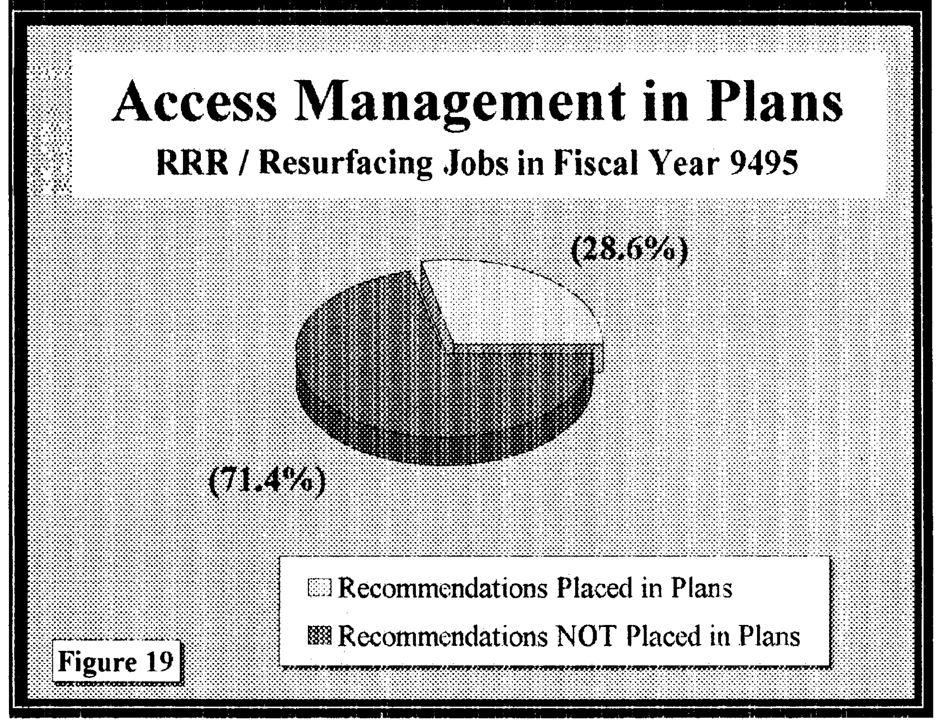

Figure 19

Questions and Answers
Access Planning and Development

Development and Administration of an Access Management Program for Local Government
The Challenges of a Town Initiated Access Management Retrofit Program on two State Highways
Access Management by Consensus, A Success Story

Question 1: Have you used the technology transfer center in Florida to help with local government coordination?

Freddie Vargas: We have used the technology transfer center in Florida for our own benefits and for locating reference material. We feel our public involvement program is doing the job by involving the public in the early stages of the project. We have been able to implement our access management program with few problems.

Question 2: Does the variance committee have the final decision in access management permit applications?

Freddie Vargas: The variance committee has the final decision, but the petitioner can still request a second review of the denial. The petitioner has the opportunity to come back and provide additional documentation to support their case. After the variance committee has reviewed the application twice the decision is final. The petitioner still has the option to use Florida Statute 120. This allows a hearing with a public officer to challenge the decision of the variance committee. During the last five years, only one hearing has been requested by a petitioner and the DOT won the case.

Question 3: How do you achieve consistency on a state wide basis from one district to another?

Freddie Vargas: The consistency element is achieved through the application procedure. Each petitioner must comply with the process that establishes the requirements to petition for a variance or deviation. This process is followed by all DOT Districts in the state.

Question 4: Do you use the intersection contour maps as a planning tool only or are they used in actually making decisions for the granting of access permits?

Stephan Ferranti: The intersection contour maps are used both as a planning tool and to make access permit decisions. We look at traffic simulation runs generated by Netsim to determine traffic que length and some detailed operational aspects of the intersection. We do not want to bring pages of these print outs to workshop meetings with business owners, so we feel it is more effective to present schematics that show the business owners exactly what these traffic simulation packages are producing. We feel these schematics are an effective tool for educating those participants that are involved or affected by the plan.

Question 5: In Florida how many people going through your application process are mom &pop operations vs. well financed developers?

Johnathan Over-ton: It really varies in Florida, the access management section deals both with mom & pop situations and developers of regional malls. A few driveway permits, mainly residential, are issued right out of the local DOT maintenance yards and are never seen by the district offices. For the most part the district offices deal mainly with the larger developers.

Question 6: Specifically in the deviation process are there many mom &pop operations that try to fight you?

Johnathan Over-ton: We realize that we have to be flexible because many times mom & pop developments do not have the frontage that is necessary to meet the access management spacing standards for driveways. We try to look at what is the intent of the access management standards, why were the standards developed and what traffic operations are occurring at the location. Many mom & pop sites are mid-block, and if we do not allow a driveway they are basically landlocked.

Freddie Vargas: The variance committees have reviewed cases from the mom & pop operations who have wanted to develop a small parcel. When their applications were denied during the preapplication process because they did not comply with the standards, we have offered them the opportunity to go to the variance committee to present their case. We particularly try to assist these applicants as much as possible by providing them with guidance to assist them in presenting their cases to the variance committee so they will get a favorable decision.

Question 7: What role does the private consultant play in your access permit application process?

Mary Jo Vobejda: The developer and his consultant often meet with us before they submit a preliminary sketch plan. We talk through the requirements and guidelines. Occasionally, especially with large developments and complicated traffic operations issues, we will deal directly with the private traffic engineer to get through some technical points before going through the more formal process.

Guidelines for Commercial Driveway Spacing On Urban and Suburban Arterial Roads

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Timothy E. White, Transportation Engineer Senior, Virginia Department of Transportation

ABSTRACT

The primary purpose of this research was to develop a methodology for determining commercial driveway spacing guidelines on arterial roads through an optimization of both safety (accident rate) and level of service (density). This project was developed due to the recognition that the lack of access control is one of the most important design and operational elements that affect roadway safety and capacity on arterial roads.

The literature search revealed that there are inconsistencies in the development of unsignalized driveway spacing standards among the states that already have access management plans. Therefore, the challenge was to develop effective driveway spacing standards that find a balance between the requirements for comprehensive land use plans and the requirements that preserve the functional integrity of the roadway. Data for the study were obtained at selected urban and suburban sites within Virginia. These spacing standards were developed mainly for arterial roads because these roads are more susceptible to the negative impacts of improper driveway spacing.

A regression analysis was used to develop models that correlated driveway spacing with both density (level of service) and accident rate. Once these two models were derived, they were used to develop unsignalized driveway spacing guidelines for roadways with varying access classifications

The resulting average commercial driveway spacing models produced values that were comparable to the existing standards in other states with access management plans. Driveway spacing distances were found for both measures of effectiveness, then the greater of the two values was used as a guideline for the driveway spacing on the roadway.

Key words: *Driveway Spacing, Access Management*

INTRODUCTION

Background

Two important pieces of legislation introduced in the early 1990's mandated that states attempt to reduce the rampant congestion and the overwhelming pollution and improve safety in urban and suburban areas throughout the United States. The Clean Air Act Amendments (CAAA) of 1990 and the Inter-modal Surface Transportation Efficiency Act **(ISTEA)** of 199 1 presented mandates such as the development of safety and congestion management systems to conform with air quality standards. **Areas that** do not meet the national standards for clear air (otherwise known as non-attainment areas) will not be permitted to construct new roads or build additional lanes until conformity is achieved. Therefore, states must develop new techniques to use the existing infrastructure more efficiently to relieve congestion and reduce accidents.

Businesses and homes have relocated outward from the city nuclei along major suburban corridors. The resultant urban sprawl has caused a change in the American lifestyle. Development in urban and suburban areas generally takes place where accessibility is provided. However, the presence of too many accesses produced by poor planning and design adds to the number of conflict points, which reduces the safety and contributes to increased travel times, delay for motorists, and therefore increased vehicle emissions. Many urban and suburban arterial roadways are now lined with strip commercial developments, with driveways spaced 25 to 85 feet apart, producing both accessibility and safety problems for the motoring public. For example, the current minimum driveway standard for commercial developments in Virginia is 7.6 m (25 ft) from the curb return of the initial driveway to the curb return of the following driveway. These guidelines apply to all commercial entrances on every type of roadway in Virginia, including the range of local to principal arterial roads. Even though this standard is identified as a minimum standard, it is often construed by developers as the desirable driveway spacing. This standard is very inadequate when compared to the access management standards in other states - the minimum spacing standard for the least restrictive roadways is 33.6 m (110 ft) in Colorado, 3 8.1 m (125 ft) in Florida, and 25.9 m (85 ft) in New Jersey.

Many state and local agencies have established driveway standards and have developed permit procedures for new or expanded developments to react to poor safety and travel conditions(1). However, most of these standards and procedures create access problems, because they do not maintain the desired operating levels of service and required safety on the roadways. Many standards concentrate solely on the design of driveways rather than on the operational effects produced by the presence of too many driveways. Access management plans which incorporate design, operational, and safety standards should be developed to resolve, or at least reduce, the problems associated with existing design standards. The necessity for a stringent access management plan is most recognizable on the arterial and collector road systems because these types of roads are used for both the movement of goods and also for access to developments along the roadway. It is along these roads that the major problems of driveway access, traffic congestion, and safety are found - where political pressures too often take precedence over engineering and planning decisions (1). Therefore, access management strategies should be concentrated on these types of roads.

Colorado, Florida, and New Jersey have devised laws to include access management standards due to the importance of improving safety and preserving the integrity of the highway system. Table 1 portrays the impacts of intersection and business density on accident rates. As the density of intersections or businesses increases, the accident rates increase at nearly the same rate.

Table 1. Effects of intersection and business density on accident rates.[1]

Intersections Per Mile	Businesses Per Mile	Accidents Per Million Vehicle Miles
0.2	1	126
2.0	10	170
20.0	100	1718

The lack of a set of common criteria for access management on arterials is also manifested in the varying criteria used by different states. Some states have developed standards based on the posted speed or the operating speed. Colorado's unsignalized driveway spacing standards, for example, are based on the American Association of State and Highway Transportation Officials (AASHTO) safe stopping sight distances. A roundtable discussion format was used to decide which factors were most important in driveway spacing. New Jersey's standards are based on minimizing right-turn overlap, thereby providing as much speed differential as possible between the mainline traffic and vehicles attempting to enter the traffic stream from a driveway. Florida's access code correlates the spacing to the access level, operating speed, and the type of median control, whereas Illinois, North Carolina, and Oregon base the spacing standards on the type of traffic generator (1). Finally, many states use a "rule of thumb" by spacing the driveways at least five times the driveway width.

Because of the lack of a nationally-recognized procedure for developing spacing criteria for unsignalized driveways and the realization of the necessity for improved access, this study was conducted to develop a methodology by which commercial driveway spacing standards could be calculated in a consistent and reliable manner, taking into account the roadway geometry, capacity, and safety conditions. This methodology would then be used to develop unsignalized commercial driveway spacing guidelines for Virginia.

PURPOSE AND SCOPE

The purpose of this research was to develop a methodology for selecting preferred commercial driveway spacing on arterial roads in Virginia by taking into consideration both safety and level of service. The scope of this study included arterial and collector roads in Virginia. Data used for the project were collected at sites selected in urban and suburban areas around the state. The primary objectives of this project were to:

- develop an access management classification system for Virginia based on the existing functional classification and roadway design features and, to a lesser extent, the degree of urbanization;
- establish uniform unsignalized commercial driveway spacing standards that take into consideration specific access classifications; and
- develop realistic unsignalized driveway spacing guidelines for Virginia.

METHODOLOGY

The challenge then was to develop effective access spacing standards that find a balance between the requirements for comprehensive land use plans and the requirements that preserve the functional integrity, capacity, and safety of the roadway. The tasks included in the methodology are as follows:

- access classification,
- identifying the factors affecting the measures of effectiveness,
- site identification,
- data collection,
- data analysis, and
- development of models.

Access Classification System

The first task in the methodology was to formulate an access management classification system incorporating the functional classification system. In Virginia, each roadway is functionally classified and then the location of the route is determined. Roadways in areas with populations greater than 5,000 are considered urban and roadways in all other areas are considered rural. The classifications for urban areas include freeways (interstates), other principal arterials, minor arterials, collectors, and local roads. The functional classifications for rural areas are: interstates, principal arterials, minor arterials, major collectors, minor collectors, and local roads.

The primary focus of this project centered around urban other principal arterials, urban minor arterials, rural minor arterials, and rural major collectors. Direct property access was permissible on these routes according to the defined access classification system. Therefore, the classification system used for this access study was: urban other principal arterials, urban minor arterials, rural minor arterials, and rural major collectors.

Factors Affecting the Measures of Effectiveness (MOEs)

The measures of effectiveness for this project were safety and level of service, because both factors greatly influence roadway operations and design. Safety can be measured in terms of the reduction in frequency and severity of accidents; whereas, the level of service can be measured in terms of density (vehicles per kilometer per hour per lane).

The process of determining which variables most influence safety and level of service on urban and rural arterials was completed in two steps. A survey questionnaire was first distributed to engineers and planners throughout Virginia both to the state and local sectors to identify the factors associated with safety and level of service. These results were then analyzed and used as the basis for the variable selection process. The objective was to incorporate as many variables into the data collection phase as possible, so that the models would provide a comprehensive, realistic, and accurate representation of the factors influencing the measures of effectiveness. However, it was not possible to account for all factors that influence accident rates, such as those variables pertaining to the driver or the vehicle as an emphasis was being placed mainly on the highway characteristics. Each of the factors in the survey was ranked in order of importance as perceived by engineers and planners around the state. These factors are shown in ranked order in Table 2.

Table 3. Variables included in the data collection phase.

Ranked for Density	*Ranked for Safety*
• ADT	• ADT
• free-flow speed	• free-flow speed
• number of lanes	• number of lanes
• percentage of trucks/buses	• number of accesses per section
• grade	• type of development
• lane widths	• percentage of trucks/buses
• type of terrain	• type of terrain
• lateral clearance	• lateral clearance
• left turn lane availability	• grade
• AM and PM peak hour volumes	• lane widths
• driveway spacing	• left turn lane availability
• free-flow speed	• right turn lane availability
• number of crossing roads	• AM and PM peak hour volumes
• medial treatment	• driveway spacing
•	• running speed
•	• free-flow speed
•	• parking conditions
•	• traffic signal spacing
•	• driveway widths
•	• square footage of all developments
•	• accidents
•	• number of crossing roads
•	• medial treatment

The variables that most influenced the measures of effectiveness were selected for data retrieval. For example, the survey results showed that the three most important factors influencing safety on arterial roadways were the left turn lane availability, peak hour volumes, and commercial driveway volumes; therefore, these factors were included in the data collection process. The same procedure was used for the factors affecting the level of service. The variables that were included in the data collection phase of the project will be discussed later in the report.

Site Identification

The survey questionnaire was also used as a source of information for the site selection process. The engineers and planners were requested to provide any corridors or roadway sections that were possible candidates for this study. From this information, several corridors throughout the state were identified as potential candidates.

Since factors such as speed limit, average daily traffic (ADT), and the number of lanes could have a direct impact on the roadway accident rate and level of service, they had to remain constant for each study section. For a section to be included in this study, the following qualifications had to be satisfied:

- uniform land use;
- consistent number of through lanes;
- constant speed limit;
- section lengths greater than 0.3 km (0.2 mi) and less than 1.6 km (1 .O mi);
- level terrain with grades less than 2 percent; and
- select functional classifications:
    - urban other principal arterials,
    - urban minor arterials,
    - rural minor arterials,
    - rural major collectors.

Besides the qualifications mentioned above, an attempt was made to collect data only on Virginia Department of Transportation (VDOT)-maintained primary routes including urban extensions. However, because of time constraints, two exceptions were accepted for the urban minor arterials - Route 617 (Backlick Road) in Fairfax County and Newtown Road in Virginia Beach/Norfolk.

Thirty locations were chosen for this study, including fourteen urban other principal arterials, eight urban minor arterials, four rural minor arterials, and four rural major collectors. The percent grade restriction coupled with the minimum length restriction were the toughest constraints to satisfy. Sites were chosen mostly from the eastern portion of the state due to the flatter topography, but other sites were found in the Northern Virginia, Suffolk, Fredricksburg, Culpeper and Richmond Districts. A description of the characteristics of the study section is shown in Table 3.

The type of data collected included driveway data, roadway data, traffic data, and accident data. The data collection process took approximately thirteen weeks. Most of the data were collected in the field; however, there were several pieces of information gathered in the office.

Data Collection

Data Collected in the Field

There were several variables collected by visual inspection of the roadway. These variables included the number of lanes, median treatments (i.e., divided, undivided, or two-way left-turn lane), number of traffic signals, parking conditions, roadway terrain, the type of development along the roadway section, and the number of accesses per section. The lane widths were measured by direction. At the same time the total length of the section was measured, the driveway spacing in each direction was

Table 3. Study section characteristics

	Route	Rot Name	Divided/Undivided	No. of Lanes	Section Length (mi)
Urban Other Principal Arterials					
1.	1	Boulevard	Undivided	4	0.335
2.	17	Broad Street	Divided+	5	0.294
3.	10	West Hundred Road	Divided	4	0.247
4.	13	Northampton Boulevard	Divided	8	0.462
5.	17	J. Clyde Morris Boulevard	Divided	4	0.372
6.	28	Centerville Road	Undivided	4	0.286
7.	29/50	Lee Highway	Divided†	5	0.305
8.	58	Virginia Beach Boulevard	Divided	8	0.388
9.	60	Midlothian Turnpike	Divided	6	0.387
10.	60	Richmond Road	Divided+	5	0.290
11.	123	Maple Avenue	Divided’	5	0.267
12.	244	Columbia Pike	Undivided	4	0.295
13.	250	Main Street	Divided+	3	0.225
14.	250	West Broad Street	Divided	6	0.476
Urban Minor Arterials					
1.	10	Broad Rock Boulevard	Divided	4	0.220
2.	279	Great Neck Road	Divided	6	0.246
3.	309	Old Dominion Drive	Divided†	5	0.267
4.	337	Portsmouth Boulevard	Divided	4	0.347
5.	407	Indian River Road	Divided	4	0.376
6.	410	Holland Road	Divided	4	0.5 16
7.	617	Backlick Road	Undivided	4	0.249
8.		Newtown Road	Divided+	5	0.306
Rural Minor Arterials					
1.	1	S. Washington Highway	Divided+	5	0.349
2.	3	Plank Road	Divided	6	0.297
3.	17	Warrenton Road	Divided	6	0.264
4.	60	Midlothian Turnpike	Divided+	5	0.406
Rural Major Collectors					
1.	1	Jefferson Davis Highway	Undivided	4	0.245
2.	15	Main Street	Undivided	2	0.238
3.	60	East Williamsburg Road	Undivided	2	0.391
4.	234	Sudley Road	Divided	6	0.309

the point-of-tangency of the successive driveway (i.e., lagging edge to leading edge). The width of each driveway was also measured. The lateral clearance on both sides of the roadway was measured. The driveway spacing was measured from the point-of-tangency of one driveway to computed by measuring the distance from the nearest fixed object (i.e., signs, trees, abutments, bridge rails, traffic barriers, or retaining

† Roads with two-way-left-turn lanes are considered to be divided sections according to the Highway Capacity Manual.

walls) to the edge of the pavement or the top of curb depending on the shoulder characteristics. This measurement was collected both on the inside (median) and outside of the roadway.

For divided roadways, the number of median openings in the study section was collected. Since left-turn lane availability is such an important factor in both the safety and capacity of the roadways, the.number of median openings with left-turn lanes was noted. The location and number of right-turn lanes throughout the study section was noted so that the percentage of driveways with right turn lanes could be computed. Furthermore, if left turn lanes were provided and left turns were restricted (either during peak periods or permanently), then it was noted since traffic flow and safety would be impacted by this type of restriction. The traffic signal spacing was obtained where more than one traffic signal existed within the study area.

Free-flow speeds and average speeds were collected using a state-of-the-art infrared laser gun that measured both the range and velocity of selected targets. Free-flow speeds were gathered with vehicles traveling at uninhibited speeds, usually during off-peak times or at the beginning of a traffic platoon. Average speeds were also obtained. Average speeds were affected by turning and queuing traffic, so this information was collected mainly from traffic in the outside lanes. Average speed data were collected during the AM peak period, the off-peak period, and the PM peak period.

Peak period traffic counts were made on the mainline roadway for both the morning peak period (between 6 A.M. to 9 A.M.) and the evening peak period (between 4 P.M. to 7 P.M.) at a central location within the study site. The counts were conducted on 15-minute intervals so the peak hour could be calculated. The number of trucks and buses was counted so that truck percentages could be computed.

Data on several land use variables were collected along the study section. As mentioned previously, the prevailing type of development through the study section was observed which was predominately commercial in nature. In addition, the number of accesses throughout the study section was counted. For undivided sections, accesses on both sides of the roadway were counted, because accesses on both sides of the roadway affect the capacity and safety of an undivided facility. For divided sections the number of accesses equaled the maximum number in one direction. The square footage of each of the commercial establishments throughout each study area was gathered by retrieving the information from the local Assessor's Office, or as a last resort, by measuring the footprint of the building.

Data Collected in the Office

ADT data was retrieved from the VDOT 199 1 Traffic Counts publication or from traffic engineering staff for the urban extensions. Historical accident information was collected for three years (January 1, 1990 to December 3 1, 1992) from the VDOT accident system and from the police accident records section within each city or town. This information was further detailed by accident severity (e.g., property damage, injury, and fatal accidents). Occupancy rates during the study period (summer of 1993) were retrieved from the hotels and motels within the sections. The total number of rooms available was also obtained at the same time. These occupancy rates were used during the trip generation phase of the project to calculate the number of trips entering and exiting the motels and hotels within the sections. A summary of some of the data collected in the field and office is shown in Table 4.

DATA ANALYSIS

Traffic Counts

The peak hour traffic volumes for both the AM and PM periods were calculated by summing the traffic counts for each of the 15-minute intervals to find the greatest one-hour traffic volume.

Table 4. Portion of the data summary worksheet for all three road types

Route	Length	Median	ADT	FF_Spd	spd_Lim	Avg_Spd *	Spd_Diff	#_Lanes	#_Access
Rural Mirror Arterials and Rural Major Collectors									
1 - Ashland	0.349	1	17348	41.49	35	36.32	5.17	2	19
1 - Stafford County	0.245	0	18425	40.16	35	32.17	7.99	4	24
15 - Warrenton	0.238	0	12156	22.48	25	19.08	3.40	2	13
17 - Stafford County	0.264	1	18120	48.05	45	36.28	11.77	3	12
AVERAGE	0.327		28668	41.30	38	33.83	7.49	3	18
Urban Minor Arterials									
10 - Richmond	0.220	1	22607	45.51	40	37.80	7.71	2	18
279 - Virginia Beach	0.246	1	35322	50.44	45	41.15	9.29’	3	13
309 - Fairfax County	0.267	1	25548	37.27	30	30.17	7.11	2	12
337 - Chesapeake	0.347	1	31512	40.96	35	33.90	7.06	2	14
AVERAGE	0.324		33208	42.93	37	35.24	7.72	2	16.00
Urban Principal Arterials									
1 - Colonial Heights	0.335	0	24436	40.05	30	30.89	9.16	4	41
10 - Chesterfield County	0.247	1	36158	44.97	35	36.18	8.79	2	12
123 - Vienna	0.267	1	40970	36.19	30	29.14	7.05	2	14
13 - Virginia Beach	0.462	1	56660	50.63	45	40.73	9.90	4	20
AVERAGE	0.331		35751	42.59	34	34.38	8.47	3	21.29

The peak hour factors were then computed using this information.

Initially, traffic data were collected for the three-year period from 1990 to 1992, which corresponded to the same period collected for the accident data. However, due to the scarcity of traffic data on several routes, ADTs were retrieved from 1988 to 1993. The ADTs for these years at each location were then averaged, and these average values were used later to calculate average accident rates and average daily traffic volumes per lane.

Speed Studies

The average free-flow and running speeds were calculated by simply averaging the speed data retrieved from the field. The average speed differential was computed by subtracting the average running speed from the average free-flow speed. The free-flow speed was mainly used in the computation of the level of service.

Trip Analysis

The average driveway spacing for each section was computed by averaging the driveway spacing observed in the field. For undivided roadways, the spacing of driveways on both sides of the roadway was simultaneously considered since the traffic from all driveways had an impact on motorists. For divided roadways, the driveway spacing on either side of the roadway was measured independently. Driveway spacing difference was computed by subtracting the smallest driveway spacing from the largest driveway spacing for each section. This term was simply used to describe the variability of the driveway spacing within a study section.

Calculations for the average driveway trips generated by the developments within each study section required the most detailed analysis. The square footage of the land use was used to calculate the total number of PM peak hour trips entering and exiting the land uses. The 5th Edition ITE Trip Generation Manual provided trip rates used to calculate the number of trips using each driveway(2). The PM peak hour on the adjacent street trip rates were used for the analysis, which means that the trip rate was based on the peak hour on the adjacent roadway rather than the peak hour of the generator.

There were many situations when this standard calculation was not possible. For example, the units for motels and hotels were not provided in total gross square footage, but were instead based on the number of occupied rooms. The data mentioned previously pertaining to hotel and motels was used to calculate the total PM peak hour trips. In the Trip Generation Manual, the rates for gas stations were not as detailed as needed. Therefore, gas station trips were obtained from results of a study performed by the New Jersey Department of Transportation(3). These gas station trips were divided into regular gas stations, gas stations with service bays, gas stations with a mini-mart, gas stations with a car wash, and gas stations with all three services.

Total trips were then distributed based on the number of driveways, the types of land use(s), and indirectly the traffic signal locations. Spot turning movement counts conducted at a select number of land uses during the data collection also provided percentages used extensively during the trip distribution phase.

For example, a McDonald's restaurant had four driveways - two on the arterial and two on a side street. Each driveway did not receive an equal amount of traffic due to its proximity to the arterial, the location of traffic signals, and the geometric design of the arterial roadway (i.e., median or no median, the number of lanes, etc.). The spot counts were conducted to determine the percentages of trips using the driveway(s) on the side street versus the driveway(s) on the arterial, depending on the type of land use and the median treatment. Separate counts for banks, fast-food restaurants, convenience stores, strip shopping centers, and gas stations on undivided, divided, and two-way left-turn-lane roadway sections were collected. Using the percentages developed from these manual counts, trips were then distributed to each driveway from land uses on comer lots. For land uses with driveways entering only onto the arterial, the total trips were divided equally for each driveway to find the average number of trips per driveway.

Most parcels contained several developments sharing the same driveway(s). For these cases, the trips for each land use were simply totaled and distributed among each driveway just as if there was only one land use. One-way driveways were included in the analysis, but the trips using the driveway were computed in only the direction of travel. Residential driveways, on the other hand, were not included in the study since they were assumed to be exempt from the spacing standards due to the low amount (about 10 trips per day) of traffic using the driveways. Colorado, New Jersey, and Florida also render the residential driveways exempt from the unsignalized driveway spacing standards.

Once the number of trips per driveway was calculated, an average value was computed based on all of the driveways within the study section. Also, the difference of the driveway volumes was computed by subtracting the smallest driveway volume from the largest driveway volume on the study section. The driveway widths were averaged for the entire site to develop an average driveway width for each site. Again, the difference of the driveway widths was computed by subtracting the smallest widths from the largest.

Level Of Service Calculations

Since this project was conducted prior to the publication of the 1994 Highway Capacity Manual (HCM), the level of service calculations for the multilane sections was calculated using the revised 1992 Highway Capacity Manual (HCM) multilane methodologies. Level of service describes the operation of the roadway in terms of density, with LOS A corresponding to free-flow conditions and LOS F corresponding to forced or breakdown flow conditions. The number of lanes, free-flow speeds, peak hour traffic volumes, percentage of trucks and buses, peak hour factors, and median condition (divided or undivided) were used to calculate the density in passenger cars per kilometer per lane (pcpkmpl).

Density was computed by dividing the service flow rate by the free-flow speed on the roadway section. Since the free-flow speed was obtained from field measurements, no subsequent adjustments to the speed (e.g., for lane widths, percentage of trucks, type of terrain, etc.) were necessary to determine the level of service.

Accident Analysis

The accident analysis included the calculation of the section accident rates in accidents per 100 million vehicle-kilometers traveled. The accident rate was the second dependent variable used in the regression analysis.

Miscellaneous Factors

The total lateral clearance was computed by adding the lateral clearance on both the left and right side of the roadway. According to the HCM, the lateral clearance should not be greater than 1.83 m (6 ft) on either side of the roadway for a total of 3.66 m (12 ft) on both sides.

Left-turn lane availability was calculated mainly for divided roadway sections. For divided roadways, the left-turn lane availability pertained to an allowance of a protected left-turn movement, which corresponded to the presence of a left-turn lane in a median opening. For example, if each median opening in the study section contained left-turn lanes in both directions, the left-turn lane availability was 100 percent. For sections with a two-way left-turn lane, the left-turn lane availability was again 100 percent since protected left-turns could be accomplished anywhere in the section. For undivided sections, the left turn lane availability was zero since there were no designated left-turn lanes unless there were specific turn lanes designated with striping.

Right-turn lane availability was calculated by dividing the number of driveways with right-turn lanes provided by the number of driveways without a right-turn lane provided. For example, if there was a continuous right-turn lane throughout the section, then the right-turn lane availability was 100 percent. If there were twenty driveways in a section and five of were accessed with a right-turn lane, then the right-turn lane availability factor would be twenty-five percent.

The average traffic signal spacing was computed by dividing the section length by the number of traffic signals in the section plus one. For example, a section with three traffic signals and a total section length of 0.81 km (0.5 mi) would have a traffic signal spacing equal to 0.81 km (0.5 mi) divided by four or 0.20 km (0.13 mi). Table 4 summarizes only a portion of the data that was collected for each type of roadway. There were twenty-six additional factors included in the complete version of the summary table.

MODEL DEVELOPMENT

The correlation, regression analyses and other related statistical analyses were initiated using the Statistical Analysis Software (SAS). First, a separate correlation analysis was conducted for each of the four access classes to determine which variables were most highly correlated to density and safety.

Higher correlations between each independent variable and the two dependent variables (density and accident rate), provided a greater probability that the variable would be included in the regression analysis for the model development. For example, if ADT per lane was highly correlated to the accident rate, then that variable was considered for inclusion in the regression analysis. Variables that were included in the accident rate regression analysis were not necessarily included in the density regression analysis, because their variables were considered to be mutually exclusive. To eliminate the problems associated with collinearity, independent variables that had a high correlation (R^2 = 0.7 or greater) with other independent variables that were already included in the model were excluded from the regression analysis.

From the safety analysis, seven variables (ADT per lane, average speed differential, right-turn lane availability, average driveway volume, traffic signal spacing, and average driveway spacing) were used for the urban other principal arterials, and six variables (ADT per lane, average speed, average number of accesses, number of crossing intersections, left-turn lane availability, average driveway spacing diffcrcnce, and average driveway spacing) were used by conducting the level of service analysis for the urban minor arterials.

Based on the correlation analysis for the rural roads, average driveway spacing ranked fifth out of six variables. The lack of a significant correlation between average driveway spacing and the level of service or safety on the rural roads is not surprising, because in rural areas the provision of frequent access to abutting properties is not usually as critical as in urban or suburban areas. Therefore, the rural sections, were then removed from further study.

The regression analysis was completed using the SAS REG (regression) procedure. The RSQUARE and AIC commands were used to conduct the R^2 analysis and model selection steps of the project. Akaike's information criterion (AIC) is a factor that made the model selection a relatively straightforward process. Using AIC as a criterion for model selection, the best model was determined to be the model with the lowest AIC value.

The AIC for any model is expressed in following equation.

$$AIC = -2 \log_e L(LK) + 2k \tag{1}$$

where:

$L(LK)$ = loge(maximized likelihood), and
k is the number ofparameter estimates.

The first term represents the badness of fit, while the second term compensates for the complexity of the model.

The following relationships were studied: linear, square root, log-linear, and log-log. Multiple linear regression was then performed using accident rate and density as the dependent variables. The best model was chosen from each of the equations and compared with models from the other relationships with respect to the AIC and R^2 value. Using this procedure, the four optimum models were selected: two for level of service (one for urban minor arterials and one for urban other principal arterials). and two for accident rates (one for each of the roadway classifications mentioned previously).

Unfortunately, the density model for the urban other principal arterials and the accident rate model for the urban minor arterials did not provide realistic results. The best density equation for the urban principal arterials produced driveway spacing between ten feet and two feet for LOS C and A, respectively. Obviously, these results were not useable. Similarly, the accident rate equation for the urban minor arterials produced unreasonable results. Based on an analysis of the results, these two models were discarded from further study.

Further analysis was conducted on the two remaining models. Equation 2 was an urban principal arterial accident rate model and Equation 3 was an urban minor arterial density model. These models included data from both undivided and divided roadways. Therefore, the user of the models must take precaution when entering values for the independent variables. Several variables differed depending on the median treatment. For example, the number of accesses and the left-turn lane availability varied with respect to the type of median treatment.

As mentioned previously, for undivided sections the number of accesses included accesses on both sides of the roadway, while for divided roadways the number of accesses included the greatest number in one direction. These models were used to develop the guidelines for unsignalized commercial driveway spacing for urban other principal arterials and for urban minor arterials. Since the R^2 values are so close to one, the two equations very closely predict the true behavior of the accident rate and density. Because these data were collected solely in Virginia at a total of thirty sites, boundary conditions will be provided for each variable in the model.

$$\begin{aligned} AccidentRate = {} & 1034.5 + 0.00274\,ADTLANE + 0.4262\,AVSPD + 3.0294\,ACCESS \\ & 514.5\,LTLA - 2.5597\,DSPG - 0.4344\,DSPGV \end{aligned} \tag{2}$$

with $R^2 = 0.9409$ and AIC = **61.21,** and where

		Boundary Conditions
ADTLANE	= *average daily traffic per lane;*	4,500 to 10,462 vehicles
A VSPD	= *average speed;*	37 to 74 kph (23 to 46 mph)
ACCESS	= *average number of accesses on study section;*	12 to 41 accesses
LTLA	= *left turn lane availability;*	0 to 100 percent
DSPG	= *average driveway spacing; and*	
DSPGV	= *average difference in driveway spacing.*	33 to 134 m (108 to 438 ft)

This linear model representing the accident rate relationship on urban other principal arterials shows that as the ADT per lane increases (40.0 percent change), the accident rate increases by only 1.4 percent. Furthermore, as the average or 50th percentile speed on a roadway segment increases (33.3 percent change), the accident rate increases slightly by 1.1 percent. In addition, as the total number of accesses increases (50 percent change), the accident rate increases by 7.7 percent and the same percent change of the left turn lane availability decreases the accident rate by 23.6 percent. It is important to note that as the driveway spacing increases (50 percent change), the accident rate decreases by 37.2 percent.

$$Density = e^{49.4740} * ADTLANE^{1.7515} * SDIFF^{-11.5031} * RTLA^{-1.8799} * DVOL^{-0.4338} * DSPG^{-6.3576} * SIGSP^{-1.1707} \quad (3)$$

with $R^2 = 0.9986$ and AIC = 24.74,

and where

		Boundary Conditions
ADTLANE	= *average daily traffic per lane;*	5,652 to 11,712 vehicles
SDIFF	= *average speed differential;*	10.8 to 15.0 kph (6.7 to 9.3 mph)
RTLA	= *right turn lane availability;*	0 to 50 percent
DVOL	= *average driveway volumes;*	27 to 72 vehicles
DSPG	= *average driveway spacing; and*	
SIGSP	= *average traffic signal spacing.*	136 to 302 m (438 to 992 ft)

This model representing the density relationship, explains that as ADT per lane increases on urban minor arterials, the density will increase. With all other variables held constant, increasing the ADT per lane on a road segment from 5,000 to 7,000 vehicles per day (40.0 percent change), as an example, would raise the density by 80.3 percent. Increasing the speed differential from 8.1 kph to 11.2 kph (40.0 percent change) would increase the density by 97.9 percent, and providing fewer right turn lanes from 50 percent to 30 percent (40.0 percent change) would increase the density by 61.7 percent. If the average driveway volumes decreased from 70 to 50 vehicles per hour (28.6 percent change), the density would increase by 13.6 percent, and if the traffic signal spacing was decreased from 305 m to 214 m (30.0 percent change), the density would increase 51.8 percent. Finally, decreasing the average driveway spacing from 45.8 m to 15.3 m (66.7 percent change) would increase the density by well over 200 percent.

GUIDELINES FOR UNSIGNALIZED COMMERCIAL DRIVEWAY SPACING

The models given in Equations 2 and 3 were used to develop the unsignalized commercial driveway spacing guidelines for Virginia. These models were used for urban other principal arterials and urban minor arterials as the data obtained in the field for geometric and operational characteristics for these types of roadways were similar and approximately in the same ranges. Equations 2 and 3 were transformed by making the average driveway spacing the dependent variable and accident rate and density the independent variables. Different driveway spacing values were then derived for variations of the independent variables within the models to develop guidelines for unsignalized commercial driveway spacing.

A sensitivity analysis was conducted by changing each of the independent variables by 10 percent to find out how much the driveway spacing was affected. For the density model, there were three variables that were much more sensitive than the others including ADT per lane, speed differential, and right-turn lane availability. Therefore, the other variables were held constant while these three variables were altered. For the accident rate model, there were two variables that were much more sensitive than the others including left-turn lane availability and number of accesses. The ADT per lane did not change significantly for this model, therefore only one table was needed to summarize the driveway spacing data. An example of the two types of tables are provided in Tables 5 and 6. These tables are not all-inclusive. There are several tables for the density model for varying ADT per lane ranges between 7,000 and 13,000 vehicles per lane. For each ADT range, the levels of service range from A to F (only LOS C for and ADT per lane of 9,000 vehicles has been provided in Table 5). There is only one table for the accident rate model for the ADT range of 5,000 to 10,000 vehicles per lane, but the accident rates range from 80.5 to 885.5 accidents per 100 million vehicle-kilometers traveled (50 to 650 accidents per 100 million vehicle-miles traveled). Table 6 is only a subset of the larger table, because it includes only the values for 242.5 accidents per 100 million vehicle-kilometers traveled.

Table 5. Example commercial driveway spacing with density (ADT/Lane = 9,000)

Density (pcpkmpl)	RTLA††	Average Driveway Spacing, meters (rounded to the nearest 5.0 m)								
Speed Differential, mph.		5	6	7	8	9	10	12	15	20
25 LOS c	0.1	110	80	60	45	40	30	20	15	10
	0.2	90	60	50	40	30	25	20	10	-
	0.4	70	50	40	30	25	20	15	10	-
	0.6	65	45	35	30	20	20	10	10	-
	0.8	60	45	35	25	20	20	10	10	-
	1.0	55	40	30	25	20	15	10	10	-

Represents distances less than 9.0 m
conversion: 1 m = 3.28 ft 1 km = 0.621 mi
Constant values: DVOL (driveway volume) = 49.15 vehicles per driveway per PM peak hour
SIGSP (signal spacing) = 597.48 meters

Right turn lane availability defines the proportion driveways throughout the section that have right turn lanes provided.

For the density model, the ADT per lane changed by 2,000 vehicles for each table. Driveway spacing ranges from 9 m (30 ft) tc 153 m (500 ft) depending on the roadway and traffic characteristics. Values for driveway spacing in the tables were rounded to the nearest 3 m (10 ft). The user can interpolate between the provided values if more detailed results are required, or if the average values provided with the tables are significantly different than the results obtained in the field. Model calibration may need to be done to make sure the models accurately reflect the operational and safety conditions at specific locations.

†† RTLA - Right Turn Lane Availability

Table 6. Example commercial driveway spacing with accident rate (ADT/Lane = 5,000-10,000)

Accident Rate (Accidents per 100 mvkmt)	LTLA[†††]	Average Driveway Spacing, meters (rounded to the nearest 5.0 m)					
Number of Accesses		60	50	40	30	20	10
241.5	*0*	115	110	110	105	100	100
	0.2	105	100	100	95	90	85
	0.4	90	90	85	80	75	70
	0.6	80	75	70	70	65	60
	0.8	70	65	60	60	55	50
	1.0	55	50	50	45	40	35

conversion: lm = 3.28 f
Constant values: AVSPD (average speed) = 34.38 mph DSPGV (driveway spacing difference) = 271.29 ft

Lef-turn lane availability is defined as the presence of left turn lanes within the study section. For two-way left-turn lane sections, the LTLA factor is 100 percent. If a section has three median openings, but none of them have left turn lanes then the LTLA factor is zero; however, if the section has two left-turn lanes then the LTLA is 33 percent since there are two out of six possible turn lane locations used. The LTLA on undivided sections is zero if there are no painted turn lanes.

For the accident rate model, the resultant driveway spacing increased as ADT per lane and number of accesses increased, and decreased as the left turn lane availability and accident rate decreased. Driveway spacings range from 9 m (30 ft) to 13 1 m (430 ft). For ADTs per lane between 5,000 and 10,000 vehicles, the driveway spacing did not change significantly so the results produced by this model were incorporated into one table. The results do not change significantly until the ADT per lane reaches 15,000 to 20,000 vehicles, at which time the driveway spacing should be increased by 3 m (10 ft).

These tables showed that the models developed for this study and are given in Equations 2 and 3 can be used for either operational analysis of existing facilities, redesign of existing roadways to find optimum driveway spacing which can be retrofitted, or the design of new roadway sections in undeveloped areas. The driveway spacing developed from these models are applicable to mainly urban and suburban environments, but are most useful in undeveloped areas since retrofitting new standards is very difficult. For example, if the user chooses to analyze an existing location, the models can be used to calculate the level of service and accident rate with the existing driveway spacing and other traffic and roadway characteristics. On the other hand, the user could provide the desirable level of service and compute the corresponding driveway spacing.

Driveway spacing derived from the density model should be compared to the spacing obtained from the accident rate model. It is recommended that the greater of the two values be used as the driveway spacing standard for the roadway section in the study. However, it is essential to use engineering judgment when employing the computed driveway spacing results from the provided tables.

[†††] LTLA - Left-Turn Lane Availability

An Example Use of the Driveway Spacing Tables

To illustrate how the two tables for accident rate and density may be used to determine a preferred driveway spacing, an example design problem is provided. The study site on Route **10** in Chesterfield County, Virginia will be used as the database for this example. The following data is required to compute the driveway spacing for the density equation. The designer would like to design the facility for a level of service C. The data such as ADT per lane, right turn lane availability, and signal spacing can all be determined from the design plans. **To** design for a safe operating condition on the roadway, a speed differential of 5 miles per hour will be assumed. The type of development (e.g., light commercial, heavy commercial, industrial, etc.) along the roadway will determine the average driveway volume throughout the section. For design situations, this piece of information can be determined using data from similar, existing roadways. In this case, the average driveway volume was 8 1 vehicles per hour.

<u>Density</u> - LOS C desired.

ADTLANE=	9,040 vehicles per lane
SDIFF =	8.1 kph (5 mph) ***(desired)***
RTLA =	100 percent
DVOLS =	8 **1** vehicles per hour
SIGSP =	610 m (2,000 **ft)**

Since the **ADT** per lane is approximately 9,000 vehicles, Table 5 should be used. The complete table includes data for all levels of service from A to F (See MAUTC Report # **UVA\529978\CE95\102** for more details), but for example purposes only LOS C was included. With a design speed differential of 8.1 kph and a right-turn lane availability factor of 100 percent, enter the table on the first column and last row. The resultant driveway spacing obtained from this table is 55 m (180 ft). The data obtained from the same study site is provided for the accident rate equation is provided below including desirable values for the average speed and the number of accesses:

<u>Accident Rate</u> - 242 accidents per hundred million vehicles kilometers traveled desired (obtained a typical critical accident rate report for urban other principal arterials in Virginia).

AVSPD =	72.4 kph (45 mph) (average speed = posted speed limit is ***desirable)***
ACCESS =	$\leq$ 10 accesses per direction in study section ***(desired)***
LTLA =	33 percent
DSPGV =	**55.5** m (182 **ft)**

Again, the ADT per lane is roughly 9,000 vehicles, so Table 6 can be used since the applicable ranges is between 5,000 and 10,000 vehicles. The accident rates range from 80.5 to 885.5 accidents per 100 million vehicle-kilometer traveled, but Table 6 only shows the portion of the table for 241.5 accidents per 100 million vehicle-kilometers traveled for example purposes. Using an average speed limit on the facility of 72.4 kph or 45 mph, less than 10 accesses per direction on the divided section, **a** left-turn availability factor of 33 percent, and the driveway spacing difference equal to 56 m or 182 feet, enter Table 6 to determine the average driveway spacing in meters. Because the number of accesses is less than ten, enter the table on the last column. By interpolation, we can enter the table between 20 and 40 percent (on the second and third rows) for the left-turn lane availability factor to find out the desirable driveway spacing on this section of roadway. The resultant average driveway spacing is between 70 and 85 meters or roughly 78 meters, which is equivalent to 255 feet. After comparing this resultant driveway spacing with the results from the density model, the average driveway spacing for the design of **the roadway** segment should be approximately 78 m (255 ft), which is the larger of the two values produced by the accident rate model.

This driveway spacing should help to maintain a LOS C on the corridor, while at the same time providing for a less than critical accident rate. This example demonstrates how these models can be used to design for acceptable average driveway spacings in an undeveloped area. There are many factors that will influence the operation and safety on arterial roadways, which has been shown with this example.

CONCLUSIONS AND RECOMMENDATIONS

CONCL USIONS

The goals of access management are to preserve roadway capacity, safety, and the level of service while simultaneously providing access to commercial developments. This project was an investigative analysis regarding the balancing act between the roadway,. the motorist, and the developer. The concept of developing a relationship between the level of service and the accident rate was strong, but unfortunately the methodology requires extensive data. The guidelines developed from the models represent an improvement on the existing minimum requirements in Virginia, and should be considered as an interim step in developing appropriate access management regulations in this state. Since this project encompassed only a small range of data for different types of roadways in Virginia, it is recommended that additional data be collected in other states to validate the developed models.

The models derived from this project were restricted to urban other principal arterials and urban minor arterials due to the number of data sites. The applicability of these models should be limited to arterial roadways only, not including limited access facilities or collector roads. The density model, which includes variables such as ADT per lane, speed differential, right-turn lane availability, driveway volume, driveway spacing, and signal spacing, indicates that not only the speed and capacity of the roadway influence the density on the roadway. As evidenced by the independent variables included in the accident rate model, traffic volume is not the only factor that influences the accident rate on a roadway section. This model contains the variables such as: ADT per lane, average speed, number of accesses, left-turn lane availability, driveway spacing, and the driveway spacing difference. These models should provide transportation engineers and planners with more information to make better-informed decisions about planning roadways for the future and for analyzing existing roadway networks.

RECOMMENDATIONS

- Since all of the data were collected in Virginia and the models were developed for specific ranges of values for geometric, traffic, and safety characteristics, it is recommended that these tables are used when values for these variables are within the given boundary conditions.

- In order to improve the data base for future modeling, concentrate on one access classification at a time to develop driveway spacing standards so that a sufficient number of study sites can be obtained (i.e., thirty or more locations).

- Incorporate the grade of the roadway at the critical sight distance locations.

- Develop an access classification not solely based on the functional classification of the roadway, instead include median treatment and development type in the classification.

- Calculate the level of service using either TRAF-NETSIM or HCM (Arterial Analysis) rather than the multilane-lane analysis, these results will more realistically predict the negative impact of both the commercial driveways and traffic signals in the study section.

- Conduct a regression analysis using data from rural sites to compare the results with the urbanized areas.

ACKNOWLEDGMENT

This project was sponsored in part by the Mid-Atlantic Universities Transportation Center, the University of Virginia, and the Virginia Department of Transportation.

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Access Management and Traffic Safety

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ABSTRACT

This paper reports and discusses results of a study of accidents within 29 miles (MP 100.00 to 129.00) of the Oregon Coast Highway 9 (US 101). This is part of a research project to assist the Oregon Department of Transportation (ODOT) to develop and maintain state's Access Management Program. The area under study is located on the Oregon coast in and around Lincoln City. It has tourist character as well as normal rural and urban traffic Using several years of data provided by the Oregon Department of Transportation - Accident Data Unit, a database was created with 756 records This database contained the location of each accident site by milepint, date of accident, formation of roadway at the accident location, the intersection or median type, result of the accidents, indicating if there were any injuries, fatalities or property damage only. The database also contained coded information that briefly described the cause, site characteristics, and type of accident that occurred Another database was also created, using two video logs provided by ODOT to compare the situation of access points during 1987 and 1994. The paper analyses the entire 29 mile stretch for accident frequency and access density. It also examines a limited number of intersections in different settings: urban, rural, isolated and with overlap of influence zones. This research establishes a direct relationship between access density and number of accidents and their severity. Results also show the significant safety improvement by construction of a non-traversable median in a section of the study area compared to undivided roadway or sections with a two-way left turn lane.

INTRODUCTION

This paper is based on research aimed at assisting the Oregon Department of Transportation (ODOT) in developing guidelines for Access Management through analysis of accident experience at intersections and driveways. The analysis section used for the study is on the Oregon Coast Highway 9 (US Route 10 1) between milepoint (MP) 100 and MP 129. The highway runs through rural and urban areas and has one or more lanes of traffic in each direction. The section is a two-lane undivided highway in some parts; has a continuous two-way left turn lane in others, and also becomes a four-lane roadway divided by a non-traversable median along the Lincoln Beach - Fogarty Creek Parkway. The number of access points varies from as few as one per mile to 83 per mile of the roadway. In addition to reviewing the entire 29-mile section for accident history, several rural and urban intersections, both isolated and those with overlapping influence zones, were examined in detail.

The most recent four years (1990-l 994) of accident records are used. Any change in accident experience as the frequency and/or number of intersections and/or approach roads increases is identified. Accident frequency is investigated as it relates to the access density along the Oregon Coast Highway 9. All intersections/driveways are included in the study based on a June, 1994 video log of the Highway. In addition, accident severity is examined in relation to access density. Accident data is also reviewed on the basis of vehicle-miles traveied m order to account for any increase in traffic volume over time. Comparisons have been made between the two rural locations and also between the two urban locations to determine any relationship between the location and/or access density to the accident experience, including accident frequency and severity. Conclusions between the rural sites relative to the urban sites arc developed and described. The data for the investigation is developed from the information sources provided by ODOT including accident listing, traffic volume tables, videologs, and highway maps supported by previous construction project plans and profiles.

A database in Microsoft Access 2.0 is created using the ODOT Continuous System Accident Listing for US 10 1 through Lincoln City. This listing provided information on all reported accidents from 1990 to 1994. The listing provided the location of each accident by milepoint, date of accident, the characteristic (or type of roadway) at the accident location, the intersection or median type, and the number of legs or branches that are present if the accident site is at an intersection or driveway. The highway section covered in this study consisted of 756 individual accident entries. The milepoints in the database are entered in with an accuracy to the hundredth place, even though they appear rounded to the tenth place in the figures. Videolog recorded in June 1994 is used to obtain the location by milepoint of all the access points to US 10 1. These access points are recorded in a database for the northbound and southbound sides separately, then combined for total access points referenced by milepoint. An accident is used in the context of a single event and does not depend on the quantity of vehicles or persons involved. Levels of severity of all accident are treated as equal in this analysis However, some analysis is included with regard to the different levels of severity.

A second database in Microsoft Excel is created using ODOT Traffic Volume Tables for the years from 1987 to 1994. This traffic "machine count" data provided the Annual Average Daily Traffic (ADT), all vehicle types, for each of the 34 stations that are contained in the study section. Traffic volume has risen in some areas, decreased in others, and remained nearly constant in yet other areas over the last seven years, No obvious relationship appears which ties ADT to the increase in accidents. As a further affirmation of this concept, the number of accidents were computed on the basis of one million vehicle miles traveled. The accident experience, whether for total number of accidents or those based on severity, still clearly tracks the access density. A plot of accidents per year over the study section shows that total number of accidents have actually decreased over the period from 1990-93, while there have been some isolated increases. It also shows which areas have experienced the greatest increase in number of accidents, namely intersections. As best as can be ascertained from an examination of the number of accidents, traffic volume, and access points over the time period of the study, it appears that the accidents are directly related to the access density.

Data Sources

The data used in this study was obtained from the following information sources provided by ODOT:

- Continuous System Accident Listing
- Traffic Volume Tables 1987 through 1994
- 1987 and 1994 videologs
- Straight-line Charts for Oregon Coast Hwy. No. 9 (August 1992) US 10 1
- Previous construction project plans and profiles

Milepoint Accuracy

The milepoint where an accident occurs is determined by using either nearby green milepoint signs or significant milepoint locations that are referenced from the straight-line charts. The authorities measure by odometer or tripmeter from any nearby noted milepoints. The green milepoint signs are not necessarily a very accurate way to determine the milepoint. In many cases they can be found to be up to ± ***0.05*** in error with regard to their location and the actual milepoint. Such a case is the situation where a milepoint sign would measure to be placed in an intersection. As a result the sign would be placed at the safest and closest place possible to the intersection.

ODOT Videolog Policy

Videolog updating is based on the state route's Level of Importance (LOI). Interstate and statewide routes are updated annually. Regional and District routes are updated biannually.

LITERATURE REVIEW

Numerous reports are available in literature which analyze the relationship between access density and accidents. However, only a limited number of reports (1, 2, 3) specifically analyze the role of the functional area of an intersection and its effects on the safety of the approaches. There is an implied appreciation for the existence of a functional area which is apparent in the numerous reports linking safety and access density. Many of the reports that analyze the effect of access density on safety are simultaneously (though not explicitly) examining the effects of functional area overlapping, which occurs when access density is sufficiently increased.

Access Density and Accidents

The research linking access density and accidents on both urban and rural roads spans several decades. In a 1957 study, Schoppert (4) determined that accidents were directly related to accesses (driveways or intersections) and that access density was a reasonably good predictor of potential accidents within a given volume range. He concluded that volume was the most important factor in accident frequency, followed by access density. Solomon (5) discusses the deterioration of highway safety records over time as volume and access points increase. He concurs with Cirillo (6) that 2-lane rural highways illustrated a dramatic increase in crash rates as intersections and business accesses proliferate. Fee et al (7) analyzed an extensive database and established that an increase of access density by 10 times resulted in a doubling of the accident rate. Dart and Mann (8) report that the accident rate on rural highways increases with traffic access points per mile (minor roads and principal access driveways). Colorado Department of Highways (9) demonstrates the safety benefits of access control on urban arterials. The results of this project show that access controlled arterials have accident rates ranging from 27% to 69% of arterials without access control. The improvement in safety with increased access spacing is also illustrated by a Wisconsin study (10) conducted on rural roads. Long & Morrison (11) analyzed over 400 miles of urban roadways in Florida and conclude that as driveways per mile increase, crash rates also increase. An interesting exception to the voluminous research linking increased access density with roadway safety degradation emerged in a Tennessee study (12), which found that accident rates remain flat as access densities rise on suburban-commercial 4-lane arterials with continuous two-way left-turn lanes (TWLTLs). In addition, on 4-lane suburban-commercial arterials with raised medians experienced a significant increase in accident rates as access density rose.

A study of rural two-lane primary arterial highways conducted in British Columbia (13) attempts to provide a somewhat comprehensive examination of the safety impact of access type, access density, traffic volume, and road geometry. The analysis reveals that all access types were significantly correlated with accidents, however, the correlation between access density and accident rates is not a simple one (at least for the highways included in this study). Among the other conclusions drawn by the researchers:

- Public road intersections appear to have the most impact on accident frequency/rate. On average, one public road has an impact equivalent to 10 private driveways.

- As access density increases (whether public road approach, business or private access) there is a linear, but diminishing, trend in the rise of the accident rate.
- The increase in accident rate due to an increase in access density is greater at higher speeds than at lower speeds.
- A business access has an impact on accident rates of about one half that of public road intersections.

Where private accesses are located on horizontal curves, accident rates rise as the degree of curve Increases.

Intersection Functional Area

Stover (1) presents an approach for conceptualizing and establishing the extents of upstream functional areas of intersections. Stover remarks that "the American Association of State Highway and Transportation Officials (AASHTO) specifically states that a driveway should not be located within the functional boundary of an intersection . . ." and that ". . .Whereas AASHTO does not present guidelines as to the size of the functional area of an intersection, logic indicates that it must be much larger than the physical area." The assertion is that the placement of driveways in the functional area of an intersection can be expected to increase accident rates. Stover defines the upstream length of the functional area of an intersection by the sum of four distances, as follows: 1) the distance covered during the driver's perception-reaction time; 2) the distance covered during the time in which the vehicle moves laterally while braking, assuming a turn lane is provided at the site of ingress; 3) the braking distance after the lateral movement has been completed; 4) queue storage sufficient for storing all turning vehicles most of the time.

Stover asserts that there is a serious degradation of safety which occurs with increasing speed differentials between turning and through vehicles. He further states that "a turn bay is essential if the speed differential between turning vehicles and though traffic is to be limited to some reasonable magnitude." Stover (1) and the TRB Draft Circular (14) make it apparent that the boundaries of the functional area cannot be exactly established, as the requisite perception-reaction and deceleration distances vary with the driver (and vehicle types) and thus the upstream functional area must be computed using an estimate such as an 85th percentile design driver.

Minimizing Effects of Intersection Functional Area Overlap

Reported research (14) has shown that managing access can significantly reduce the frequency and severity of accidents. To address the access density issue, jurisdictions throughout the country are currently using essentially three theoretical bases for determining recommended unsignalized access spacing: 1) speed differentials, 2) stopping sight distance, 3) right-turn conflict overlap.

AASHTO (15) provides sight distances for a wide range of intersections and traffic movements, such as the right-turn (from a minor road) onto a major highway. AASHTO states in effect, that there must be sufficient sight distance for a vehicle turning right onto a highway to accelerate to a predetermined speed before the highway's through vehicles from the left overtake it while traveling at the same predetermined speed. The TRB Draft Circular (14) presents tables of suggested intersection stopping sight distances, which are generally longer than those used by AASHTO. In effect, where sight distance is utilized as a basis for setting access spacing, the TRB Circular (14) favors using a wider spacing than would be computed using AASHTO's values for intersection sight distance. Reducing right turn conflict overlap is also suggested as a means of recommending desirable access spacing.

Other Factors

The factors that affect a facility's safety are often interactive and cannot usually be isolated completely from one another in the course of analyzing the facility's safety performance. A recent report (16) based on a survey of 49 state Departments of Transportation (DOTs) lists factors which adversely affect safety as follows:

- difficulty in gauging the opposing traffic's arrival times at an intersection
- misjudging of the necessary intersection clearance time
- sight distance obstruction caused by opposing left-turning vehicles
- high-speed differentials between through and-turning traffic
- intersections at grade which drivers do not expect to encounter on an expressway.

The impact of any of these factors could well be expected to be magnified by increasing access density, and therefore, it is not surprising that the study mentions access control as one of the common approaches which the state DOTs are taking in order to mitigate intersection problems on rural expressways. Other common approaches which are mentioned included signing and signalization and offsetting of left-turn bays to minimize sight distance obstruction. Hearne (17) ranks rural road and traffic variables contributing to accidents in the following order: 1) total vehicle miles traveled; 2) development density; 3) absence of a hard shoulder; 4) road width; 5) design speed. Once again the most important influences are found to bc volume and development density, which increase both exposure and conflicts. Gambard (18) examines the accident histories of 2000 rural intersections comes to the following conclusions:

- The average number of accidents per intersection is found to be proportional to the Average Daily Traffic (ADT) of the secondary road.
- The average number of accidents increases with the number of lanes on the main road and the number of legs at the junction.
- 70% of the accidents arc the result of crossing conflicts and left-turns.

Kihlberg and Tharp (19) examine a wide array of geometric variables using data from Connecticut, Florida, and Ohio and arrive at the following conclusions:

- rates for single vehicle crashes decrease with increasing ADT, while multi-vehicle accidents increase;
- without access control, undivided 4-lane roadways have higher accident rates than 2-lane access control had the most powerful effect on accident reduction;
- roadways;
- medians tend to decrease accident rates;
- elements such as curvature, gradients, structures and intersections increase accident rates, with intersections having the most significant effect;
- combinations of these elements produce accident rates higher than the isolated elements.

The ITE Traffic Engineering Handbook (20) looks at some of the roadway safety factors that are relevant from an access management viewpoint. Among the findings that it presents are the following:

- Accidents increase with both ADT and access density.
- Accident rates exhibit a sharp rise as speed differentials between through and turning traffic increases.
- Collision potential increases as the space between unsignalized right-turn access points is decreased.-

Left-Turning Vehicle Movement

One of the most dominant factors bearing on the safety performance of a roadway or intersection is the left-turning vehicle. When analyzing intersection safety, it is difficult to ignore the left-turn movement, not only because it generally generates a large share of total accidents, but because it also is a major contributor to other accident types. McCoy and Malone (2 1) examine the accident experience at 46 intersections on 4-lane urban roadways in Nebraska to assess the effects on safety of left-turn lanes. Sites without left-turn lanes are on undivided roadways, while sites with left-turn lanes are on divided roadways with 16-ft raised curb medians. Signalized and uncontrolled intersections are analyzed separately. The following conclusions arc arrived at:

- as found in a number of previous studies, the presence of the left-turn lane could not be associated with a statistically significant reduction in side-swipe (opposite direction), head-on, or right-turn accident rates;
- as expected, the presence of left-turn lanes on both signalized and uncontrolled approaches was associated with significant reductions in rear-end, side-swipe (same direction), and left-turn accident rates;
- the presence of left-turn lanes on uncontrolled approaches of 4-lane undivided urban roads is associated with a statistically significant 68% increase in the rate of right-angle accidents.

The report concludes that "except for right-angle accidents at unsignalized intersections and rear-end accidents at signalized intersections, left-turn lanes were consistently found to be associated with fewer accidents". The report further concludes that at uncontrolled approaches there is a tradeoff between decreased left-turn, rear-end, and same-direction side-swipe accidents and increased right-angle accidents.

Hammer (22) finds that the installation of left-turn lanes results in statistically significant reductions of rear-end, left-turn, and total accidents at unsignalized intersections. At the same time, right-turn accidents at these unsignalized intersections increase; as is also noted by McCoy and Malone (21), who offer an explanation that the increase in right-angle accidents is likely due to the comparison between undivided sections without left-turn lanes and divided sections with left-turn lanes. The cross-street driver finds it more difficult to judge the adequacy of gaps and requires more crossing time when crossing the road with the turn lane, because of the added width Hammer (22) reports a significant decrease in left-turn and total accidents at signalized intersections respectively, with no change in right-angle or rear-end accidents.

Greiwe (23) reports a significant drop in both total and left-turn accidents after restriping to provide left-turn lanes. Craus and Mahalel (24), state that "from a traffic or safety viewpoint, it would be difficult to imagine circumstances in which an intersection without a left-turn lane would be preferable to an intersection with such a lane . . . under no budget constraints, the designer will recommend construction of a turning lane at each intersection". This research establishes the left-turn lane as a very attractive option for mitigating intersection safety problems. Hammer (22), found an 85% reduction in rear-end collisions following the installation of a turning lane, while Ben-Yakov and Craus (25) analyzed a sample of 25 inter-urban intersections and determined that the installation of left-turn lanes resulted in a 38% decrease in total accidents (at a 99% significance level).

Although left-turn lanes find substantial support in the literature as a safety treatment for minimizing collision potential, it has been found that when opposing left-turn lanes are installed, total intersection accident rates can actually increase in some cases. McCoy, et al (26) cite previous research which indicates that intersections with opposing left-turn lanes experience higher accident rates than intersections without the opposing left-turn lanes. These higher rates are attributed mostly to the sight distance obstruction caused by the left-turning vehicles. AASI-ITO design guidelines provide only a cautionary note on sight distance problems due to opposing left-turn lanes when medians are greater than 18 ft in width. In this report, the authors present a table of recommended offset distances for a range of design speeds. They calculate the offset distances by collecting vehicle positioning data at intersections, then analyzing the distributions. From our own search of the literature, it appears that although some state transportation departments are presently offsetting opposing left-turn bays as a means to mitigate left-turn safety hazards, there has not yet been a study which has established the effectiveness of this measure.

OREGON COAST HIGHWAY 9 (U. S. HIGHWAY 101) - TRAFFIC ENVIRONMENT & ANALYSIS

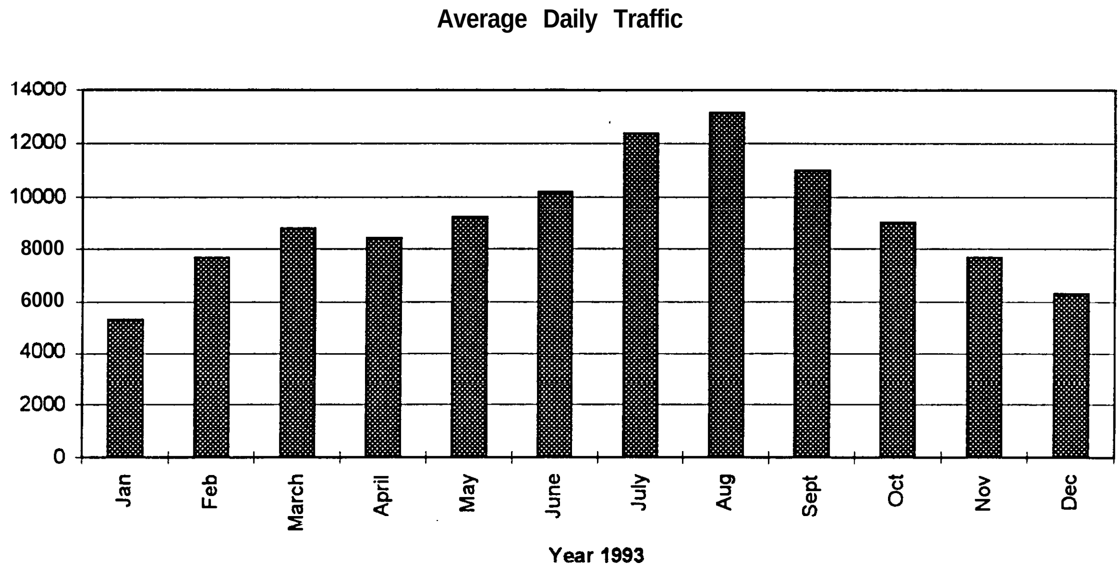

Figure I -Average Daily Traffic during 1993

This area enjoys a high volume of tourist traffic during the summer, on the average registering 10,000 daily trips from June until end of September. Figure 1 shows the Average Daily Traffic (ADT) averaged over a month for the year 1993.

Figure 2 shows a history of traffic growth and accident rates for the area during the period 1990 to 1993. It is observed that the overall number of accidents has decreased from 159 accidents in 1990 to 133 accidents in 1993. The average ADT during the same period has increased from 8322 in 1990 to 9089 in 1993. A decline in the number of accidents can be attributed to the modifications to the corridor, specially the Lincoln Beach - Fogarty Creek Parkway improvement. However, other improvements and drivers' behavior might have had an impact in reducing the number of accidents.

The severity of accidents over the same three year period, namely 1990- 1993 as well as the total number of accidents is displayed in Figure 3. While the total number of accidents decreased during the period from 1990-1993, there were reductions in all categories of accidents, namely fatal, injury and Property Damage Only (PDO). The number of fatal, injury and PDO accidents decreased from 3 to 0, 81 to 72 and 75 to 61 respectively.

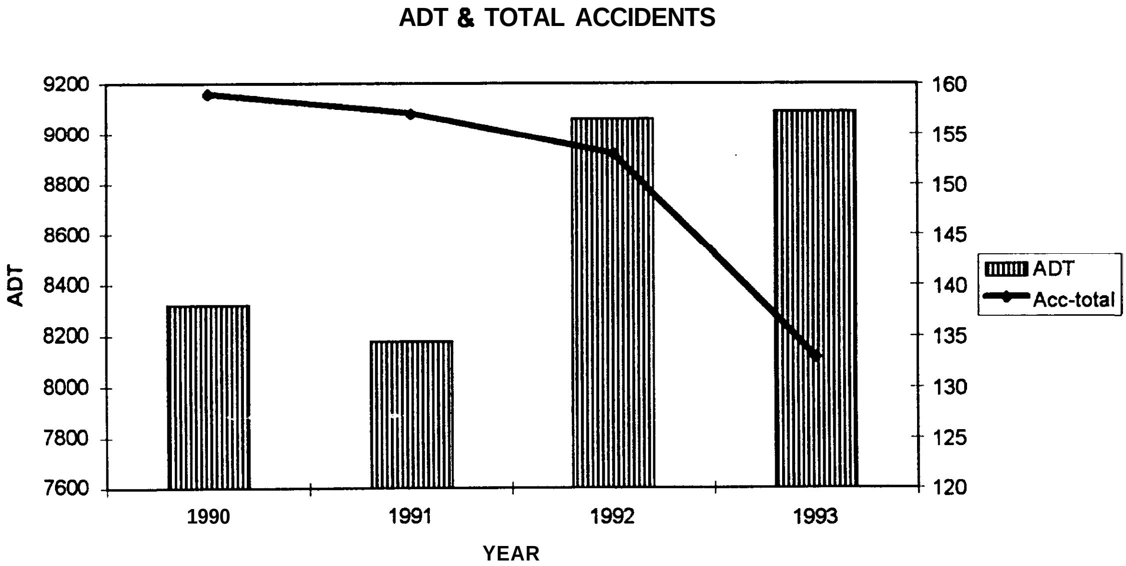

Figure 2-ADT & total accidents, years 1990-1993

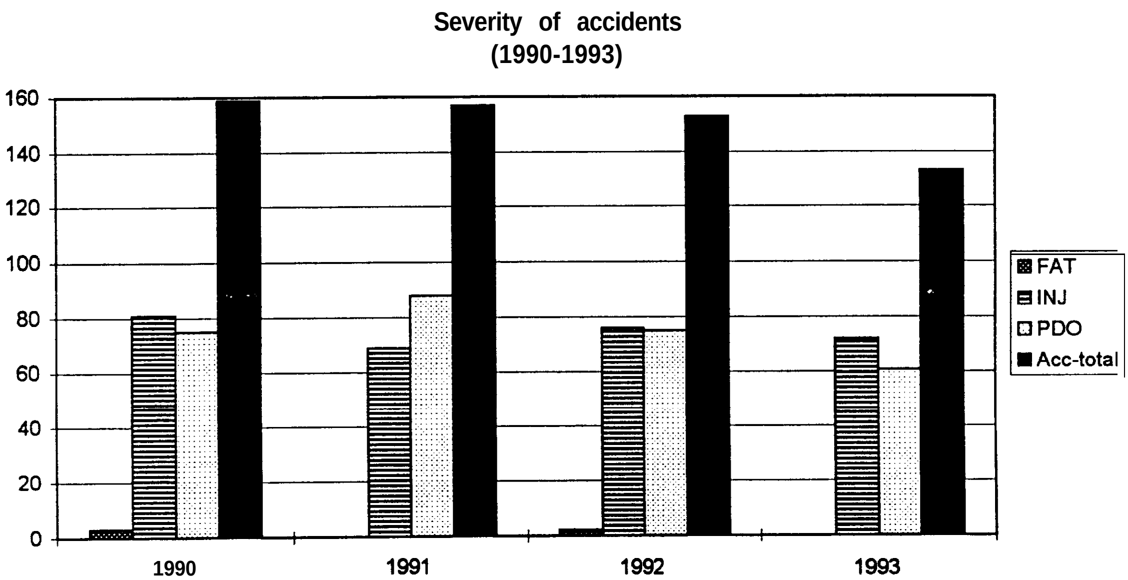

Figure 3-Severity of Accidents, years 1990-I 993

Using National Safety Council's cost estimates (accident facts 1994 edition), this decline in the number of accidents over the three year period represents an economic saving of $3'076,400.

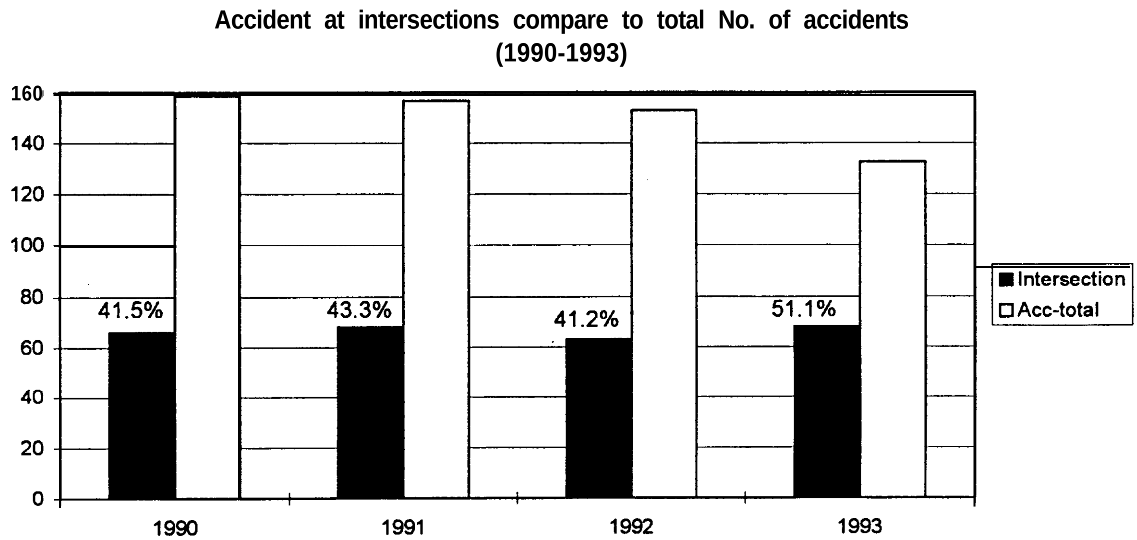

Figure 4-Accident at intersections compared to total No. of accidents

A distribution of accidents occurring at intersections in this area along with total number of accidents is shown in Figure 4. The percentage of accidents occurring at intersections has increased from 4 1.5% to 5 1.5% during 1990- 1993 period. This is despite the fact that the total number of accidents within the area under study has decreased in the same period of time. Increase in the number of accidents at intersections can, to some extent, be attributed to concentration of turning movements to a limited number of intersections with the introduction of a Non-Traversable Median (NTM) on a part of the Oregon Coast Highway 9.

A relationship between access density and accidents for the Highway is provided in Figure 5. In order to eliminate the effect of the construction period of the Lincoln Beach - Fogarty Creek Parkway, accidents for the period from July 2 1, 1992 to November 30,1994 are not included in the database. The frequency of accidents and access points at intervals of 0.2 miles are calculated and then these numbers are accumulated per mile. The access density is derived from the highway's video log, which was provided by ODOT. The video log is recorded in two directions (Northbound and Southbound) and is entered into the access point database in the same manner. In other words: full intersections are counted as two and T-intersections are counted as one. This system of data entry provides **a** way of representing each intersection by the number of minor roads, which becomes the measure of access or driveways. Since turn data was not available for all intersections, the number of conflict points has not been considered in this analysis. Densities of accidents and access points are shown versus the milepoints at 0.2 mile intervals.

From figure 5, a significant relation between frequency of accidents and density of access points is clearly obvious. Accident density follows the ebb and rise of access points, as represented by driveways per mile, except in the section from MP 123.35 to MP 124.95, known as the Lincoln

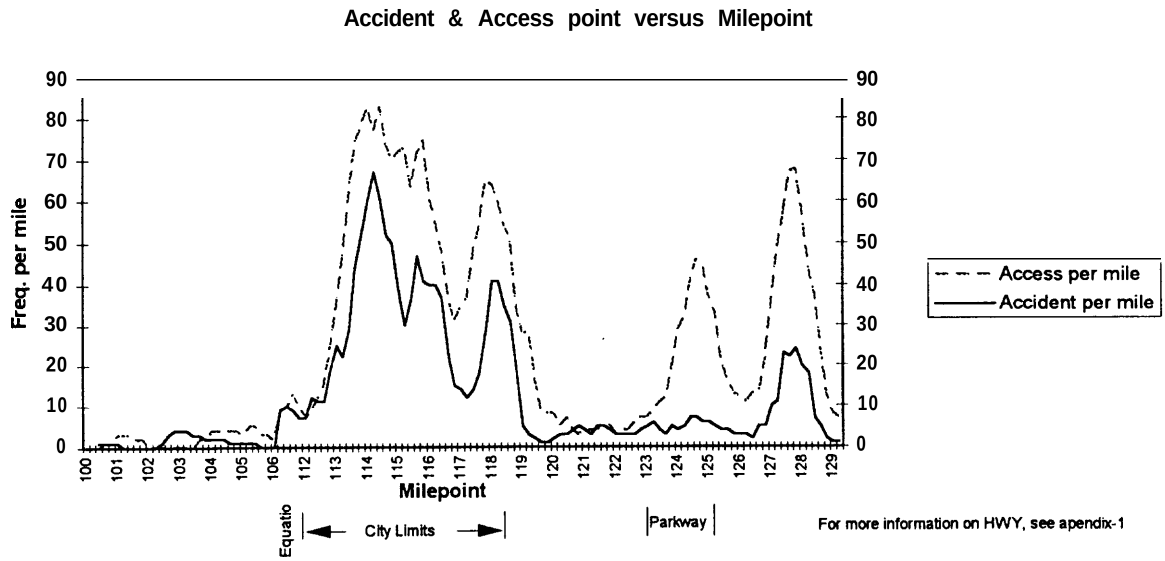

Figure 5-Density of Accidents & Access points

Beach - Fogarty Creek Parkway limits, where there is a non-traversable median. Accident density in this section ranges between 3 and 9 per mile even though access density increases from below 10 to 48 per mile. This emphasizes the safety impact of a non-traversable median in areas with high density of access points. However no such significant impact was observed in areas with painted medians or Two-Way Left Turn Lanes (For a comparison, sections between milepoints 118.42 to 118.76, 116.65 to 117.32, 114.38 to 115.65 and 112.70 to 114.00 were examined).

Accidents per Million Vehicle Miles

Using traffic counts obtained from ODOT and the frequency of accidents within 0.2 mile intervals, the following equation is utilized to calculate the frequency of accidents per million vehicle miles:

AMVM = (NA *1,000,000) / (ADT * 833 * 1)
Where :
AMVM = Accidents per million vehicle miles traveled
NA = Number of Accidents
ADT = Average daily traffic

(833 is the number of days of records, and 1 mile is the length of the intervals of recorded accidents)

Number of accidents per MVM and density of access points are plotted versus the milepoints at the middle of intervals in two segments for Urban and Rural areas.

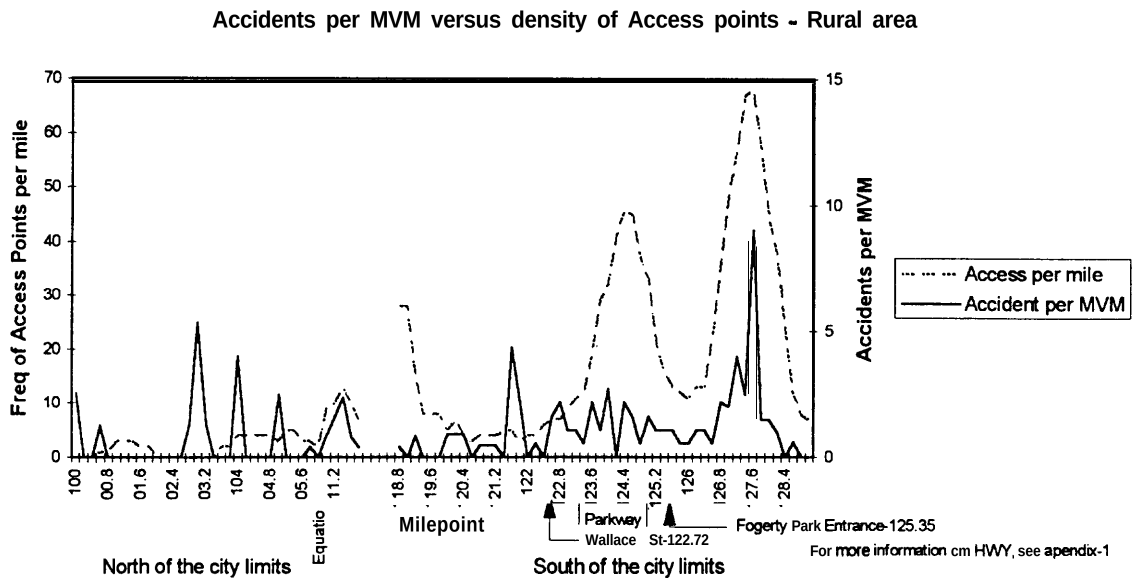

Figure 6-Density of Accidents & Access points-rural area

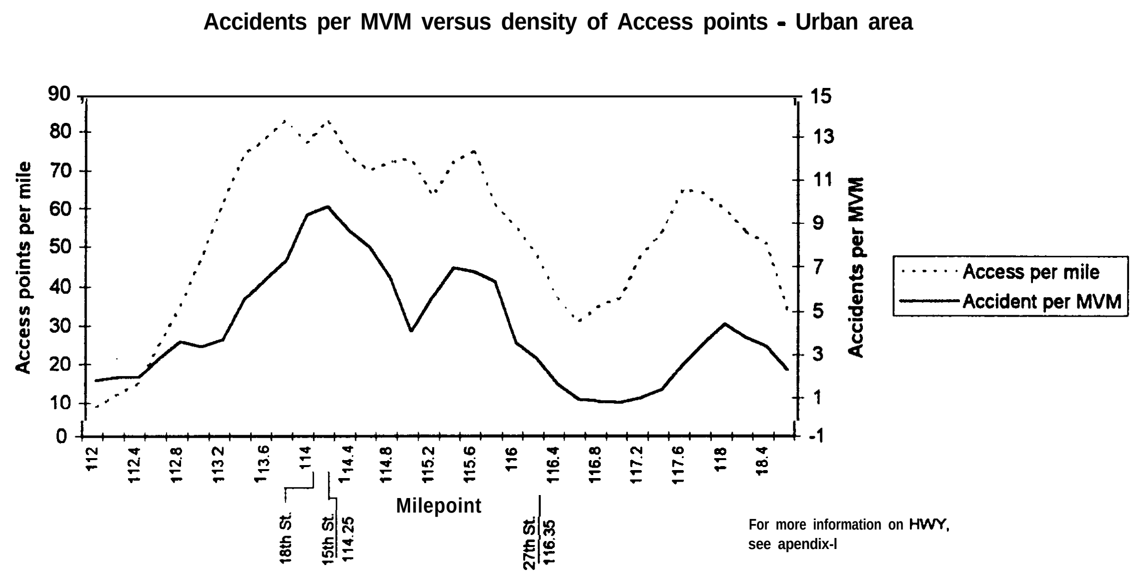

Figure 7-Density of Accidents & Access points-urban area

Figure 6 and 7 also show a significant relation between density of access points and number of accidents per million vehicle miles. The number of accidents per MVM appears to increase as the density of access points goes up. This pattern however can not be found in an area with non-traversable median (MP 123.35 to MP 124.95) known as Lincoln Beach - Fogarty Creek Parkway once again emphasizing the safety benefits of this median treatment.

The number of accidents per MVM and the density of access points at each milepoint are also plotted against each other in two scatter graphs for urban and rural segments shown in figure 8 and 9 respectively.

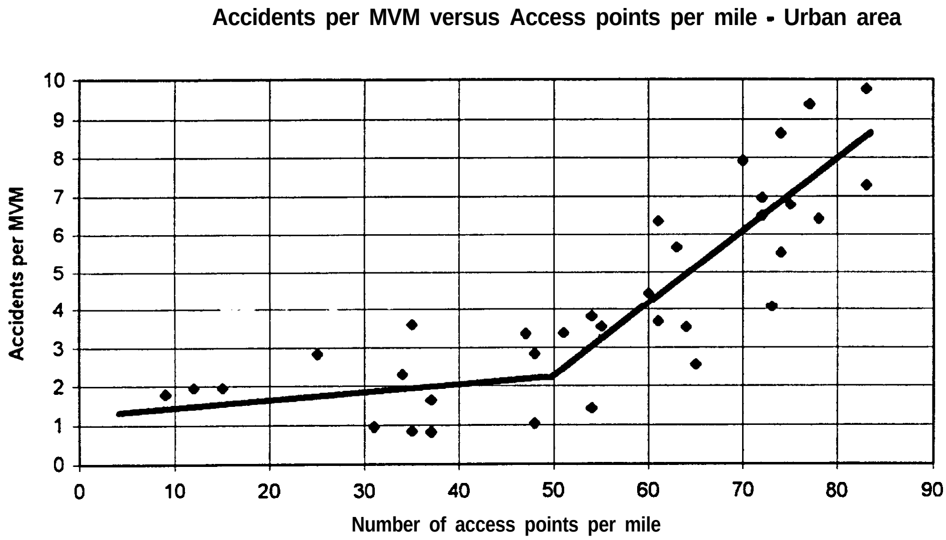

Figure 8 Density of Accidents & Access points, urban area

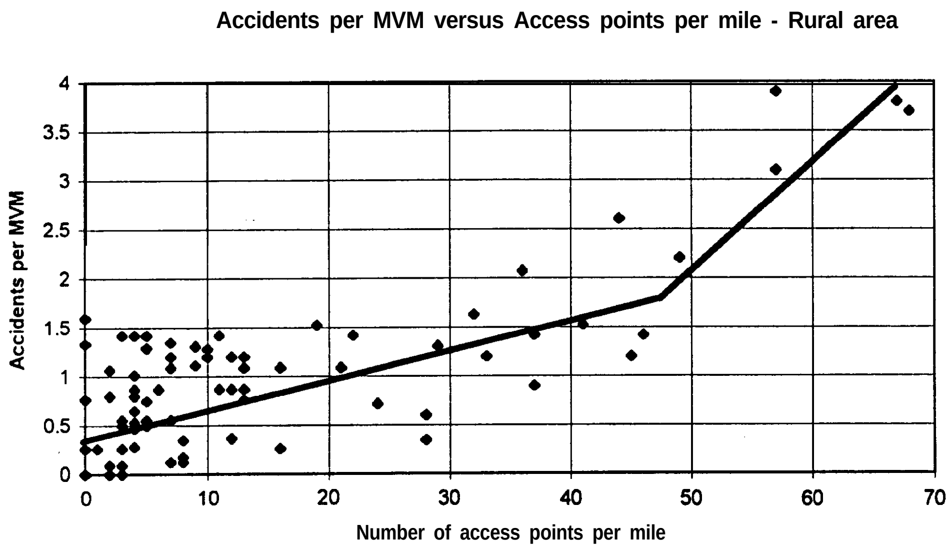

Figure 9-Density of Accidents & Access points, rural area

A study of Figures 8 and 9 indicates that in an urban setting, in areas with less than 50 access points per mile, the number of accidents per MVM increased with a slope of 20: 1. It can be established that in areas with more than 50 access points per mile the slope shows a significant increase of about 4 times to 5 : 1. In the rural setting, in areas with less than 50 access points per mile, the number of accidents per MVM increased with a slope of 30: 1, while in areas with more than 50 access points per mile the slope showed a significant increase of about 3 times to 10: 1. It is obvious in both areas that the higher the density of access points, the stronger the possibility of accidents.

Accident severity density per MVM, versus access point density

In order to check the effect of access density on the type of accidents, two different categories are used; accidents with injury (INJ) or fatal (FAT) casualty and another for accidents with property damage only (PDO). The frequency of each category of accidents and access points at intervals of 0.2 miles are calculated and then these numbers were accumulated per mile and normalized to correspond to million vehicle miles. Then the density of accidents for different categories per MVM and access points are plotted versus the milepoints at 0.2 mile intervals.

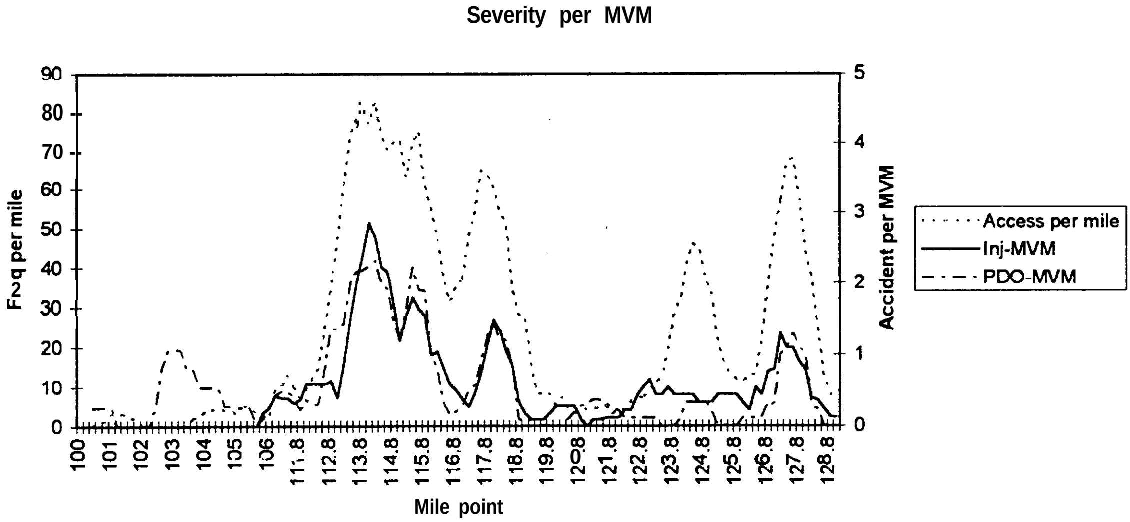

Figure I O-Density of Accidents per severity & Access points

Figure 10 shows that frequency of severe injury and fatal accidents and property damage only accidents follow the same ebb and rise that appears in the access points graph. It is also observed that, as it is with the total number of accidents, from MP 123.35 to 124.95, known as the Lincoln Beach - Fogarty Creek Parkway limits, the accident severity frequency graph stays consistently below 0.5 per million vehicle miles even though access density increases up to 48 per mile.

Accident severity at Urban area Intersections

As indicated in the scope of work, one intersection at MP 116.35 was selected as an isolated intersections and four others were selected with overlap of the influence zone. The latter intersections were at 15th St, 16th St, 17th St and 18th St, between MP 114.11 and MP 114.26. For different severity categories, an average of four intersections with overlap of influence zones was calculated and used to compare with the isolated intersection. It should be mentioned that finding an isolated intersection in the urban area was very difficult and the selected one does not have all the same characteristics as the others. ADT for the isolated intersection is 24000, and for the area with overlap of influence zones is 15000. Posted speed at studied areas are 35 and 30 MPH respectively.

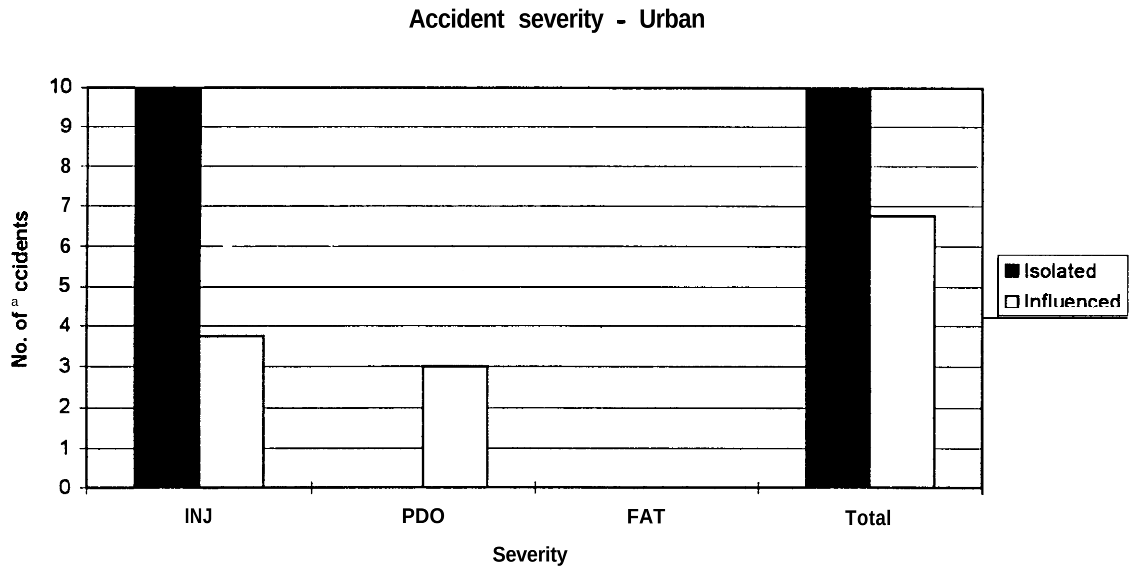

Figure 11 -Accidents severity in urban area

Figure 11 displays two sets of accidents data for different locations identified as isolated and influenced. The total number of accidents was higher in the isolated intersection (10 accidents) than it was at the average intersection with overlap of influence zone (6.75 accidents). Also, severity of accidents were higher at the same location; 10 injury related accidents versus 3.75 at average isolated intersection. There are no property damage only accidents at the isolated intersection perhaps indicating that when accidents do occur, they are severe in nature. Higher accident rates at isolated intersection can be attributed to drivers' lack of expectancy of a conflicting vehicle movement when they are driving in an open corridor. Sudden encounter of a vehicle maneuvering a conflicting path against them may lead to a collision. On the other hand, when they are driving in an area with more intersections and access points they do expect such maneuvers and hence are more cautious about a collision. In the context of intersections with overlapping influence areas, on the other hand, conflicting traffic movements due to the presence of several intersections over a short distance may have had a constraining effect. In addition, lower travel speed at closely spaced intersections may have reduced the severity of accidents.

Accident types, causes & errors at Urban area Intersections

For comparison of accident types, causes & errors in urban zone, one intersection at MP 116.35 is selected as an isolated intersection and four others are selected with an overlap of influence zone. The latter intersections are at 15th, 16th, 17th and 18th between MP 114.11 and MP 114.26. For different types of accidents, causes and errors, are tabulated as an average of four intersections with overlap of influence zones and used to compare with the isolated spot.

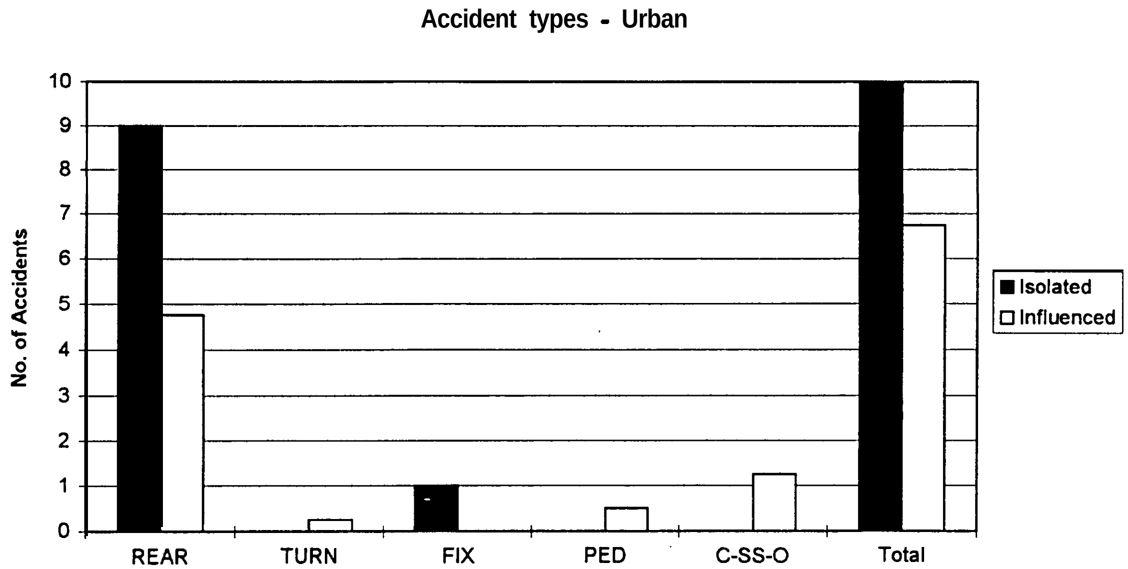

Figure 12-Accident types in urban area

Accident types in the urban section of the Highway are shown in Figure 12; while figures 13 and 14 show causes of accidents and driver errors as they appear in the accident reports. Detailed study of accidents at both locations shows that most of the accidents (56% for isolated; 50% for location with overlap of influence zone) occur due to vehicles following too close. This shows that because of the nature of the area under study (recreational in summer and heavy volume of traffic), drivers in the urban area are driving too close to each other. There may have been a certain amount of inattentive driving due to the recreational attractions appearing regularly on both sides of the highway and that may cause the vehicle in front to stop or slow down.

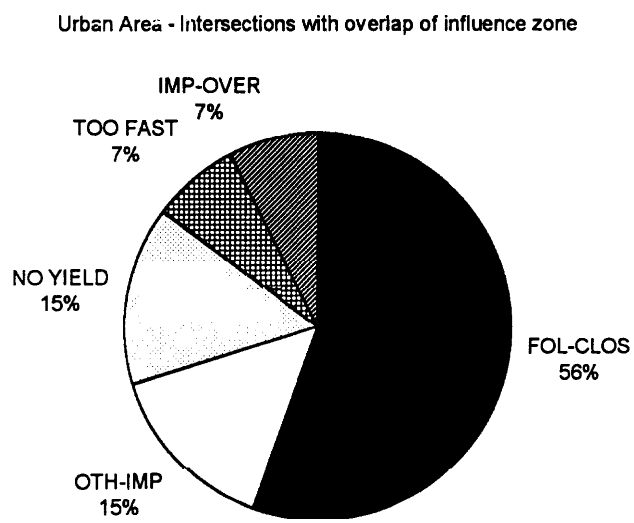

Figure 13-Cause of accidents in urban area at intersections with overlap of influence zone

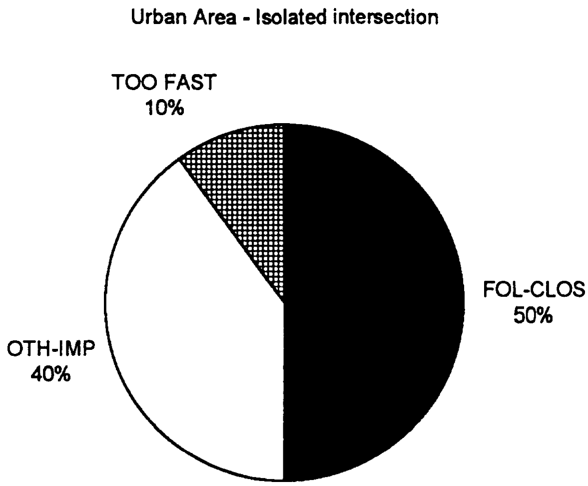

Figure 14-Cause of accidents in urban area at an isolated intersection

Safety Priority Index versus density of Access points at Urban area Intersections

For this graph the frequency of access points at intervals of 0.05 miles are calculated and then the number of access points are accumulated per mile. Information about Safety Priority Index (SPI) was provided by ODOT. Figure 15 shows a graph with SPI and density of access point per mile on the Y-axis versus milepoints on the X-axis. The Safety Priority Index System is a method used by ODOT for identifying locations where safety money can be spent most beneficially. The Priority Index has three parameters. They are the accident frequency, accident rate, and accident severity. SPI values are calculated on all segments of the State Highway system where there are three or more accidents or one or more fatalities during a three year period. SPI printouts are sorted by Highway number and milepoint and provided to the State field offices for investigation.

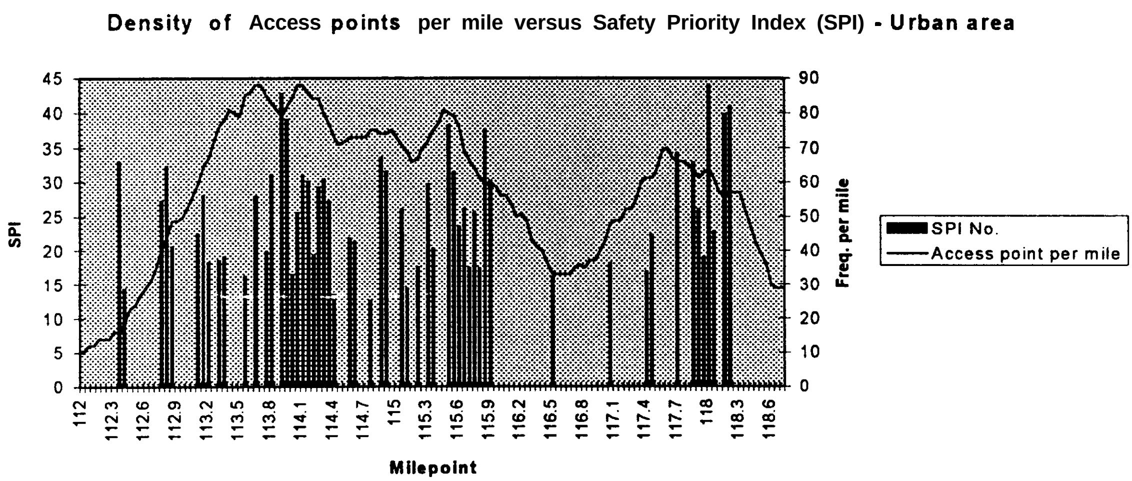

Figure 15-Safety Priority Index, urban area

Computer program that calculates SPI for ODOT does not take into account the points with less than 3 accidents. This has caused the graph to be discontinuous. Still it can be observed that there are several critical points inside the areas with high density of **access** points.

Accident severity at Rural area Intersections

The intersection at MP 125.34 was selected as an isolated intersection and four others were selected with overlap of influence zones. The latter intersections were at MP 122.55, MP 122.66, MP 122.72 and MP 122.80. For each one of these intersections a list of information is extracted from the original database. For calculation of the influence zone at upstream and downstream, AASHTO definition of acceleration and deceleration for passenger cars are used. For different severity categories, an average of four intersections with overlap of influence zones are calculated and used to compare with the isolated spot. ADT for the isolated intersection and area with overlap of influence zones are 11,000. Posted speed at both areas are 50 MPH. Sight distances for all intersections and in both directions are unlimited.

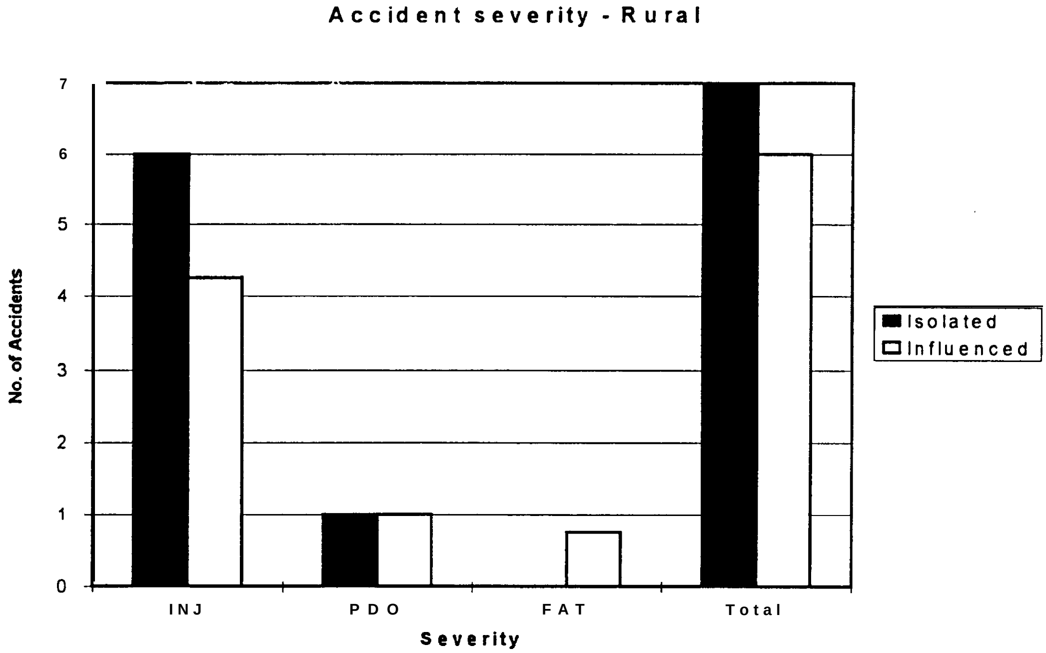

Figure 1 &Accident severity in rural area

Figure 16 is based on two sets of accidents data for different locations identified as isolated and influenced. The total number of accidents is somewhat higher at the isolated intersection (7 accidents) than it was at the average intersection with overlap of influence zone (6 accidents). Also, severity of accidents was higher at the same location, 6 injuries verses 4.25 at average isolated intersection. Database shows that most of the accidents at the isolated intersection had happened because of speeding and loss of control which in turn can be determined as the reason for higher number of injuries. It appears as if drivers' lack of expectancy contributed to the accident; when they are driving in an open corridor and suddenly encounter a vehicle executing a conflicting maneuver against them. On the other hand, when they are driving in an area with more intersections and access points they do expect such conflicting maneuvers and are, therefore, more cautious about them.

Accident types, causes & errors at Rural area Intersections

For comparison of accident types, causes & errors at rural zone, one intersection at MP 125.34 is selected as an isolated intersection and four others were selected with overlap of influence zones. The latter intersections are at MP 122.55, MP 122.66, MP 122.72 and MP 122.80. For each one of these intersections a list of information was extracted from the original database. For calculation of the influence zone at upstream and downstream, AASI-ITO definition of acceleration and deceleration for passenger cars were used. For different type of accidents, causes and errors, an average of four intersections with overlap of influence zone were calculated and used to compare with the isolated spot.

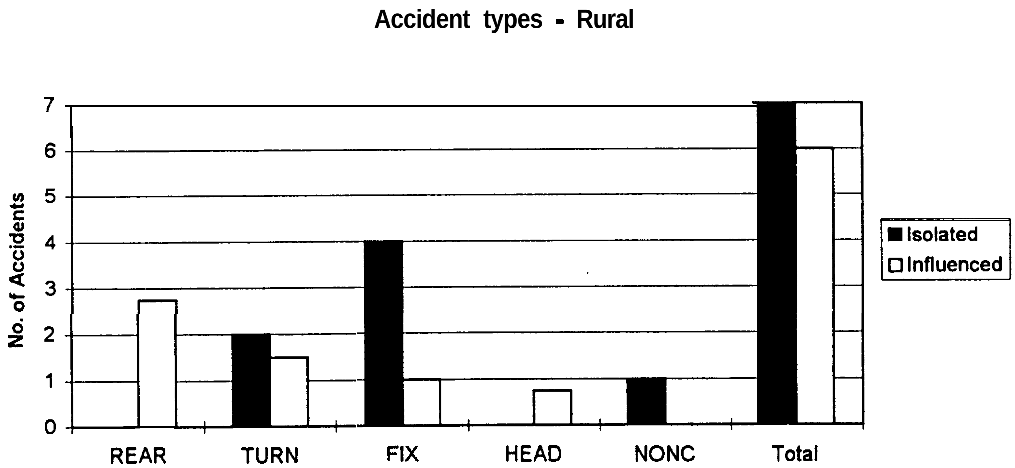

Figure I 7-Accident types in rural area

Figure 17 provides information on accident types on the rural sections of the Highway under study. While figures 18 and 19 describe causes of accidents and driver errors as reported. Detailed study of accidents at the isolated location shows that most of the accidents (5 of 7 = 72%) occurred due to driving too fast for conditions, and loss of control by the drivers. Compared to that, it is observed that at intersections with overlap of influence zone, the most important cause of accidents was waiting for left turn (2.75 of 6 = 45%) and 1.5 other accidents were also seen to be turn related (0.75 wide turn and 0.75 turn from wrong lane, total of 26%). This supports the conclusion that drivers at the isolated intersection were driving fast and were not expecting vehicles that may enter the road from the driveways at the intersection or vehicles that might be turning into the side roads. It may have resulted in drivers' loss of control and cause them to either overturn or hit a fixed object (such as a tree, guardrail, ditch, . ..). While at intersections with an overlap of influence zones they are driving within the appropriate speed but are getting involved in the accidents due to turning vehicles into and from the intersections (4.25 of 6 = 7 1%).

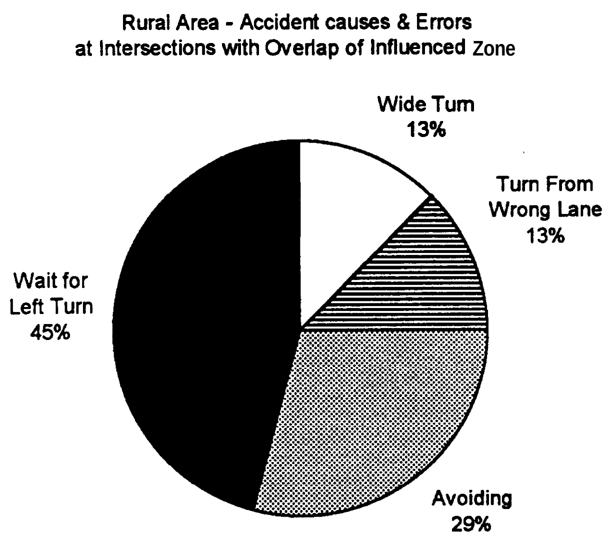

Figure 18-Accident cause in rural area at intersections with overlap of influenced zone

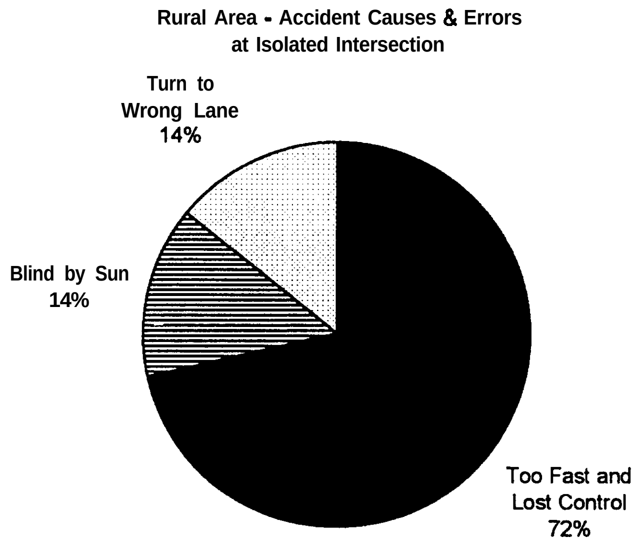

Figure 19-Accident cause in rural area at an isolated intersection

CONCLUSION & RECOMMENDATIONS

While the Oregon experience supports some of the findings reported under literature review, there are some distinct differences as well. The frequency of accidents and access density clearly seem highly related whether considered as total number of accidents, rate per million vehicle miles. This holds even when accidents are reviewed based on categories of severity and the relationship is valid in both rural and urban sections of the highway. Safety Priority Index system maintained by the State of Oregon to highlight locations where safety improvements are needed in general confirms that locations with higher access density tend to be unsafe. An access density of fifty access points per mile appears to be critical again in both rural and urban areas of the highway. Above fifty driveways per mile the accident rate appears to increase at a much steeper rate. Introduction of a non-traversable median has definitely provided a safety impact, reducing accidents in general even though the number of accidents at the intersections has increascd somewhat. It appears that in an area dominated by tourist traffic, introduction of the non-travcrsablc median and related improvement in lane markings and kerb development on both sides, have contributed to disciplined and safer driving. A limited number of intersections are examined in detail for accident history. These intersections have comparable geometric characteristics. In the urban area, an isolated intersection appears more accident prone than an average intersection with several other intersections within its influence zone as defined in AASHTO Policy. Also accidents are more severe at the isolated location. In both situations there is a predominance of rear end collisions indicating drivers following too close as might be expected in urban locations. In addition, due to the tourist nature of the area, perhaps frequent roadside distractions may have contributed to drivers' inattention. An isolated intersection in rural section of the highway still shows marginally higher number of accidents than an average intersection which is impacted by influence zone of other intersections. However, the type of accidents now appear to speed related and vehicles out of control, which perhaps typifies the rural nature. Examination of a small number of intersection is intended to be exploratory, and not of any statistical significance. Further work is expected in future research.

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Comparison of Delay and Accidents on Three Roadway Access Designs in a Small City

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ABSTRACT

The quality of service on three arterial segments in a city with population of 40,000 (not a part of a larger metropolitan area) was compared. Each segment's quality of service was measured by travel time runs and the accident frequency over a three year period.

Each segment was four-lane with a non-traversable median. East-west Segments B and C werejoined at the segment endpoints; a US highway route that followed Segments B and C continued to also follow north-south Segment A. Therefore, some drivers will travel two or all three segments in a single trip. The amount of signalization was similar on all three segments. Terrain was similar on all three, except that Segment C included one overcrossing of a railroad. Commercial developments bordered all three segments. Segment A was bordered by an older style of development, with a plethora of individual tracts abutting the roadway, and had many driveway and street intersections. Segment B had some individual tracts and a few large ones, and for the most part included at-grade frontage roads on both sides. Segment C was bordered by large tracts with shared/combined access points.

Although Segment C exhibitedgreater speeds and lower travel times, it had a much lower accident rate than Segment A. Segment B had the lowest travel times, but an accident rate similar to that of Segment A.

Key words: access management, accidents, geometric design, medians

INTRODUCTION

Two of the benefits purported to result from access managed arterials are greater safety and enhanced mobility. Traffic flow theory would support this claim. The reduction in the number of conflict points should, in theory, simplify the driving task with a subsequent reduction in accidents. Fewer conflict points should also reduce median and marginal "flow friction", allowing speeds to increase and arterial street delay to decline. Validating this theory is another matter, because it is difficult to find two streets with similar traffic patterns and abutting land uses, the only differences being the type of access control, which one can compare. Said another way, real world roadway and land developments were not built with traffic experiments in mind.

Three similar roadway segments with differing types of access control can be found in Muskogee, Oklahoma, a small city with population of 40,000. Muskogee is not a part of a larger metropolitan area, but rather is a town in a rural area. East-west Segments B and C are joined at the segment end points; a US highway route that follows Segments B and C continues to also follow part of north-south Segment A. Therefore, some of the same vehicles travel two or all three segments in a single trip. The three segments provide an opportunity to compare and contrast the travel times and accident histories on roadways with similar volumes and predominately commercial abutting land development, but with differing degrees of access management.

The discussion of this comparison consists of two parts. First, a detailed comparison of the three segments is presented, to document the degree of similarity among the three segments. This is followed by the comparison of accidents and delay.

COMPARISON OF THE THREE SEGMENTS

Many different families of characteristics can be employed to describe or "paint a mental picture" of a given roadway. These include

geometric characteristics (number of lanes, alignment descriptors);
volumes;

traffic controls (intersection controls, speed limits);
environment (abutting land uses).

A comparison and contrast of the three road segments' characteristics is in order before evaluating their accident histories and flow attributes. Figure 1 shows photographs from each of the three segments.

Traffic Patterns and Characteristics

Figure 2 displays the relative locations of the three segments. Segment A is part of a north-south arterial. Segments B and C are two abutting parts of an east-west arterial. US Highway 62 traverses both east-west segments (i.e., B and C), and follows a short north-south jog that includes the north part of Segment A, to connect with another east-west alignment. This latter east-west alignment forms the major signalized intersection on Segment A. US 64 is routed over the south part of Segment A, and turns to overlap US 62 on the east-west alignment that intersects Segment A. US Highway 69 is routed over Segment A. State Highway 16 intersects Segment C near the east end, then follows Segments C, B, and finally the north part of A before also turning to follow the afore mentioned east-west alignment carrying US 62 and US 64. The intersection of Oklahoma 16 with Segment C forms the only signalized intersection in that segment.

US 69 appears to have a higher percentage of trucks than either US 62 or US 64. It is surmised that US 69 is used by more out-of-state travelers, accounting for the higher degree of traveler-oriented businesses along Segment A.

Geometric Characteristics

The three segments being compared all have four through lanes with a raised or depressed median, and have auxiliary lanes at major intersections. Parts of Segments B and C have frontage roads. Segments A and B traverse relatively level terrain; Segment A has a mild upgrade from south to north. Segment C terrain varies from flat to rolling, and includes one overcrossing of a railroad track. All three appear to be straight, except Segment C has gentle horizontal curvature as it rises to cross the railroad tracks. Table 1 further describes the three segments.

Volumes

The Oklahoma Department of Transportation furnished recent-year traffic count data. Machine-tube counts were recorded for 1984, 1986, 1988, 1989, 1992, and 1994; counts for some years were missing at some locations. Volumes were counted only on the main lanes: frontage road volume counts were not made. Since volumes can fluctuate on a daily basis, and counting machines and tubes can malfunction, it was decided to use a combination of recent year averages and judgment to derive volumes shown in Table 1.

Intersections and Signalization

Segment A traverses an old-style grid street network, with many intersections at one block spacings. (A block is defined as the distance equal to the depth of two backing residential lots plus street width, about 100 m or 330 A.) As Table 2 shows, Segment A has relatively uncontrolled driveway access. Segment B is bordered on both sides by frontage roads close to the main lanes for most of its length. Frontage roads are absent on the south side for about three blocks on the east end. On the north side at the east end, the frontage road is farther back from the arterial. Segment C has 4 median openings and only a small length of frontage road, set back from the main lanes, at both ends. Segment C has only 3 driveway t-intersections.

The amount of signalization is similar on all three segments. Segment A traffic encounters two signals that are spaced one block apart: one at a major east-west arterial (also a U.S. route), the other at a parallel street that tends to function as an auxiliary route to the main arterial. These two signals operate in a synchronized manner, allowing traffic to move in progression. There is also an actuated signal at an intersection with a low volume crossing street.

Segment B is signalized at two intersections: with a low volume collector, and with a major north-south arterial. Segment C has one signalized intersection, with a major north-south arterial (also a state highway).

Speed Limits

The posted speed limits are somewhat dependent upon the degree of access control present. Increasing the medial and marginal fiction, which supposedly results from higher numbers of median openings and driveway access points, will tend to lower the travel speeds. The posted speed on Segment A is 56 km/hr (3 5 mph), on Segment B is 72 km/hr (45 mph), and on Segment C is 72 km/hr (45 mph).

Abutting Land Use

Commercial land use predominates along all three roadway segments. The land development styles along all three segments affect and are affected by the type of roadway access. Segment A passes through an older type of development, with a plethora of individual tracts abutting the roadway. Segment B is surrounded by some individual tracts and a few large ones. Segment C is bordered by large tracts with shared/combined access points. The following abutting land uses were catalogued in 1995.

Segment A is bordered by 5 restaurants; 7 fast food establishments;

8 convenience store or gas station sites; 8 motels; a grocery; a used car dealership; banking, commercial, and office uses; a strip shopping center with a grocery and a gas station; and vacant buildings.

Segment B is bordered by 3 religious and social service tracts; 5 restaurants; 5 fast food outlets; a convenience grocery; a gasoline station; small commercial uses; an automobile dealership; an outdoor entertainment center; a large strip center with a major discount store and large grocery; and both vacant and residential land.

Segment C is abutted by a large strip center with a major discount store and large grocery (the same one abutted by Segment B); a large strip center with a building materials store, gas station, motel and restaurant; a large strip center with a major discount store; a small junior college; banking and office uses; and vacant land.

ACCIDENT HISTORIES

Summary accident records for 199 1 through 1993 were obtained from the Oklahoma Department of Transportation. These accidents were plotted on a city street map and counted. Table 3 shows total numbers of accidents over the three year period, and accident rates per million vehicle-kilometers (mvkrn), for Segment A, B, and C. Values for the western 0.87 km (0.54 mile) part of Segment B having lower intensity development abutting the frontage roads than the eastern part are also shown. Table 4 presents details about the types of accidents occurring.

The summary statistics, compiled from police reports, noted if the accident was considered “intersection related”. Frontage road accidents were distinguished from main lane accidents.

Accidents locations were dispersed along the length of Segment A. The highest frequency was 26 at the highest volume intersection. Interestingly, there were 2 1 accidents reported at the signalized intersection with the parallel, lower volume auxiliary street one block away. At these two intersections, 32% of the accidents involved injury.

Accidents on Segment B were concentrated near the major intersection. Of the 63 accidents at this intersection, 25 were coded as angle accidents and 27 as rear-end accidents. Only 20 of the 63, or 32%, were injury accidents.

The greatest accident frequency along Segment C accidents was at the signalized intersection. Of the 40 accidents at this intersection, 15 were coded as angle accidents and 18 as rear-end accidents. A higher proportion, 47%, involved injury.

Considering the non-intersection accidents alone, Segments B and C had lower proportions of angle and sideswipe accidents, and higher proportions of miscellaneous “other” accidents, than did Segment A. Segment C had a lower proportions of angle and sideswipe accidents than did Segment B, and a higher proportion of rear end/following too close than either of the other two segments. Over 60% of Segment B non-intersection accidents were on the frontage roads.

Examining only intersection accidents, Segment C had a somewhat higher percentage of rear-end/following too close accidents and a lower percentage of angle accidents than did Segments A and B. Although Segment B had much more length of frontage road than did Segment C, the proportion of intersection accidents on the frontage roads to intersection accidents on the main lanes were about the same for both segments.

Looking at all accidents combined, Segments A and B had similar proportions of intersection and non-intersection accidents: about 75% were intersection accidents. Segment C had 67% listed as intersection accidents.

Overall, Segments A and B had similar accident attributes, while Segment C performed much more safely than either Segment A or B. Segment A had the highest accident rate, slightly higher than Segment B and about 75% higher than Segment C. The reported property damage rate for accidents on Segment C was less than half that of Segments A and B. The injury accident rate on Segment C was about 40% of that of the other two segments. It should be noted that since frontage road volumes were unknown and therefore not included in computations of million vehicle-kilometers of travel, any comparisons involving mvkm-of-travel probably show Segment B in a relatively less favorable light than is actually the case.

In an attempt to focus only on the western part of Segment B, which has less intense abutting development than does the eastern part, accident statistics for only the western 0.87 km (0.54 miles) of Segment B were calculated. The results show that the proportion of intersection accidents along the western, lower development-intensity part of Segment B was very close to the proportion for the entire segment. The accident, property damage, and injury accident rates for the lower development-intensity part were somewhat lower than for the entire segment, but still higher than those for Segment C. In comparison with the main lane intersection values found for the three segments, a much higher proportion of the accidents on the west part of Segment B were angle accidents: about 50% on the three segments versus 83% on the west part of B. Even though the western end of Segment B appears to have rather low crossing volumes, angle accidents still seem to predominate.

TRAVEL TIMES

To evaluate the quality of flow on each of the three segments, travel times were measured. A vehicle was driven from the beginning to the end of each segment, trying to travel along with surrounding vehicles, but not exceeding the speed limit. When traffic ahead was moving slower than required by conditions, and it was both safe and easy to maneuver around slow vehicles by using the adjacent lane, such movements were made. All runs were made by the same driver.

The majority of the time the segments were traversed in sequence; for instance, the vehicle traversed segments A, then B, then C, after which the vehicle turned around and traveled the three segments in the opposing direction and in reverse order. For a few runs, the vehicle pulled off the road at the end of one segment, and paused a short time before proceeding into the next segment. Six runs in each direction were made on a March Tuesday between 12:30 p.m. and 2:30 p.m.; five runs were made between 4:15 p.m. and 6:20 p.m. The day was sunny, windy, with the high temperature in the low 80s°.

Table 5 presents the travel time data. For each of the three segments, the actual total travel time is shown, followed by an adjusted total travel time, then the actual running time. The adjustment is made to compensate for the different lengths of the three segments: each travel time was “normalized” or converted to a 1.6 1 km (1 .O mi) travel time. Not shown are the stopped times, found by subtracting running time from total time. Average times and standard deviations were figured separately for the 6 midday runs and for the 5 evening runs, and were figured for all 11 runs per direction combined.

Average travel times on Segment A were longer than those on Segments B and C for both midday and evening, and also for both directions of travel. Using a one-tail t-test for both directions of travel, Segment A travel speeds were statistically higher than those of both Segments B and C, with 90% confidence (a = 0.10). Comparing travel times of Segments B and C, the westbound difference was significant, while the reverse direction difference was not significant.

Evaluating the average stopped times (total time less running time), eastbound Segment C had the largest value (0.73 min.), with southbound Segment A (0.68 min.) closely following. Then came northbound Segment A (0.52

min.) and eastbound Segment B (0.45 min.). Westbound Segments C (0.3 1 min.) and B (0.10 min.) had the lowest average stopped times. Even though Segment A has coordinated traffic signals, overall, it gives drivers the most stopped delay. In comparison with the next best alternative for stopped delay (Segment C), the 22,000 per day Segment A drivers experience a total of 29.3 hours more stopped delay. The following "Observations" section offers a possible explanation for the highest stopped delay found along eastbound Segment C.

OBSERVATIONS

The process of collecting and analyzing the data highlighted certain aspects of the three studied roadway segments. Some of the observations pertained to the particulars of the specific roadways, while other observations had a global application.

Signalization, Volumes, and Delay

It seemed signalization had some impact on the travel times. Since the two successive signals in Segment A were synchronized for progressive flow, traffic flowed smoothly between the two, minimizing the impact of the second signal. On the other hand, the signals on abutting Segments B and C were timed in a manner that eastbound through traffic, having departed from the green signal near the east end of Segment B, seemed to regularly encounter a red at the signal near the east end of Segment C. It appeared that modifying the timing of the signal in Segment C would have significantly reduced the eastbound stopped time.

It should be noted that Segment C has slightly higher volumes than Segments A or B, although all 3 have similar volume levels. The cross street volumes at signalized intersections along Segment B were lower than the cross street volumes on streets intersecting the other two segments. The lower cross street demand could in turn decrease the amount of delay relative to the delay on the other two segments. Likewise, the cross street volume on the signalized intersection along Segment C was higher than that on the streets intersecting the other two segments, which could account for part of the higher amount of delay on Segment C relative to the other two segments. If differences in stopped delay were adjusted to reflect differences in cross street volumes, it is expected that Segment C stopped delay would be adjusted downward and Segment B stopped delay adjusted upward. This could reduce differences between the Segment B and Segment C travel times.

Intersection Design

Access management operations will concentrate traffic at a few key intersections. The "standard" or default intersection layout template normally employed may be inadequate for the volumes that will use an intersection on an access managed roadway. Additional left and right turning lanes may be needed to keep intersection the level-of-service tolerable. An inadequate intersection design will result in increased delay and somewhat offset the delay savings achieved away from the intersections. Robust intersection design and operations practices are needed to get the full benefits from access management.

Comparing Median Types

The findings from this analysis highlight an important consideration in the ongoing debate regarding non-traversable (raised or depressed) medians and flush-paved medians (continuous two-way left turn lanes, TWLTL) on urban and suburban arterials. By contrasting operating characteristics such as delay and accident histories on roadways with different median types, some (1, 2) have concluded that either the non-traversable median or the TWLTL is the preferred design over the other type.

An analysis that contrasts only board categories of median type may give false impressions. This study found even with the median type (i.e, raised) held constant, delays and accident histories varied. Perhaps contrasts between the non-traversable median and the TWLTL should also include volume, access frequency, or presence of frontage roads as independent variables.

Need for Data

Evaluations of the performance of various design and operations options cannot take place unless reliable accident and volume records are maintained. Two conflicting trends are affecting data availability. The 199 1 federal transportation bill, the Intermodal Surface Transportation Efficiency Act (ISTEA), mandated establishment of both Congestion Management and Safety Management systems for each state. The mandated systems tend to encourage state transportation agencies to perform data collection and analysis activities. On the other hand, cuts in enforcemcnt or record-keeping activities may result in the failure to report non-injury or non-serious accidents. Recent legislation has abolished the management systems mandate.

Failures to report and record accidents limit the ability of analysts to evaluate aspects of the transportation system and in turn uncover deficiencies in existing practices or to propose improved practices. In order to monitor and improve roadway traffic practices, it is imperative that agencies collect and maintain a complete and accurate database reflecting all attributes of roadway performance.

SUMMARY

A comparison of accidents and travel times along three arterial roadway segments, each with a different level of access management, was made. The three segments were in a small city of 40,000, surrounded by rural land.

The land uses along all three segments are predominately commercial. Segment A has more highway-oriented businesses than the other two segments, but the overall tenor of land uses among all three is not dissimilar.

All segments are four lane divided roadways. The volumes on all three segments are similar. The total volumes on signalized intersecting streets are similar.

Segment A has the least access control, with frequent driveway, intersecting street, and median opening access. Segment B has a higher level of control: frontage roads parallel the main lanes for most of the length, and crossing streets are less frequent. Segment C has the highest degree of access control, with few median openings, driveways, or cross streets.

A review of summary accident data from 199 1 through 1993 found Segments A and B had similar accident frequency, property damage, and injury accident frequency rates. Segment C, with the highest access control of the three, had a property damage loss rate half that of the other segments. The accident and injury accident rates on Segment C were about 40% less than those of the other two segments.

Travel times were measured on each of the segments, separately for both directions. When adjusted to compensate for slightly different lengths-of-segment, Segment A travel times were, on average, 30% greater than those of Segment C. Segment B had average travel times somewhat less than those of Segment C.

Comparing the three access designs, the older-style “frequent access” design had a safety record similar to that of the at-grade frontage road design but had over 30% more delay. The arterial with the highest degree of access management had slightly more delay than the roadway with at-grade frontage roads, but had a much lower accident rate and injury rate than either of the other two designs. From this study, it cannot be determined whether the accident history of the at-grade frontage road segment was related to the small width of the outer separation, the frequency of access points, or both.

There is an ongoing debate as to whether non-traversable medians or TWLTLs are more desirable for urban arterials. The research findings suggest that delay and accident evaluations of raised/depressed medians versus continuous two-way left turn lanes may be faulty unless access frequency or frontage road presence are considered.

One could argue travel times are greater on Segment A because of the lower speed limit. More realistically, speed limits are set to reflect the speeds at which most drivers are comfortable. The lower speed limit on Segment A reflects inherent mobility limitations and safety deficiencies on an arterial with a high degree of access. Both the lower speed limit and the longer travel time result from the access design choice that has been made.

One study does not necessarily establish a general truth. Repeated studies in various locales are needed to conclusively establish the presence of any benefits from a particular design or operations strategy. This study is one part of a growing body of research (3, 4, 5, 6, 7) showing benefits to the traveling public from access managed corridors.

ACKNOWLEDGEMENT

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TABLE 1 -- Description of the Three Segments

Segment	Description	Length	Daily Volume	Volume on Signalized Cross Streets
A	Frequent intersections and left turn lanes, very frequent driveways on right	1.45 km (0.90 mi)	22,000	3,900 13,700 6,000
B	Few median crossings; almost continuous frontage roads on both sides, small margin between frontage roads and the main lanes	1.53 km (0.95 mi)	23,500	1,600 16,000
C	Very few median or margin access points; a small amount of frontage road	1.93 km (1.20 mi)	26,600	20,600

Note: volumes in vehicles per day (vpd); frontage road volumes not included

TABLE 2 – Main lane intersection characteristics

	Segment A #	Segment A per km	Segment B #	Segment B per km	Segment C #	Segment C per km
Signalized intersections	3	2.1	2	1.3	1	0.5
Median openings, total	7	4.8	5	3.3	4	2.1
For streets	7		5		3	
For driveways	0		0		1	
Intersections, total	89	61.4	12	7.8	7	3.6
Streets	11		6		3	
Drivewavs	78		6		4	

Note: driveway intersections with frontage roads not included

TABLE 3 -- Accident Summarv

	Segment A	Segment B		Segment C
		All	Part	
Total number of accidents (non-work zone)	123	136	38	112
Number of work zone (not inc'l)	0	7	0	2
Main lane, non-intersection	28	13	7	27
Main lane, intersection	95	90	24	65
Frontage Road, non-intersection	na	21	3	10
Frontage Road, intersection	na	12	4	10
Proportion of non-intersection	23%	25%	26%	33%
Proportion of intersection	77%	75%	74%	67%
Severity (for non-work zone)				
Property damage costs	$305,102	$324,835	$92,575	$2 19,695
Number of injuries	88	94	35	67
Number of injury accidents	48	58	18	47
Main lane, non-intersection	10	9	4	9
Main lane, intersection	38	33	12	30
Frontage Road, non-intersection	na	9	0	4
Frontage Road, intersection	na	7	2	4
Proportion of injury to all accidents	39%	43%	5 1%	42%
Number of fatal accidents	0	0	0	0
Accidents per million vehicle km (mvkm)	3.52	3.45	2.73	1.99
Main lane accidents per mvkrn	3.52	2.61	2.23	1.63
Property damage ($) per mvkrn	$8,727	$ 8,243	$6,656	$3,904
Number of injuries per mvkm	2.52	2.39	2.52	1.19
Number of injury accidents per mvkm	1.37	1.47	1.29	0.84

NOTE: Accidents from 1991, 1992, 1993

Property damage costs are from police accident reports.

Accident rates on Segments B and C would actually be somewhat lower if frontage road volumes were known and factored into the calculations.

TABLE 4 -- **Accident Types**

	Segment A	Segment B	Segment C
NON-INTERSECTION			
All	28	34	37
Angle	9	9	8
Backing		0	1
Rear end/Following too close	9	11	9
Sideswipe	4	4	2
Other	5	10	8
Main lanes	28	13	27
Angle	9	4	2
Backing	1	0	1
Rear end/Following too close	9	5	15
Sideswipe	4	0	3
Other	5	4	6
Frontage Road	na	21	10
Angle	na	5	6
Backing	na	0	0
Rear end/Following too close	na	6	1
Sideswipe	na	4	0
Other	na	6	3
INTERSECTION.			
All	95	102	75
Angle	51	59	37
Backing	3	3	4
Rear end/Following too close	28	28	27
Sideswipe	7	8	5
Other	6	4	2
Main lanes	95	90	65
Angle	51	48	30
Backing	3	3	4
Rear end/Following too close	28	28	25
Sideswipe	7	7	4
Other	6	4	2
Frontage Road	na	12	10
Angle	na	11	7
Backing	na	0	0
Rear end/Following too close	na	0	2
Sideswipe	na	1	1
Other	na	0	0

TABLE 5 -- Travel Time in Minutes

Run #	Segment A Total Time	Segment A Adjust. Total Time	Segment A Running Time	Segment B Total Time	Segment B Adjust. Total Time	Segment B Running Time	Segment C Total Time	Segment C Adjust. Total Time	Segment C Running Time
	Southbound			Westbound			Westbound		
1	2.47	2.72	2.28	1.98	2.07	1.63	1.95	1.71	1.83
2	2.98	3.19	1.90	1.38	1.46	1.38	2.77	2.53	1.80
3	3.40	3.59	1.75	1.28	1.35	1.28	2.80	2.57	1.77
4	1.82	2.01	1.73	1.77	1.85	1.52	1.67	1.45	1.67
5	1.73	1.93	1.73	1.27	1.33	1.27	1.93	1.69	1.85
6	2.28	2.49	1.83	1.83	1.92	1.68	2.22	1.98	1.80
avg		2.66	1.87		1.66	1.46		1.99	1.79
std		0.60	0.19		0.29	0.16		0.43	0.06
7	2.58	2.77	1.70	1.73	1.81	1.53	2.63	2.39	1.88
8	2.92	3.13	1.95	1.55	1.63	1.50	1.55	1.35	1.55
9	3.30	3.51	1.85	1.28	1.35	1.28	1.78	1.55	1.78
10	1.95	2.17	1.95	1.28	1.35	1.28	1.60	1.39	1.60
11	2.75	2.97	1.97	1.63	1.71	1.48	1.77	1.54	1.77
avg		2.91	1.88		1.57	1.42		1.64	1.72
std		0.44	0.10		0.19	0.11		0.38	0.12
AVG		2.77	1.88		1.62	1.44		1.83	1.75
STD		0.55			0.26			0.44	
	Northbound			Eastbound			Eastbound		
1	3.38	3.62	2.12	2.60	2.68	1.48	1.68	1.46	1.68
2	2.10	2.32	1.97	1.47	1.54	1.47	2.73	2.51	1.73
3	1.55	1.72	1.55	2.05	2.13	1.50	2.65	2.41	1.85
4	1.97	2.14	1.58	2.28	2.36	1.53	2.97	2.73	1.80
5	1.80	1.99	1.70	1.33	1.40	1.33	2.02	1.78	1.83
6	2.52	2.74	2.00	1.88	1.96	1.45	2.55	2.31	1.85
avg		2.42	1.82		2.01	1.46		2.20	1.79
std		0.62	0.22		0.44	0.06		0.44	0.06
7	2.67	2.88	1.93	1.53	1.60	1.32	1.53	1.33	1.53
8	2.52	2.73	1.92	1.73	1.82	1.57	2.55	2.31	1.82
9	3.32	3.51	1.78	1.93	2.01	1.50	2.82	2.60	1.63
10	2.02	2.24	1.98	2.50	2.59	1.65	3.20	2.97	1.80
11	2.40	2.61	1.93	2.17	2.26	1.72	2.65	2.42	1.75
avg		2.80	1.91		2.05	1.55		2.33	1.71
std		0.42	0.07		0.34	0.14		0.54	0.11
AVG		2.59	1.86		2.03	1.50		2.26	1.75
STD		0.57			0.40			0.49	

Segment A

Segment B - between main lanes and frontage road

FIGURE 1 Photographs of each segment

Segment C

FIGURE 1 con't Photographs of each segment

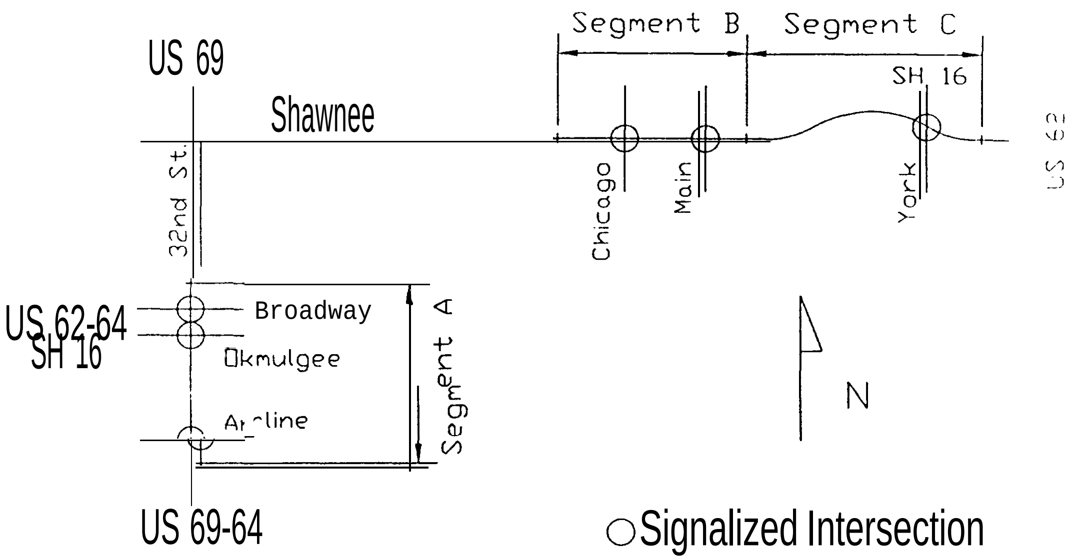


FIGURE 2 Schematic drawing of the three segments

Questions and Answers
Access Planning and Development

Development and Administration of an Access Management Program for Local Government
The Challanges of a Town Initiated Access Management Retrofit Program on two State Highways
Access Management by Consensus, A Success Story

Question I : Have you used the technology transfer center in Florida to help with local government coordination?

> **Freddie Vargas:** We have used the technology transfer center in Florida for our own benefits and for locating reference material. We feel our public involvement program is doing the job by involving the public in the early stages of the project. We have been able to implement our access management program with few problems.

Question 2: Does the variance committee have the final decision in access management permit applications?

> **Freddie Vargas:** The variance committee has the final decision, but the petitioner can still request a second review of the denial. The petitioner has the opportunity to come back and provide additional documentation to support their case. After the variance committee has reviewed the application twice the decision is final. The petitioner still has the option to use Florida Statute 120. This allows a hearing with a public officer to challenge the decision of the variance committee. During the last five years, only one hearing has been requested by a petitioner and the DOT won the case.

Question 3: How do you achieve consistency on a state wide basis from one district to another?

> **Freddie Vargas:** The consistency element is achieved through the application procedure. Each petitioner must comply with the process that establishes the requirements to petition for a variance or deviation. This process is followed by all DOT Districts in the state.

Question 4: Do you use the intersection contour maps as a planning tool only or are they used in actually making decisions for the granting of access permits?

> **Stephan Ferranti:** The intersection contour maps are used both as a planning tool and to make access permit decisions. We look at traffic simulation runs generated by Netsim to determine traffic que length and some detailed operational aspects of the intersection. We do not want to bring pages of these print outs to workshop meetings with business owners, so we feel it is more effective to present schematics that show the business owners exactly what these traffic simulation packages are producing. We feel these schematics are an effective tool for educating those participants that are involved or affected by the plan.

Question 5: In Florida, how many people going through your application process are mom &pop operations vs. well financed developers?

> **Johnathan Overton:** It really varies in Florida, the access management section deals both with mom & pop situations and developers of regional malls. A few driveway permits, mainly residential, are issued right out of the local DOT maintenance yards and are never seen by the district offices. For the most part the district offices deal mainly with the larger developers.

Question 6: Specifically in the deviation process are there many mom &pop operations that try to fight you?

Johnathan Overton: We realize that we have to be flexible because many times mom & pop developments do not have the frontage that is necessary to meet the access management spacing standards for driveways. We try to look at what is the intent of the access management standards, why were the standards developed and what traffic operations are occurring at the location. Many mom & pop sites are mid-block, and if we do not allow a driveway they are basically landlocked.

Freddie Vargas: The variance committees have reviewed cases from the mom & pop operations who have wanted to develop a small parcel. When their applications were denied during the preapplication process because they did not comply with the standards, we have offered them the opportunity to go to the variance committee to present their case. We particularly try to assist these applicants as much as possible by providing them with guidance to assist them in presenting their cases to the variance committee so they will get a favorable decision.

Question 7: What role does the private consultant play in your access permit application process?

Mary Jo Vobejda: The developer and his consultant often meet with us before they submit a preliminary sketch plan. We talk through the requirements and guidelines. Occasionally, especially with large developments and complicated traffic operations issues, we will deal directly with the private traffic engineer to get through some technical points before going through the more formal process.

Questions and Answers
Access Spacing

Guidelines for Commercial Driveway Spacing on Urban and Suburban Arterial Roads
Access Management and Traffic Safety
Comparison of Delay and Accidents on Three Different Roadway Access Designs in a Small City

Question 1: Which of the variables in the accident analysis was the most significant in the contribution to the accidents?

Timothy White: The speed differential was the variable that had the greatest impact on the contribution to accidents.

Question 2: Were the critical accident rates calculated based on a particular type of accident or did they include all accidents?

Timothy White: The critical accident rates were based on all accidents in the study section.

Question 3: Did you encounter any problems concerning inconsistencies in the manner that accident data was recorded?

Kent Lall: There were problems not only concerning the types of accidents, but also concerning the exact location of accidents because there has to be an approximation from a certain milepost. We try to read between the lines of the accident reports and make any obvious corrections.

Ali Eghtedari: The Oregon DOT has a very extensive code that they are using to specifically classify accidents. Their reports collect information including access type in the area of the accident. We basically have to rely on the information contained in these accident reports.

Question 4: Could you convert the travel times to running speeds so that they can be compared to the speed limits?

James Gattis: The data is available, but it is not something that I can whip up quickly off the top of my head. There is more data in my paper than was included in this presentation.

Question 5: Table 3 of your paper refers to non-work zone accidents. Could you explain this?

James Gattis: There was some construction work done in the study area during the period examined in the analysis. Work zone accidents were subtracted from the study because I believe including them would have distorted the analysis.

Question 6: Was there not any significant difference in accidents between Segment A and Segment B?

James Gattis: There was not a significant difference in accidents between Segment A and Segment B, but travel time was significantly better for Segment B.

Question 7: Are the frontage road accidents recorded separately?

James Gattis: Frontage road accidents were coded separately, but my total included accidents that occurred on the frontage roads. I felt that it would be cheating to throw out the frontage road accidents.

Question 8: Could you provide some information on the types of accidents for each of the segments?

James Gattis: I will refer you to pages 11 and 12 of my paper. The only characteristic that I mentioned during my presentation was a greater proportion of rear end accidents in Segment C versus more right angle accidents in Segments A and B. In my paper I included approximately 30 rows of accident comparisons.

V Abstracts/Papers - Session 6

6A - More On The Management Of Access Management

Moderator: Arthur Eisdofer, New Jersey Department of Transportation

Variances - An Important Part Of Access Management Decisions

Access Management Project - British Columbia

Access Management Practices In Connecticut

Deviations From Median Opening Spacing Standards

6T - Geometric Design, Roadway Operation and Access

TRB Committee On Operations Effects Of Geometries
Moderator: Pat McCoy, University of Nebraska

Reducing Crashes At Driveways Close to Intersections

Influence Of Access And Land Use On Vehicle Operating Speeds Along Low Speed Urban Street

Sight Distance For Vehicles Turning Left Off Major Roadways

Warrants For Left Turn Lanes

Variances-An Important Part of Access Management Decisions

Arthur Eisdorfer, Bureau of Civil Engineering, New Jersey Department of Transportation
Robert Siley, Bureau of Major Access Permits, New Jersey Department of Transportation

ABSTRACT

The application of any law, set of rules, or guidelines is not likely to be so comprehensive and well planned that it will satisfactorily address every issue that arises. Therein lies the need to provide for variances, which are also referred to as waivers.

Any exception which is granted to a standard has the effect of lowering that standard. Because agencies are obligated to act consistently, agency staff should be wary of recommending approval of any variance which they are not prepared to grant every time a similar circumstance arises.

To achieve consistency, an agency must consider future decisions based on a record established through past decisions. This requires tracking of all exceptions which have been requested and noting the disposition and reasoning behind the outcome of each one. In addition to promoting consistency, such a log provides documentation, in the event of a challenge to a decision.

Our experience in New Jersey has been an evolutionary process with regard to variances. When the regulations required by the State Highway Access Management Act were being developed, there was an expectation that variances would be routinely granted. It quickly became evident that each granted variance diminished the strength of the regulations, which in turn reduced the levels of highway safety and capacity that the regulations were intended to provide. New Jersey currently uses a more judicious approach to variances.

Consideration should also be given to the long term consequences of variances. Variances help set the future direction of an Access Code. Variances that are routinely granted should eventually be authorized as acceptedpractice.

This paper suggests a hierarchy for variances and some reasons to consider before deciding to grant a variance.

INTRODUCTION

The requirements of any access management program should be well defined. The results of applicant-initiated work should be similar to the results of agency-initiated work. These principles apply to state, county, and local levels of government. Part of the program should also include a process for access personnel to grant variances, waivers, or exceptions to the standards, in instances where strict compliance with the standards is not in the overall public interest or would impose an unreasonable burden on an affected property owner.

> *"My property is different"*
>
> *"'My business is different."*
>
> *'I am an exception to the rule"*
>
> *"My case is unique"*

These are frequently heard statements in the access management profession. They are all signals that the speaker wants to deviate from a prescribed standard. They all should sound a "variance" alarm for the access management professional for what Webster's Dictionary defines as "a license to do some act contrary to the usual rule".

The general public expects an agency to be fair, consistent, and predictable in its actions and determinations. However, this set of expectations often undergoes a dramatic transformation when an agency encounters a citizen who owns private property adjacent to a roadway. This citizen's personal perspective frequently lacks concern for the welfare of the general public and is more likely to be self-centered. Agency staff must voice the interests of the general public in these interactions.

Although citizens have often been known to be unreasonable, the access management professional must always be reasonable. This means being sensitive to the needs and desires of citizens, while striving to maintain the desirable balance between mobility on a roadway and access to that roadway. This is a major challenge. In addition, granting a variance is an administrative determination which can have significant legal consequences. Therefore, deciding whether or not to grant a variance must be an informed decision. The access management professional must carefully weigh the consequences of requiring compliance with the standards against accepting the property owner's preference. Having a systematic approach to addressing variances is a key element of a successful access management program.

HIERARCHY OF ACCESS MANAGEMENT FEATURES

Obviously, some access management features are more important than others. For example, the location of a traffic signal is likely to have more of an effect on traffic safety, capacity, and operation than the location of a driveway. Likewise, the distance between two adjacent driveways is likely to be of greater significance than the distance between a driveway and the nearest property sideline. Therefore, it is important to establish a hierarchy of access management features based on their relative importance. This will help agency staff to reach appropriate conclusions in cases where increasing compliance with one access management criterion can only be accomplished by decreasing compliance with another criterion.

The following list suggests a hierarchical order of common, access-related features, from most critical to least critical:

- Safety (Sight distance, etc.)
- Spacing of interchanges
- Spacing of traffic signals
- Spacing of driveways
- Corner clearance
- Number of driveways on one property
- Edge clearance between driveway and property sideline

Some jurisdictions are sensitive to access management features which are not listed, such as the spacing of median openings, the width or geometric details of access points, access density, or the need for turning lanes. Those jurisdictions may expand the list to encompass additional features to suit regional needs. Whatever the listed features, having made general decisions to create a framework will aid in making specific decisions when there are conflicting parameters regarding a particular site.

An example of working within the hierarchy of access management features is depicted on Figure 1. It shows an existing service station on the downstream side of an intersection. The intersection is proposed to be signalized. The top of the hill to the right of the service station limits sight distance. The farther from the intersection that the driveway to the service station is proposed, the poorer the sight distance. Therefore, using the above hierarchy, the decision on where to locate the driveway should rely more heavily on sight distance than on corner clearance.

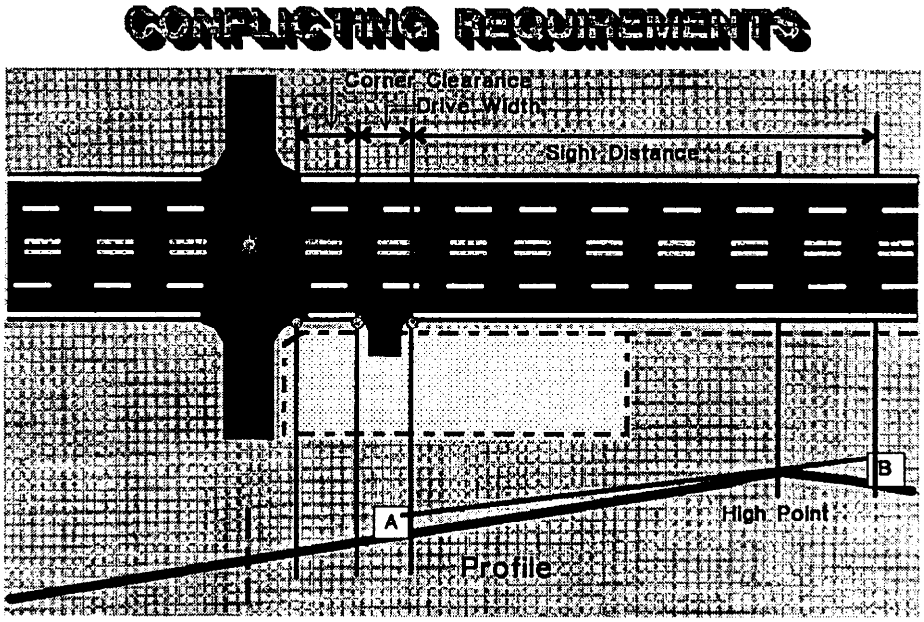


Figure 1

BASES FOR VARIANCES

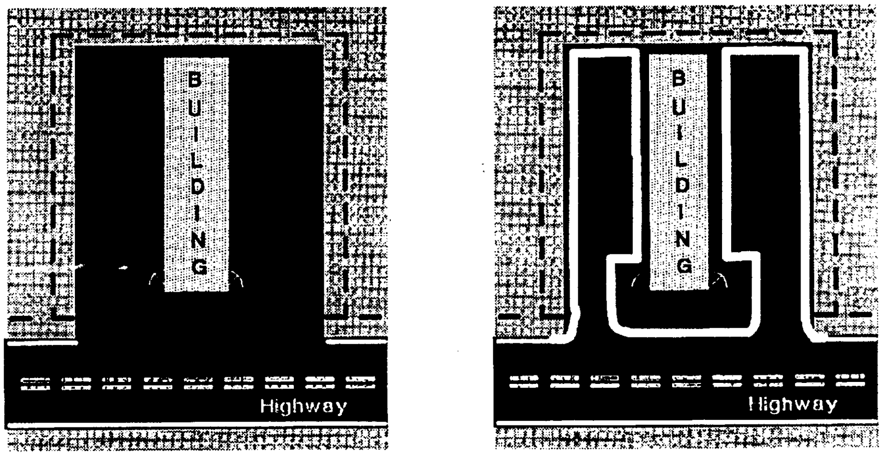
The circumstances under which applicants seek variances is unlimited. However, it is possible to group the reasons for which variances are requested into the several broad categories that follow.

Unreasonableness of strict application of the standards

There are times when full compliance with the requirements of access management standards will result in an outcome that both the property owner and the access management specialist agree is unreasonable. Such a situation should be resolved through a solution which produces a reasonable outcome. Clearly, a variance will be associated with the solution. However, the preferred solution is one which can be applied every time similar circumstances present themselves.

Consider the following situation, as shown on Figure 2. A large, vacant building sits near a road, and the building is centered between the side property lines on a small lot. There is no curb or other means of control of access along the frontage of the lot. The access standards provide for one driveway for the lot. The owner proposes to use the property for a real estate office, but there is not enough parking area for staff and clients on either side of the building and there is not enough room behind the building for a vehicle to get from one side of the building to the other side. The owner needs an access permit because the change in use enables the municipality to require the construction of curb and sidewalk across the frontage of the property.

Unique Conditions



Before After

Figure 2

Full compliance with the access standards would only allow a single driveway for the property. However, this limitation would not allow for an adequate parking area to support even a low volume use like a real estate office. Granting the variance for the second driveway could be the reasonable and prudent action. In addition, allowing a second driveway is likely to be an appropriate solution when a similar situation arises.

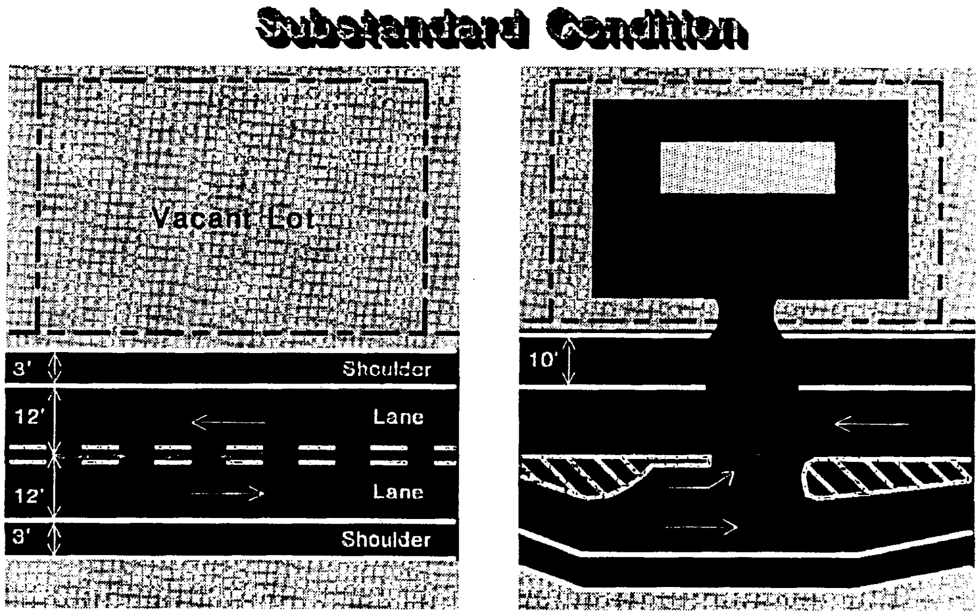
Existing substandard conditions

It is common practice for new highway construction to meet the appropriate state and federal standards. Unfortunately, not every existing feature of every highway meets the current standards of the agency having jurisdiction over the highway.

When an applicant proposes to develop property adjacent to a highway, the applicant may be responsible for improving the highway in the vicinity of the property. While the agency may view this as an opportunity to address longstanding needs or existing geometric deficiencies, care must be taken to sort those substandard items for which the applicant truly shares some responsibility (a rational nexus can be demonstrated in both the nature and extent of the mitigation) from those which should remain the responsibility of the agency.

For example, consider an existing highway as depicted on Figure 3. There is one 12' wide lane in each direction, with shoulders of a substandard width of only 3'. The traffic generation from a proposed development supports the need for a left turn slot for the left turns into the site, but not a right turn lane for right turns into the site. Based on proposed traffic generation to the site, the agency may establish the need for the shoulder in front of the site to be widened. It will provide for separating right turning vehicles from through vehicles, a basic principle of access management. However, there is no basis to make the applicant responsible for widening the shoulder on the opposite side of the highway. The narrow shoulder width is an existing substandard condition. The need for improving the shoulder on the opposite side of the highway is not attributable to site generated traffic. The agency remains responsible for addressing this shoulder width. An approved design exception or variance, which is usually required for construction that will not meet the applicable standards, is the responsibility of the agency.

This example does offer opportunities for creativity. One opportunity is for a public / private partnership.



Before Figure 3 After

The agency could participate in the improvement of the shoulder on the side of the road opposite the site, in conjunction with the work to be performed by the applicant. Alternatively, the applicant and the agency could agree that the applicant would improve the shoulder opposite the site in exchange for the applicant not making an improvement of comparable cost that the applicant had responsibility for at another location.

Existing environmental, economic, or social constraints

There are numerous impediments to implementing transportation improvements. These include limited right of way, wetlands, historic districts, utility conflicts, topographic constraints, and environmentally sensitive areas. An applicant may be able to provide an improvement despite these constraints. On occasion, an applicant can do what the agency may not be able to do, because an applicant may not be bound by the same regulatory requirements. However, most times an applicant will encounter the same obstacles as an agency. No agency should attempt to compel an applicant to do the impossible in terms of sound public policy.

Figure 4 is an example of an environmental constraint. A narrow, four lane highway, near capacity, snakes between historic buildings along the banks of a river. An applicant proposes a small shopping center just outside of the historic district. The added traffic from the proposed shopping center will bring the highway just over capacity. Widening the highway would require taking right of way from a historic site or intruding into the floodplain of the river.

One option for the agency to consider is the merit of granting a variance from the requirement of widening the highway to provide the needed capacity. However, this should only be done after consideration is given to downsizing the development to eliminate the need for the capacity increase. A more holistic approach should also be considered. How far over capacity would the highway be? Is the community generally tolerant of traffic congestion? Is the development of sufficient size that it could be profitable if it was downsized? Are other variances also required? Viewing the decision in a broader context should increase

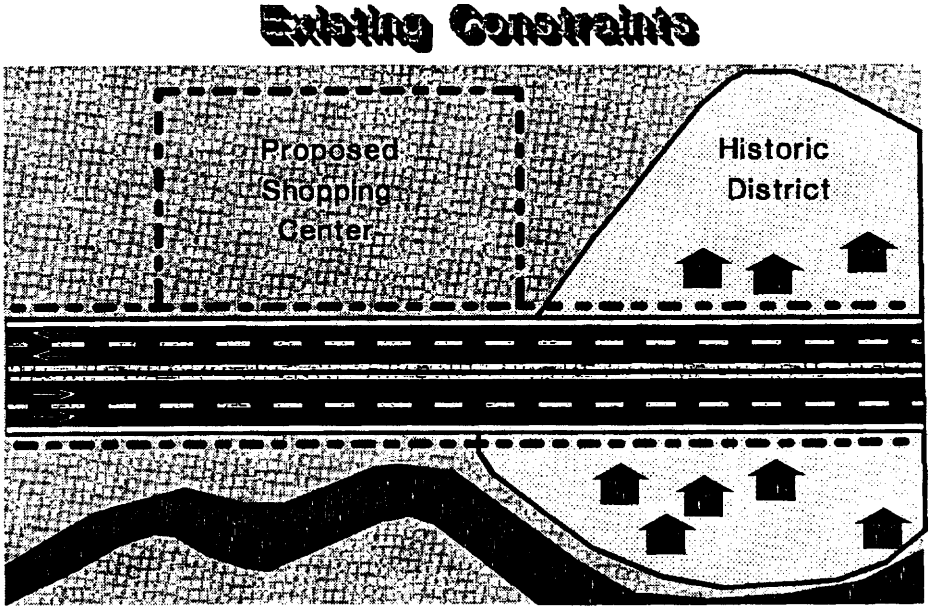


Figure 4

the likelihood of reaching a justifiable and supportable conclusion.

Uniqueness of the situation

While many situations are claimed to be unique, the ones which are genuinely unique provide fertile ground for variances because these situations have limited precedential value. The access management practitioner should be extremely cautious when confronted with an allegedly unique situation. The practitioner should seek input from associates to ensure that the circumstance is truly unique and look for other locations which may be similar. After careful study, the access management professional can reach a solution in compliance with the requirements, or approve warranted variances.

Conflicts between the requirements of agencies having jurisdiction

In many locations around the country, a developer needs approval from over a dozen agencies to develop or redevelop property. Each agency having jurisdiction has its own purposes and requirements. It is not unusual for the requirements of two or more agencies to conflict.

Common conflicts with transportation features include environmental goals and affordable housing provisions. Widening a highway may also conflict with environmental policies if the widening impacts land covered with wetlands or in a floodplain. A transportation agency must be sensitive to its responsibility to serve the community as a whole and recognize that an environmental goal could be more important than a transportation goal.

Consider a very large parcel which served as the home of a chemical manufacturing plant for many years. See Figure 5. The plant closed, leaving the soil contaminated and the groundwater polluted. The parcel has

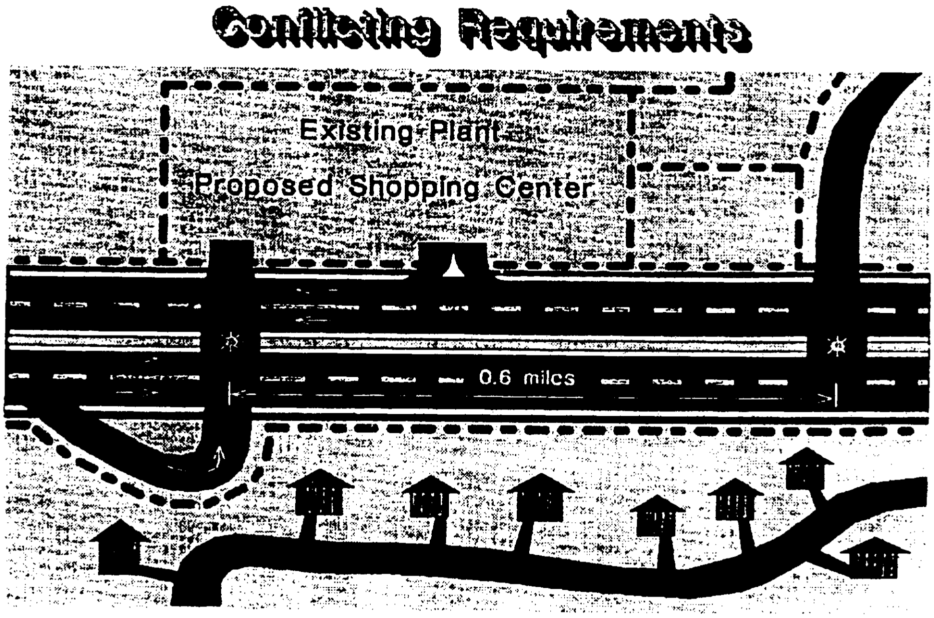


Figure 5

almost ½ mile of State highway frontage, including access to a traffic signal on the highway. The next traffic signal is 0.6 miles away. The State Highway Access Management Code requires that traffic signals be spaced at least ½ mile apart. The municipal zoning is for a shopping center, no smaller than one million square feet. The single traffic signal along the frontage of the site cannot adequately accommodate the traffic generated by a shopping center which is of the zoned size. Redevelopment, consistent with the zoning, is the most likely source of funding for the extensive environmental cleanup that is required.

This constitutes a major dilemma because the requirements of the State and the municipality cannot both be met by the same solution. The conflict between the requirements of the agencies can only be resolved by one of the agencies granting a variance. In this case, if the municipality granted a variance to allow a smaller shopping center, the financial elements would render the cleanup costs unaffordable. However, the State may be able to grant a variance for the spacing of an additional traffic signal, if the existing progression could be maintained. The best protection of the public health and safety may be provided by the cleanup of the site, the construction of the shopping center, and the addition of a traffic signal 0.3 miles from the signals on either side.

Near the threshold

Many people are surprised at the number of boundaries that are associated with access management. In this context, a boundary is any line where conditions differ on either side of the line. Under this definition, the location where a speed limit changes is a boundary. The requirements in many states and municipalities create other boundaries, such as access levels and municipal, county, urban, or rural boundaries. It follows that for each of these parameters the condition changes at some point along a highway.

It is not uncommon for a property to be situated with a portion of its frontage falling within one classification and the remainder of the frontage falling in another classification. This is illustrated in Figure 6.

The speed limit could be 55 mph on one side of a boundary and 45 mph on the other side of the boundary. A factor based on the speed limit, such as driveway spacing, could also change at the boundary. This could result in a driveway being acceptable on the 45 mph side of the boundary, and not be acceptable on the 55 mph side of the boundary.

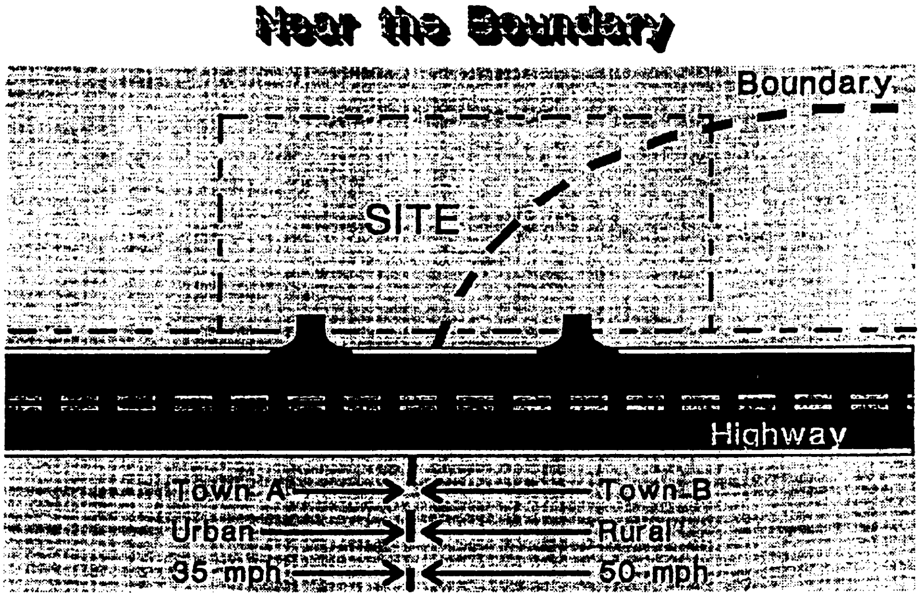


Figure 6

In the interests of simplicity and consistency, it is beneficial to fit each property into one classification, rather than having different criteria apply to parts of the lot. A variance would allow this to occur. Some agency personnel may be inclined to rely upon the location of the access to a property, rather than its entire frontage, when determining which classification is applicable to a lot. While this would reduce the likelihood of a boundary issue, it would not address all boundary situations. Another alternative would be to decide each of the threshold issues in the manner that most favors the property owner. Obviously, this method would meet with the least resistance. However, deciding if the property and the highway conditions are most like those found on one side of the boundary or the other side of the boundary may be the best approach from an access management perspective.

Fees

One of the most frequently sought variances is for a reduction or elimination of application and permit fees. An agency should first consider whether it has the authority to waive or reduce fees. If so, the agency should prepare to handle the requests for variations from the fee schedule. Once the door opens, there could be an onslaught of applicants seeking reductions or elimination of fees for a seemingly endless variety of hardship reasons.

New Jersey has not provided the Department of Transportation with the authority to waive fees. However, its regulations allow waiving the requirement to submit an application. If there is no application required, there is no fee required either. The Department has limited the use of this provision to circumstances where someone has expressed a willingness to undertake an activity encouraged by the Department, but the fees stand in the way of their performance of the work.

CIRCUMSTANCES MAKE A DIFFERENCE

People who apply for a State highway access permit can be divided into two categories: people who must have a permit and people who want a permit. The propensity to grant variances for these different types of applicants is not the same.

The "musts" are typically those undertaking an activity that cannot be accomplished without a permit. This would be the case for an undeveloped property, having only State highway frontage, which is proposed to be developed. There is no choice for the owner but to obtain a State highway access permit in order to develop the property.

There are also those who "want" a permit, but can meet their goals without one. For example, there could be someone redeveloping a property having three driveways, who prefers to eliminate one of the driveways, but the reduction in the number of driveways is not necessary to accomplish the redevelopment. In such an instance, the property owner may be interested in improving the existing access, while not being willing to fully comply with the requirements of the Access Code.

Many of the variances granted in New Jersey have been associated with "want" or "voluntary" applicants. The agency faces the choice of approving a variance to obtain some improvement in highway safety, or not approving the variance. If the agency does not approve the variance, it is likely that the developer will withdraw its application, and leave the existing conditions unimproved. When the agency does not have the leverage to obtain full compliance with the standards, the "something is better than nothing" approach is clearly in the public interest.

CONCLUSION

Since 1992, New Jersey has had comprehensive access management regulations. There is a provision in the regulations for granting variances. The number of variance requests received by the Department of Transportation is comparable to the number of State highway access applications received. This demonstrates, that even regulations as comprehensive as those in New Jersey do not address every detail of access management in a reasonable manner under all circumstances. However, variances provide the Department, or any other agency, with the flexibility that is necessary to create reasonable solutions in unique situations, to account for existing substandard conditions, to resolve conflicts between public policy goals, and to address environmental constraints.

The goal of an access management program is to provide for safe and efficient mobility. Access staff plus applicants and their professional representatives should work together to establish site access that meets all of the requirements of the agency. When meeting all of the requirements does not yield an acceptable access solution, variances should be considered. If some of the requirements or needs conflict, there should be a systematic approach to consider access management techniques within a predetermined hierarchy. The goal is to reach a solution that the agency can approve for the specific location, as well as other similar locations when comparable circumstances arise in the future.

The variances that an agency is willing to grant today will shape its future approvals and the direction that its standards will take tomorrow.

Access Management Project Of British Columbia
MINISTRY OF TRANSPORTATION AND HIGHWAYS OF BRITISH COLUMBIA

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ABSTRACT

The Ministry of Transportation and Highways of British Columbia established the BC Access Management Project as an effective response to congestion, loss of arterial capacity and access related accidents being experienced on the provincial highway system. Initial reviews of existing programs within the province and in North America indicated that the Ministry 's mandate and program for access management is neither well-known nor widely understood.

An outcome of the initial stages of the BC Access Management Project was the recognition that a number of external stakeholders should be consulted in order to ascertain what issues, concerns and expectations these groups may have with respect to any modification in the Ministry's authority, policies, procedures or standards regarding a comprehensive access management program. This consultation led to a systematic gathering offeedback with key stakeholders andpermit applicants.

The first phase of this research involved a series of unstructured telephone interviews with key stakeholders such as local government planners, developers and other provincial reviewing agencies. The second phase of the study involved a structured telephone interview with a representative sample of permit applicants throughout the province. The feedback from this research and the resulting recommendations were documented in the Preliminary Consultation Program for the Access Management Project.

1 .O BACKGROUND

In response to increasing pressure to provide cost effective solutions to safety and capacity problems on its highways, the Ministry of Transportation and Highways of British Columbia assigned Highway Planning Branch to review and update existing access management in B.C. The B.C. Access Management Project was initiated in June of 1993.

Phase I of the Access Management Project was completed in the 1993/94 fiscal year producing a report summarizing the findings of ten tasks associated with the planning, design and implementation of the proposed Access Management Program. One of the components of Phase I was the design of a Consultation and Communications Strategy.

It was recognized that there are many individuals, groups and organizations who have an interest in access management. The nature and level of their interest differs according to their role. For this reason, it was determined that the development of a comprehensive access management program will need to document and deal with this variation in interest.

At the beginning of Phase I of the project, an "internal" issue summary was conducted through Regional focus group discussions with Ministry staff involved in reviewing and issuing permits under existing development permit processes. It was intended that the Preliminary Consultation Program should be undertaken in order to determine "external" issues associated with access management in British Columbia in order to ensure that interested parties have an opportunity to present their various perspectives early in the development of the program.

2.0 PRELIMINARY CONSULTATION PROGRAM OBJECTIVES

The Preliminary Consultation Program was initiated in June of 1994 with the signing of the project objective statement by the project owners. The following were the approved objectives of the Preliminary Consultation Program.

1. Identify interested parties associated with access management.
2. Provide forums for scope development of future Consultation and Communications Strategies for the proposed Access Management Program.
3. Provide opportunities for interested parties to communicate their interests through a survey which will;
    - identify key issues,
    - gauge level of interest in these issues,
    - gauge level of customer satisfaction in current access management policies and procedures
    - gauge level of understanding of access management legislation, policies and procedures,
    - provide opportunities for suggestions,
    - identify level of support for changes to access management policies, and procedures.
4. Summarize issues to reflect various perspectives and to determine how best to consult and inform the parties during implementation. This would include exploration off the perceptions related by Ministry staff during the internal issue summary.
5. Liaise appropriately with that work done in Phase I of the Access Management Project related to Public Consultation to ensure that there is no duplication of effort and that conclusions and recommendations will fit in with proposed Phase II activities.

The Highway Planning Branch was given the responsibility to organize and conduct this survey in consultation with the project team members. The results of the scope development and the final conclusions were to be reviewed with the Project Owners and the Ministry Executive Committee.

3.0 PRELIMINARY CONSULTATION PROGRAM INITIATION

It was determined that an external consultant familiar with the issues of marketing surveys should be hired to gather and document the information. A Request for Proposals was written, approved and sent out to four local companies with the expertise required to conduct the survey. The information which accompanied the Request for Proposals consisted of;

1. Previous work completed in the Communications and Consultation Strategy for the proposed Access Management Program.
2. A list documenting parties who may have an interest in the Access Management Project and the level of that interest was predicted as Low, Medium or High. (See Table 3.1)
3. The internal Issue Summary which had been completed in 1993 at the start of the Access Management project.

The proposals were then reviewed and the Ministry selected one of the consultants to complete the Preliminary Consultation Program. The consultant proposal evaluation was based on evaluation criteria which graded the proposals on the basis of presentation, methodology, originality. personnel and project management.

Table 3.1 - Interested Parties and Level of Interest

Interested Part	Nature of Interes	Level of Interest
Ministry Access Managers		
Highway Planning and Policy Branch	Sponsorship & Management	High
Highway Safety, Engineering, Environment, Operations & Maintenance	Contribution of Technical Expertise	Medium
Regional Planning and Development Review	Contribution of Technical Expertise	Medium
District Development and Review	Administration of Program Functions	High
Ministry Solicitor	Contribution of Technical Expertise	Medium
Regional Directors	Sponsorship of Access Management Plans	Medium
Government		
Ministry Executives	Statutory requirements, regulations, policies, program funding, program support and project ownership	High
Ministry of Municipal Affairs - Planning and Corporate Relations	Municipal impacts, public relations, OCP's and MSNP's	High
Customers (Road Users)		
Individual Road Users	Safety, efficiency and convenience	High
BC Transit	Access, stops, exchanges, safety, routing	Medium to High
Automobile Associations, Taxi Firms and Cyclist Associations	Safety, efficiency and convenience	Medium
Truckers Associations	Safety, efficiency and convenience	High
Local Governments		
Regional Districts	Impacts of transportation on land development	High
Municipalities	Impacts of provincial highways on land development and municipal road network (OCP's and MSNP's)	High
Aboriginal Governments	Impacts of transportation on land and land development	High
Development Community		
Develoners	Impact on development industry	High
Real Estate Boards	Impact on development industry	High
Chambers of Commerce	Impact on development industry	High
Homebuilders	Impact on development industry	High
Ministry of Environment, Lands and Parks - Crown Lands	Developer, Owner	Medium
Ministry of Employment and Investment	Encourage economic investment and development	Medium

Transportation Funding Authority	Encourage investment and alternative funding sources	High
Ministry of Tourism - Community Development	Tourism Industry Support	Medium
Road Construction and Maintenance Firms	Construction and maintenance standards and requirements	Medium
Private Property Owners	Access permit requirements and potential impact on properties	High
Stakeholders		
Motor Vehicle Branch - Traffic Safety Programs	Contribution of technical Expertise	Medium
Police Forces (RCMP, Municipal)	Safety, enforcement	Medium
Insurance Corporation of BC	Reduction in accidents and claims	High
Transportation Association of Canada	Contribution of standards and guidelines	Low
Professional Engineering Associations	Impacts to Professional Practice	Low
Law Society of BC	Impacts to Professional Practice	Low
Appraisers Institute of BC	Impacts to Professional Practice	Low
Planning Institute of BC	Impacts to Professional Practice	Low
BC Land Surveyors	Impacts to Professional Practice	Low
Emergency Response Agencies	Safety response times and routing	High

4.0 KEY ELEMENTS OF THE PRELIMINARY CONSULTATION PROGRAM

4.1 Interviews with "Expert" Stakeholders

The first phase of this research involved a series of unstructured telephone interviews with key stakeholders such as local government planners, developers and other provincial reviewing agencies. Each stakeholder was defmed in terms of the following four categories of interest;

1. Political/Economic
2. Technical
3. Process Related
4. Road Users

These people were selected by the Ministry from across the province as "experts" in the impacts of transportation and development including;

- Municipal and Regional District Planners
- Developers
- Other Provincial government agencies involved in land use planning
- Royal Canadian Mounted Police
- Realtor
- BC Transit
- Insurance Corporation of BC

The Ministry contacted these people in advance to ensure that they were willing to undergo the interview with the consultant's staff. A questionnaire was developed to aid the interviewers in directing questions and to provide some structure for documenting the responses.

4.2 Interviews with Access Permit Applicants

The second phase of the study involved a structured telephone interview with a representative sample of permit applicants throughout the province. The Ministry processed over 7,000 access permit applications in the 1993/94 fiscal year. These applications are tracked in a computer data base which was used to randomly select 200 applicants from across the province for the telephone survey.

The questionnaire for the telephone survey was developed jointly by the Ministry and the consulting firm. Some preliminary surveys were done to ensure that the questions were straight forward and understandable. The results of both surveys were documented in a final report along with various recommendation.

5.0 KEY FINDINGS OF THE INTERVIEWS WITH "EXPERT" STAKEHOLDERS

5.1 The Balance Between Land User Needs and Road User Needs

It was felt that coordination of local government planning with provincial highway planning to ensure that there was manageable growth throughout the province is important. However, many cited sooner and more frequent involvement by the Ministry in the planning process for community development as well as for individual applications. Highway network plans are not always available to local governments in a timely fashion.

Seventy percent of the respondents believe that the Ministry has done a good job balancing land user needs with road user needs but many commented that this process is often "painful" and not well defined. For this reason, most stakeholders were not satisfied with the existing level of joint planning between the Ministry and municipalities, regional districts, and developers.

Respondents felt that their inputs were not being sought and that land use planning was subordinate to highway planning. Often, it is the local government who must get the Ministry to sit down and discuss joint issues facing both parties. It was suggested that the local government and the Ministry participate in joint approvals so that developers would not invest in land where there was little hope of development approvals.

5.2 Road Access Location and Design

Road access location and design was of high importance to local government planners because of its impacts to road safety and land use patterns. Developers indicated that road access location had the ability to "make or break" their developments by regulating traffic flow. Both rural and urban stakeholders commented that the Ministry was very "road oriented" and were more concerned with continuity of traffic flow than land use.

5.3 Funding of Road Improvements

Perceptions on how road improvements were funded varied widely. Developers felt that they were paying a large share of the costs and local government representatives empathized with them on this. Many cited the use of development cost charges as a good way to ensure more equitable distribution of the costs of transportation improvements to all developers in the area. Posting bonds to finance future improvements was seen as unfair by developers when the Ministry did not know when those improvements could be funded. Many thought that the Ministry was the primary beneficiary in funding arrangements for highway improvements.

5.4 Awareness of Ministry Policies, Procedures and Regulations

All respondents were aware that permits are required for highway access in BC although there were varying degrees of familiarity with the development approvals application processes for controlled access highways and ordinary access highways. These stakeholders dealt with the Ministry more often on subdivision applications and rezoning approvals.

5.5 Strengths of Ministry Policies, Procedures and Regulations

Only a few respondents chose to discuss the strengths of existing processes commenting on the importance of safety of the traveling public, keeping highways flowing freely and coordinating the local street network with the provincial highway system.

5.6 Weaknesses of Ministry Policies, Procedures and Regulations

The length of time to process applications and make a decision was an issue which came up in the interviews. This process could take from three months to a year. However, many respondents stated that they would receive a preliminary decision within several weeks of submitting the application and the permit or formal approval would be issued several months later.

Reasons for delays in the application process were attributed to;

- Belated requests from the Ministry for additional information,
- Conflicting decisions between headquarters, regional offices and district offices of the Ministry,
- Unclear policies and procedures led to interpretation and delays,
- Poor initial communication with the Ministry early in the development approval process,
- Poor communication with or delays by other Ministries and regulatory agencies involved in the development approval process.

Other weaknesses which were cited included;

- Lack of flexibility of Ministry policies and procedures especially to accommodate special situations, geographic characteristics or unique land use situations,
- Lack of coordination between the Ministry and local governments,
- Policies and procedures apply more to urban areas than rural,
- Conflicts over the function of highways when they run through rural communities,
- The need for clear direction on highway policies, procedures and plans for new or existing roadways,
- Many conflicts arise over disagreements about parking requirements and setbacks.

5.7 Consistent Application and Enforcement of Policies, Procedures and Regulations

Respondents were split on their attitudes towards this issue. Some felt that uniform application of policies brought consistency to the highway system while others felt that it led to inflexibility. Lack of uniformity in the decision-making process was cited as a problem when it led to changes in decisions and delays to application processing. However, most respondents felt that general policies, procedures, and regulations were consistently applied.

Because policies, procedures and regulations are not clearly set out, some respondents felt that they are open to interpretation by the stakeholders and various Ministry staff. This was especially difficult to deal with when Ministry staff interpretations conflict with professional evaluations. Enforcement was not considered a problem by stakeholders since Ministry decisions were generally carried through. Illegal accesses are handled by the Ministry and so were not considered important by the respondents.

5.8 Attitudes About Legislated Zoning Controls

All the stakeholders had a good understanding of legislated zoning controls on controlled access highways and did not feel that these controls conflicted with their objectives in any major way. However, many respondents also questioned whether the Ministry should be able to have jurisdiction over zoning bylaws and challenged the amount of road dedications that the Ministry often takes.

More than one half of the respondents did not think that communication on zoning requirements was major problem. Some local government representatives said they could benefit from a better understanding of specific requirement for rezoning and the rationale behind them. Local governments often get caught in the middle of negotiations with developers and have to try to resolve conflicts or negotiate compromises. The Ministry should be involved earlier in the process than third reading.

5.9 Defensibility of Ministry Policies, Procedures and Regulations

Most respondents gave defensibility a relatively low rating stating that they found it difficult to justify policies, procedures and regulations based solely on technical reasons. Many felt that the Ministry placed too much emphasis on safety and mobility of the road user at the expense of people's legitimate right to road access.

Some respondents felt that defensibility issues arose when people without any professional flexibility administered applications. Site impact analysis studies should be reviewed by people with the background to determine whether site impacts can be mitigated.

5.10 Need for Update of Ministry Policies, Procedures and Regulations

The following are some of the comments generated by questions related to the need for updating policies, procedures and regulations.

- Most felt that regular updates should be done.
- Respondents wanted input to changes, especially consultants and developers who felt they were rarely asked for their views.
- Existing policies do not reflect the unique characteristics of different communities.
- Policy updates should reflect long term strategies which the Ministry clearly articulates on overall direction, goals and objectives of the BC highway system.
- Some criticism was directed at the Ministry's attitude toward public consultation processes which are often only entered into at the end of the planning process.

5.11 Availability of Access Permit Process Information from the Ministry

The level of satisfaction on the availability of information seemed to depend on which office the respondent was dealing with. Deficiencies in this area were attributed to high staff workload levels and staff turnover. Some respondents had never seen Ministry policies and procedures. Others said that there were forms outlining the access permit process readily available in the district offices and the various steps in the permit process are spelled out on the application form.

5.12 Availability of Construction Requirements and Design Standard Information from the Ministry

Few stakeholders had requested construction requirements. The design standards are available in the Ministry's Design Manual although some felt that it needed to be updated and that some discussion with Ministry design staff was often still required to determine exactly what was required. One respondent did not know that the Ministry had design standards and was using architect's standards.

5.13 Availability of Information from Ministry Planning Studies

Stakeholders were extremely critical of the Ministry's planning studies. The following comments relate to this issue;

- The Ministry is reluctant to share information on planning.
- Long term plans never seem to get done or are changed on a regular basis.
- Outside inputs to plans are often not sought from stakeholders.
- The Ministry is only interested in road geometrics and not on the impacts their roads have on land use.

- Planning studies rarely provide information or direction to local governments and applicants who come to local governments for information.
- An information circular which would outline priorities and future direction would be helpful.
- The Ministry should be more involved in the Official Community Plans which must also account for broader community issues.
- One person should be dedicated to a specific community acting as liaison to the local government in order to improve communication between various levels of government.
- Direct discussions with Ministry technical staff or traffic consultants would help to answer questions and address issues before they become problems.

5.14 Evaluation of Ministry Staff

Most respondents were satisfied with the technical knowledge of Ministry staff with the exceptions occurring in rural areas. There were some concerns with staffturnover and the lack of familiarity with local issues which this causes. Some respondents indicated that they preferred to deal with senior staff who had decision-making authority.

The majority of stakeholders felt that Ministry staff did not have a good understanding of economic issues and many thought that the Ministry did not take community concerns into consideration nor alternative modes of transportation. Only about 40% of the stakeholders felt that Ministry staff lacked an understanding or appreciation of local politics. Ministry staff were felt to have a good understanding of development issues related to project scope, schedules and budgets.

Other issues which arose included lack of awareness or knowledge of transportation design principles, environmental considerations, use of design standards that are very land intensive and impacts to Agricultural Land Reserves.

5.15 The Appeal Process

Relatively few stakeholders were familiar with the appeal process or had contested a permit denial. Those who were familiar characterized the appeal process as a process of negotiation and working their way up the chain of command to someone in a position of authority.

6.0 DETAILS OF THE PERMIT APPLICANTS SELECTED FOR THE TELEPHONE INTERVIEWS

6.1 Type of Applicant

In order to classify the responses, the permit applicants interviewed were asked to indicate which of the following best describes them. The following table provides a breakdown of the responses.

Table 6.1 - Type of Applicant

Type of Applicant	Percent
Independent Property Owner	52
Small to Medium Size Developer	15
Professional Consultant	9
Single Familv Home Develoner	5
Work for a Municipality or Regional District	5
Large-Scale Developer	3
Agent of a Real Estate Company	1
Miscellaneous Mentions	11

6.2 The Number of Times Applied

The applicants were asked whether this was the only time in which they had ever applied for an access permit with the Ministry. If they had applied before, they were asked how many times they or their organization had applied in the past year for a highway access permit. The following table provides the results of the responses.

Table 6.2 - Previous Experience With the Application Process in the Past Year

Number of Times Applied	Percent
First Time Applicant	60
Multiple Applicant - Once in the Past Year	20
Multiple Applicant - Twice in the Past Year	10
Multiple Applicant - Three Times or More in the Past Year	10

6.3 Value of the Developments Related to the Requested Permits

Of those applicants who responded that this was the first access application that they had ever made, the average value of the related development was $4 19,500. The following table summarizes the responses to a question about the value of related developments for all applicants.

Table 6.3 - Estimated Develonment Value for All Applicants

Estimated Development Value	Percent
$50,000 or less	22
$50,001 to $100,000	26
$100,001 to $249,000	24
$249,00 1 to $2,000,000	24
Over $2,000,000	4

6.4 Status of Development Approvals at the Time of Application for Access

The Ministry wished to gauge the status of the development approvals at the time of the access application. Table 6.4 summarizes the responses which indicated that by the time the access permit applications are actually submitted, the development approvals are in a variety of stages. It is important to keep in mind that an access permit is tied to the owner of the land and a permit application must be resubmitted for each new owner. This means that often, an access permit is requested for an access which is already in place and for which there is no change in use proposed.

Combining these results, we can see that at the time of access application, many respondents had approvals on zoning (60%), site plans (38%) and local government development permits (33%). About one third (3 1%) had an existing access already in place or traffic studies complete (7%). Only 11% are at a very preliminary stage where no plans have been developed or approvals granted

Table 6.4 - Status of Development Approvals at the Time of Application for Access

Zoning Approved	Local Gov't Development Permit Approved	Site Plans Approved	Access Existing	Traffic Study Complete	Other Approvals In Place	%
X			X			12
						11
X	X	X				11
X	X					7
X		X	X			6
X		X				6
X						6
X	X	X	X			5
X	X	X	X	X		4
			X			4
		X				3
	X					3
X	X	X		X		
					X	16

6.5 Length of the Application Process

The respondents were asked to indicate the length of time it took for Ministry staff to inform them of their decision on their application. The average waiting time among all applicants interviewed was 5.7 weeks. The results of this question appear in Table 6.5.1. They were then asked about their level of satisfaction with the review period and these results appear in Table 6.5.2.

The applicants who indicated that they were dissatisfied (19%) with the review period, were asked what impacts (read from a list) the delays to the review period caused to their developments and what items (read from a list) might have caused those delays. These responses are summarized in Tables 6.5.3 and 6.5.4.

Table 6.5.1 - Length of Time For The Applicant To Receive Ministry Decision

Period of Time	Percent
One Week or Less	25
Two to Three Weeks	27
Four to Six Weeks	25
Over Seven Weeks	23

Table 6.5.2 - Level of Satisfaction with the Application Review Period

Very Satisfied	Somewhat Satisfied	Somewhat Dissatisfied	Not At All Satisfied
52%	29%	11%	8%

Table 6.5.3 - Impacts of Delays on Developments of Dissatisfied Applicants

Impacts of Delays	Percent
Increase Project Uncertainty or Risk	51
Increase Project Costs	27
Cause Difficulties with Construction Schedules	25
Cause Difficulties With Construction Contracts	10
No Problems	27

Table 6.5.4 - Perceived Causes of Delavs

Perceived Causes of Delavs	Percent
Heavy Backlog of Applications at Ministry Offices	47
Ministry Policies and Procedures Are Not Clear	28
Poor Coordination of Ministrv and Local Government Processes	27
Ministry Requests for More Information/Application Not Complete	22
Need Approval From Another Ministry	10
Need Approval From a Local Government	9
Application Required a Traffic Impact Study	6
None of the Above	32

Applicants were asked what they felt would be a reasonable turnaround time for reviewing access permit applications. The responses for reasonable turnaround times for "simple" applications and "complex" applications are shown in Tables 6.6.1 and 6.6.2. A simple application was one which did not require a traffic impact study. These responses exclude "don't know" responses.

Table 6.6.1 - Expectation of a Reasonable Turnaround Time for Simple Applications

Period of Time	Percent
One Week or Less	38
Two to Three Weeks	38
Four to Six Weeks	21
Over Seven Weeks	

Table 6.6.2 - Expectation of a Reasonable Turnaround Time for Complex Applications (includes a site impact analysis study)

Period of Time	Percent
One Month or Less	44
Two Months	18
Three Months	17
Four or Five Months	4
Six Months or More	17

It is interesting to note that the expectations of turnaround times vary significantly from actual experiences. Of the total applicants, the expected turnaround time for an access permit application which did not require a traffic impact study averages 2.5 weeks compared to the 5.7 week average it actually took. There are many permit applicants (38%) who expect the turnaround time to be one week or less and a further 38% expect an answer in two or three weeks. Property owners have higher expectations (1.9 weeks) relative to developers (2.4 weeks) or those in other occupations (3.7 weeks).

Major differences exist in terms of expectations for complex applications which involve traffic impact studies and highway design changes. In fact, the average expected turnaround time for these types of applications is 2.6 months. However, there is also a large number of applicants (30% of the total) who did not know what their expectations were for these types of applications. These were property owners and first time applicants.

6.7 Coordination of Application Review Processes with Local Governments

When the applicants were asked whether the Ministry worked closely with other local government planners in processing their access permit applications 41% thought they had and 13% thought they had not. Of the remainder, 34% said they didn't know and 12% said that local govemment processing did not apply to their application.

6.8 Influence of Other Agencies

The Ministry wanted to gauge the level of understanding which applicants had over who had the final authority to approve their access permit application. This would provide some indication of their understanding of the process of determining whether an access permit can be granted for roads which may be perceived as local or municipal.

The following table provides a summary of the responses to the question about who has final authority over whether to issue the access permit to the applicant. It is interesting to note that 11% thought that other agencies had final approval authority.

Table 6.8.1 - Applicant's Perceptions of Which Agency Which Has Final Authority to Issue Access Permits to Provincial Highways

Agency	Percent
Ministry of Transportation and Highways	86
Municipality	2
Regional District	8
Ministry of Environment	1
Don't Know	

7.0 KEY FINDINGS OF THE INTERVIEWS WITH PERMIT APPLICANTS

7.1 Overall Satisfaction with the Permit Application Process

There was some variation in satisfaction levels in the different regions of the province. The satisfaction levels were also higher when the application was processed in ten days or less. First time applicants gave higher ratings than those who has submitted other applications.

Table 7.1 - Overall Satisfaction with the Permit Application Process

RATING LEVEL	PERCENT
Excellent	30
Good	47
Fair	16
Poor	4
Vet-v Poor	3

7.2 Quality of Ministry Communications - Overall

The following table above provides a breakdown of the level of satisfaction with the information that Ministry staff provided in filling out their access permit application. Satisfaction levels vary somewhat by region and by the length of time it took to process the application. The number of people who were "very satisfied" increased to 79% if it took less than 10 days and dropped to 52% for those whose application took longer.

Table 7.2.1 Quality of Ministry Communications - Overall

RATING LEVEL	PERCENT
Very Satisfied	61
Somewhat Satisfied	28
Somewhat Dissatisfied	6
Not at all Satisfied	5

The following table indicates the level of satisfaction with Ministry communication for each stage of the application process.

Table 7.2.2 - Quality of Ministry Communications - By Stage of Application Process

	Excellent	Good	Fair	Poor	Very Poor
Initial Contact	37%	49%	9%	3%	2%
Application Review	27%	49%	15%	6%	3%
Final Decision	31%	48%	11%	4%	2%

The telephone interview also solicited suggestions for improved communication and information and the results are shown in the table below.

Table 7.2.3 - Suggestions for Better Ministry Communication and Information

Suggestions	Percent
Don't Know	44
Nothing	I7
Clearer Written Information Regarding Requirements	12
Information Requirements Communicated Earlier in the Process	8
Qualified/More Competent/Helpful Staff at the Local Level	7
Better Information About Time Required to Process Application	5
Have Someone Come On Site/By Appointment	3
Immediate Notification of Delays or Additional Requirements	4
Staff Could Be More Friendly	2
Better Liaison with Local Government	4
Prompt Response to Inquiries About Application Status	2
Better Links Between Applicant and Decision Maker	2
Miscellaneous Mentions	5

7.3 Awareness of and Understanding of Access Permits

The following table contains the responses to a question about how the respondent first became aware that an access permit was required.

Table 7.3.1 - How Applicants Found Out About The Need For An Access Permit

Methods of Determining Need For An Access Permit	Percent
Was Informed by Local Government Staff	35
Was Informed by Ministry Staff	30
Learned from Work Colleagues, Friends or Relations	29
Was Informed by another Ministry	4
Prior Knowledge/Past Experience	2
Don't Know/Can't Recall	4
Other	0

The interviewer also asked the respondents for the reasons why the Ministry required access permits. More than one response was allowed.

Table 7.3.2 - Understanding of Reasons Why An Access Permit is Required

Reasons For Requiring Access Permits	Percent
Safety	42
To Control Access	36
Traffic Control	29
To Regulate and Control A Proper Road and Highway System	15
To Ensure Proper Drainage/Installation of a Culvert	11
To Ensure Proper Road and Highway Maintenance	7
To Ensure That the Road is Properly Built	6
To Ensure Better Future Planning	2
Other Reasons	5
Don't Know	5

7.4 Perceptions of the Importance of the Benefits of Access Permits

Applicants were also asked to rate the importance of nine separate benefits of access permits. The high levels of importance which are ascribed to these benefits show that many strongly support the rationale for the application process. The table below provides the responses to this question.

Table 7.4 - Perceptions of Access Permit Benefits (excludes don't *know)*

	Very Important	Somewhat Important	Somewhat Unimportant	Not At All Important
Ensure User Safety is not Compromised	84	15	0	0
Maintain Drainage On Road Right-of-wav	78	18	2	1
Establish Access Design Requirements	44	45	5	1

Ensure Traffic Signals are Spaced Properly	56	25	5	4
Establish Terms and Conditions of the Permit	50	38	4	4
Allow Construction on Crown Lands	37	38	7	5
Estimate Trips and the Capacity of the Access	36	44	7	6
Assign Maintenance Responsibility to Owner	39	43	8	4
Maintain an Inventory of Accesses	46	36	8	8

7.5 Level of Agreement with Statements About the Permit Application Process

In order to obtain direct responses to applicant's experiences with the entire road permit application process, a series of 15 statements were read to the applicants and they were asked the extent to which they agreed or disagreed with each statement. Table 7.5 provides the results of the responses to this question.

As with the overall ratings presented earlier, those whose applications were processed quickly (ten days or less) are in much stronger agreement with the positive comments relating to Ministry staff relative to those whose applications took longer to process. It is also interesting to note that multiple applicants who have dealt with Ministry staff over a longer period of time are much more likely to feel that disagreements are dealt with effectively and that negotiation is often required to get permit approval.

There is a split in opinion on many of the issues relating to the policies and regulations surrounding the applications process. Although many strongly agree (44%) that large developers should have a different application process than small developers, there are also many who "disagree strongly" (16%) and "somewhat" (14%). This division is particularly true among developers where 48% "agree strongly" with this dual policy and 32% "disagree strongly". Property owners think this would be a good policy (63% strongly agree).

Table 7.5 - Level of Agreement with Statements About the Application Process (excludes Don't Know responses)

	Agree Strongly	Agree Somewhat	Disagree Somewhat	Disagree Strongly
Staff Provided Technical Info For Your Application	45	35	8	1
Access Design Standards Are Poorly Defmed	11	19	36	16
Access Policies and Regulations are Clear	33	37	15	5
Staff Rarely Know When the Permit Review Will Be Complete	26	23	23	16
Application Wording is Easy to Understand	41	43	8	3
Some Negotiation Is Required for an Approval	19	37	21	13

Permit Application Requirements are Uniform Throughout the Province	15	14	10	7
Rules Regarding Access Permits Should Be Uniform Throughout BC	45	18	17	16
Large Developers Should Have Different Application Processes Than Small Developers	44	19	13	16
Once Submitted, Staff Gave Timely Information on Application Progress	29	30	13	15
Lack of Access Control Is the Largest Cumulative Design Element Reducing Road Safety and Capacity	30	23	19	9
Ministry Staff Understand the Issues Facing Permit Applicants	37	34	8	10
Information From Staff on Filling Out The Application Was Helpful	57	32	4	2
	Agree Strongly	**Agree Somewhat**	**Disagree Somewhat**	**Disagree Strongly**
Paying a Permit Application Fee Would Be Acceptable If It Ensured Better and Faster Service	20	28	15	33
Disagreements About Permit Denials or Terms Were Effectively Dealt With by District Staff	19	26	7	6

8.0 RECOMMENDATIONS

Based on the study findings, the following recommendations have been developed.

1. Review the Ministry's existing and ongoing public consultation process with a view to making it more responsive to the needs of stakeholders.
2. Develop an education/orientation program for stakeholders to familiarize local government representatives, developers, consultants and road users with Ministry policies, procedures and regulations.
3. Hold annual open houses at regional and district offices to introduce and familiarize local government representatives, developers, consultants and road users with Ministry personnel.
4. Issue a regional directory of Ministry personnel so stakeholders know who to contact about specific issues.

5. Additional training and procedures should be in place with Ministry staff in order to effectively deal with multiple and single time applicants - each of these two groups of applicants have very different levels of understanding, needs and expectations with respect to the permit application process.
6. Produce a brief, simplified version of the Ministry's Policy and Procedures Manual clarifying policies, procedures and regulations and the access requirements and the steps involved in the permitting process. Ensure that this publication is available to potential applicants early on in the process.
7. Work towards either improving turnaround times and/or increase awareness of the expected length of time for the application process. This can be accomplished by removing the scope development of site impact analysis studies from the application process and dealing with it in a preliminary stage.
8. Review and update the employee orientation program for new Ministry employees assigned to Regional or District Offices.
9. Considerations should be given to revising existing policies and procedures to make them more responsive to the needs of local stakeholders and road users.
10. Ministry staff should investigate mutually acceptable ways to become involved earlier in the development planning process with local governments.
11. Given the small number of stakeholders interviewed who were familiar with the process of contesting or appealing permit denials or terms and conditions, the Ministry may want to consider compiling a database of appellants and conducting a separate survey on the appeal process.

Access Management Practices In Connecticut

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ABSTRACT

Connecticut ***was*** *one of the first states to recognize the value of access controls and to pioneer the concept of a limited access highway. After a period of disinterest, Connecticut's communities have, in recent years, shown increased interest in access management. This paper describes and assesses ongoing activities within the broader context of the state's history, geography, andpolitical structure and past access management actions. It presents access management proposals for Route 7 -- a major roadway in the western part of the state. Finally it identifies the emergent access management implications for the role of local governments, regional planning agencies and the state.*

Key Words: *Connecticut, Access Management Practices, Curb Cuts*

INTRODUCTION

Connecticut's communities have shown increased interest in access management in recent years. This paper describes and assesses ongoing activities within the broader context of the state's history, geography, and political structure and past access management actions. It presents access management proposals for Route 7 -- a major roadway in the western part of the state. Finally it identifies the emergent access management implications.

BACKGROUND

Many of the State highways in Connecticut, were established as Indian trails or during the colonial era. This network of roads connecting historic communities has remained the skeletal structure for Connecticut's expanding transportation system. The tendency to rely on old routes has been encouraged by the topography of the state. Many of the original regional highways followed river valleys because these were the most level, direct routes. Additional or alternative routes are limited by the hilly topography.

Urbanization has also crystallized around these road systems and the early communities they connected. As a consequence, where there is existing development, much of it is likely to be of historic significance, be located close to the road and have access directly to the main highway. These features may limit the practicality of road widening to address capacity and safety concerns. Increasing the right-of-way would require losing or relocating too many historic structures. There also may be a reluctance on the part of many towns to expand regional highways.

Another consequence of Connecticut's early development is its a patchwork of 169 separate towns. Unlike many of the states that developed later, where early communities have been swallowed up by the spread of urbanization, Connecticut communities were well established before major growth occurred and have retained their autonomy under Connecticut's strong home rule provisions. Although many, if not most, of Connecticut's principal arterials are under state jurisdiction, local government decisions are likely to have significant effects on them. Arterials are, by their nature, likely to pass through a number of local governments which have control over local concerns such as zoning, subdivisions, local circulation and parking. These govemments in turn, however, have no real control over planning for regional traffic.

In Connecticut there is no intermediate governmental level (such as a County) between the state and local government that has power over both land use and arterial highway planning. Local governments may feel thwarted by their lack ofcontrol over the regional highways that pass through their jurisdictions while state planners may feel frustrated by the lack of ability to influence (coordinate) local land use regulations in support of regional needs for traffic planning. Regional Planning Organizations provide the mechanism for coordinating local communities to address regional concerns of importance to them all.

HISTORY OF ACCESS MANAGEMENT IN CONNECTICUT

Connecticut was one of the first states to recognize the value of access controls and to pioneer the concept of a limited access highway. In 1934, the state began construction on the Merritt Parkway -- perhaps the first inter-city, fully controlled access highway in North America. The first 17 miles (27.4 kilometers) opened in 1938, and by 195 1 the Parkway and its continuation, the Wilbur Cross Parkway extended about 60 miles (69.6 kilometers) from Greenwich to Meriden.

The Parkway was built within a 300-foot (9 1.5 meters) wide, heavily landscaped "strip" park. The wide right-of-way provides space for expansion and made it possible to obtain full control of access from adjoining properties.

The Berlin Turnpike (Route 15), a four-lane divided highway linked the Parkway system with the Hartford area. Signalized access has mainly been limited to public road intersections and access to adjacent properties was usually limited to right turn entry and exit. The traffic signals were placed about a mile (1.6 1 kilometers) apart and were coordinated to allow 45 mph progression in each direction of travel. Most of these access controls exist today.

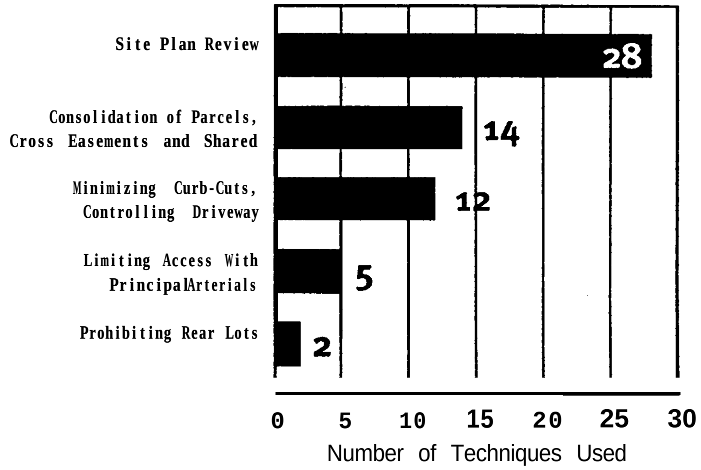
Other pioneering examples include the Derby Turnpike (Route 34) in the New Haven Area, the Saltonstall Parkway (Route 1) in East Haven and U.S. 5 in South Windsor. Each is a four-lane divided highway with median breaks at public street intersections; and signals spaced to allow progressive traffic flow.

From the 1950's through the 1980's congestion/corridor management was not actively pursued by most planning entities in the state. In the mid- 1980's interest was again awakened. In 1984, "How to Limit Traffic Congestion In Your Community" was published by the Housatonic Valley Council of Governments. It was exceptional because of its comprehensiveness and because of its recognition of the linkage between access management, zoning, trip generation and long term traffic planning.

Because of its growing interest in access management, the Capital Region Council of Governments (CRCOG) recently (1995) performed a survey of access management practices in the towns and cities of Connecticut. The survey obtained responses from 97 of the 169 municipalities of the state. It indicated that most communities feel that access management is at least "moderately important." Questions about current practices show, however, that communities may still not have addressed access management issues commensurately with the importance they ascribe to them. Only one town had a formal access management plan, while just two respondents indicated that they had a curb cut plan in place. Many more communities practiced access management in a more informal way. Figure lshowsthe five broad categories of techniques that communities use. The most common practice, used by 28 of the responding communities, was to try to control access during site plan review; in reality, a very limited perspective of access management. Only 5 communities limited access on principal arterials as a formal practice.

Figure 1

Techniques and Practices Currently Utilized



Source: Access Management Survey
Capital Region Council of Governments
September 1995

In general, the CRCOG study found municipal focus has been on specifically controlling curb cuts. The most common techniques are:

- regulate width & sight distance of driveways
- regulate construction of new driveways along arterials
- regulate &stances between driveways and public streets
- encourage shared driveways
- encourage placement of driveways on side streets
- encourage cross easements for adjoining parcels
- regulate the number of driveways per parcel

Over the last several years there have been renewed efforts to implement access management -this time at the local level with encouragement from the state. This increased activity stems from the convergence of several factors:

- Access management has received increased impetus at the Federal level as part of broader congestion management actions. This has increased awareness at the state level.
- The state capital budget, as in many other states, is contracting. Therefore, the state must do more with fewer resources. Missing links in the state expressway system are not likely to be completed, at least in the near future due to financial constraints and environmental issues. This places increased pressure on the existing arterial road system. These factors, combined with the hard-learned knowledge that newly

constructed capacity can quickly disappear, make it necessary to explore management alternatives to road construction.

- State controls over land use along state highways are limited. Connecticut presently has guidelines that govern the granting of encroachment/access permits along state highways. There are also requirements for traffic impact studies, but there are no driveway spacing standards, only guidelines. Moreover, as in other states, the control over zoning and subdivision regulations remains a local responsibility.

In this context, the renewed effort by ConnDOT has focused on funding access management studies for State roads. The goal of these studies is to develop access management plans for important state highway corridors. The projects are managed by the Regional Planning Organizations (RPOs). The state has encouraged regional and local planning groups to develop access management actions, often as part of broader corridor plans. This is in sharp contrast to New Jersey, where the State has developed a comprehensive plan and code for state highways.

Recent and on-going access management projects are managed by the regional planning organizations (RPOs). The Housatonic Valley Council of Elected Officials (HVCEO) has completed a curb-cut plan for Federal Road North of Danbury. The South Western Regional Planing Agency (SWRPA) and HVCEO are completing access management plans for Route 7. The Capital Region Council of Governments is performing corridor studies for several major highways in the Hartford area including Routes 6 and 44, the town of South Windsor is studying Route 94, the Mid-State Regional Planning Agency is studying Route 17 in the Middletown area and the Central Connecticut Regional Planning Agency is conducting a corridor study of Routes 6 and 72 in Plymouth.

The RPOs, who are coordinating these studies have no legislative or regulatory authority; consequently they rely on individual town consensus or approval.

ROUTE 7 EXPERIENCE

The Route 7 Driveway and Access Management Study bridges the gap between the earlier curb-cut studies and the subsequent corridor studies. This study of Route 7 between Norwalk and Danbury Connecticut, a distance of just over 20 miles (32.2 kilometers), as shown on Figure , is funded by the State and adrninistered in two parts by the South Western Regional Planning Agency and the Housatonic Valley Council of Governments, both RPOs. The purpose of the study is to develop access management plans including curb cut plan and recommendations for regulatory modifications. The study's scope does not, however, include the assessment of controls which could indirectly affect access planning, such as potential build-out limitations.

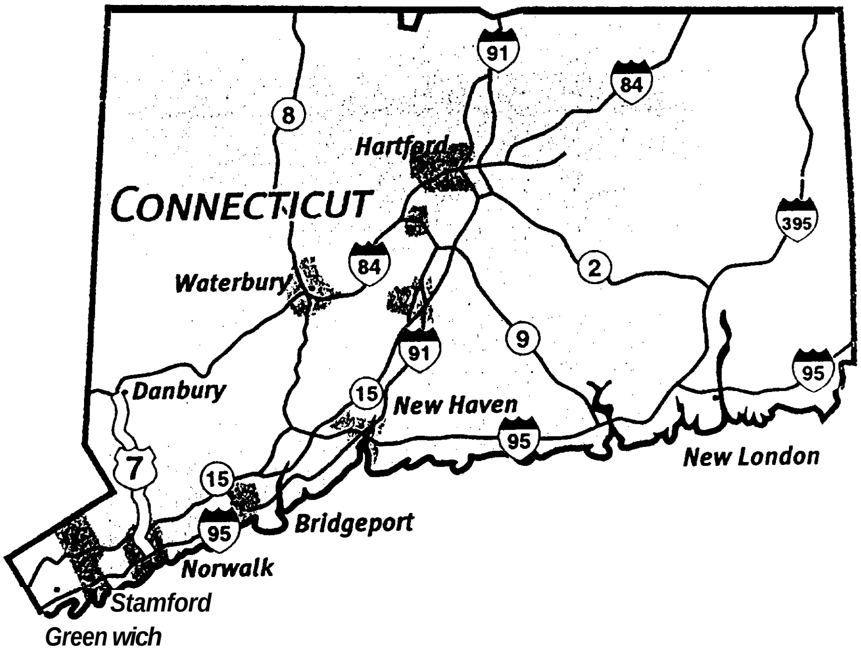
The RPOs are the logical vehicle in Connecticut to administer studies like the Route 7 project, since they have established channels of communication between the communities and can assure the coordination is carried through on Route 7 planning. This is important to enable regulations/improvement plans in each community to relate to the proposals for the adjoining towns along Route 7.

Context

Route 7 is one of the State's historic highways. The study segment generally follows the Norwalk River Valley connecting the cities of Norwalk and Danbury, and passing through the historic communities of Redding, Ridgefield and Wilton. In many places the topography on either side is hilly. Along its length, the route is bordered by numerous historic buildings and strip development, making widening difficult. In the south, property abutting Route 7 is fully developed with offices, industrial buildings and strip commercial buildings. With few exceptions, all adjacent properties have access directly onto Route 7. As the road heads north, the density of development generally decreases and setbacks increase. Eventually, adjacent land appears more rural. Many buildings are historic, creating the feeling of an archetypical New England town. There is the danger that development densities will increase in these areas, so that like southern Route 7, the highway's role as an arterial will be compromised.

Figure 2

Study Area



The southern-most 2 miles (3.2 kilometers) of the study route are paralleled by a new Route 7 expressway. There are plans to extend the expressway eventually to Route 33 in Wilton in order to relieve Route 7 of some of its traffic. In addition, there are plans to increase capacity on existing Route 7. Access management is viewed as a means of increasing safety and extending the life of Route 7. The State DOT believes that any curb cut closure or access management procedure put into practice will assist their efforts on Route 7.

Problems

Route 7 varies in character, cross-section, capacity, and use throughout the 20-mile (32.2 kilometer) study area. The southern section between New Canaan Avenue and the Merritt Parkway provides four travel lanes, has frequent curb-cuts for adjacent strip developments, and carries about 14,000 vehicles per day. Bctwccn Merritt Parkway and Grist Mill Road, Route 7 is four to five lanes wide, serves major commercial developments,and carries about 13,000 vehicles per day. Between Grist Mill Road and Route 33 in Wilton Center, Route 7 varies from two to five lanes in width, serves a variety of uses, and carries about 14,500 vehicles per day. Between Route 33 and Route 35 in Danbury, it is two to three lanes wide, serves scattered developments, and carries 13,000 to 20,000 vehicles per day, depending on the location. Between Route 35 and the beginning of the Route 7 Expressway it is two lanes wide, has few curb-cuts, and carries about 20,000 vehicles per day.

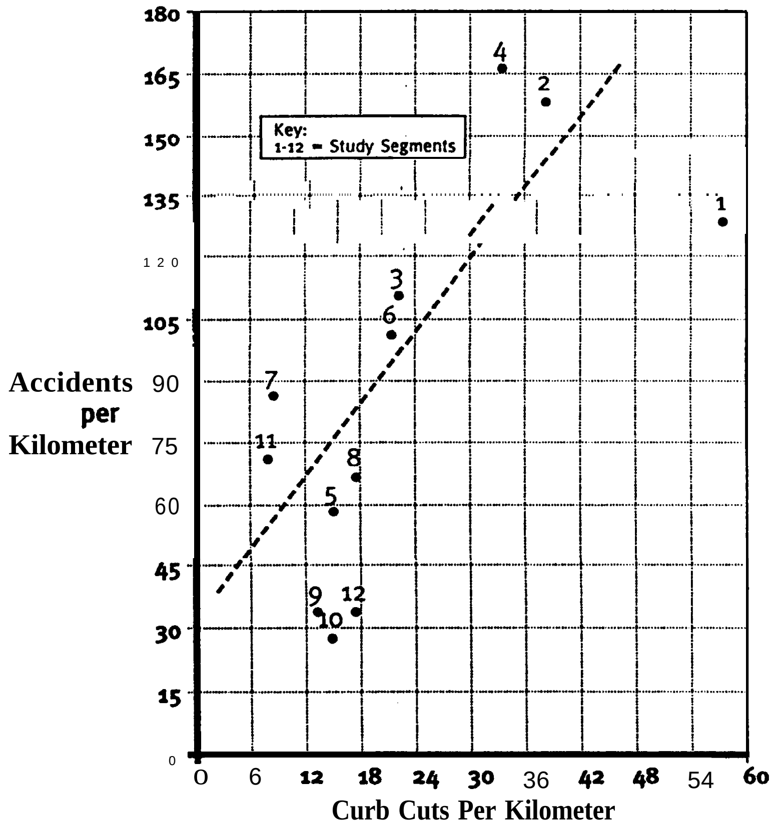
Curb cuts are numerous and spaced closely in the developed portions of the study area. The density of curb cuts is greatest in Norwalk, but there are scattered concentrations of development all along the study segment of Route 7. The effect of these cuts on safety has been distinct. Figure 3 clearly shows how Route 7 accidents correlate with the numbers of curb cuts and provides an important safety basis for setting access spacing standards.

Travel speeds are limited by the close spacing of traffic signals, especially in the southern part of the corridor where the average distance between signals is about 1,100 feet (335.5 meters). In the northern part of the corridor, signals are farther apart and would allow a l/2 mile (.8 kilometer) spacing standard to optimize progression.

Peak hour congestion occurs at Grist Mill Road (where the expressway traffic enters Route 7), at Route 33 in Wilton, and at Route 35 in Danbury. These are the locations where the heaviest cross-street volumes occur.

Figure 3

Relationship Between Route 7 Curb Cuts and Accidents Per Kilometer



Source: Urbitran Associates analysis for SWRPA
Connecticut Department of Transportation, "Accident Experience" Data files for Route 719 @ Route 123 in Norwalk to Route 7 @ Wilton/Ridgefield town line 19914993

The Study Effort

A high degree of coordination was achieved in the study corridor through the cooperation of the RPOs. Planning on segments of Route 7 in Wilton and Norwalk was managed by SWRPA, while in Danbury, Redding and Ridgefield Route 7 planning was managed by HVCEO. Both RPOs set up technical advisory committees to provide direction to the consultant. The committees were made up of representatives from each town, Connecticut DOT and the other participating RPO. Coordination was further facilitated by the decision of both RPOs to hire the same planning consultant to perform the technical work. Work plans for the two studies were also coordinated.

The study provided two products for each community: a curb cut plan and recommendations for proposed modifications to planning and zoning recommendations. The curb cut plans included recommendations for closing some driveways, consolidating driveways or relocating others. Opportunities for improvement, however, were limited by several factors:

- Lack of alternative access for a given property
- Land uses that would be incompatible for joint access
- Abundance of gas stations (state regulations require two entrances)

- Abundance of gas stations (state regulations require two entrances)
- Abundance of fast food outlets with standardized layouts
- Abundance of low trip generators (eg. single family residential) for which the financial/political costs of correction would not have sufficient benefit
- Community's desire to minimize restricting property access more than necessary

Suggested changes in zoning regulations were also prepared. These contained standards for traffic signal and driveway spacing, provision of alternative access, and improved subdivision guidelines.

Implementation of the study recommendations is uncertain and will require further consideration by the affected municipalities and State.

CONCLUSIONS

Access management in Connecticut has evolved over a half-century. The early actions were bold -- acquiring rights-of-way to develop the Merritt Parkway, and signal coordination/median opening control on the Berlin Turnpike. More recent efforts, include the State incentives for regional and local planning agencies to develop access management plans, usually as part of broader corridor improvement plans.

The lessons learned from the history of access management and the recent access management efforts, such as Route 7, lead to the following generalizations about the ingredients for success and failure:

Regional highways pass through more than one town and therefore require coordinated approaches by the towns impacted, as well as the RPO and State.

Regional planning agencies can play a major role in coordinating access management activities, and in ensuring coordinated approaches to regional transportation issues. This has been one of their traditional roles in Connecticut, but they are limited in their ability to implement or legislate.

The states working jointly with the MPOs can bring communities together and provide the funding incentives for access management activities.

The state, working cooperatively, should expand its role in encouraging access management along the State's primary roadways. It should also consider such measures as installing physical medians along multi-lane arterials, and incorporating signal coordination requirements into traffic impact studies. Over the long run, it could establish access spacing standard for principal state highways.

ACKNOWLEDGEMENTS

This paper was prepared based on work performed for the Route 7 Driveway and Access Management Study prepared for HVCEO an SWRPA in Connecticut. The studies were funded by the Connecticut Department of Transportation. The effort was supported by members of the RPOs, the Technical Advisory Committees, the towns of Redding, Ridgefield and Wilton, and by the cities of Norwalk and Danbury. In addition to funding, Connecticut DOT and its staff provided data, technical review and **support.**

Deviations From Median Opening Spacing Standards

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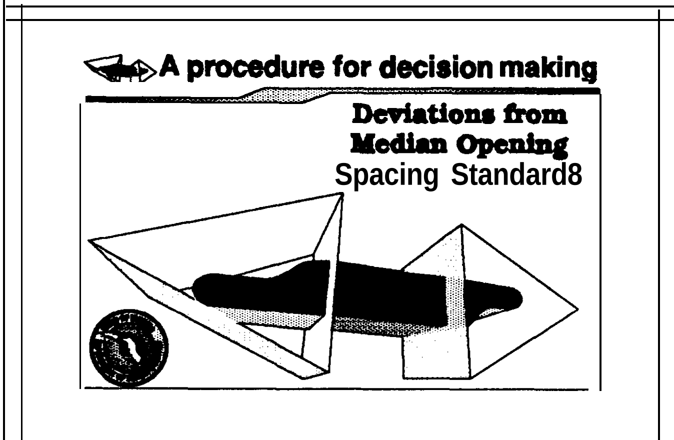

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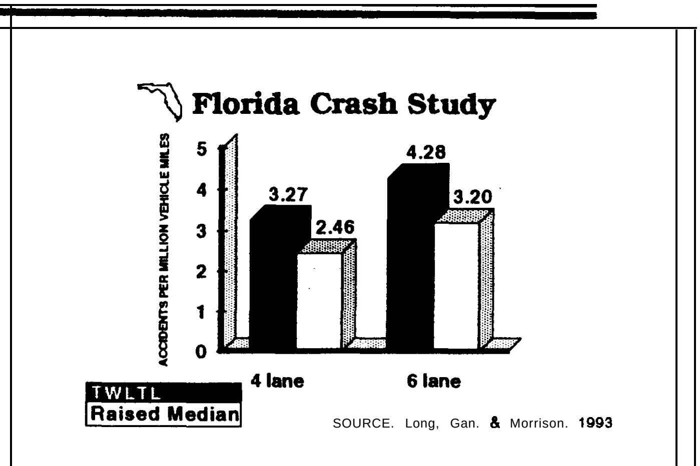

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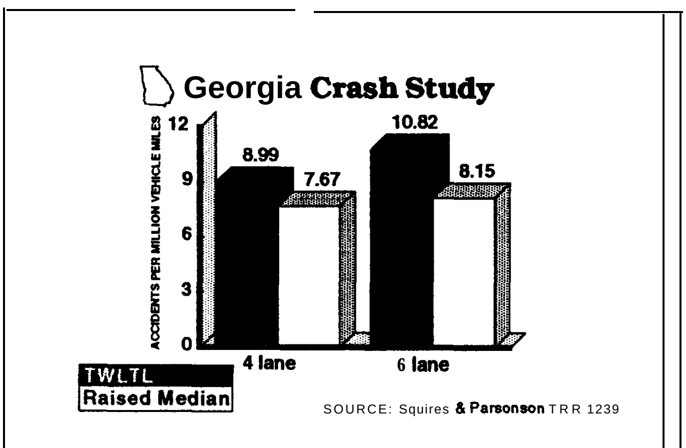

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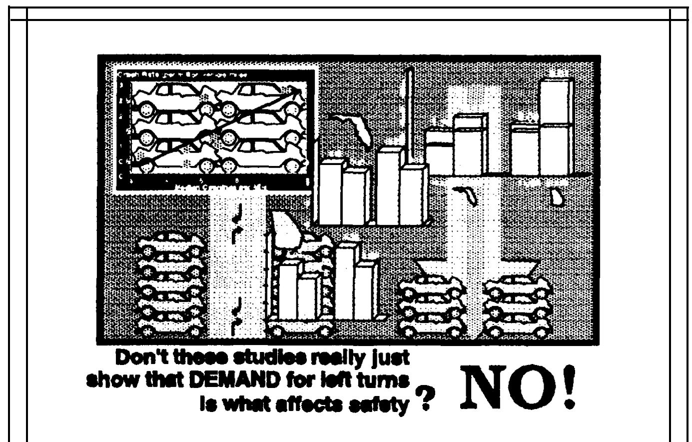

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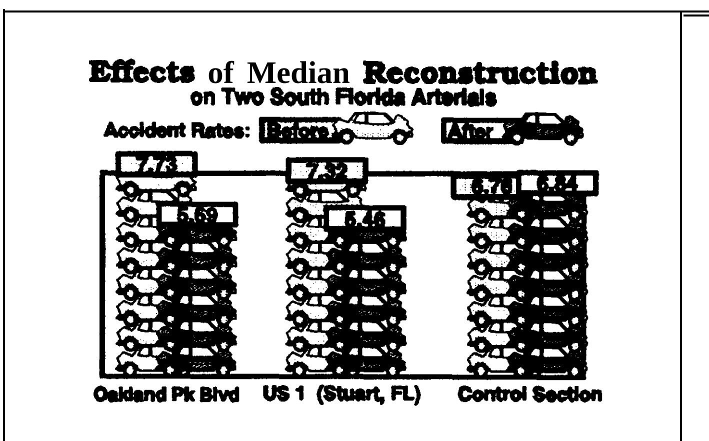

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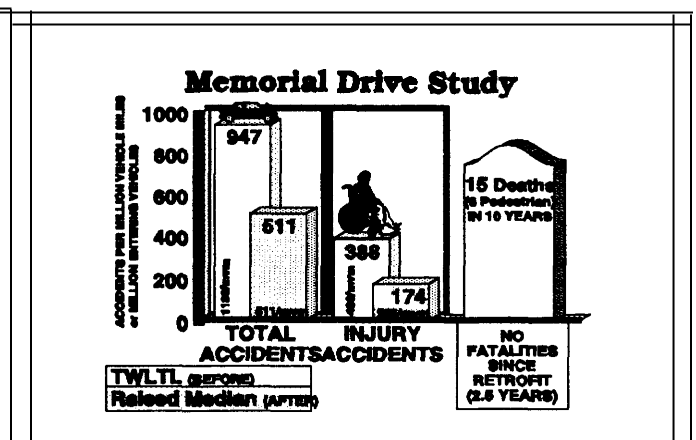

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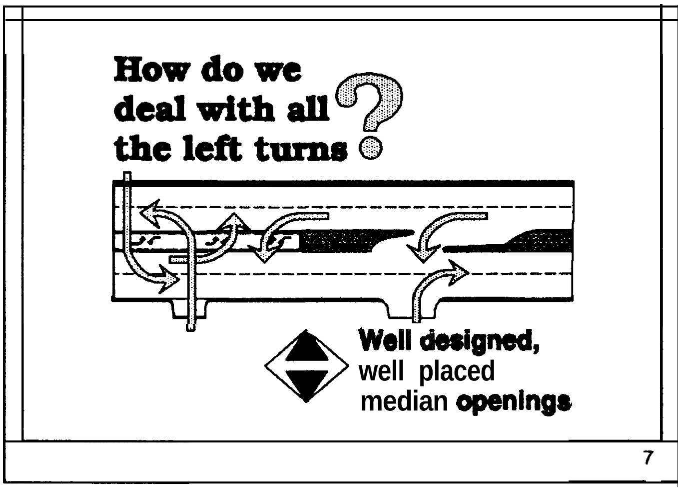
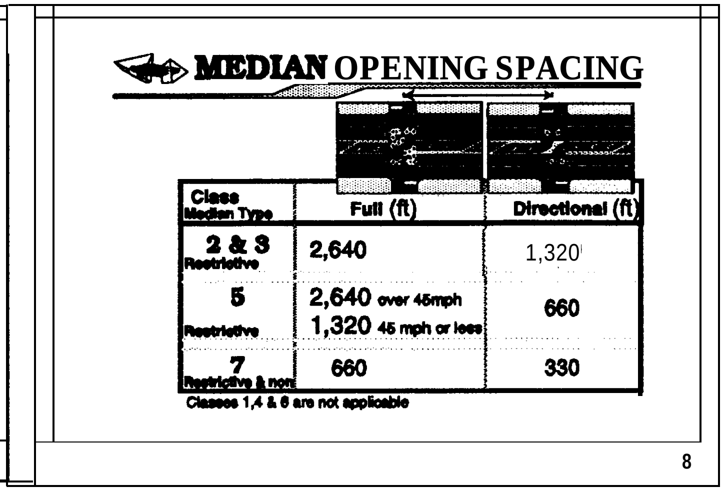
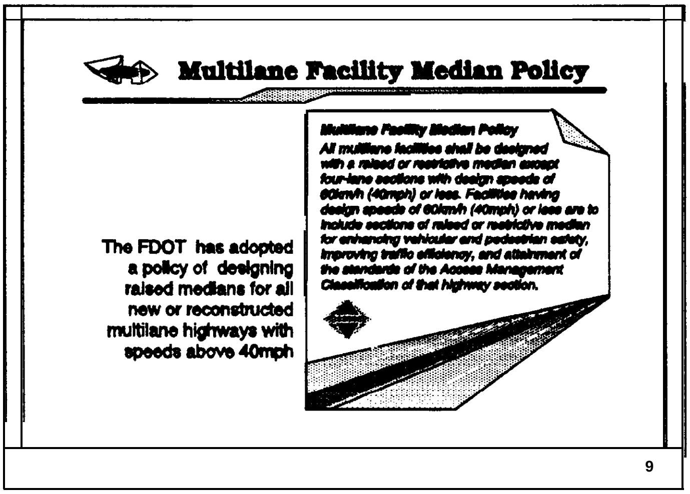
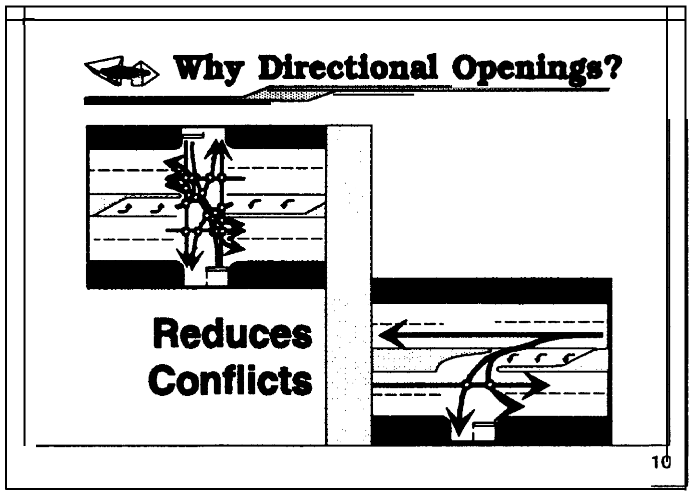


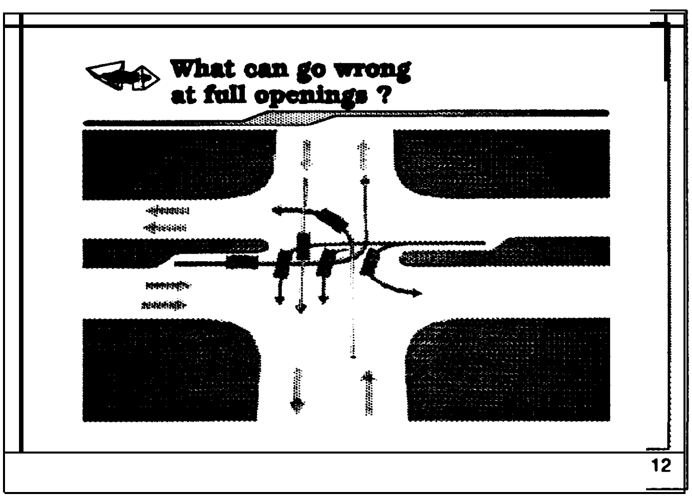


Class Median Type	Full (ft)	Directional (ft)
2 & 3 Restrictive	2,640	1,320
5 Restrictive	2,640 over 45mph 1,320 45 mph or less	660
7 Restrictive & non	660	330

Classes 1,4 & 6 are not applicable







Median Opening Review Team

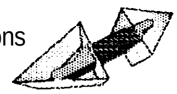
- **Appointed** by **District Secretary**
- **To provide:**
  - **multi disciplined review**

    may fit into current committee structure

13

Minor Deviation8

- **Decision** can be **made** by **responsible engineer**
- 10% for 'Full" opening8
  - **District can be more strict**
- Directional opening8 - **"case-by-case"**
- **Remember:**
  even less than 10% deviations might be **a** problem



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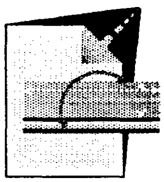
Things that will be looked at

- Space to handle **movements**
- What happens to rerouted traffic
  - **Ability** to make **"U" turns**
  - **Side street movements**
  - **Neighborhoods**
    - Cut-thru(upordown)
- **Maneuver distances**
- **Future traffic** or **plans**
- **Pedestrian concerns**



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Keeping People Informed

- Important even when not required by law
- Big public hearings not always the way

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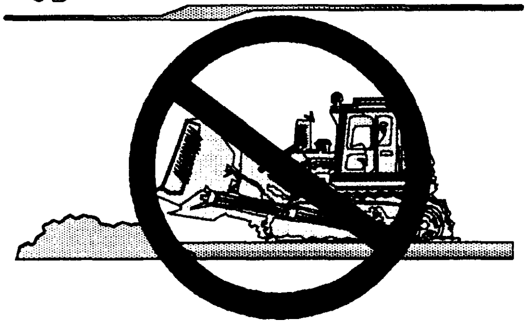
No More Median Removals



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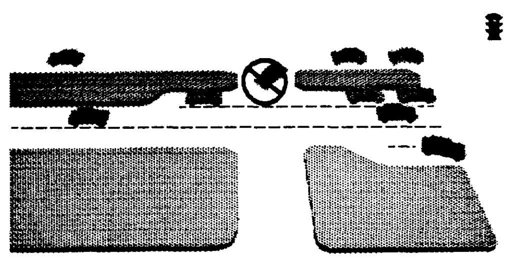
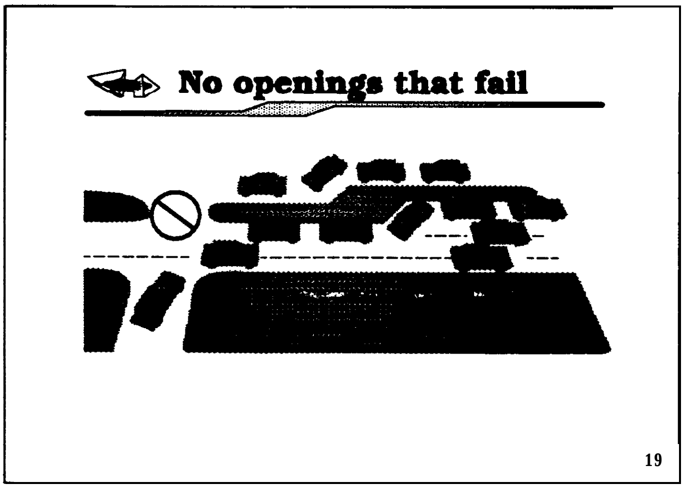
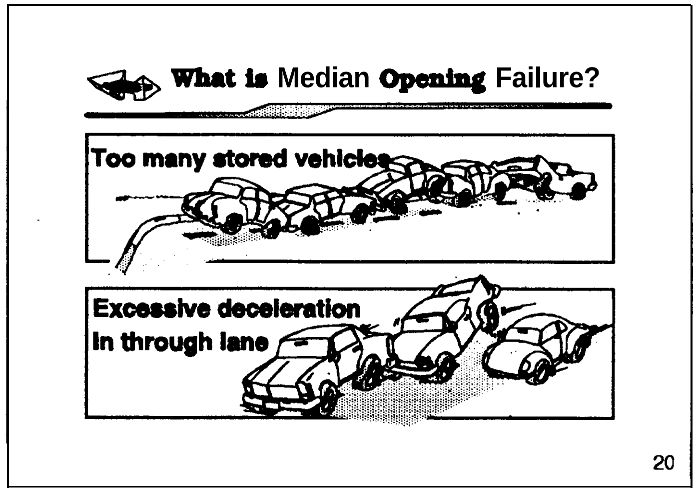
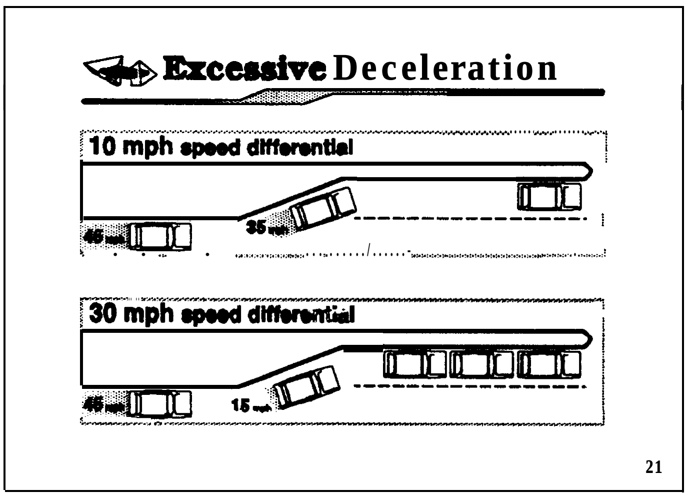
No openings across left turn lanes

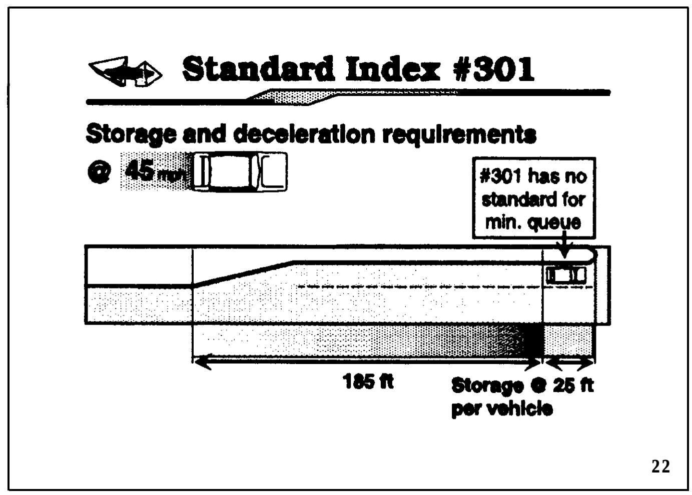


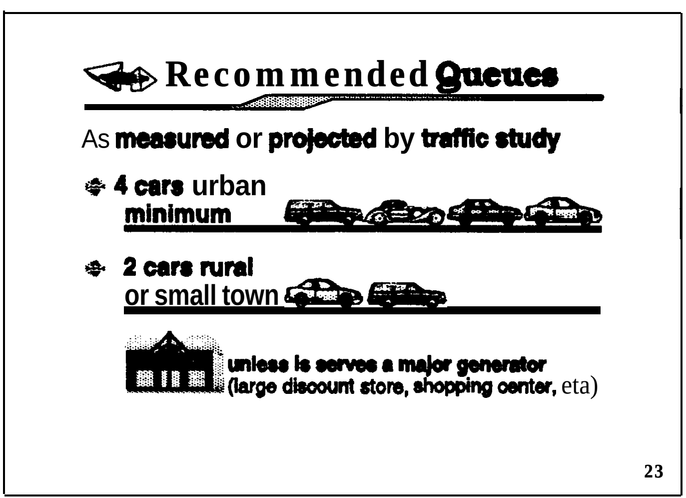
18

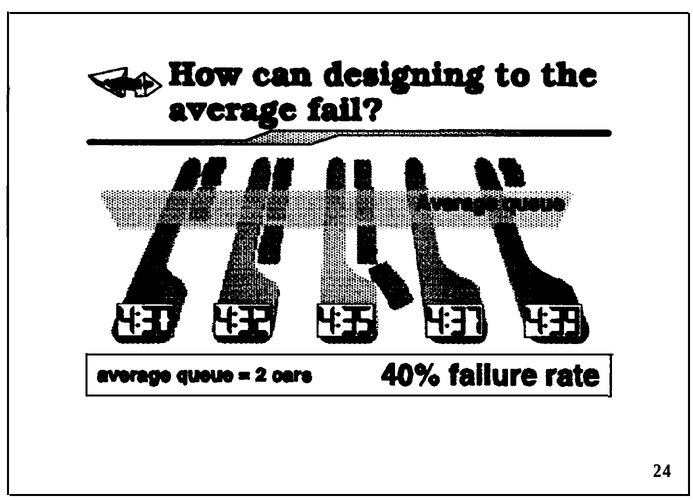

No openings that fail
19


What is Median Opening Failure?
Too many stored vehicles
Excessive deceleration
in through lane
20


Excessive Deceleration
10 mph speed differential
35
30 mph speed differential
15
21

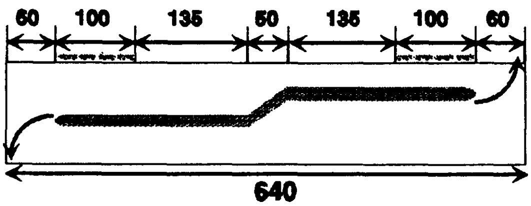

Standard Index #301
Storage and deceleration requirements
@ 45
#301 has no standard for min. queue
185 ft
Storage @ 25 ft per vehicle
22


Recommended Queues
As measured or projected by traffic study
4 cars urban minimum
2 cars rural or small town
unless is serves a major generator (large discount store, shopping center, eta)
23


How can designing to the average fail?
Average queue
average queue = 2 cars
40% failure rate
24

One Very Tight Possible Scenario

Urban **conditions @ 45** mph **design**



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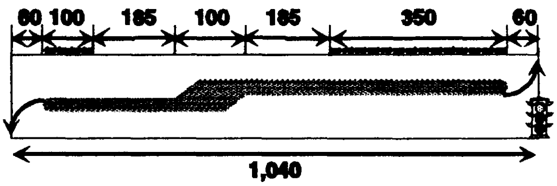
More **realistic minimum scenario**

Urban **conditions @ 45** mph **design**



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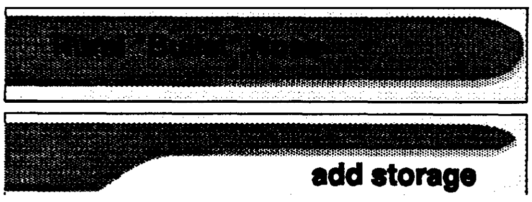
Staying ahead of problems

Rural multilane in suburbanizing areas

- ***Change bullet nose to storage***
- ***Close under-used openings***



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Prefabricated Medians To Reduce Crashes At Driveways Close To Intersections

Peter S. Parsonson, Professor, School of Civil & Environmental Engineering, Georgia Institute of Technology, Atlanta, Georgia

ABSTRACT

Left turns into and out of driveways within about 30m (100 ft) of an intersection are a leading cause of crashes. Interviews with state-DOT traffic engineers in the southeast suggest that easy-to-implement countermeasures are seen as either hazardous in themselves or else ineffective.

One countermeasure could be a narrow raised device, or series of small devices, installed along the dividerline as a median. It must be reasonably traversable by a small, high-speed vehicle, yet must be high enough to be conspicuous and to deter a significant fraction of drivers from crossing it to make the hazardous turn. It would be safer instead to install a triangular island at the driveway entrance to try to force right in and out. However, experience has shown these islands to have little deterrent effect.

This paper reviews alternative median treatments and recommends development of a prefabricated raised median of 90mm (3.5 in.) height and 305mm (I foot) width. It could be retrofitted to arterials with two-way left-turn lanes, at intersection approaches, without widening the road or narrowing the lanes. Its cross-section complies with AASHTO standards for mountable curbs, but is lower than AASHTO's IOOmm height, which might drag the undersides of some vehicles. The design appears not to create an unreasonable hazard to even a small vehicle that strikes it. It could be sold in easy-to-handle lengths such as 2.5m (8 ft) and could be cheaper and quicker to install than a cast-in-place concrete island.

Prototype designs should be field tested under controlled conditions for effectiveness and safety

Key Words: median, access, traversable, island, device

INTRODUCTION

Left turns into and out of driveways within about 30m (100 ft) of an intersection are a leading cause of crashes. The metro Atlanta intersection with the most traffic accidents (123 per year, with 42 injuries) (1) has nine nearby driveways that are blamed for its poor record of safety. (Crashes within 30m of an intersection are tabulated as occurring at the intersection). The local traffic engineer was quoted as saying "People are making left turns into or out of driveways where the visibility is restricted by standing autos. It's not conducive to making left-hand turns." Figure 1 is a photograph of conflicting turning movements at this intersection.

Many highway agencies have the authority to close a hazardous driveway if there is a second driveway to provide access, but it does not appear that this authority has provided the solution to the problem.

Interviews with state-DOT traffic engineers in the southeast suggest that easy-to-implement countermeasures are seen as either hazardous in themselves or else ineffective. Two general types of such countermeasures are recognized: one is a median barrier of some type installed in the road, along the separation of directions of travel. The other is a triangular island installed off the road, at the entrance to the driveway.

Access laws relating to driveways will not interfere with such restrictive measures. "Reasonable access" at a driveway requires only that right turns in and right turns out be accommodated. There is no legal right to access to and from the other side of the divider line.

The median-barrier type of countermeasure must be reasonably traversable by high-speed errant vehicles, including motorcycles, yet must be high enough to be conspicuous and to deter a significant fraction of drivers from crossing it to make the hazardous turn from either direction.

The triangular island at the driveway entrance would be preferred by engineers as safer. However, such islands have been found in practice to be ineffective in reducing lefts in and out, since a driver turning from or into the driveway can easily increase the angle of left turn from 90 degrees to about 135 degrees and thus defeat the design. See Figure 2. This second approach seems to have little promise and is not discussed further herein.

Because of these disadvantages of both approaches, it is common to address the problem only by major projects in which continuous raised-concrete medians are installed along entire mid-block road sections. These medians are typically 600mm to 1.2m (2 to 4 ft.) wide at the left-turn lanes at intersections. Existing arterials cannot be retrofitted with such medians without widening the road or narrowing the lanes. That is a deterrent to their use.

Furthermore, some engineers prefer two-way left-turn lanes (TWLTL) over raised medians for certain conditions, such as volume levels that are not extremely high. There are many urban arterials with TWLTL that are unlikely to be retrofitted with continuous raised-concrete medians in the near future.

Collision diagrams prepared routinely by traffic agencies show clearly which driveways are hazardous. What is needed is a raised median that can be retrofitted to arterials with TWLTL, only at the intersection legs with hazardous driveways, without widening the road or narrowing the lanes, and without creating an obstruction that would be an unreasonable hazard to even a small vehicle that strikes it. The median should be inexpensive and easy to install quickly with minimum disruption of traffic. It should not break away from the pavement when struck, and should have a retro reflective yellow surface that desirably requires no repainting. When the road is to be resurfaced, the island should be removable and then easy to replace after the repaving. It could be a manufactured product rather than cast-in-place concrete.

This paper discusses several existing treatments, concludes that they do not meet these requirements, and recommends development of a prefabricated median.

CHANNEL MARKERS (RAISED BUTTONS)

A row of channel markers, known as raised buttons, mushroom buttons, hemispheres or turtle shells, has deterrent value due to the height of 75mrn (3 in.). They have a diameter of 200mm (8 in.) and are fastened down by epoxy or bituminous cement. Buttons are purchased by state and local authorities in certain states, such as Georgia, but their use has not been standardized. They do not appear in *the Manual on Uniform Traffic Control Devices (MUTCD) (2).*

A steel or ceramic button costs about $17 and its installed cost is about twice that. In the author's experience, they need to be installed very close to one another, in an almost solid row, in order to deter crossing. Installation with a 1 OOmm (4 in.) gap between them would result in a cost of about $3,400 for a 30m (100 ft.) median. Because of their significant cost in this configuration, buttons tend to be used instead to delineate small triangular islands, perhaps to protect a STOP sign, where it would be more expensive to pour a concrete island.

Due to a button's rounded shape, a vehicle striking one could potentially be redirected to either the right or left, depending on which side of the button is struck. The Georgia DOT recognizes that a small vehicle could possibly lose control, and so avoids using them where they are unexpected. One use in Georgia is to extend a comer turning island for perhaps 30m (100 ft.), to discourage premature lane changing. (Note that this application has vehicles on either side of the buttons traveling in the same direction). The Georgia DOT has had no safety problems or lawsuits in connection with its use of buttons.

Another southeastern state, by contrast, has not used buttons since it was named a defendant in two lawsuits, one involving a car and the other a motorcycle that struck one or more buttons. Details of these suits have not been available.

The literature appears to be silent on the safety aspects of buttons. Experience has been mixed, and there are no documents comparing successful applications in, for example, Georgia and Texas, with installations elsewhere that have turned out to be troublesome. Overall, interviews by the author have suggested that there is a general feeling that buttons are potentially hazardous. They do not appear to be a good choice for separating opposing flows of high-speed arterial traffic in order to discourage left turns into and out of driveways.

TUBULAR MARKERS (FLEXIBLE POSTS)

The MUTCD recognizes tubular markers, also called flexible posts, as delineators. With their diameters of over 5Omm (2 in.) and heights of 9 lmm (36 in.), they enjoy excellent visibility, especially when installed in a closely spaced group. Their bases are cemented or otherwise fastened to the pavement.

The cost to purchase and install a flexible post is comparable to that of a button, but posts need not be spaced so closely and therefore have a lower first cost. However, experience shows that the posts tend to break off too readily when struck repeatedly by high-speed vehicles and are therefore a maintenance burden. The remaining bases are safely traversable, but have little or no value in deterring crossing movements.

CONCRETE ISLANDS

Figures 3 and 4 show three narrow (4OOmm, 16 in.) concrete islands installed in Mayaguez, Puerto Rico between two low-speed lanes moving in the same direction. There are three active driveways visible to the right in Figure 3. Both figures show that the maximum height of 15Omm (6 in.) has caused some vehicles to drag their undersides while straddling the median. The corrugations resembling those of a rumble strip add to the consp-icuity of the island, as does its yellow color.

If a narrow island beginning on the approach to an intersection cannot be offset from the lane line, it would appear reasonable to require that a car or truck be able to pass over it without dragging its underside. If normal ground clearance is as little as 125mm (5 in.) and it is considered that the front end may dip at least 25mm (1 in.) during braking, then the median should be no more than 1OOmm (4 in.) high and preferably should be less. Figure 5 shows a proposed traversable cross section with a height of 90mm (3.5 in.). This height is intended to be a conspicuous deterrent to crossing but reasonably traversable. The shape of the sides of the cross section of Figure 5 is identical to that of one of AASHTO's mountable-curb designs, Figure IV-4 © in Reference 3, shown herein as Figure 6, except that the height has been reduced from 1 OOmm (4 in.) to 90mm (3.5 in.) to reduce the risk of **dragging.**

A concrete island narrower than 1.2 m (4 ft.) does not have the mass to hold it in place when hit. Therefore it must be keyed in by a surrounding asphalt surface course about 25mm (1 in.) thick. Alternatively, 150mm (6 in.) spikes or dowels can be driven into the surfacing, staggered on 6OOmm (2 ft.) centers, with half their length left above the pavement, to key the poured concrete island to the pavement (**4**). Either of these alternatives adds significantly to the difficulty of implementation. What is needed is a median design that requires neither a surrounding asphalt surface course nor a series of spikes or dowels to hold it in place.

A TEMPORARY RAISED ISLAND

AASHTO's *Roadside Design Guide* (5) mentions a temporary raised island developed to separate opposing flows in two-lane two-way operation (6). An island 46 cm. (18 in.) wide, made of either portland cement concrete or bituminous concrete, supports rigid tubular markers with steel bases. See Figure 7. The AASHTO publication states that there is limited operational experience with this design, so it should be used only on roadways with speeds of 70-75 km/h (45 mph) or less except when recommended by an engineering study.

CONCLUSIONS

It is concluded that there are significant disadvantages to channel markers (buttons), tubular markers (flexible posts) and concrete islands, for retrofitting a narrow median to an arterial with TWLTL, without widening the road or narrowing the lanes. These disadvantages explain why the hazards of driveways close to intersections are often allowed to persist. There is a need for an innovative design that would overcome the drawbacks. Widespread installation of a suitable median would significantly reduce the number of crashes caused by hazardous left turns in and out of these driveways.

RECOMMENDATIONS

It is recommended that a prefabricated raised-median design be developed, with dimensions similar to those of Figure 5. It could be retrofitted to arterials with TWLTL, as shown in Figure 8, at intersection approaches with hazardous driveways, without widening the road or narrowing the lanes. It should be cheaper and quicker to install than a cast-in-place concrete island with minimal disruption to traffic. The material might be metal treated not to corrode excessively, or a high-impact plastic, that will not yield excessively from the vertical or lateral force of a wheel of a design vehicle. It should be produced in sections or lengths, such as 2.5m (8 ft.), that are easy to transport and light enough to be handled by two men. Each section should fit into (overlap) the adjacent ones by perhaps 15Omm (6 in.) to add resistance to lateral impact. The sections should be designed to be fastened to the pavement by the application of a material such as an epoxy or bituminous cement, securely enough so that they wilI not break away from the pavement when struck. However, there should be a way to remove them easily for resurfacing the road. At the factory, the sections should receive a yellow, retro reflective finish that is exceptionally durable.

Prototypes of the design should be field tested under controlled conditions to determine whether they are effective and reasonably safe, especially in the northern states, where the median might be covered by snow. Details should be worked out, such as a means to provide suitable warning of the presence of the nose of the median, perhaps through additional striping or by fastening a number of raised pavement markers (RPMs) to the pavement in advance of the nose.

In view of the high incidence of crashes due to driveways too close to intersections, the recommended prefabricated median section is expected to be highly cost-effective.

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2. *Manual on Uniform Traffic Control Devices,* Federal Highway Administration, Washington, D.C., 1988.

3. *A Policy on Geometric Design of Highways and Streets, 1994,* American Association of State Highway and Transportation Officials, Washington, D.C. 1994.

4. North Carolina D.O.T., Division of Highways, Raleigh, N.C., Standard Plan Sheet 852.01, July, 1995.

5. American Association of State Highway and Transportation Officials, *Roadside Design Guide,* Washington, D.C., 1988, pp. 9-18 to 9-21.

6. Lewis, R. M., "Review of Channelizing Devices for Two-Lane Two-Way Operations," Report No. FHWA/RD-83/056, Federal Highway Administration, NTIS, Springfield, Virginia, June, 1983.

LIST OF FIGURES

Figure 1 - Driveway Close To Intersections Invite Hazardous Left Turns

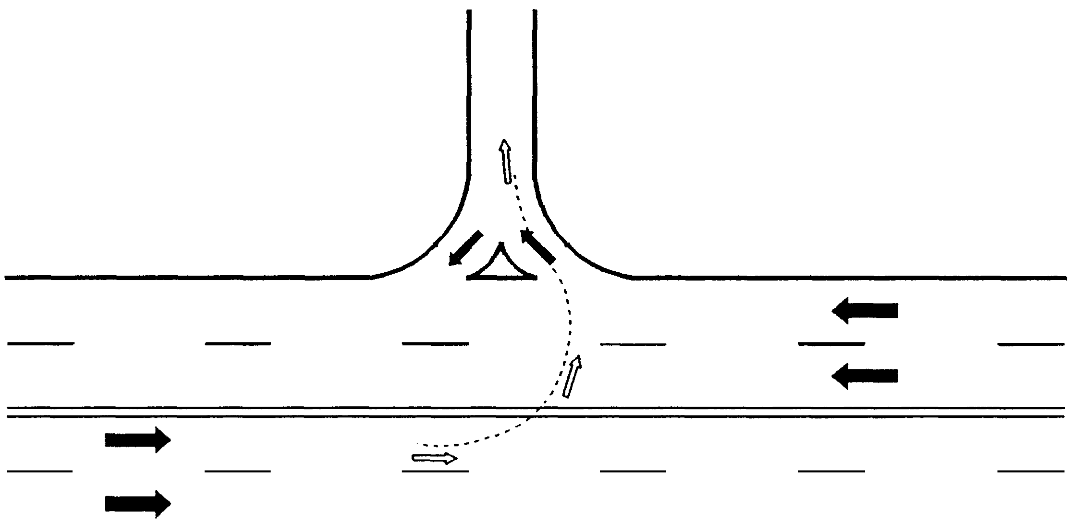

Figure 2 - Left-Turning Drivers Easily Defeat a Triangular Island

Figure 3 - Raised Curbing in Puerto Rico to Control Turns At Driveways

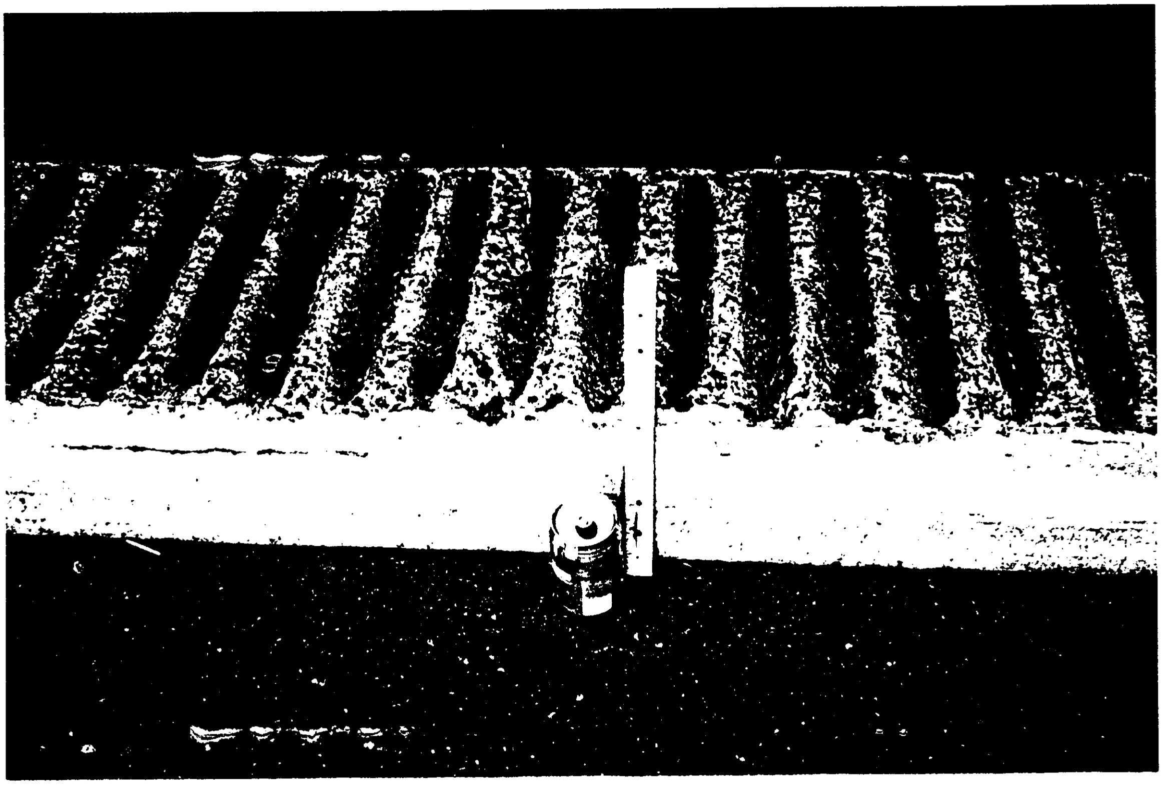

Figure 4 - Vehicles Have Dragged Their Undersides On The 150MM (6-in) High Curb

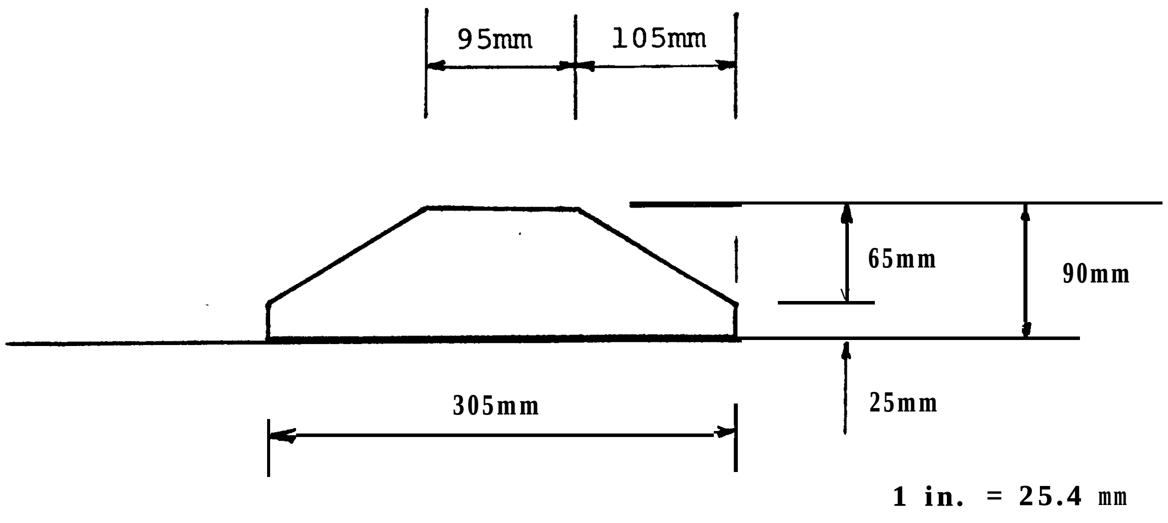

Figure 5 - Proposed Traversable Cross-Section Of Prefabricated Median

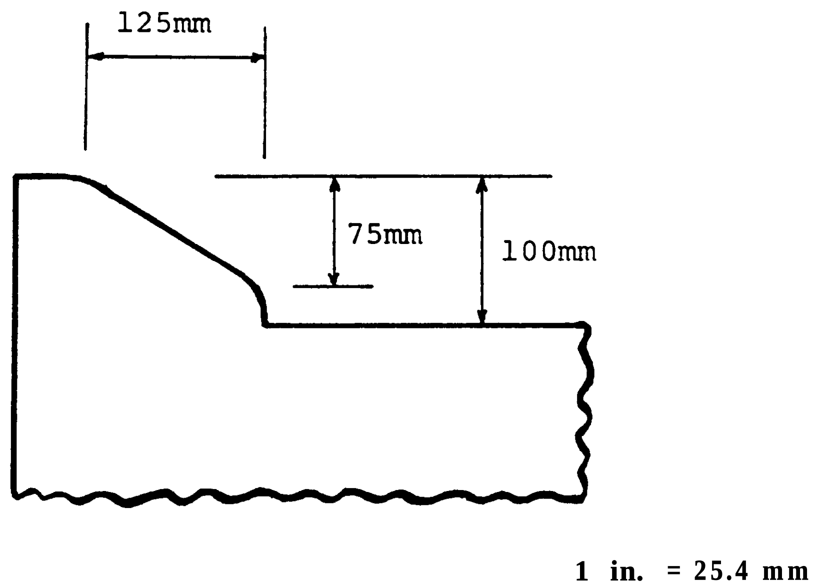

Figure 6 - One of AASHTO's Mountable-Curb Designs (3)

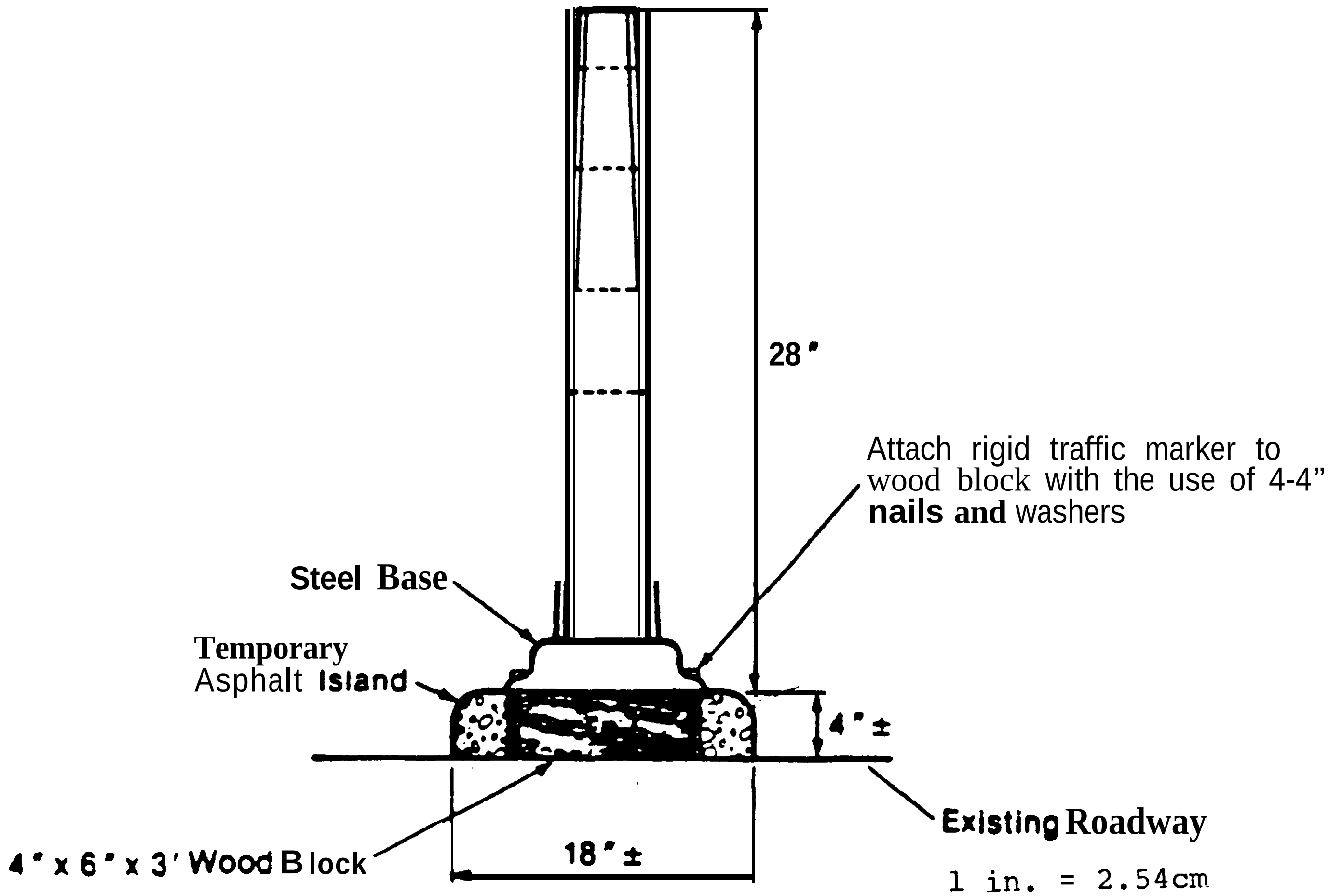

Figure 7 - A Temporary Raised Island (5)

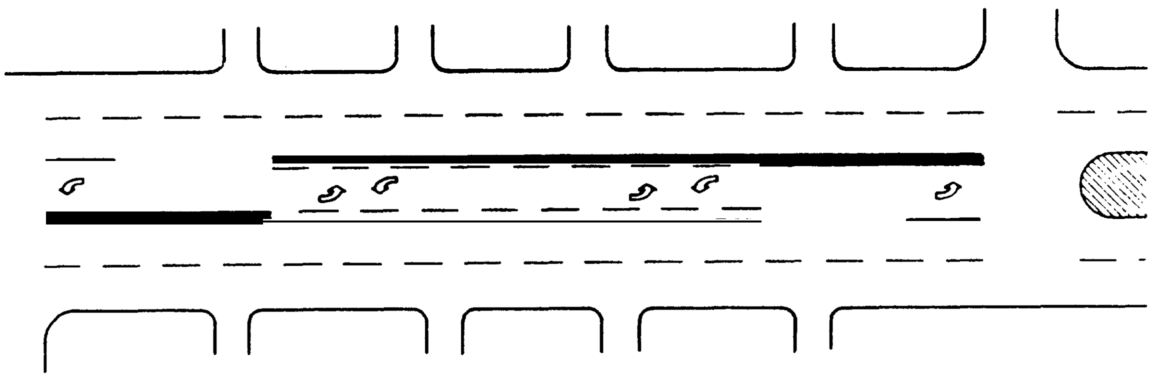

Figure 8 - Prefabricated Raised Medians Retrofitted To An Arterial With TWLTL

Influence of Access and Land Use on Vehicle Operating Speeds Along Low-Speed Urban Streets

Christopher M. Poe, P.E., Director, TransLink Research Program, The Texas Transportation Institute
Joseph P. Tarris, P.E., Ph.D. Candidate, The Pennsylvania Transportation Institute
John M. Mason, Jr., Ph.D., P.E., Director, Transportation Operations Program and Professor of Civil Engineering, The Pennsylvania Transportation Institute

ABSTRACT

Geometric design has a direct impact on vehicle operating speed, traffic engineering and the eventual safety of low-speed urban streets. If vehicles operate above the intended speed of the facility, the risk of becoming involved in an accident and the resulting level of injury increases. In urban areas, this increased risk of becoming involved in an accident and the resulting level of injury increases. In urban areas, this increased risk is for pedestrians and bicyclists as well as motorists Additionally, if vehicles operate above the intended speed, speed differentials can result between vehicles. The potential for speed differentials between vehicles increases with the number of conflict points created where vehicles enter streets from driveways and intersections.

Currently, the design speed criterion is used to select design values for geometric elements. Based on the selected design speed, minimum curve radii, stopping sight distance, and intersection sight distance values are established. Vehicle operating speeds along urban collector streets, however, are influenced by alinemen t, grade, roadway cross section, access and land use characteristics, and driver/vehicle characteristics. The access frequency, in terms of driveway density and number of intersections, does impact the vehicle operating speeds.

This paper presents the results of a Federal Highway Administration sponsored study on the relationship between geometric design of urban streets and vehicle operating speeds. Operating speeds were analyzed along urban collector streets with varying geometric alinement, access density, and land use. A speed estimation model was developed to assist designers and planners in determining the expected operating speeds along urban streets. This model provides feedback on how access density influences operating speeds.

Key Words: Access, Driveway density, Geometric design, Urban street design, Vehicle operating speed

INTRODUCTION

Geometric design has a direct impact on vehicle operating speed, traffic engineering, and the eventual safety of low-speed urban streets. In the low-speed environment, geometric street design must balance access, pedestrian/bicycle use, and right-of-way issues with speed and safety. Providing this balance results in vehicle operating speeds along urban collector streets being influenced by alinement (both vertical and horizontal), roadway cross section, access, land use, and driver/vehicle characteristics.

If vehicles operate above the intended speed of the facility, the risk of becoming involved in an accident and the resulting level of injury increases. In urban areas, this increased risk of becoming involved in an accident and the resulting level of injury increases. Additionally, if vehicles operate above the intended speed, speed differentials can result between vehicles. The potential for speed differentials between vehicles increases with the number of conflict points created where vehicles enter streets from driveways and intersections.

One tool designers and traffic engineers have is access management. By controlling the design, location, and frequency of access points, improvements can be made in vehicular speeds, and thus, safety. This paper highlights findings from a Federal Highway Administration sponsored study on the relationship between highlights findings from a Federal Highway Administration sponsored study on the relationship between geometric features and vehicle operating speeds. Operating speeds were analyzed along urban collector streets with varying geometric alinement, access density, and land use. Access variables directly measured were frequency of driveways and intersections, availability of parking, and roadway configuration.

BACKGROUND

The project sponsored by the Federal Highway Administration was titled, "Relationship of Operating Speeds and Roadway Geometric Design Speeds." The intent of this research was to develop a procedure to collect data and analyze the relationships between vehicle operating speeds and various geometric, roadside, and land use elements.

Data Collection

Vehicle operating speed data were collected at 34 sites on urban collector streets in central Pennsylvania. Both older, traditional sites with restrictive geometry and more modern suburban sites were targeted. Because horizontal alinement is an influential geometric feature, several study sites were selected with varying horizontal curvature. Twenty-seven of these sites examined the characteristics of the horizontal curve and the tangents before and after the curve (curvilinear sites). Seven study sites were included on tangent street segments with no horizontal curve (tangent sites).

Only free-flow vehicles that traveled the entire study section, and were not impeded by any other vehicles, were included in the database. A vehicle was considered impeded if the headway was five seconds or less anywhere within the study section. Manual observation also assured that vehicles impeded by other users (bicyclists/pedestrians) or vehicles that failed to travel over each of the speed sensor locations were excluded from the database.

Vehicle Speed Data Collection

The dependent variable of interest was vehicle operating speed. Speed sensors recorded the speed of each vehicle traversing the study segment. The speed sensors were placed to capture speed changes associated with alinement changes for both curvilinear and tangent sites. Typical layouts of the curve and tangents sections are shown in figure 1.

For curvilinear sites, sensors were placed at the point of curvature (PC), mid-curve, and point of tangency (PT) for each horizontal curve. A sensor was also placed 46 m (150 feet) prior to the point of curvature (PC 150) and 46 m (150 feet) past the point of tangency (PT 150). A sixth sensor was placed at a point in the roadway where the geometric alinement was thought to have little effect (i.e., tangent). This sensor acted as a control sensor to capture the typical speeds in a particular roadway environment.

For tangent sites, the midpoint sensor was placed at the point in the roadway deemed to be most controlled by geometric features (i.e., restriction in lane width, middle of crest vertical curve, etc.). The other sensors were spaced 46 meters (150 feet) and 92 meters (300 feet) before and after this mid-point sensor. As with the curvilinear sites, a control point was selected to collect speeds where the influence of the geometric features would be minimal.

Field observation teams, positioned along the roadside, documented each vehicle traversing the study sites. The field personnel manually documented information about each vehicle and driver. By tracking individual vehicles, individual vehicle operating speeds could be analyzed for the different geometric and environmental features at the various sites.

Roadway/Roadside Characteristics

Several types of variables were examined The roadway and roadside explanatory variables collected along each study site consisted of the following types of information:

- alinement variables (e.g., curve radius, grade, available sight distance)
- cross section variables (e.g., lane width, parking, lane configuration)
- roadside variables (e.g., lateral obstructions, sidewalks)
- land use variables (e.g., residential, commercial, industrial)
- traffic control variables (e.g., speed limit, pavement markings)

The data collection variables from this study applicable to access management are: land use, intersection frequency, driveway frequency, parking availability, proximity to the central business district, and roadway configuration (the roadway configuration identifies the street segment as: two-way operation, one-way operation, or a two-way left-turn lane for additional access). Land use corresponds to one of the major study categories listed above, but the other variables are spread among the cross section and roadside categories.

The selection of these access/land use variables describes the environment along a street corridor and identifies the function of the roadway. This environment is one indication to the driver of the speed expected along the facility. Another indication to the driver of the intended roadway environment is the posted speed limit. The streets in this study consisted of sections posted at 40 km/h and 64 km/h. A specific objective of this project was to examine the influence of access/land use variables on vehicle operating speeds.

DATA ANALYSIS

This paper uses multiple linear regression analysis to develop point speed models at each sensor location. The point speed models estimate vehicle operating speeds at a particular point along the roadway considering the existence of various geometric alinements, roadside variables, land use characteristics, and traffic control variables within 30.5 meters (100 feet) of that study point.

Descriptive Statistics

The type of land use may have significant influence on the frequency of access and type of access. For this study eight different land uses were recorded. In analyzing the mean speeds between the different land uses, the following classifications were significant at a 95 percent confidence level.

Table 1. Mean speeds for land use.

Strata	Description	Percentages of Sensors	Mean Speed
1	residential	71%	45 km/h (28 mi/h)
2	commercial	7%	48 km/h (30 mi/h)
3	all other land uses	22%	50 km/h (31 mi/h)

Although statistically significant, a minor difference in mean speeds was observed for different land uses. Residential land uses experienced the lowest speeds followed by commercial land uses. The highest speeds were at the remaining land uses that can be characterized by open, park lands. The largest difference in mean speeds (5 km/h [3 mi/h]) was observed between residential and this last land use category.

The driveway frequency was also strati&d according to the number of driveways within a 30.5 meter (1 00-foot) length in front of the speed sensor location. The differences in mean speeds are more pronounced.

Table 2. Mean speeds for driveway density.

Driveways per 30.5 m length	Mean Speed
0	47 km/h (29 mi/h)
1	48 km/h (30 mi/h)
2	38 km/h (24 mi/h)

There is little difference in vehicle operating speeds when driveway density is less than 2 driveways per 30.5 meters (100 feet). If two driveways exist, however, in a 30.5 meter (100 foot) section, then the observed mean speeds were 10 km/h (7 mi/h) less than the for sites with lower driveway densities.

Intersection frequency was also classified according to the number of intersections within a 30.5 meter (1 00-foot) length after the speed sensor location. Sites either contained one or no intersections within this distance. (i.e., there were no sites with 2 intersections spaced less than 30.5 meters (100 feet) apart.) All intersections were stop-controlled on the minor street. There were no stop or yield signs nor signals along the major street of study.

Table 3. Mean speeds for intersection density.

Intersections per 30.5 m length	Mean Speed
0	47 km/h (29 mi/h)
1	44 km/h (27 mi/h)

There was a statistically significant difference at a 95 percent confidence level, in the mean speeds for 30.5 meter (100 feet) sections with one intersection as opposed to no intersections. This difference was, however, only 3 km/h (2 mi/h).

Aggregate Speed Analysis

The 85th percentile operating speed was calculated for each sensor location at each study site. This commonly used measure of speed provides the speed trends for the different sites, but it does not show the variability in speeds of individual drivers. The individual speed observations were used in the data analysis.(l)

A plot of *the 85th* percentile operating speeds *versus the critical design speed* is shown in figure 2. The *critical design speed* represents the "design" speed at the study site resulting from back calculating design speed using the AASHTO design equations for horizontal and vertical alinement. The relationship between design speed and operating speed has been presented by McLean for rural, two-lane roadways in Australia.@) There are several comments that can be made regarding the relationship found in the low-speed urban environment.

Study segments with low critical design speed (data points on the left side of figure 2 with critical design speeds below 64 km/h) have lower 85th percentile operating speeds. This indicates the strong influence geometric features exhibit on operating speed. Although 85th percentile operating speed generally exceeds the critical design speed in the lower design speed range, a strong linear relationship between operating speed and horizontal alinement is suggested (this is shown in figure 2 by the cluster of data points paralleling the line of equality - where the 85th percentile operating speed equals critical design speed).

As *critical design speed* increases beyond 64 km/h (40 mi/h), the 85th percentile speeds do not increase proportionately. For example, study sites with a critical design speed near 120 km/h (70 mi/h), as determined from the horizontal and vertical alinement, still have corresponding operating speed near or below 64 km/h. For study sites with critical design speeds above 90 km/h (55 mi/h), variables other than the geometric variables of curve radii and available stopping sight distance appear to influence driver speed choice in the low-speed environment. Between 64 km/h (40 mi/h) and 90 km/h (55 mi/h) there appears to be a transition area where both geometric and other variables influence operating speed. These other variables result in an operating environment that provides visual cues to the driver and gives the appearance of a "low-speed' facility that encourages lower speed operation. The research task was to investigate which variables influence speed and incorporate them into an operating speed approach to low-speed street design.

The vehicle operating speeds shown in figure 2 indicate that geometry and the operating environment influence speed. This relationship is further depicted in figure 3. When the geometry is very restrictive (i.e., small curve radii, narrow lane widths, and significant gradients), the operating speeds are lower. Roadways with non-restrictive geometry, however, do not necessarily have high-operating speed. The environment, classified by density of variables such as driveways, intersections, parking, and land use, impacts on the operating speeds of that facility. Urban streets can contain high density development that will induce lower speeds regardless of geometry. Streets with both non-restrictive geometry and low density development will exhibit higher speeds.

Regression Analvsis

A regression analysis was performed on the data at each of the six sensors to investigate which variables are significant in estimating the vehicle operating speeds. The unit of analysis is the individual vehicle. For each sensor, there were approximately 2,500 to 2,700 vehicle observations.

Access/Land Use Models

The first regression models run attempted to isolate the access and land use variables to investigate their influence on operating speeds. Regression models were run for the sites with curvilinear alinements. The coefficient of determination (R^2) for these models ranged between 15 and 27 percent for the different sensor locations. These R^2 values for the models are shown in figure 4 and the general form of the model is shown in equation 1. These values indicate that the access and land use variables were able to explain a small portion of the variability in operating speed. The variables significant at a 95 percent confidence level were: land use, number of intersections, number of driveways, road configuration, and parking. One reason the significant variables did not explaining more of the variability in operating speed is due to the strong influence of the horizontal alinement. Another issue is that many of the access variables are not present near horizontal curves. Therefore, the next step was to analyze these same variables for tangent sites.

$$\text{Speed} = \beta_0 + \beta_i(\textbf{land}\ \text{use})_i + \beta_j(\textbf{access})_j \quad (1)$$

On tangent street segments, there are fewer geometric features that tend to influence operating speed. The coefficient of determination for access/land use models run at the tangent sites were considerably higher. The R^2 values ranged from 17 to 40 percent and are shown in figure 5. The pattern of these values across the different sensors support the relationship between the geometric features and environmental variables. The highest R^2 values were in tangent sections where little influence from geometric features such as radius, lane width, or lateral obstructions existed. The tangent sites were chosen with the most restrictive geometry near the midpoint. It is at this location that the explanatory power of the access and land use variables decreases. This trend indicates that the access/land use variables decrease in explanatory power in the presence of restrictive geometry. Again, as with the curvilinear sites, the tangent sites were not likely to have driveways and intersections at the point with the most restrictive geometry.

It is recognized that posted speed limit will have some influence on some driver's choice of operating speed; however the posted speed limit was found to be collinear with many of the alinement and roadside variables, and thus, was omitted from the regression models to examine the other land use and access variables. The premise of the study was to investigate the relationship between geometric variables (including land use and access) and operating speed. Even for roads with the same posted speed limit there are variations in operating speeds. To examine these relationships the geometric variables were added to the land use and access variables to develop a full regression model.

Full Model Development

The alinement, cross section, roadside, and traffic control variables were grouped into their respective classifications. The access variables of driveway and intersection density were classified with the roadside model for one analysis and separately as an access model as described previously. Each variable group was analyzed to see how much variation in speed could be explained. A full model with the most significant variables from all groups was also analyzed. The general form of the full model is shown in equation 2.

$$\text{Speed} = \beta_0 + \beta_i(\text{alinement})_I + \beta_j(\text{cross section})_j + \beta_k(\text{roadside})_k + \beta_l(\text{land use})_l + \beta_m(\text{traffic control})_m \tag{2}$$

The results of the different models developed for the midpoints of the 27 curvilinear sites are shown in table 4. The midpoint sensor is used for comparison purposed because the full model has the highest explanatory power at this sensor.

Table 4. Midpoint regression models for groups of explanatory variables.

Regression Model	Coefficient of Determination
Alinement	69%
Cross Section	29%
Roadside	24%
Access/Land use	20%
Full Model	75%

The coefficient of determination, R^2, indicates the percent of speed variation being explained in each model. The results in table 4 compare speed estimation capability of the access and land use variable models against the other models. As expected, the alinement model explains the highest portion of speed variation. The cross section, roadside, and access/land use models, however, also explain a substantial portion of the speed variation. The significance of these variables is important in the low-speed design, especially on sections with no horizontal curvature.

The best regression model at the mid-curve sensor resulted in several variables being significant at the 95 percent confidence level. Presented in table 5 are these variables within their respective groups.

Table 5. Significant explanatory variables in best regression model.

Variable Group	List of Variables
Alinement	critical design speed, degree of curve, available stopping sight distance, available decision sight distance, absolute value of grade
Cross Section	road configuration, lane width, superelevation, type of curb, road surface
Roadside	Hazard rating (distance to, and severity of, lateral obstructions), land use, number of driveways, number of intersections, proximity to the CBD

It is significant to note in the low-speed environment the different geometric and environmental features that influence vehicle operating speed. Additionally, the access and land use variables are significant in the full model which explains the greatest portion of variability in operating speed.

FINDINGS

In the low-speed environment, horizontal curvature is not the only significant variable influencing the driver's selection of operating speed. The driving environment is more complex due to restrictive geometric and roadside features closer to the travelway. Along urban collectors where there is not full control of access, the driver must be concerned with interaction with vehicles from driveways, intersections, median areas, and parking.

The data collection and speed estimation modelling research presented in this paper indicate that the access and land use variables do influence the operating speeds. These variables impact the environment which the driver apparently uses in selecting the appropriate speed. This proposed methodology offers a tool to designers and planners to assist in making decisions about the design, location, and operation of access along low-speed urban streets.

The frequency and location of access has an effect on the resulting vehicle operating speeds. These access decisions can be examined in the overall planning of a street. If the function of an urban collector streets is to provide access with a desired operating speed below ***40*** km/h ***(25*** mi/h), higher access density may contribute to the low-speed environment and result in lower operating speeds. For low-speed urban streets designed for greater mobility and higher operating speed, limited access may be more consisted with the operating environment. The proposed speed modelling approach will allow access decisions to be made in context with other geometric and roadside design decisions.

CONCLUSIONS/SUGGESTED RESEARCH

An operating speed approach to the design of urban streets may result in use of a predictive speed model. This type of model can be used for new street construction or to examine traffic engineering and planning decisions along existing streets. This type of model could also be used in an access management program to investigate the impact of access strategies on the overall operation of a street. Improved estimation of the vehicle operating speed prior to implementation of a design will assist designers and planners in constructing streets consistent with the intended operation.

To increase the applicability of this modelling approach to access management, the database for low-speed urban streets needs to be expanded to include more variability in access design and land use. Data are need on the frequency of use of driveways, intersections, and parking in addition to their availability. The study was not designed to record the number of movements in and out of access locations and on-street parking spaces, but this activity will intuitively have some influence on vehicle operating speeds along streets.

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2. McLean, J. R., "An Alternative to the Design Speed Concept for Low Speed Alinement Design," *Transportation Research Record* 702, National Research Council, Washington DC, pp. 55-63, 1979.

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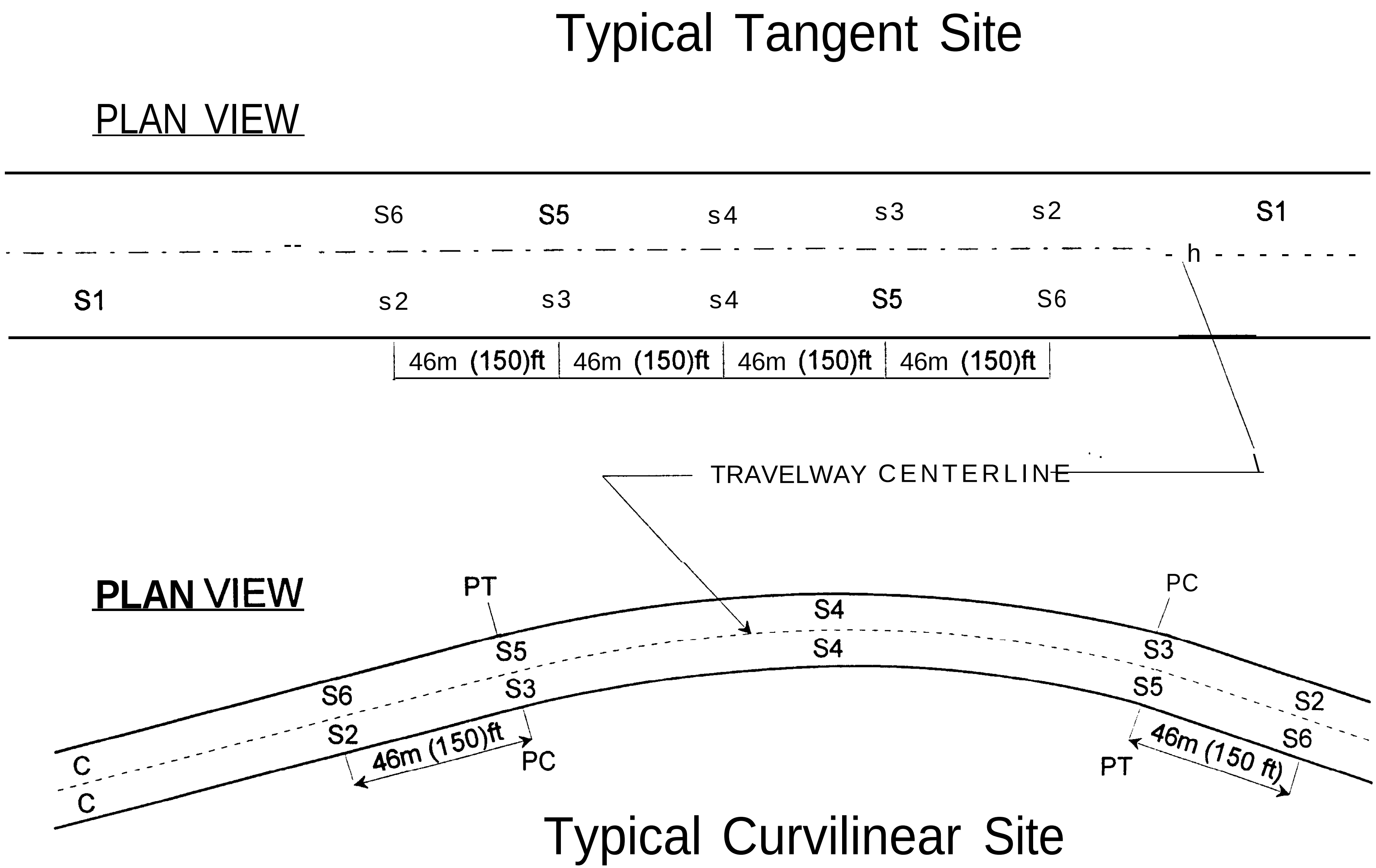

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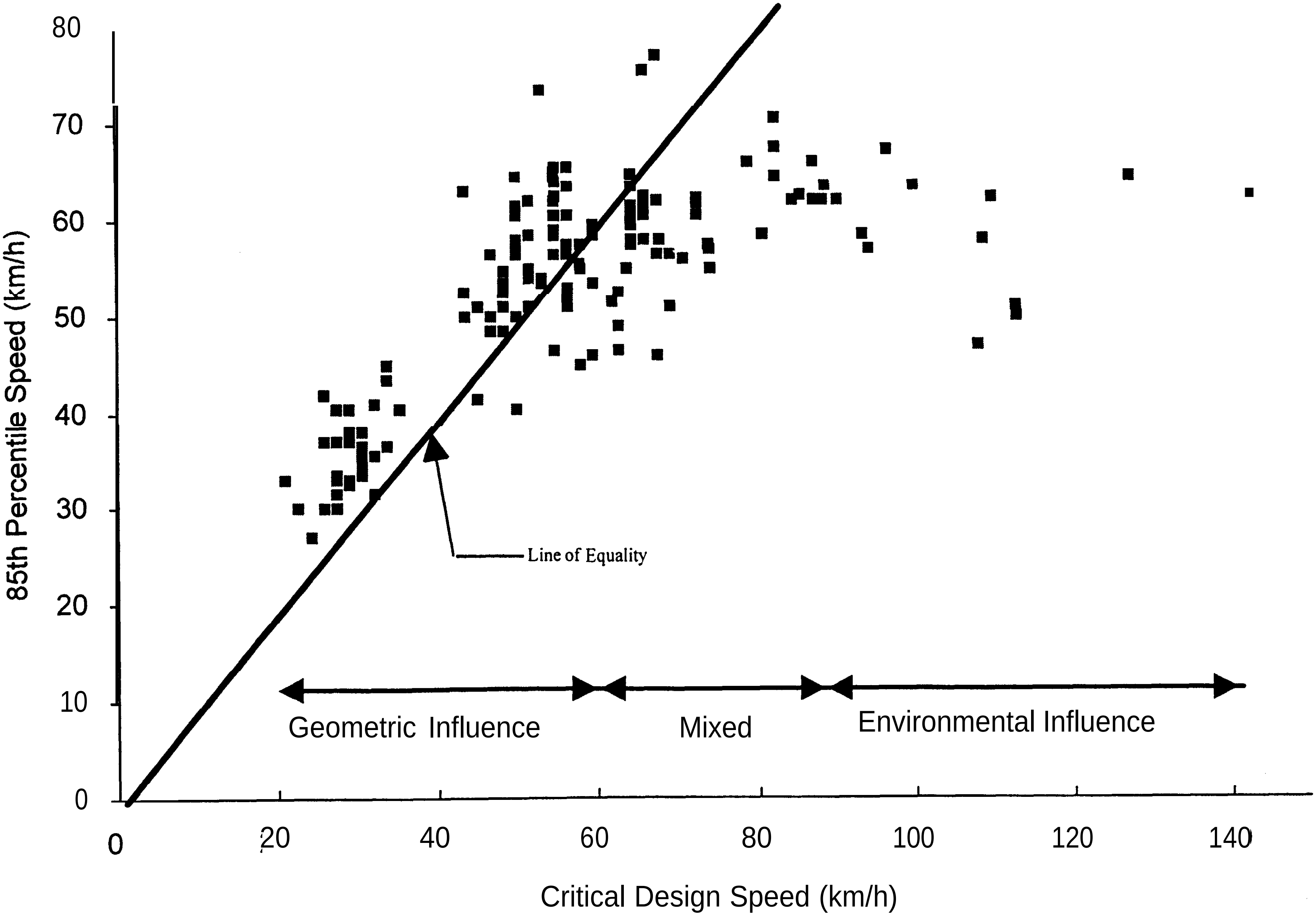

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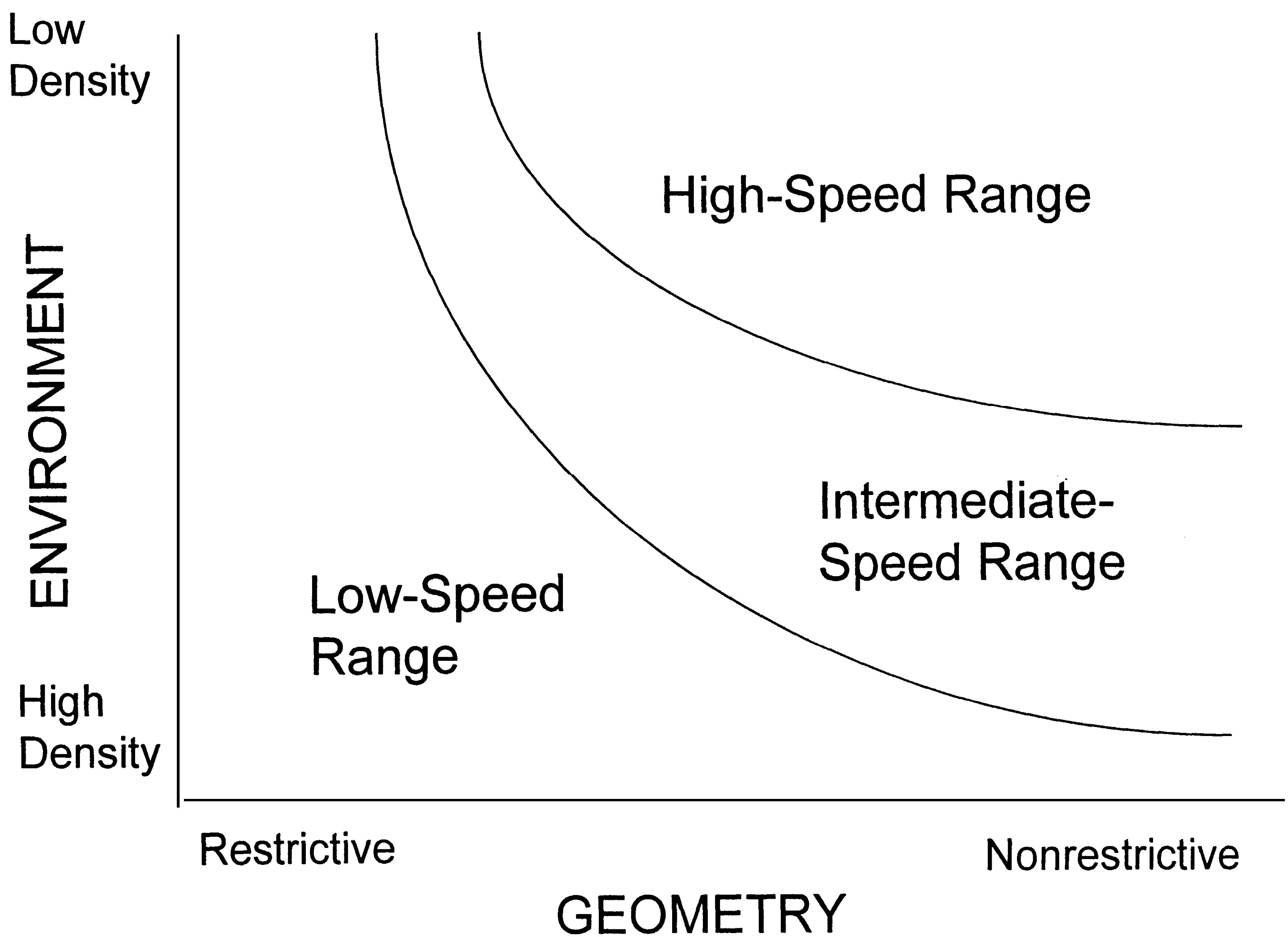

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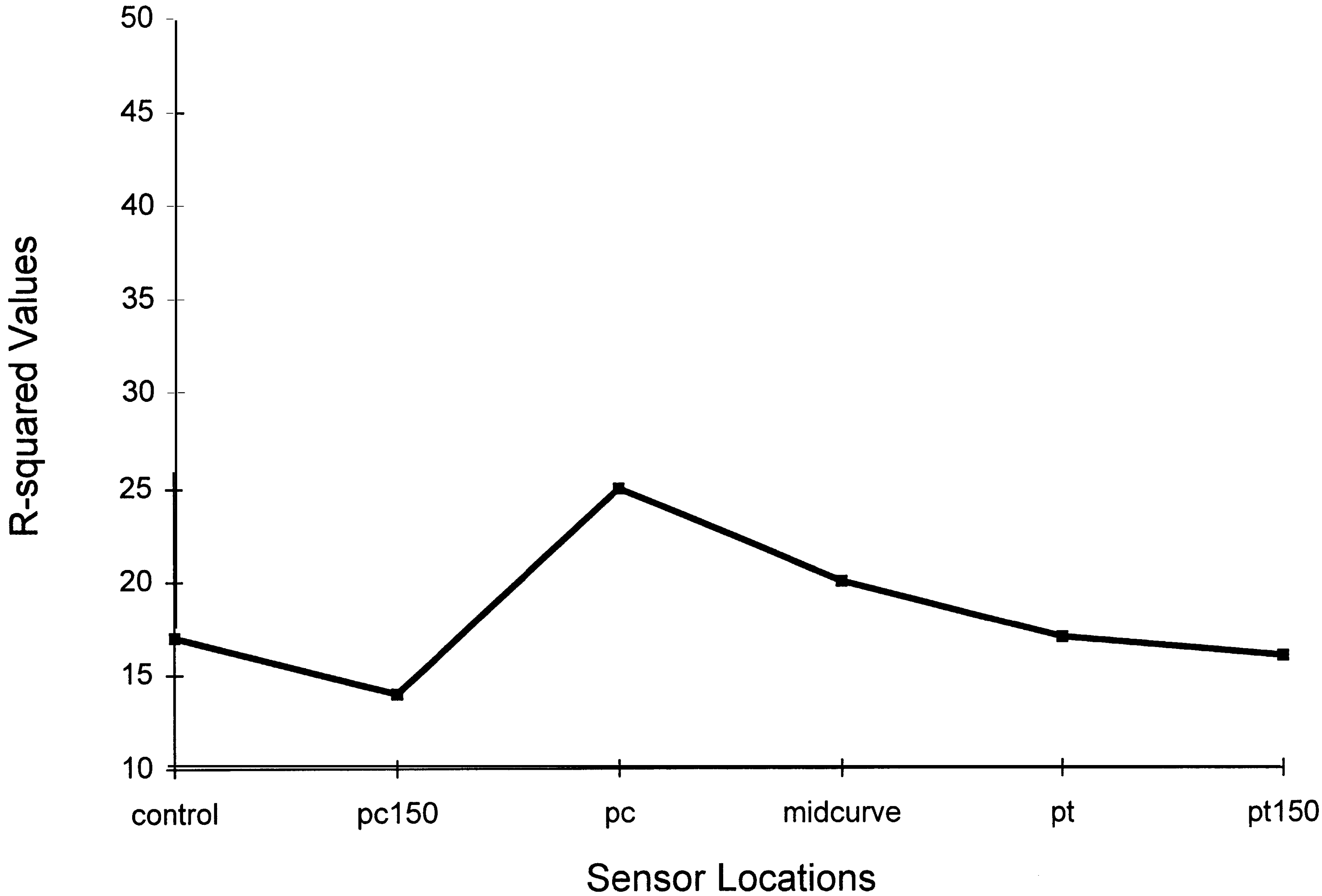

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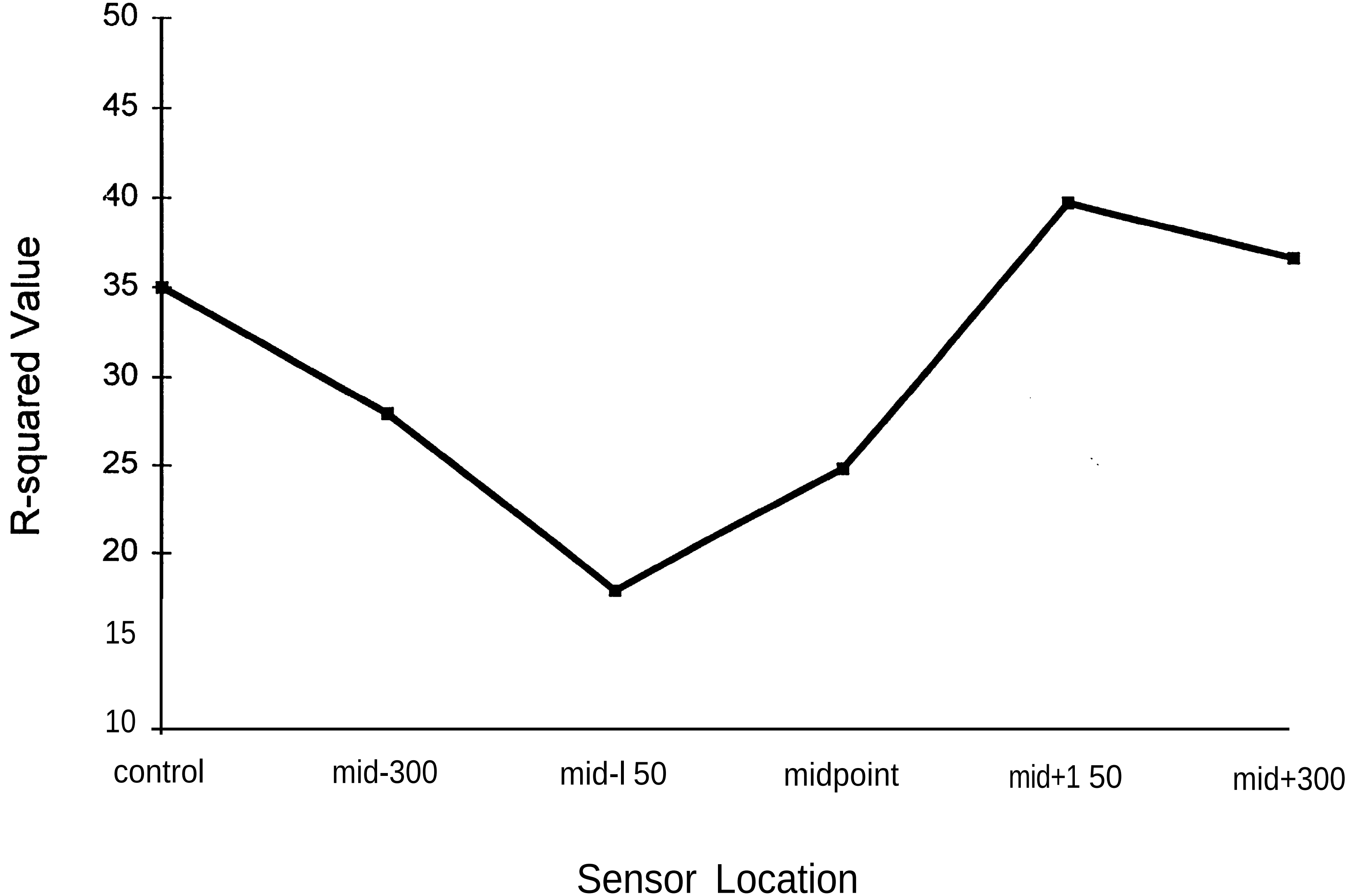

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Sight Distance For Vehicles Turning Left Off Major Roadways

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ABSTRACT

At-grade intersection designs (driveways, crossroads, median openings) address various sight distance considerations. AASHTO geometric design policy cites several cases for drivers to cross or turn at intersections. This paper presents the results of field observations for vehicles turning left off major roadways. The situation is defined as Case V intersection sight distance (ISD). Provision of adequate Case VISD affects the selection of individual intersection design elements and the operational and safety aspects of the access points along a major roadway corridor.

The theoretical arguments and data collection plans for evaluating Case V ISD are summarized. Field information included surrogate measures of perception-reaction times, left-turn travel times, oncoming vehicle speeds, and the gaps accepted/rejected by drivers turning left off major roadways. Descriptive statistics and logit models were used to analyze the field data. Recommended Case V ISD values are graphically compared to each AASHTO Case III and Case V ISD procedure.

Field observed ISD requirements were greater than the calculated ISD for AASHTO Case IIIA, Case IIIB (clearing the closest lane), and Case V. However, the Case V ISD field observations were less than the computed AASHT0 Case IIIB or Case IIIC scenarios.

Access management policies should emphasize the need for sufficient at-grade sight distance. Likewise, related geometric and operational guidelines should clearly cite the need to determine whether Case III or Case VISD is appropriate for a specific intersection design.

Key Words: *sight distance, intersections, perception-reaction time, gap acceptance, left-turn*

INTRODUCTION

At-grade intersection designs (driveways, crossroads, median openings) address various sight distance considerations. AASHTO geometric design policy cites several cases for drivers to cross or turn at intersections.

The 1994 AASHTO publication A Policy on the Geometric Design of Highways and Streets (hereafter known as the 1994 AASHTO Green Book) provides guidelines to determine Case V intersection sight distance (ISD) for a stopped vehicle turning left from a major highway onto a minor roadway (1). Case V ISD is computed by multiplying the design speed of the major highway **by the sum of the driver's perception-reaction** time and the vehicle's acceleration time.

However, the 1994 AASHTO Green Book does not justify the assumed perception-reaction time of 2.0 s or the acceleration time based on actual research or field observations. AASHTO assumes these times are similar to Case III, where the minor roadway has stop control and intersections are designed to allow drivers to safely: cross the major highway (Case IIIA); or turn left (Case IIIB) or turn right (Case IIIC) onto the major highway. If Case V drivers require longer sight distances than Case III drivers, left-turning vehicles may collide with oncoming traffic.

This paper examines how much Case V ISD is required based on theoretical arguments and several data collection plans. The theoretical arguments define a methodology to evaluate the required Case V ISD. Also, several data collection plans were used at two stop-controlled intersections to estimate: perception-reaction times and left-turn travel times of Case V drivers; speeds of oncoming vehicles traveling through and turning at the intersection; and gaps accepted/rejected by Case V drivers. Descriptive statistics and logit modeling were used to analyze field data and compare the results with AASHTO Case III and Case V ISD procedures.

Access management policies should emphasize the need for sufficient at-grade sight distance. Likewise, related geometric and operational guidelines should clearly cite whether Case III or Case V is appropriate for stop-controlled intersections.

INTERSECTION SIGHT DISTANCE POLICY

The 1994 AASHTO Green Book considers a stopped vehicle turning left from a major highway as Case V ISD. It states:

> All at-grade intersections along a Major Highway including those with Minor Roads, Entrances, or Driveways, where a stopped vehicle desires to enter by turning left across the opposing lanes of travel, must be checked for adequate sight distance. The driver will need to see ahead a sufficient distance to have time to turn left and clear the opposing travel lane before an approaching vehicle reaches the intersection (1).

AASHTO recommends the following equation to compute Case V and also Case IIIA, IIIB, and IIIC ISD:

$$d = 0.28\,V\,(J + t_a) \tag{1}$$

where:

d = sight distance along the major highway (m)

V = design speed on the major highway (km/h)

J = sum of the perception time and the time required to actuate the clutch or actuate an automatic shift

t_a = time required to accelerate and traverse the distance S to clear the pavement of the major highway

For J, the perception-reaction time, AASHTO recommends using the time taken by the slower driver. For t_a, the acceleration time, AASHTO presumes most drivers accelerate more rapidly than normal but not at the full vehicle acceleration rate.

Previous research has examined the perception-reaction times for Case III ISD (2, 3, 4, 5). Brydia et al. recommended no change in perception-reaction times "because of their validation from several empirical studies and the insensitivity in changes in ISD values relative to changes in perception-reaction times (3)." Hostetter et al. recommended shorter perception-reaction times for a Case IIIA crossing maneuver (2.0 s) than for Case IIIB and IIIC turning maneuvers (2.5 s) (5).

However, for Case V ISD, AASHTO does not justify J = 2.0 s or t_a based on previous research or field observations. The Traffic Institute at Northwestern University summarized sight distance requirements turning left off major highways but did not explain how J or t_a were found (6).

Several situations may affect Case V ISD. Offset left-turn lanes, skewed intersections, horizontal and vertical curvature, narrower lanes, and painted medians are not evaluated in previous research (7,8).

Furthermore, Case V drivers may require longer perception-reaction times than Case III drivers. While Case III drivers view oncoming vehicles from the left or right, Case V drivers view vehicles head-on and may have more difficulty judging the speed and distance of opposing vehicles. Mason et al. (9) McKnight (IO), and Haucr (I I) document the problems of drivers, particularly the elderly, that fail to yield to oncoming traffic when turning left off the major highway.

Also, Case V vehicles may require longer acceleration times than Case III vehicles because of different travel paths and/or starting times.

Most importantly, stop-controlled intersections that provide sufficient Case III ISD may not provide enough Case V ISD. If true, Case V vehicles may collide with oncoming vehicles. Actual field observations may confirm how much Case V ISD is necessary.

INTERSECTION SELECTION

Potential stop-controlled intersections were selected based on the following criteria:

- Minor roadway had stop control.

- Intersection sight distances exceeded values in the 1994 AASHTO Green Book.
- Major and minor highways intersected at or near a 90-degree angle.
- Grades of each approach were two percent or less.
- Signalized intersections were at least 300 m (1000 ft) from the intersection.
- Significant left-turning and opposing traffic volumes were present.
- Pavement markings or channelization defined the travel lanes of major and minor highways.

At each possible intersection, traffic volumes were recorded during off-peak and peak periods. If an adequate sample size was not obtained, the intersection was not considered further.

If an intersection met the criteria, second visits were made to document available sight distances, geometric design, traffic control devices, and other details. Two stop-controlled intersections were selected.

MINIMUM INTERSECTION SIGHT DISTANCE

Definition

Sight distance is the distance drivers must see to safely operate their vehicles. At-grade intersections should provide the minimum intersection sight distance d so Case V drivers may turn safely.

Figure 1 and Table 1 define the minimum Case V ISD. A driver in a stopped vehicle (Vehicle A) desires to turn left off the major highway. Vehicle C is in the opposing traffic stream. The conflict area is where Vehicle A may collide with Vehicle C. It is defined as the edges of the travel lane for Vehicle C and the edges of the travel lane Vehicle A enters.

Distance d equals the sum of three distances. First, the driver in Vehicle A uses perception-reaction time to decide whether it is safe to turn left in front of Vehicle C. The distance $d_{J_A(C)}$ Vehicle C travels equals the perception-reaction time multiplied by the assumed speed for Vehicle C.

Once the driver decides to turn between Vehicles B and C, Vehicle A requires left-turn travel time to accelerate and clear the conflict area before Vehicle C enters it. The distance $d_{lt_A(C)}$ Vehicle C travels equals the left-turn travel time multiplied by the assumed speed for Vehicle C.

Minimum ISD also includes the third distance d_{ca}. Distance d_{ca} depends upon the driver's eye location in Vehicle A before the left-turn begins. Distance d_{ca} is the distance from the initial driver's eye location to the edge of the conflict area Vehicle C enters first.

Therefore, the equation for minimum intersection sight distance d is:

$$d = d_{ca} + d_{J_A(C)} + d_{lt_A(C)} \tag{2}$$

Critical Case V ISD

Suppose the driver in Vehicle A debates whether to turn in front of an opposing vehicle (Vehicle B). The driver, however, determines that when Vehicle B reaches a critical distance d_{cd} from the driver, and if the driver attempted the turn Vehicle A would collide with Vehicle B. In other words, the driver in Vehicle A would always reject the gap in front of Vehicle B and would not turn.

Consequently, the driver begins to examine whether to turn between Vehicle B and the next oncoming vehicle (Vehicle C). When Vehicle B reaches d_{cd}, the driver in Vehicle A requires the minimum Case V ISD d to see Vehicle C. This is critical Case V ISD.

Figure 2 presents a theoretical argument to compute d. The driver in Vehicle A wants to turn left off the major highway. Vehicles B and C are opposing through vehicles.

The driver in Vehicle A can reasonably approximate his minimum left-turn travel time t_{lt_A}. Assuming Vehicle B approaches at the constant speed V_B, d_{cd} is:

$$d_{cd} = 0.28\, V_B t_{lt_A} + d_{ca} \tag{3}$$

When Vehicle B reaches d_{cd}, it is assumed the perception-reaction time J_A begins for the driver in Vehicle A. Perception-reaction time ends when the driver accepts the gap between Vehicles B and C and begins to accelerate. During J_A, the distance $d_{J_A(C)}$ Vehicle C travels at the speed V_C is:

$$d_{J_A(C)} = 0.28\, V_C\, J_A \tag{4}$$

Once Vehicle A starts to accelerate, it requires the left-turn travel time t_{lt_A} to clear the conflict area before Vehicle C enters it. While Vehicle A turns left, the distance $d_{lt_A(C)}$ Vehicle C travels is:

$$d_{lt_A(C)} = 0.28\, V_C\, t_{lt_A} \tag{5}$$

The minimum d is determined by using equation 1.

The assumptions forming this theoretical argument are justified for several reasons. For example, drivers completing a Case V maneuver while moving would require less left-turn travel time, and consequently less ISD, than vehicles accelerating from a stopped position.

Also, **suppose** Vehicle A must wait for Vehicle B to pass, but Vehicle C is not present. The driver in Vehicle A will not have to decide whether to accept or reject the gap between Vehicles B and C. Hence, no ISD is required to see Vehicle C.

The two most important reasons deal with critical distance d_{cd} and distance d_{ca}. Distance d_{cd} is based upon the minimum left-turn travel time for Vehicle A and the speed of Vehicle B. Suppose the driver in Vehicle A knows these values and sees Vehicle B has reached d_{cd}. The driver in Vehicle A would reject the gap in front of Vehicle B every time and would not turn in front of Vehicle B. At this moment, the driver's perception-reaction time begins. When the driver's perception-reaction time begins, distance d_{ca} ensures d is defined from the driver's eyes to Vehicle C.

Perception-Reaction Time

Assuming Vehicle B always approaches at V_B, an observer may be situated at d_{cd}. Once Vehicle B passes d_{cd}, J_A is recorded until Vehicle A begins to accelerate. If Vehicle B travels at a speed other than V_A, J is adjusted.

Suppose V_B = 75 km/h (47 mph) and J_A = 2.00 s. Beforehand, the observer assumed V_B and computed t_{lt_A} to establish d_{cd}. For example, if V_B = 53 km/h (33 mph) and t_{lt_A} = 3.46 s, d_{cd} = (0.28)(53)(3.46) = 51 m (167 ft) from the edge of the conflict area closest to Vehicle B.

When Vehicle B reached d_{cd}, the observer began to record J_A. However, since V_B = 75 km/h (47mph), d_{cd} should have been d_{cd} = (0.28)(75)(3.46) = 73 m (240 ft). Therefore, the adjusted $J_A = 2.00 + (75 - 53)(2) / 53 = 2.83$ s.

Minimum Left-Turn Travel Time

Once Vehicle A starts to accelerate, it turns left to clear the conflict area before Vehicle C arrives. Assuming Vehicle A takes the minimum left-turn travel tune t_{lt_A}, the distance $d_{lt_A(C)}$ Vehicle C travels while Vehicle A turns left is:

$$d_{lt_A(C)} = 0.28\, V_C\, t_{lt_A} \tag{6}$$

To estimate $d_{lt_A(C)}$, the travel path of Vehicle A was established. Figure 3 shows the travel path of Vehicle A turning left off a two-lane major highway from a stopped position onto a two-lane minor roadway.

The travel path consists of three segments. During the first segment, Vehicle A accelerates in low gear along a circular arc s_1 from a stopped position to its maximum acceleration rate a_{max}. At the end of the first segment, Vehicle A reaches the maximum attainable speed V_{max}. The relationship between the available side friction, roadway superelevation, and vehicle speed is:

where:

$$f = \frac{V^2}{127R} - e \tag{7}$$

f = side friction factor

e = roadway superelevation rate (% / 100)

v = vehicle speed (km/h)

R = curve radius (m)

Rearranging the equation:

$$V_{max} = \sqrt{(e + f)\ (127R)} \tag{8}$$

Knowing V_{max}, the first elapsed time t_1 during which Vehicle A travels from a stopped position to V_{max} at a_{max} is:

$$t_1 = \frac{V_{max}}{a_{max}} \tag{9}$$

The distance s_1 Vehicle A travels is:

$$s_1 = 0.5 a_{max} t_1^2 \tag{10}$$

During the second segment, the vehicle travels in low gear along the remaining circular arc s_2 at V_{max}, given the restrictions of traveling a horizontal curve. The second elapsed time t_2 occurs when Vehicle A travels s_2 at V_{max}. The vehicle continues at a_{max}. The total distance s_{arc} traveled along the arc is:

$$s_{arc} = \frac{\pi \Delta R}{180} \tag{11}$$

where:

A = internal angle formed by the intersecting minor and major highways (deg)

R = curve radius (m)

The distance s_2 traveled is:

$$s_2 = s_{arc} - s_1 \tag{12}$$

Knowing s_2, t_2 is:

$$t_2 = \frac{s_2}{V_{max}} \tag{13}$$

During the last segment, Vehicle A travels its length s_3 at a_{max} to clear the opposing travel lane. Meanwhile, the speed of the vehicle increases because side friction does not limit rectilinear motion. Solving by quadratic equation, the third elapsed time t_3 is:

$$t_3 = \frac{-V_{max} \pm \sqrt{V_{max}^2 - 2a_{max}(-s_3)}}{a_{max}} \tag{14}$$

Knowing the three elapsed times t_1, t_2, and t_3, the equation to calculate t_{lt_A} is:

$$t_{lt_A} = t_1 + t_2 + t_3 \tag{15}$$

Note in Figure 3, Vehicle A is assumed to travel a circular arc with $\boldsymbol{R}$ = 1.5 × lane width (e.g., 3.6 m (12 ft) lane width × 1.5 = 5.4 m (18 ft) radius).

To compute t_{lt_A} , values for a_{max} and s_3 were required. Glauz et al. projected vehicle characteristics of passenger cars through 1995 (12). Acceleration performance curves and 5.2 m (17 ft) vehicle lengths were assumed. Table 2 lists the calculated t_{lt_A}.

To account for the changing acceleration rate, Table 2 also summarizes the computed iterations for t_1, d_1, and a,,,, for each speed increase of 1.5 m/s (5 ft/s) up to V_{max}.

Opposing Vehicle Speeds

Opposing vehicles may approach an intersection at many different speeds because of the available sight distance, intersection geometry, other turning vehicles, or nearby intersections and driveways. To compute ISD, the 1994 AASHTO Green Book specifies opposing vehicle speeds as the design speed of the major highway (1).

Gap Acceptance

Fitzpatrick (13) and other researchers have evaluated gap acceptance of drivers wanting to turn left in relation to opposing vehicles. Vehicles B and C may be separated by different time gaps or travel at different speeds. The driver in Vehicle A must decide either to accept the gap and turn between Vehicles B and C, or reject it and examine the next gap. The dependent variable is binary (accepted gap or rejected gap); the three independent variables are the time gap t_{BC} and the vehicle speeds V_B and V_C.

Suppose the gaps the driver accepts or rejects are known, as well as V_B and V_C. As shown in Figure 2, when Vehicle B is at the critical distance d_{cd}, the perception-reaction time J_A starts. At that moment, the distance d_{GAP} Vehicle C must travel to reach the conflict area may be found. Distance d_{GAP} depends upon the minimum left-turn travel time t_{lt_A} for Vehicle A and the probability of the driver accepting the time gap t_{GAP} between Vehicles B and C. The equation is:

$$d_{GAP} = 1.47 V_C (t_{lt_A} + t_{GAP}) \tag{16}$$

A logit model was used to estimate t_{GAP}, given the accepted time gaps, rejected time gaps, and speed differentials are known (I 3).

This simple, dichotomous choice logistic function is:

$$P = \frac{1}{1 + e^{-(\beta_0 + \beta_1 t_{BC} + \beta_2 V_B + \beta_3 V_C)}} \tag{17}$$

where:

P = probability of accepting t_{GAP}

β_0, β_1 = regression coefficients

β_2, β_3 = regression coefficients

When the dependent variable is a 0 (reject gap) or 1 (accept gap) indicator variable, the mean response is a probability. To linearize the logistic function, the transformed probability P' is:

$$P' = \log_e \frac{P}{1 - P} = \beta_0 + \beta_1 t_{BC} + \beta_2 V_B + \beta_3 V_C \tag{18}$$

Inserting t_{GAP} and t_{lt_A} into equation 16 yields d_{GAP}.

Intuitively, $d_{GAP} > d$. The theoretical argument for d assumes Vehicle A clears the conflict area at the same time Vehicle C enters the conflict area. Gap acceptance accounts for a "time cushion" between Vehicle A and Vehicle C. Consequently, when J_A begins for gap acceptance, Vehicle C would be located farther from the conflict area for gap acceptance than for the theoretical argument.

Based on gap acceptance, finding the accepted gaps, rejected gaps, and opposing vehicle speeds would define the ISD drivers require. Using the theoretical argument, fmding the perception-reaction times, left-turn travel times, and overall left-turn times would clarify the ISD drivers require.

DATA COLLECTION PLANS

Five Data Collection Plans (DCP) were completed at two stop-controlled intersections: West Whitehall Road and Waupelani Drive in State College, PA; and Routes 150 and 64 near Mill Hall, PA. The plans included pneumatic tubes, tapeswitches, automatic traffic recorders, video cameras, and enoscopes.

DCP-1: Pneumatic Tubes

Pneumatic tubes recorded opposing vehicle speeds at a distance where vehicles did not decelerate to turn off the major highway or brake for other vehicles. This setup provided information about where to install equipment for the remaining data collection plans.

DCP-2: Pneumatic Tubes

Three pairs of pneumatic tubes recorded opposing vehicle speeds. DCP-2 documented opposing vehicle speeds at 106 m (350 ft), 76 m (250 ft), and 46 m (150 ft) from the conflict area.

DCP-3: Tapeswitches

Three'pairs of tapeswitches recorded the speed and type of opposing vehicles. As with DCP-2, DCP-3 recorded opposing vehicle speeds at 106 m (350 ft), 76 m (250 ft), and 46 m (150 ft) from the conflict area.

DCP-4: Tapeswitches and Video Camera

A video camera recorded opposing vehicles passing over each pair of tapeswitches during DCP-3. The videotape and the data from the automatic traffic recorders were used to compile opposing vehicle speeds traveling through or turning right at the intersection.

DCP-5: Video Camera and Enoscopes

A video camera and two enoscopes were used to estimate: perception-reaction times, left-turn travel times, and overall left-turn times for Vehicle A; speeds of Vehicles B and C; and accepted and rejected time gaps of Case V drivers.

The video camera was placed perpendicular to the major highway to maximize the area filmed. Reference points were marked at 30 m (100 ft), 15 m (50 ft), and 0 m (0 ft) from the conflict area to estimate opposing vehicle speeds during data reduction.

Enoscopes are L-shaped boxes with two openings and a mirror set at a 45-degree angle; they enabled the observer to begin timing a vehicle when viewed in the mirror.

One enoscope was at distance d_{cd} - d_{ca}, assuming Vehicle B approached at speed V_B. When Vehicle B passes it, Vehicle A should not attempt to turn left. Instead, the driver begins perception-reaction to examine the gap between Vehicles B and C. This distance equaled V_B multiplied by t_{lt_A}. If Vehicle B traveled at a speed other than V_B, J_A was adjusted.

The second enoscope was placed 5.2 m (17 ft) from the right edge of travel lane for opposing vehicles and denoted when Vehicle A cleared the conflict area.

Site-Saecific Data Collection

Whitehall and Waupelani functioned as a four-leg intersection, with stop control on Waupelani. Whitehall provided one lane in each direction with no exclusive left-turn lane.

Routes 150 and 64 functioned as a three-leg intersection, with stop control on Route 64. Route 150 provided one lane in each direction with an exclusive left-turn lane.

Samples were eliminated if: Vehicle A did not stop completely; Vehicle C turned at the intersection; or if the time gap between Vehicles B and C was greater than 20 s. At this time gap, Vehicle C did not influence the driver's decision-making process.

DATA ANALYSIS

The analysis objectives were to examine:

- Effects of the data collection plans on driver behavior.
- Equality of the data for opposing vehicle speeds collected by pneumatic tubes (DCP-2) and tapeswitches (DCP-3).
- Speed variations between opposing through vehicles and right-turning vehicles (DCP-4).
- Perception-reaction times, left-turn travel times, and overall left-turn times of Case V drivers (DCP-5).
- A relationship between the dependent variable (probability of a driver accepting a gap) and three independent variables (the time gap between opposing vehicles and the speed of each vehicle).
- Required Case V ISD based on the theoretical argument and gap acceptance.
- Required Case V ISD from DCP-5 against Case III and Case V ISD in the 1994 AASHTO Green

Book.

Opposing Vehicle Speeds

Descriptive statistics determined the 15th, 50th, and 85th percentile speeds, mean speeds, standard deviation, 95 percent confidence interval, skewness, and kurtosis.

An additional statistical test compared the means of the two independent random samples from DCP-2 and DCP-3. The null hypothesis was the mean from DCP-2 equaled the mean from DCP-3. To test the null hypothesis, a 95 percent confidence interval ($C.I._{95\%}$) was computed about two independent means. The equation is:

$$C.I._{95\%} = \mu_{DCP-2} - \mu_{DCP-3} \pm 1.96 \sqrt{\frac{\sigma_{DCP-2}}{n_{DCP-2}} + \frac{\sigma_{DCP-3}}{n_{DCP-3}}} \qquad (19)$$

where:

μ = mean

σ = standard deviation

n = number of observations

Table 3 summarizes the descriptive statistics about opposing vehicle speeds. As the distance from the conflict area decreased, opposing vehicle speeds decreased while standard deviations increased. At Whitehall, the standard deviations at 106 m (350 ft) were considerably higher than at 76 m (250 ft) due to vehicles entering Whitehall just 15 m (50 ft) from the setup at 106 m (350 ft).

At Whitehall and Waupelani, the null hypothesis was not satisfied primarily because the mean for DCP-2 was 2.1 km/h (1.3 mph) to 3.2 km/h (2.0 mph) below the mean for DCP-3. A sag vertical curve made the pneumatic tubes more visible and caused about three percent of opposing vehicles to brake while crossing them. Less than one percent of drivers braked while crossing the tapeswitches. These results suggest the pneumatic tubes influenced driver behavior.

At Routes 150 and 64, equality about the means was not achieved at 106 m (350 ft) primarily because the data was not collected over the same time period. Pneumatic tubes recorded speeds for 25 h, but the tapeswitches collected data for only 5.5 h before the automatic traffic recorder failed.

Opposing Through and Right-Turn Vehicles

Table 4 shows the descriptive statistics for DCP-4. As the distance from the conflict area decreased, the difference in percentile speeds, mean speeds, and standard deviations increased between through and right-turn vehicles.

The difference in percentile speeds between through and right-turn vehicles was much greater on Route 150 than on Whitehall. These results may have occurred because a higher percentage of heavy vehicles (more than two axle) turned right from Route 150 (29 of 446 vehicles, 6.5 percent) than from Whitehall (1 of 266 vehicles, 0.4 percent).

While the speeds of right-turning vehicles decreased as they neared the intersection, the speeds of through vehicles remained relatively constant.

Perception-Reaction Time

As shown in Table 5, the 85th percentile of J_A, which is considered as the time taken by the slower driver, was 1.21 to 1.50 s greater than the 2.0 s AASHTO recommends. Even the "average" driver (50th percentile) exhibited perception-reaction times greater than 2.0 s.

Left-Turn Travel Time

AASHTO estimates well the left-turn travel time of an average vehicle. Table 5 summarizes the recorded left-turn travel times. The means were 3.98 and 4.3 1 s. Using Figure IX-33 from the 1994 AASHTO Green Book, with a travel distance of approximately 14.3 m (47 ft), the estimated acceleration time is 4.3 s.

The percentile values were approximately 0.3 to 0.4 s higher at Routes 150 and 64 than at Whitehall and Waupelani. Vehicles turning off Route 150 displayed large turning radii and started farther back than the theoretical argument defined.

Overall Left-Turn Time

For these two intersections, the 1994 AASHTO Green Book estimated the overall left-turn time = J_A + t_a = 2.0 s + 4.3 s = 6.3 s. Table 5 shows most Case V drivers required overall left-turn travel times greater than what AASHTO predicts. The 50th percentiles (say 6.75 s) and 85th percentiles (say 7.50 s) are greater than 6.3 s. Also, the 95 percent confidence intervals about one mean and two independent means suggest 6.3 s represents the minority of Case V drivers.

Logit Modeling

Table 6 summarizes the probability of a driver accepting a gap. The logit coefficient for t_{BC} was much greater than the coefficients for V_B and V_C. The t-ratios suggest t_{BC} is statistically significant at the 95 percent confidence level (3.69 > 1.96) but is not significant for V_B and V_C.

The chi-square statistics also indicate opposing vehicle speeds are not significant. The chi-square statistics increase only slightly from the values for t_{BC} only to the values for all three independent variables. The chi-square statistics greatly exceeded the chi-square random variable with one degree of freedom, indicating the data fits the model well. Therefore, only t_{BC} was selected for further analysis.

The 50th and 85th percentile probability of accepting t_{GAP} at Routes 150 and 64 (5.31 s and 5.89 s) were greater than at Whitehall and Waupelani (4.58 s and 5.45 s).

Required Case V ISD

Figure 4 and Table 7 compares ISD requirements of the 50th and 85th percentiles from DCP-5 with Case V and Case III from the 1994 AASHTO Green Book. The 50th percentile defined the average driver and the 85th percentile represents most drivers.

Field observations indicated Case V ISD requirements were greater than the calculated ISD for AASHTO Case IIIA, Case IIIB (clearing the closest lane), and Case V. However, Case V field observations were less than the computed AASHTO Case IIIB or Case IIIC scenarios.

CONCLUSIONS

The results of this research suggest the following:

- Case V drivers display perception-reaction times greater than the 2.0 s recommended in the 1994 AASHTO Green Book.
- Case V drivers have mean left-turn travel times comparable to the estimated acceleration time from the 1994 AASHTO Green Book.
- The overall left-turn times (6.75 s at 50th percentile, 7.50 s at 85th percentile) from DCP-5 infer that the Case V ISD procedure in the 1994 AASHTO Green Book represent the minority of Case V drivers.

The current AASHTO procedure may undesirably place the majority of drivers at risk to collide with oncoming vehicles.

- Case V ISD for the 50th and 85th percentiles from DCP-5 were greater than AASHTO's Case IIIA, Case IIIB (clearing the closest lane), and Case V ISD.
- Passenger vehicles turning left or right (AASHTO Case IIIB and Case IIIC) require greater ISD than Case V ISD from DCP-5.

IMPLICATIONS

The AASHTO Case V ISD procedure may need to be reexamined to verify whether the procedure is adequate for all vehicles maneuvering through at-grade intersections.

Findings from this research could be included in design guidelines defining Case V ISD. Guidelines should emphasize why Case V drivers may require greater perception-reaction time to judge the speed and distance of oncoming vehicles. The guidelines should clearly state when the required ISD should be based upon Case V or Case III maneuvers. Finally, the guidelines should supply accurate information about perception-reaction times, left-turn travel times, and overall left-turn times.

POSSIBLE RESEARCH AREAS

- Justify perception-reaction times, left-turn travel times, and overall left-turn times of passenger vehicles and trucks through additional field observations.
- Complete observations at intersections with wider cross-sections, horizontal curves, vertical curves, and opposing left-turn lanes.
- Develop a step-by-step procedure to determine what crossing or turning maneuver should be used to provide adequate ISD. Consider basing the guidelines on functional classification, traffic volumes, vehicle types, intersection geometries, and/or gap acceptance.

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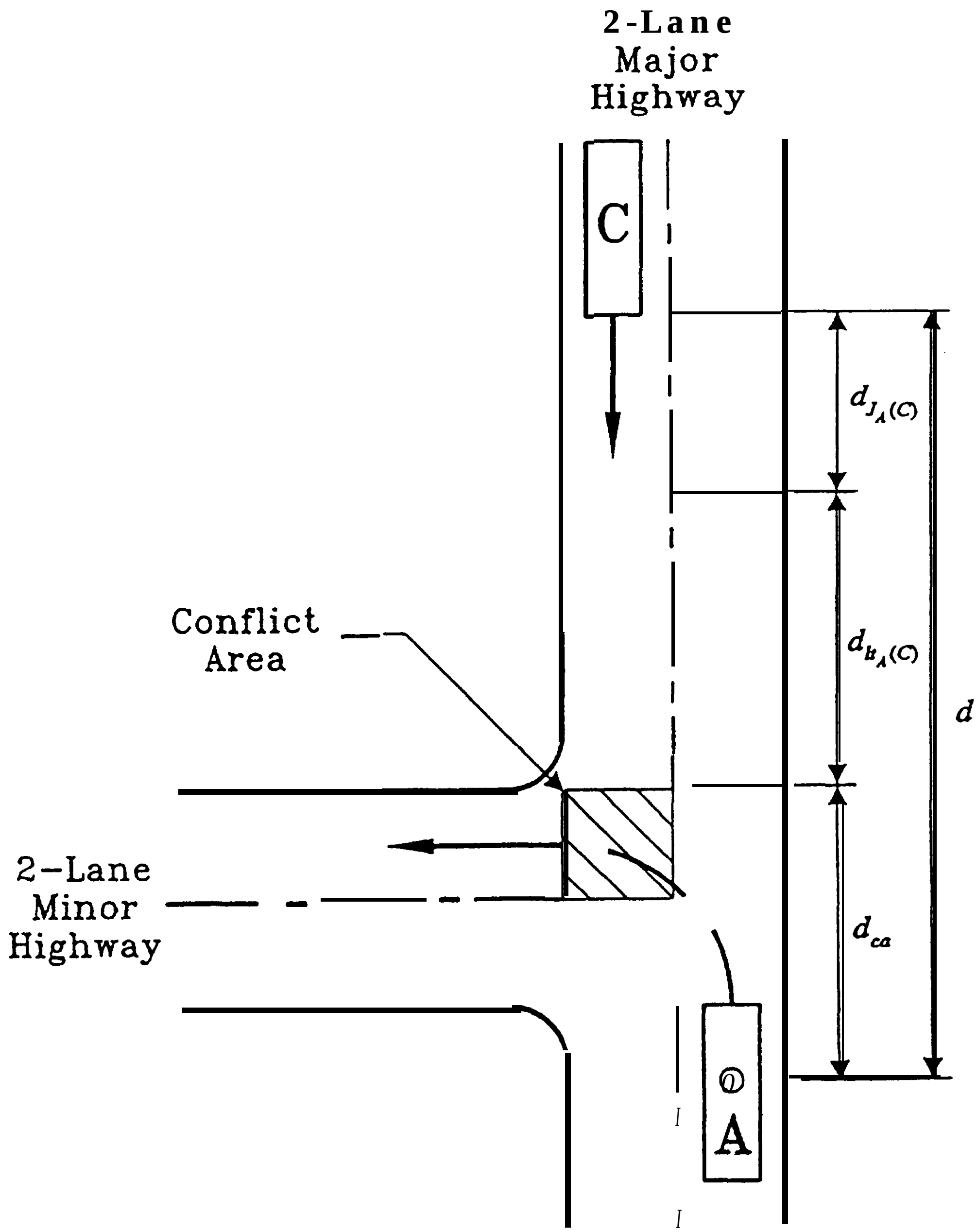

FIGURE 1 **Defiition of Minimum Case V ISD**

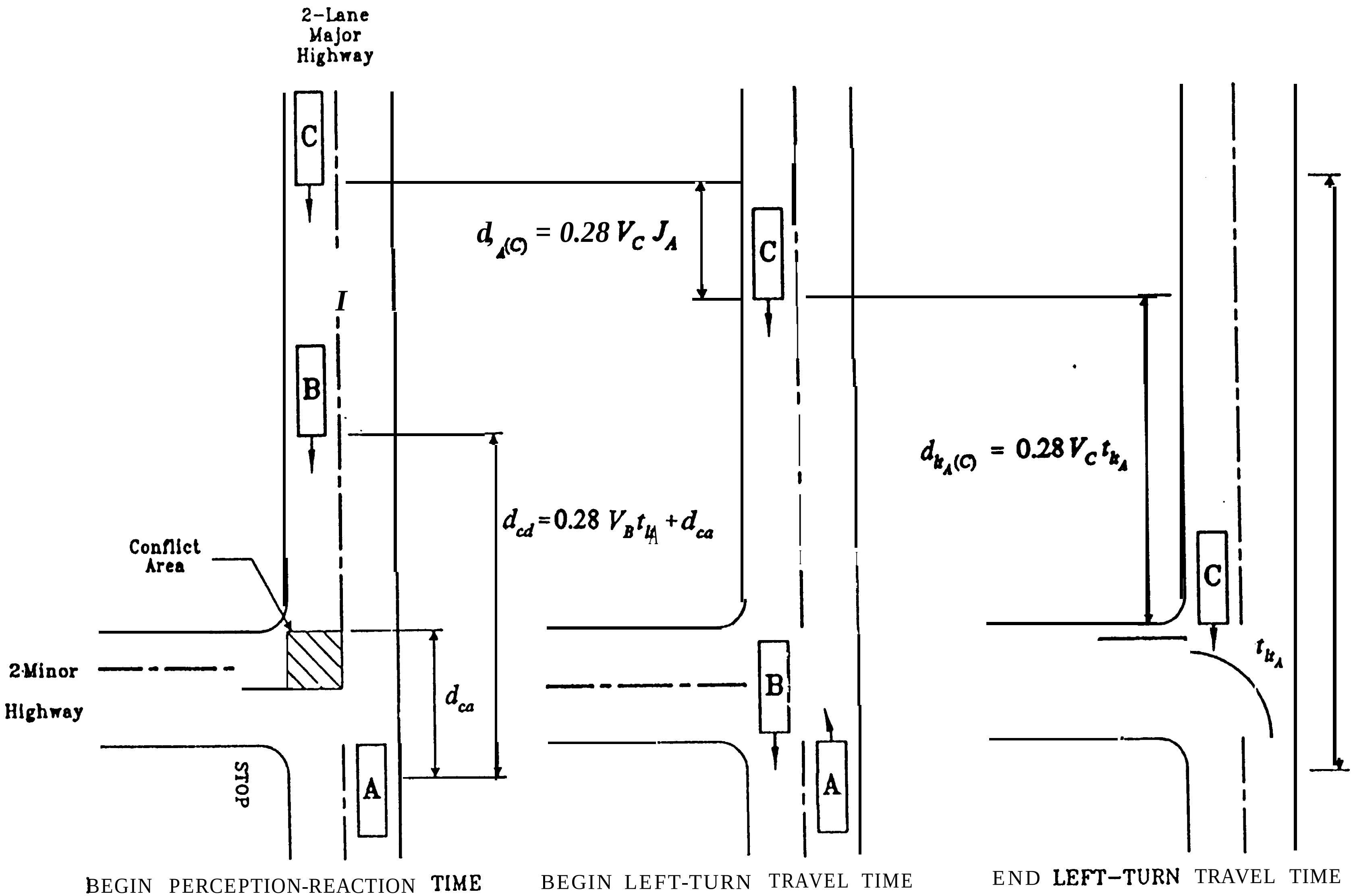

FIGURE 2 **Theoretical Argument to Compute Minimum Case** V ISD

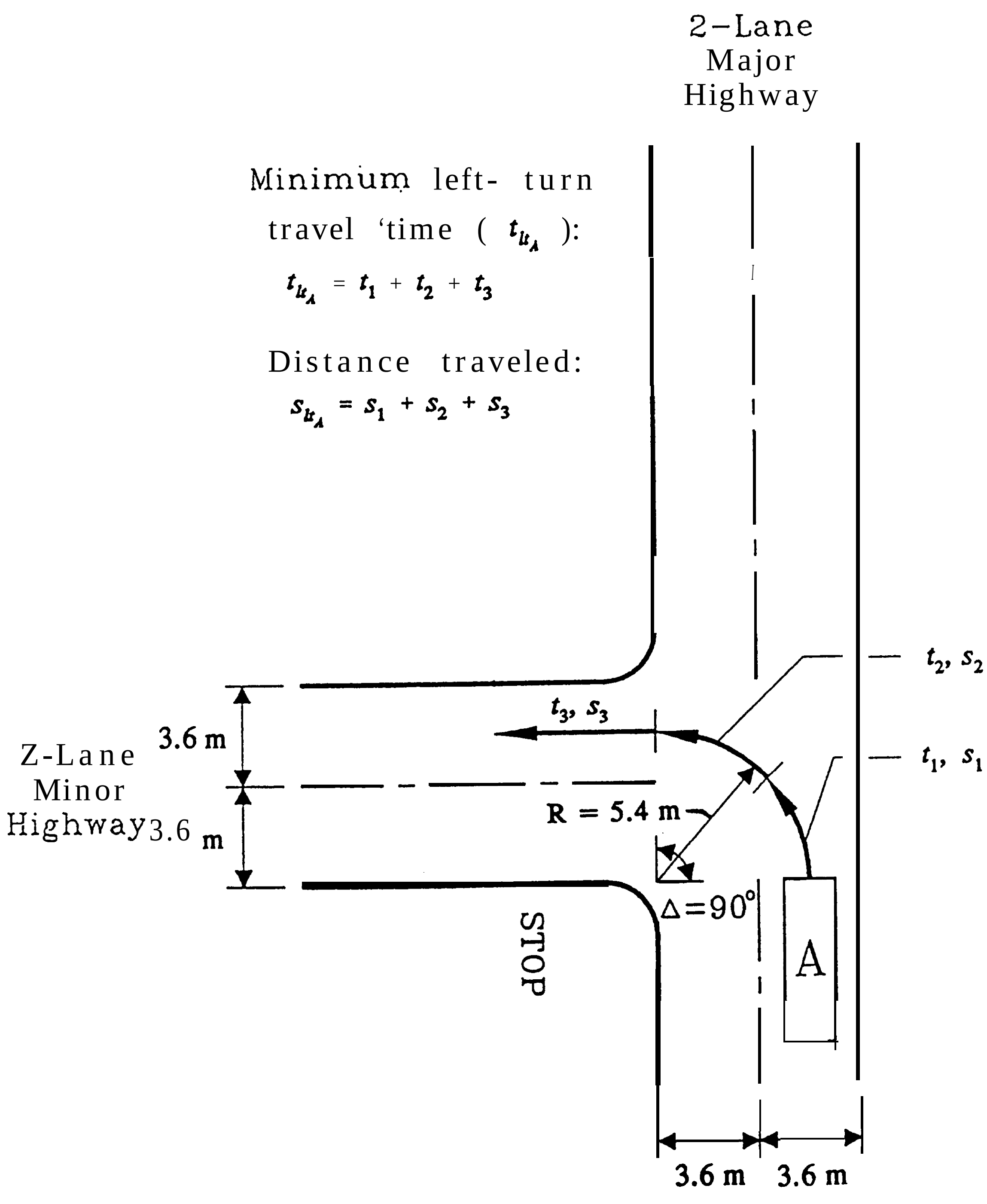

FIGURE 3 **Theoretical** Minimum **Left-Turn Travel Time** for **Case** V ISD

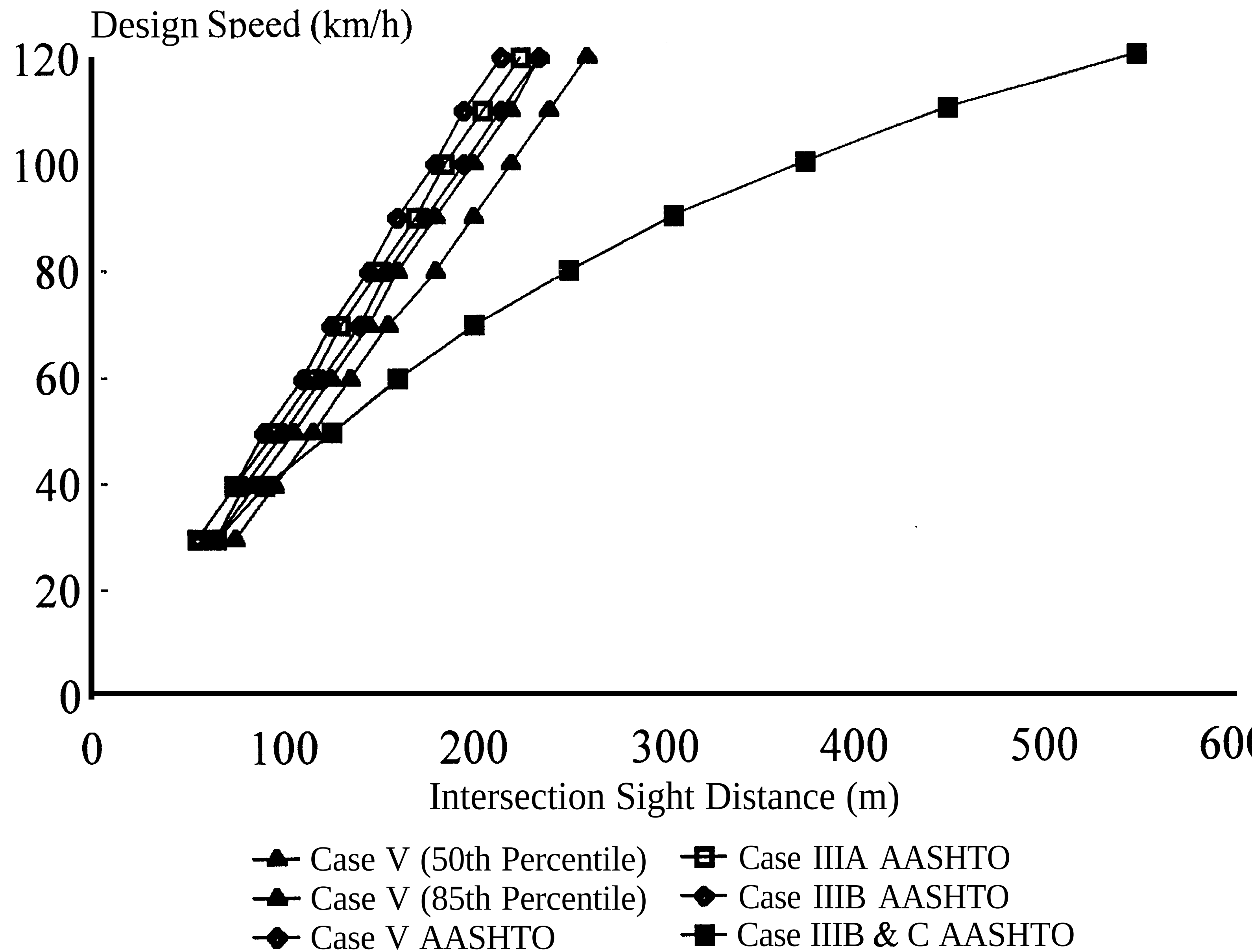

FIGURE 4 Comparison of ISD Requirements from DCP-5 and 1994 AASHTO Green Book

1 m = 3.28 ft
1 km = 0.62 mi

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TABLE 1 Terms Defining Minimum Case V ISD

Term	Definition	Unit
d	Minimum Case V ISD	m
Vehicle A	Stopped vehicle waiting to turn left off the major highway	---
Vehicle C	Vehicle in the opposing traffic stream	---
Conflict Area	Area where Vehicle A may collide with an oncoming vehicle	---
$d_{J_A}(C)$	Distance Vehicle C travels during perception-reaction time for driver in Vehicle A	m
$d_{lt_A}(C)$	Distance Vehicle C travels during left-turn travel time for Vehicle A	m
d_{ca}	Distance from driver's eyes in Vehicle A to edge of conflict area farthest from driver	m
Vehicle B	Vehicle in opposing traffic stream between Vehicle A and Vehicle C	---
d_{cd}	Critical distance from Vehicle B to Vehicle A. If the distance between Vehicle B and the driver's eyes in Vehicle A is less than or equal to the critical distance, the driver in Vehicle A should not attempt to turn left. When Vehicle B reaches the critical distance, the perception-reaction time for the driver in Vehicle A begins.	m
t_{lt_A}	Left-turn travel time for Vehicle A	s
V_B	Speed of Vehicle B	km/h
J_A	Perception-reaction time for the driver in Vehicle A	s
V_C	Speed of Vehicle C	km/h

1 m = 3.28 ft

1 km = 0.62 mi

TABLE 2 Minimum Left-Turn Travel Times for Case V ISD

Description	Symbol	Units	Equation	1995 Car
Maximum acceleration rate	a_{max}	m/s^2	---	3.2
Maximum attainable speed	V_{max}	m/s	8	4.48
First iteration (0- 1.5 m/s)	$t_{1\ (1)}$	s	---	0.45
	$s_{1\ (1)}$	m	---	0.34
	$a_{1\ (1)}$	m/s^2	---	3.3
Second iteration (1 S-3.0 m/s)	$t_{1\ (2)}$	s	---	0.46
	$s_{1\ (2)}$	m	---	1.04
	$a_{1\ (2)}$	m/s^2	---	3.2
Third iteration (3-O-4.48 m/s)	$t_{1\ (3)}$	s	---	0.48
	$s_{1\ (3)}$	m		1.79
	$a_{1\ (3)}$	m/s^2	---	3.0
First elapsed time	t_1	s	9	1.39
Distance traveled	s_1	m	10	3.17
Distance along intersection curve	$s_{arc}{}^b$	m	11	8.48
Distance traveled along remaining portion of intersection curve	s_2	m	12	5.31
Second elapsed time	t_2	m	13	1.19
Assumed vehicle length	s_3	m	---	5.2
Third elapsed time	t_3	s	14	0.88
Minimum left-turn travel time	t_{lt_A}	s	15	3.46

Notes: “Radius = 5.4 m (18 ft); Side friction factor = 0.3 8; Superelevation rate = 0.00%.
[b]Deflection angle = 90 degrees (Figure 3).

1 m = 3.28 ft

TABLE 3 Descriptive Statistics of Opposing Vehicle Speeds from DCP-2 and DCP-3

	Distance from Conflict Area & Data Collection Plan											
	Whitehall & Waunelani						Routes 150 & 64					
	106 m		76 m		46 m		106 m		76 m		46 m	
Description	DCP-2	DCP-3	DCP-2	DCP-3	DCP-2	DCP-3	DCP-2	DCP-3	DCP-2	DCP-3	DCP-2	DCP-3
Number of Vehicles	4243	3198	4183	3633	4152	3614	4738	1612	4898	4853	5243	5021
15th Percentile Speed”	51	53	48	51	43	47	60	56	56	56	50	48
50th Percentile Speed	60	61	58	61	53	56	69	68	66	68	64	66
85th Percentile Speed	66	71	66	68	63	66	79	74	76	77	74	76
Mean	58.4	60.5	56.8	59.5	52.8	56.0	68.7	66.1	66.0	66.8	63.1	62.9
Standard Deviation	9.83	10.88	9.06	9.21	9.66	9.95	10.41	9.11	11.38	10.88	12.33	13.90
95 % Confidence Interval about Mean	58.3 - 58.7	60.2 - 61.0	56.5 - 57.0	59.2 - 59.7	52.5 - 52.9	55.7 - 56.3	68.4 - 69.0	65.7 - 66.6	65.7 - 66.3	66.5 - 67.1	62.8 - 63.4	62.6 - 63.2
Skewness	-1.13	-1.31	-0.34	-0.31	-0.10	-0.20	-0.64	-0.64	-0.72	-0.62	-0.60	-0.80
Kurtosis	5.87	6.06	4.06	4.12	3.93	3.70	5.00	4.47	5.55	4.79	4.01	4.19
95 % Confidence Interval about Two Independent Means	1.00 - 1.60		1.45 - 1.95		1.73 - 2.27		1.27 - 1.93		0.23 - 0.78		(-0.22) - 0.42	
Equality about Means	No		No		***No***		No		No		Yes	

“Speed in kilometers per hour.
l m = 3.28 **ft**
1 km = 0.62 mi

TABLE 4 Descriptive Statistics of Opposing Vehicle Speeds from DCP-4

	Distance from Conflict Area & Maneuver											
	Whitehall & Waupelani						Routes 150 & 64					
	106 m		76 m		46 m		106 m		76 m		46 m	
Description	Through	Right	Through	Right	Through	Right	Through	Right	Through	Right	Through	Right
Number of Vehicles	1492	266	1492	266	1492	266	2457	446	2457	446	2457	446
15th Percentile Speed[a]	56	50	53	50	50	45	60	51	61	50	60	43
50th Percentile Speed	63	58	61	56	60	51	68	60	69	58	69	50
85th Percentile Speed	66	66	71	63	68	55	76	66	77	64	77	53
Mean	63.2	58.4	62.0	56.2	59.2	48.9	67.6	59.5	68.6	57.5	67.8	48.8
Standard Deviation	7.68	7.16	7.82	6.63	8.56	5.63	7.98	7.26	8.38	6.41	9.06	13.47
95 % Confidence Interval about Mean	62.6 - 63.7	57.3 - 59.7	61.6 - 62.4	55.4 - 57.0	58.9 - 59.7	48.1 - 49.6	67.1 - 68.1	58.6 - 60.5	68.2 - 68.9	57.0 - 58.1	67.3 - 68.2	48.1 - 49.2
Skewness	-0.02	-0.18	0.03	-0.27	-0.15	-0.41	-0.41	-0.34	-0.36	-0.18	-0.72	-0.31
Kurtosis	3.75	2.88	3.41	3.42	3.35	3.77	3.57	3.40	3.43	3.04	3.93	3.46

[a]Speed in kilometers per hour.
1 m = 3.28 ft
1 km = 0.62 mi

TABLE 5 Descriptive Statistics from DCP-5 for Case V ISD Drivers

Description	Perception-Reaction Time: Whitehall & Waupelani	Perception-Reaction Time: Route 150 & Route 64	Left-Turn Travel Time: Whitehall & Waupelani	Left-Turn Travel Time: Route 150 & Route 64	Overall Left-Turn Time: Whitehall & Waupelani	Overall Left-Turn Time: Route 150 & Route 64
Number of Drivers	77	135	77	135	77	135
15th Percentile Value	2.17	1.70	3.25	3.60	6.20	6.15
50th Percentile Value	. 2.94	2.50	3.84	4.24	6.79	6.74
85th Percentile Value	3.50	3.21	4.60	5.05	7.42	7.48
Mean	2.88	2.49	3.98	4.31	6.85	6.80
Standard Deviation	0.61	0.75	0.74	0.72	0.65	0.67
95 % Confidence Interval about Mean	2.74 - 3.02	2.36 - 2.62	3.81 - 4.14	4.19 - 4.43	6.70 - 7.00	6.69 - 6.91
Skewness	-0.27	0.10	1.16	1.02	1.79	0.56
Kurtosis	3.07	3.01	4.88	4.89	9.89	3.46
95 % Confidence Interval about Two Independent Means	0.20 - 0.58		0.12 - 0.54		(-0.13) - 0.23	
Equality about Means	No		No		Yes	

TABLE 6 Probability of Gap Acceptance from DCP-5 for Case V ISD Drivers

Description	Units	Symbol	Logit Coefficient	Standard Error	t-Ratio	Units	Symbol	Logit Coefficient	Standard Error	t-Ratio
	Logistic Regression Coefficients (Time Gap and Vehicle Speeds)									
	Whitehall & Waupelani					Route 150 & Route 64				
Constant	---	---	-16.8	6.65	-2.53	---	---	-37.0	13.0	-2.85
Time Gap	s	t_{BC}	2.18	0.59	3.69	s	t_{BC}	4.96	1.49	3.33
Speed of Vehicle B	km/h	V_B	0.06	0.09	0.67	km/h	V_B	-0.32	0.14	-2.29
Speed of Vehicle C	km/h	V_C	0.12	0.11	1.09	km/h	V_C	0.58	0.23	2.52
	Other Statistical Results									
Log of likelihood function					-12.7					-15.4
Chi-sauare statistic					192					401
	Logistic Regression Coefficients (Time Gap Only)									
Constant	---	---	-9.08	2.00	-4.54	---	---	-15.9	3.57	-4.45
Time Gap	s	t_{BC}	1.98	0.45	4.40	s	t_{BC}	3.00	0.68	4.41
	Other Statistical Results									
Log of likelihood function					-13.8					-21.5
Chi-square statistic					190					388
Time Gap (t_{GAP}), 50th Percentile					4.58 s					5.31 s
Time Gap (t_{GAP}), 85th Percentile					5.45 s					5.89 s

1 km = 0.62 mi

TABLE 7 Comparison of ISD Reauirements for DCP-5 and 1994 AASHTO Green Book

	DCP-5”		1994 AASHTO GREEN **BOOK**[b]			
Design Speed (km/h)	Case V 50th Percentile (m)	Case V 85th Percentile (m)	Case V AASHTO (m)	Case IIIA AASHTO (m)	Case **IIIB**[c] AASHTO (m)	Case IIIB **&** C AASHTO (m)
30	65	75	55	55	65	65
40	85	95	75	75	80	90
50	105	115	90	95	100	125
60	125	135	110	115	120	160
70	145	155	125	130	140	200
80	160	180	145	150	155	250
90	180	200	160	170	175	305
100	200	220	180	185	195	375
110	220	240	195	205	215	450
120	235	260	215	225	235	550

NOTES: [a] $d = 0.28 V t_{lt_A} + d_{ca}$ where: d_{ca} = 5.4 m (turning radius) + 3 m (distance from front of vehicle to driver)

t_{lt_A} = 6.75 s (Case V 50th Percentile)

t_{lt_A} = 7.50 s (Case V 85th Percentile)

[b] **ISD** was estimated using Figure IX-41 or computed.

“Clearing the closest lane.

1 m = 3.28 ft

1 km = 0.62 mi

Guidelines For Left-Turn Bays At Unsignalized Access Locations

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ABSTRACT

Transportation professionals have long recognized that effective access management along arterial streets can alleviate traffic congestion. A major element of access management is to limit the speed differential between turning and through vehicles. Providing left-turn bays along major roadways can reduce this speed differential.

The left-turn lane guidelines and warrants in existence today were developed by focusing on how the turn maneuver impacts the turning vehicle. The purpose of this paper is to study how the left-turn maneuver impacts the through vehicles at unsignalized intersections and to determine under what volume conditions do left-turn lanes show a significant benefit to the mainline flow of traffic.

The TEXAS Model for Intersection Traffic simulated the impact of left-turning vehicles on the through traffic at various speeds, advancing volumes, opposing volumes, and left-turn volumes. A measure of effectiveness termed the minimum delay to through vehicles was used to develop left-turn lane guideline curves. After the curves were developed, a conflict analysis based on the probability of two vehicles arriving at the intersection at the same time assessed the safety aspects of the guidelines. A probability of 0.01 was selected as the maximum likelihood of a conflict. The conflict analysis showed that guidelines would result in a probability of 0.01 or less for all but the highest through volumes.

The TTI guideline curves represent a change in philosophy of left-turn bay guidelines. Existing guidelines, such as the Colorado warrants, are predominantly a function of the directional volume rather than the turn volume. This means the existing guidelines require left-turn bays above a set turn volume. The philosophy of the new TTI guidelines requires left-turn bays above a set directional volume.

INTRODUCTION

It is recognized that the construction of new roadways or additional lanes on existing arterial streets cannot fully alleviate current or future congestion. In response to the need to conserve investment in transportation infrastructure, the 199 1 Intermodal Surface Transportation Efficiency Act (ISTEA) mandated the development and implementation of six management systems (traffic congestion, safety, public transportation, inter-modal, pavement, and bridges). Urbanized areas with populations exceeding 200,000 are defined as transportation management areas (TMA's). In a TMA classified as a non-attainment area, federal funds may not be used for any project that will result in a significant increase in carrying capacity for single occupant vehicles (SOV), unless the project results from a congestion management system (CMS) (I). Since there are several non-attainment areas in the United States, four of which are in Texas, the final rules governing CMS programs will be heavily relied upon for implementing new projects.

Access control is an important strategy to be incorporated into a CMS and is an effective method for improving roadway capacity and safety in accordance with ISTEA. In addition to the final rules governing TMA's, access management is effective in small urban areas (populations less than 200,000) as well as in rural areas. Access management is also an essential strategy to preserve the functional integrity of, and the public investment in, major public streets and highways. Access management techniques include signal coordination, signal spacing, the use of non-traversable medians, the spacing of median openings, the design of unsignalized medial access to prohibit crossings and limit left turns, the location and design of driveways and intersection spacing, the provision of deceleration lanes for turning traffic, and interparcel circulation. These methods are effective in improving traffic flow, increasing safety, and reducing congestion on arterial streets.

Non-traversable medians are the only positive access control measure to control or restrict left turns. By restricting median breaks to selected locations and only allowing specific movements, left-turn movements can be safely accommodated at unsignalized median openings. Transportation professionals generally agree that left-turn bays should be provided at the intersection of major urban arterial streets. However, there is less agreement on the need to provide left-turn bays at median breaks serving unsignalized intersections and private driveways. A major question is, under what traffic conditions do turning vehicles significantly impact the flow of traffic in the *through* lanes when no left-turn bay is provided at an unsignalized intersection?

The primary objective of this research was to quantify the effect of left-turning vehicles on through traffic when no turn bay is provided, and then use this information to develop design guidelines for implementing left-turn lanes (termed the TTI guidelines). A literature review was conducted to investigate existing left-turn bay guidelines and warrants along four-lane divided urban arterial roadways. A final objective of this paper was to compare the existing guidelines and warrants to the newly developed design guidelines.

The explanation of the various warrants and guidelines will be helpful to state highway and local governmental officials in understanding the potential application and use of these guidelines or warrants. In addition, the guidelines developed through this research should serve to verify and complement or replace the existing guidelines and warrants.

EXISTING LEFT-TURN LANE GUIDELINES AND WARRANTS

The following section gives an explanation of some of the existing left-turn lane guidelines and warrants in use. The term *warrants* appeared liberally throughout much of the literature reviewed. However, in this report the term warrant is used only when guidelines have been adopted by a government agency. The term *guidelines* is a more appropriate description when they are offered as suggested or recommended practice and is used herein when discussing the volume curves generated by this research effort.

The University of Texas at Austin, Agent, Harmelink, and the Colorado Highway Commission have each developed specific guidelines for left-turn lane placement, and AASHTO's *A Policy on Geometric Design of Highways and Streets* (1994 Green Book) suggests qualitative guidelines for constructing left-turn lanes. The rationale of the methodology and assumptions used to develop each of the guidelines was investigated and documented. A brief summary of this rationale for two of the more widely recognized and implemented guidelines, Harmelink and the Colorado Access Code, is included in this paper.

Harmelink

One of the pioneers in studying left-turn lanes, Harmelink (2) derived volume guidelines and design curves for left-turn lanes at signalized intersections on two- and four-lane roadway facilities. His development entailed the use of queuing theory to analyze left-turning vehicles at intersections. Queuing theory is based on the premise that a sequence of left-turning vehicles arrive at an intersection that permits each left-turning vehicle to proceed when there is an acceptable gap in the opposing traffic stream.

Harmelink's left-turn lane guidelines limited the probability of left-turning vehicles in the through lane to under 0.03 for undivided arterial streets. The curve for four-lane arterial streets is shown in Figure 1 (additional curves for storage of left-turn vehicles are not included in the figure). The directional volume is a one way volume assuming a 50/50 directional split.

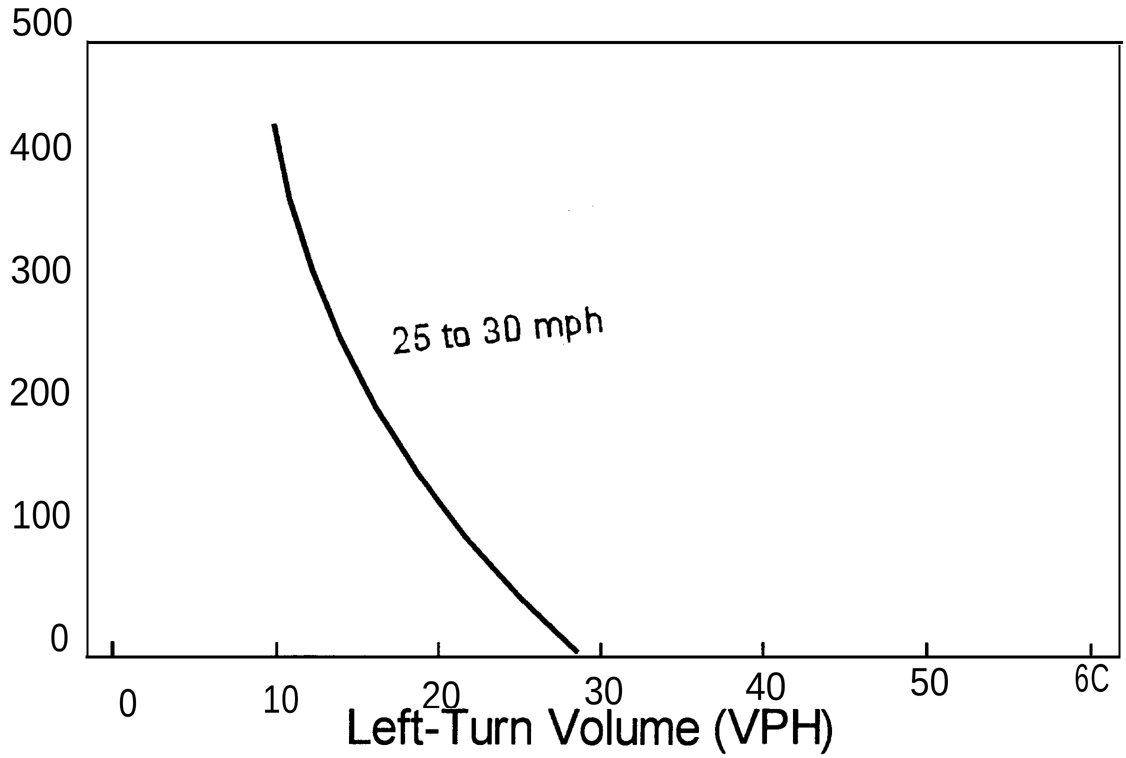

Figure 1 Harmelink Guidelines

Following Harmelink's work, little theoretical research has been done on guidelines for left-turn lanes. **Various** transportation agencies have either adapted the Harmelink guidelines or developed warrants on their own. The State of Colorado developed a set of let-turn lane warrants for two and four-lane roadways.

<u>**Colorado Access Code**</u>

In July 198 1 the Colorado Highway Commission adopted the rule and regulation known as the State Highway Access Code (3). The purpose of the Code is ". ..to provide the procedures and standards necessary to protect the public health, safety and welfare, to maintain smooth traffic flow, to maintain highway right-of-way drainage, and to protect the functional level of public highways while meeting state, regional, local, and private transportation needs and interests (3). " Specifically related to this research are Colorado's standards for implementing 1eft-turn bays at unsignalized intersections. Within the Code, there are volume curves depicting turn lane volume warrants as a function of posted speeds and the design hourly volumes of the turning and through movements. Specifically for the deceleration of left-turning vehicles, turn lanes are required according to curves in Figure 2 for all reconstructed arterials in Colorado. The Code also states that speed change lanes (right or left, deceleration or acceleration) on Colorado highways may be installed due to site specific safety conditions regardless of the volume warrants.

As explained in a telephone conversation with Mr. Philip Demosthenes of the Colorado Department of Transportation, the traffic volumes shown in the warrant curves for left-turn lanes are actually adjusted warrant curves for right-turn lanes. The right-turn lane curves were adjusted to warrant left-turn lanes at volumes (left-turn and advancing) higher than warranted for right-turn lanes. This seems illogical from a traffic operations standpoint since the 1eft-turning vehicles actually have a greater impact on traffic flow than right-turning vehicles. However, the curves were adjusted to account for the typically higher cost and difficulty associated with constructing left-turn bays along an existing arterial roadway (especially an undivided roadway).

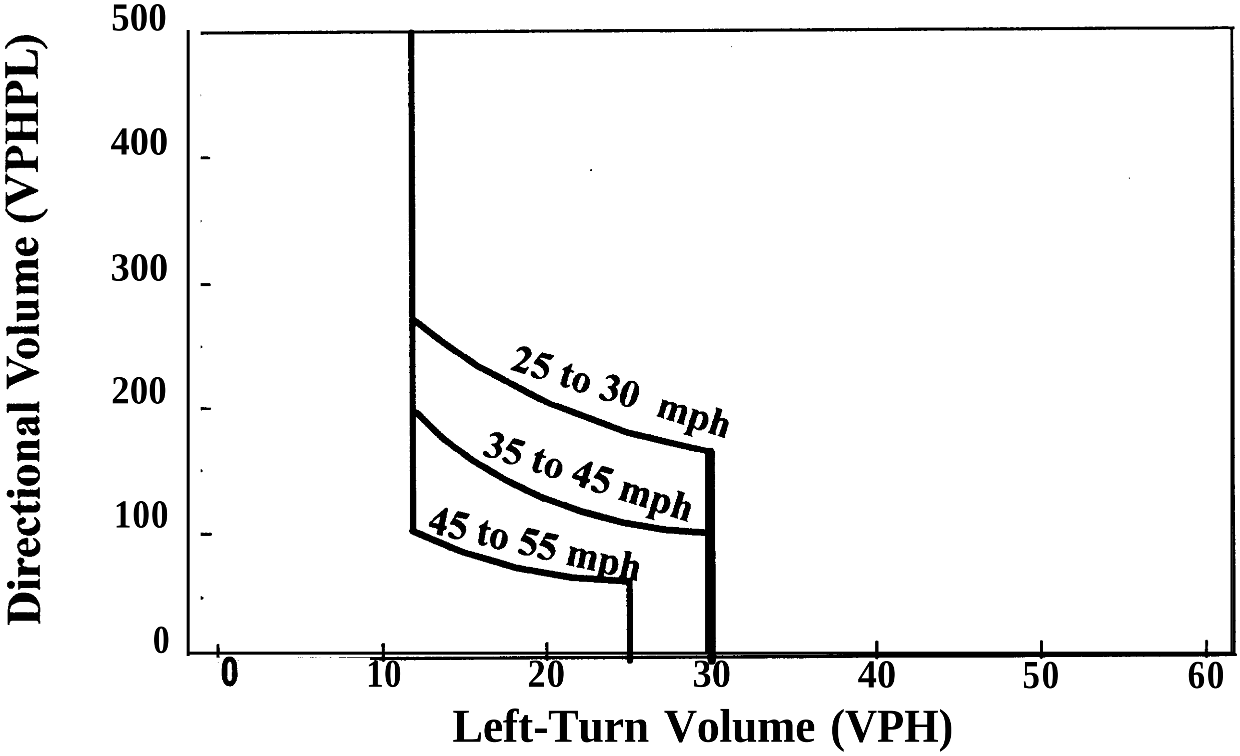

Figure 2 Colorado Access Code Warrants

DEVELOPMENT OF NEW LEFT-TURN LANE GUIDELINES

In analyzing the existing guidelines and warrants, it was decided that the best indicator for determining when to recommend left-turn bays is delay. Because a functional objective of major arterials is the enhancement of the *flow* of *through traffic* the delay of *advancing vehicles* (identified as the through traffic traveling in the same direction as the left-turning vehicles), rather than the delay of 1eft-turning vehicles, was chosen as the appropriate measure of effectiveness.

The TEXAS Model for Intersection Traffic simulation program was chosen to calculate delays incurred due to 1eft-turning vehicles by using a range of volumes and speeds on a four-lane undivided arterial at an unsignalized intersection. The TEXAS Model was chosen due to its applicability to isolated intersections for a wide range of volumes (advancing, opposing, and 1eft-turning and for its ability to model weaving vehicles.

One of the assumptions used in the development of the new guidelines was the arterial roadway had an equal directional distribution. Although an equal distribution was assumed for the development of the left-turn lane guidelines, a few additional simulation runs were done to determine the sensitivity of the curves to an unbalanced directional distribution.

Modeling Analysis

The TEXAS Model outputs the delay of the advancing vehicles for each simulation run. For each set of simulation runs, the speed and advancing volume were held constant while the left turn volume increased. The goal was to pinpoint the left-turn volume where a sharp increase in delay was recorded for one speed and one advancing volume (i.e., at a speed of 35 mph and an advancing volume of ***200*** vehicles per hour, the delay increased linearly for left-turn volumes less than 30 vehicles per hour. Above ***30*** left-turn vehicles per hour the delay suddenly increased.) The minimum delay is defined as the delay prior to the sharp increase.

The analysis used an unsignalized intersection with the following characteristics:

1) The major arterial was a four-lane divided roadway (20 foot median). The minor cross street was a two-lane undivided roadway.
2) The cross street was STOP controlled and the major arterial was uncontrolled.
3) The average travel speed on the inbound and outbound lanes of each approach was set to 35, 45, and 55 mph for the first, second and third volume curves created, respectively. These speeds were intended to represent typical speed limits on urban, suburban and rural four-lane arterials.
4) Due to the relatively low volumes encountered in this analysis, the traffic was assumed to "break out" of any platoons and form a more random distribution. (Note: The TEXAS Model does not model platoon flows. In areas with closely spaced signalized intersections, the volume curves developed might not apply.)
5) Conflicting left-turns from the opposing direction were not allowed.

As explained, for a given speed and advancing volume, the total delay recorded was a function of the number of left-turns. Every combination of a speed and an advancing volume yielded a minimum delay. The directional volumes associated with each minimum delay was plotted as a function of the number of left turns and average travel speed. The best fit exponential line of the three plotted data sets resulted in the TTI left-turn lane guidelines for speeds of 35,45 and 55 miles per hour. With an assumed 50/50 directional split along the arterial, the directional volume is defined as either the advancing volume or the opposing volume.

Conflict Analysis

The TTI guidelines represent the maximum allowable left-turn volume for a given speed and directional volume based on a minimum delay value. Although the value was the *minimum* delay for a given speed and advancing volume, it was uncertain whether that delay would pose a safety hazard to through vehicles. If the minimum delay was unsafe, then the TTI guidelines were unsafe. However, if the minimum delay was quantified as not presenting an undue accident risk, then the TTI guidelines would have some degree of validity from a safety standpoint.

The method used to determine the validity of the curves was to use a hypothetical conflict analysis much like the one Harmelink developed. The conflict analysis was based on the premise of determining the probability of two vehicles (a left-turning vehicle immediately followed by a through vehicle) arriving at the intersection simultaneously in the left-lane. The probability of this occurring would be the probability of a potential conflict at the intersection due to the lack of a left-turn bay.

The purpose of calculating the probability was to use it as a measure of potential conflicts due to left-turning vehicles -- the lower the probability, the lower the conflict potential. As the probability increases, there is more interaction between through vehicles and left-turning vehicles. The maximum off probability was arbitrarily set at 0.0 1 for this research.

It should be obvious that as the left-turning and through volumes increase, the average headways decrease and the potential for a conflict increase. Using the conflict analysis results, the TTI guidelines were discontinued prior to exceeding the 0.0 1 critical probability.

TTI LEFT-TURN LANE GUIDELINES

Figure 3 shows the TTI left-turn lane guidelines. Left-turn lanes are recommended for traffic volumes above and to the right of the curves corresponding to the speed of the facility. The horizontal line on the end of each of the curves accounts for the results of the conflict analysis. The termination of the curves above 325,350 and 375 vehicles per hour for 55,45 and 35 miles per hour, respectively is logical. As the directional volumes increase, the headways decrease, and the probability of a conflict increases. At higher advancing volumes, it also becomes more difficult for through vehicles to safely weave out of the left-lane prior to arriving at the back of the left-turn queue. At lower directional volumes (75 to 100 vehicles per hour per lane), a high percentage of left turns can easily be accommodated without impacting the advancing traffic. With a high percentage of left turns and a low advancing volume, the left lane essentially becomes a pseudo left-turn lane, while the through traffic travels in the right lane.

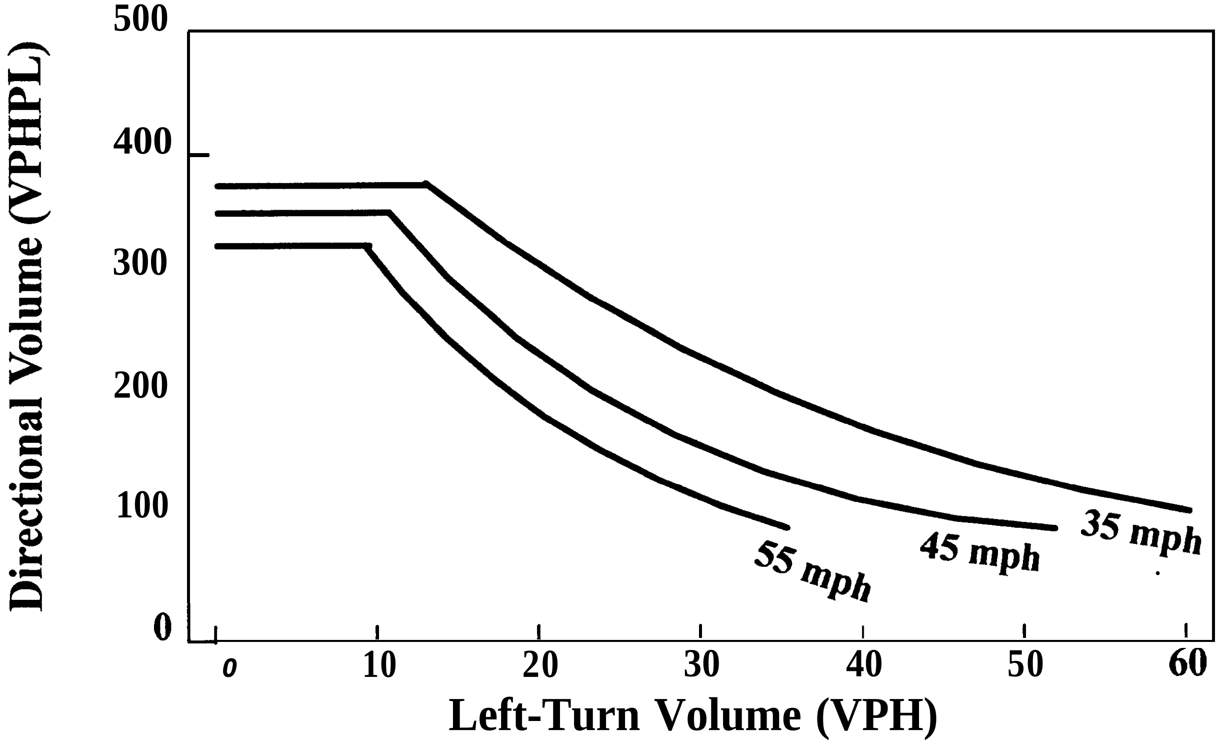

Figure 3 TTI Left-Turn Lane Guidelines

The TTI guidelines recommend turn lanes at lower left-turn volumes along streets with higher travel speeds. Vehicles traveling at lower operating speeds (i.e., 35 mph) can often complete the left-turn maneuver without a significant decrease in speed (approximately 10 mph) if there are acceptable gaps in the opposing traffic stream. This is not true at higher operating speeds. The left-turning vehicles slow down to make a safe left-turn regardless of the gaps in the opposing traffic. **At** higher advancing and opposing volumes, the speed of the roadway becomes less of a factor in recommending turn bays as Figure 3 shows. For all travel speeds, as the through volumes increase, the headways between left and through vehicles decrease and the mobility of the arterial is impacted at approximately equal volumes.

As stated in the introduction, additional simulation runs were done to test the sensitivity of various directional distributions, The sensitivity analysis showed that at high advancing volumes (more than 300 vphpl), the directional distribution had no impact on the outcome. At lower advancing volumes (100 and 200 vphpl), left-turn lanes were suggested at identical left-turn volumes for directional splits of 50/50 and 33/67. Only when the directional distributions reached 25/75 did the guidelines change at the lower advancing volumes. The analysis showed that even with this extreme of a directional imbalance, the difference between the 50/50 and 25/75 splits was less than five left-turning vehicles (five fewer left-turning vehicles were needed to suggest a left-turn lane with the 25/75 directional distribution). Although only a few advancing and opposing values were simulated, the results indicate the following:

1. At higher advancing volumes (300 vphpl and above) a directional imbalance does not alter the

guidelines; and

2. At Low advancing volumes extreme directional imbalances (25/75) lower the guidelines by about five vehicles.

In another attempt to verify the validity of the newly developed curves, the new guidelines were compared to the Colorado curves and the Harmelink curve. Figure 4 shows the new guideline curves and the Colorado curves.

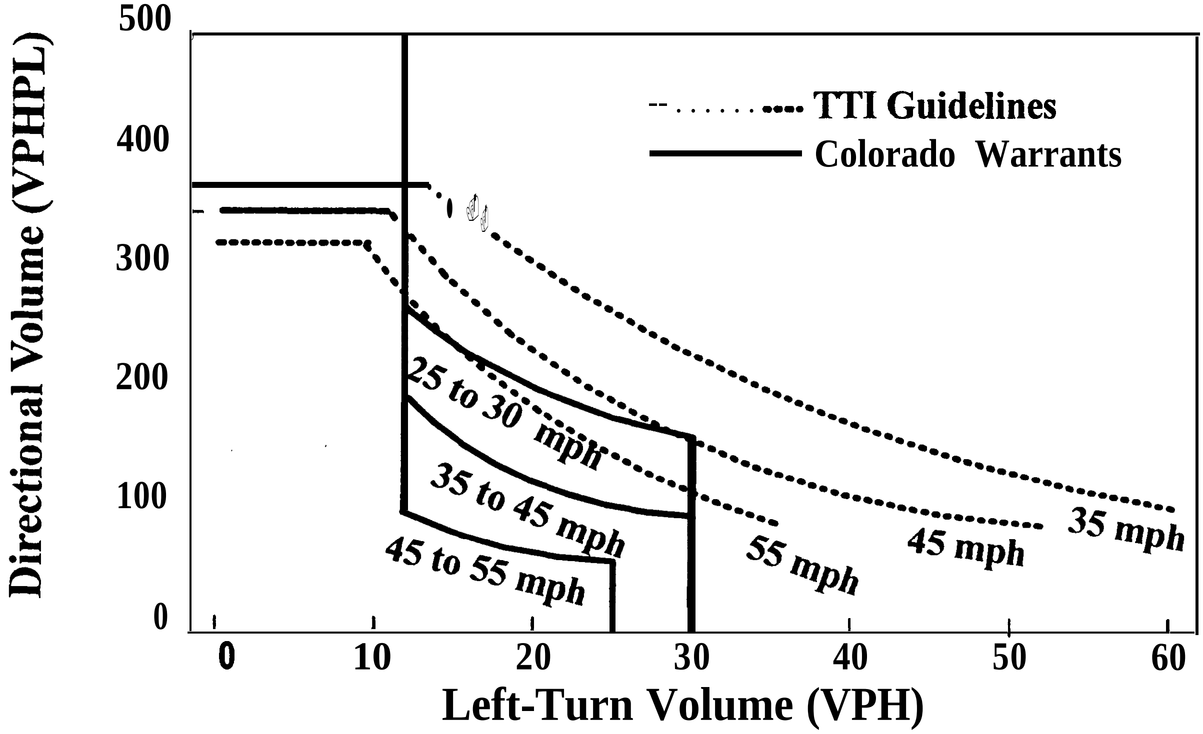

Figure 4 TTI Guidelines and Colorado Warrants

The difference in the methodologies used to develop the curves is evident in the termination of the Colorado curves compared to the termination of the new guideline curves. The Colorado curves recommend left-turn lanes at left-turn volumes above 25 to 30 vehicles per hour, regardless of the directional volume. Inversely, the new guidelines recommend left-turn lanes at directional volumes above 325 to 375 vehicles per hour per lane, regardless of the left-turn volume. The essence of the TTI guidelines is described with the following statements:

1. With low directional volumes, the left lane will function as a pseudo left-turn lane and not impact the through traffic traveling in the **right** lane; however

2. With higher directional volumes, the introduction of relatively few left-turn vehicles will result in a substantial increase in delay to the through vehicles.

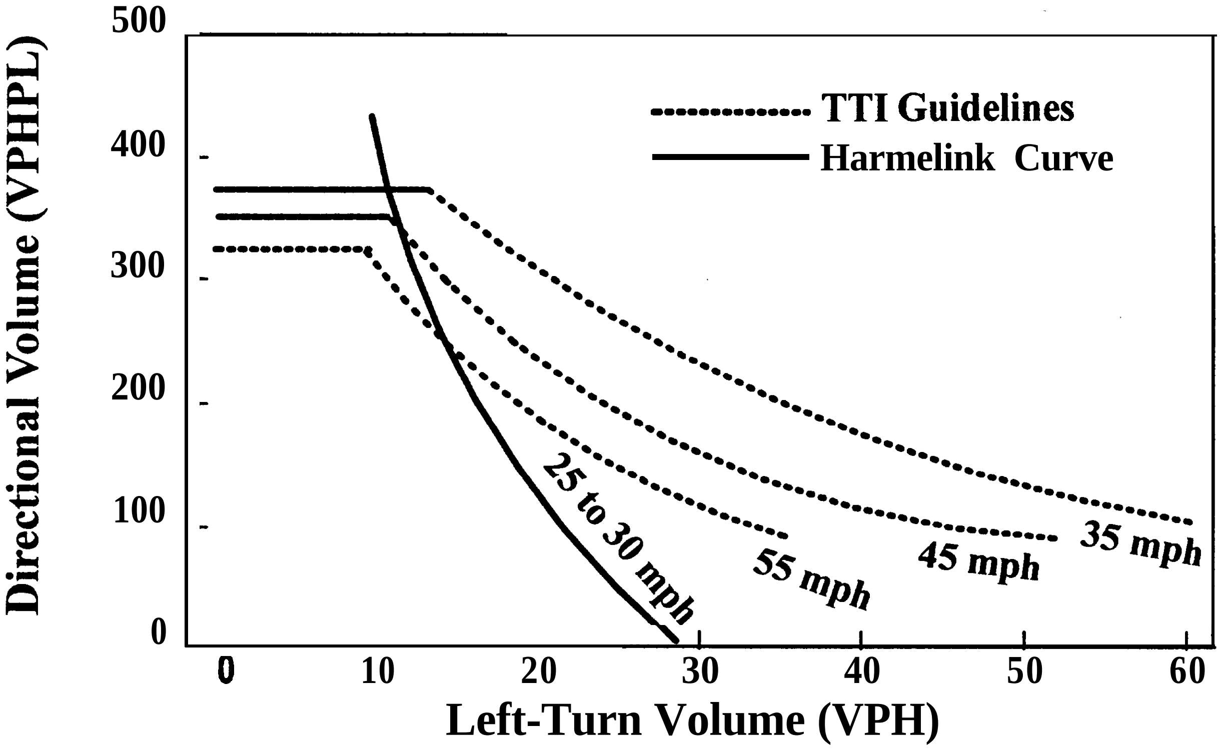

Figure 5 TTI and Harmelink Guidelines

The Harmelink **and** new guideline curves recommend left-turn lanes at similar left-turn volumes for **high** directional volumes. However, at low directional volumes, the Harmelink curve resembles the Colorado curves by recommending left-turn lanes at left-turn volumes less than needed for the new guidelines.

The similarities in the three guidelines lend credence to the validity of the methodologies used to develop the individual guidelines and warrants. Figures 4 and 5 show that despite the differences in their methodologies, the guidelines recommend turn lanes within for a fairly tight range of directional and left-turn volumes. The common objective of the three guidelines is to recommend turn bays for volumes that impact the mobility of the arterial.

CONCLUSIONS AND RECOMMENDATIONS

Left-turn lanes are an asset along major arterial streets (and many minor arterials and collectors as well) at any volumes. In an ideal transportation system, the design of all major arterial facilities would include non-traversable medians and left-turn lanes at all median breaks. However, this is not an ideal world and a lack of funding and available right-of-way often make it unreasonable to construct turn bays at every median break.

Past research efforts focused on the impact of 1eft-turn bays on the left-turning traffic. Although a direct correlation may be found between the delay of 1eft-turning vehicles and the resulting delay of the through vehicles, very little research has been done to quantify the delay on through vehicles. The purpose of this research was to determine under what volume conditions do left-turn lanes show a significant benefit to the mainline flow of traffic.

The TTI 1eft-turn lane guidelines developed through this research exhibit the breakpoint volumes at which turning vehicles seriously impact through traffic. The guidelines were developed for non-signalized intersections along undivided arterial streets with non-platoon flow characteristics.

Regardless of the manner in which these 1eft-turn guidelines (or any others) are used, it should be remembered that the curves are only one indicator of the impact of turning vehicles. The accident history of an intersection is another indicator of when to implement 1eft-turn lanes. Left-turn bays can be implemented as safety measure without regard for the volumes. In the past, the public has often accepted reconstruction measures when safety is the primary issue.

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Questions and Answers
Geometric Design, Roadway Operation and Access

Prefabricated Medians to Reduce Crashes at Driveways Close to Intersections
Influence of Access and Land Use on Vehicle Operation Speeds Along Low Speed Urban Streets
Sight Distance for Vehicle Turning Left Off Major Roadways
Warrants for Left Turn Lanes

Question 1: Do you believe a transversible median that is only 4 inches high will deter left turns?

Peter Parsonson: You would not have to deter all left turns. If you could discourage 50% of these hazardous maneuvers, it would make a significant contribution to the safety record. One thing you would have to do is check to see if the median could be traversed by small vehicles without unreasonable hazard. You would also have to conduct field tests to determine if drivers would simply run over the medians or if drivers would be deterred. If a 3 inch high channel marker is enough to deter motorists, I believe a 4 inch median would deter a large number of motorists.

Question 2: In California we utilize a double yellow striping, which prohibits encroachment, to restrict left turns movements. Is this practice not utilized in other states?

Peter Parsonson: This is also the practice in other states, but many motorists do not respect double yellow lines. If motorists want to make a left turn, it is going to take a lot more than a double yellow stripe to deter them.

Question 3: Do you have any suggestions related to utilizing these medians in states which receive significant amounts of snowfall?

Peter Parsonson: You can put a flexible tubular marker on each of the noses of the median to warn that there is some type of device under the snow.

Question 4: Out of the 34 sites you analyzed did you document any where the operating speed was significantly different that the posted speed?

Christopher Poe: At the first few sites we examined the operating speed were significantly greater than the posted speeds. As we attempted to get variability concerning geometric alinement in our cross section of sites, we encountered operating speeds in line with the posted speed at sites with more restricted geometries. Speed was related to the restrictiveness of the geometries of the site. In situations with the least restrictive geometry the greatest difference between operating speeds and posted speeds were observed. There were not many cases where the operating speed was well below the posted speed in the areas with restricted geometries, as operating speeds were generally within 5 kilometers per hour of the posted speeds.

Question 5: Was there any consideration of the impacts that historical law enforcement efforts may have had on the operating speed?

Christopher Poe: The roadways examined tended to be low volume with relatively little visibility of the presence of enforcement. Historically they have not been targeted as sites where police strictly enforce speed limits.

Question 6: In your research could you come up with any conclusions as far as a general rule for how much the number of access points per mile lowers speed?

Christopher Poe: This information is contained within the coefficient of the model. It should be noted that the majority of facilities we examined were two lanes that served collector types of operations.

Question 7: Did you test your model outside of the 34 sites on which it is based?

Christopher Poe: Although the model has not been tested outside of the 34 sites, analysis was conducted with a reconstructed model that considered all but one of the sites, which was held out as a control. The model was used to predict speed on the one site that was not included. We found good correlation with the model when this was done, except when the control site had characteristics which were very different from those of the group as a whole. When the geometries of the control site fell outside the range of the data used to generate the model, the model was a poor indicator. When the geometries of the control site fell in the range of the data used to generate the model, the model was accurate within a few kilometers per hour.

We have confidence the model is working well, although we have not taken it beyond the 34 sites we examined. We hope to move forward to examine additional sites in the future, so this study can be further expanded.

Question 8: Do you have any data concerning the drivers demographics?

Russell Micsky: Unfortunately I do not have any data on the drivers demographics as I was working alone on this study. I can tell you some generalizations concerning the drivers that I observed. In areas further from the university, where the population is more aged, the left turn times were quite a bit longer than in areas closer to the university, where the population was younger due to the presence of college students.

Question 9: Did you consider that the gaps availability may have some relation to the gap acceptance of those making the left turns?

Russell Micsky: **Yes,** in the more expanded version of the research work there is a discussion concerning gap acceptance.

V Abstracts/Papers - Session 7

7A - Corridor Case Studies

Moderator: Eddie Shafie, Texas DOT

US 93, Somers To Whitefish, Montana - Access Management

Corridor Preservation In Delaware

A Case Study On Access Management - The History And Findings Of The Sheridan Blvd Access Plan

Trials And Tribulation Of Enforcing A Locally Established Corridor-wide Restrictive Access Plan - Implementation Of The K-l 50 Study

7T- Models And Modeling For Access

Moderator: Ron Giguere, FHWA Office Of Technology Applications

Does Access Management Improve Traffic Flow? Can Netsim Be Used To Prove It?

Evaluating Driveway Access And Intersection Design With Multiple Measures Of Effectiveness

Interactive Intersection Safety Design And The AMA Model, And Practical Design Models For Safe Intersection Spacings

Insights Into Access Management Details Using TRAF-NETSIM

US 93, Somers to Whitefish, Montana
Access Management Issues

Joseph A. Hart, P.E., Transportation Manager, Carter & Burgess, Denver, Colorado
Dale Paulson, P.E., Federal Highway Administration, Helena, Montana
Jim Weaver, P.E., Montana Department of Transportation, Missoula, Montana
Nanette Neelan, P.E., Jefferson County, Colorado, Highways & Transportation, Golden, Colorado

ABSTRACT

Many rural resort areas of the United States are experiencing rapid increases in traffic demand resulting from increasing tourism andpopulation shifts to these desirable, but relatively remote locations. Rural two-lane highways are being expanded to accommodate these traffic demands. Subsequent development of adjacent lands places increasingpressure to provide direct highway access, particularly where the local road system is incomplete due to physical constraints and limited local funds. Provision for existing highway access as well as planning for future access needs is critical to local economic development, weighed against the goal of maximizing the investment in new highway capacity for through travel demands.

This paper draws on the analysis and findings of the I994 Environmental Impact Statement for expansion of 46.2 kilometers (28.7 miles) of US 93 from Somers to Whitefish Montana, highlighting planning and design considerations for dividedfour-lane versus five-lane alternatives. The corridor serves the increasing tourist traffic to Glacier National Park, Big Mountain Ski Resort, Flathead Lake and the City of Kalispell, as well as the logging industry, local commerce, agriculture and commuters. The existing two-lane highway is characterized by a frequency of access points in developed sections and long rural segments (prime for development) with access to agricultural lands, small businesses and widely-spaced residences.

Alternative access management guidelines were considered, appropriate to the characteristics of the highway segment, including restrictive and situational access control. The analysis considered the benefits and impacts of a center median versus a paved center turn lane, related to design, operations and enforcement of the alternative access guidelines. The access plans would be implemented consistent with the Montana Department of Transportation 's April 1992 Access Management Plan. (The plan is now undergoing an update in conjunction with the Statewide Transportation Planning process). Flexibility in application of the guidelines considered topographic constraints, existing access spacing, type of proposed adjacent development and the supplementary city street and county road network, particularly where right-turn-only access would create unsafe U-turn traffic at downstream intersections. Concepts for U-turn accommodation of large trucks and recreational vehicles were considered, along with access closure, consolidation, and frontage roads.

Key Words: Access Management Rural Highways Resort Corridors

INTRODUCTION

An Environmental Impact Statement (EIS) was completed in 1994 for a 46.2~kilometer (28.7-mile) segment of US 93 from Somers to Whitefish, Montana that focused on planning and design considerations for divided four-lane versus five-lane widening of the two-lane rural highway. US 93 extends along the western portion of the State of Montana and is the primary regional access route for tourist traffic to Glacier National Park, Big Mountain Ski Resort, Flathead Lake and the City of Kalispell. The study corridor is depicted in Figure 1. It is on the National Highway System and is classified in Montana as a primary arterial. In addition to substantial tourist travel, the corridor is also used extensively by the regional logging and agriculture industries, local commerce, and commuters and residents of the rapidly-growing area. The existing two-lane highway is characterized by a frequency of access points in the currently developed segments through the cities of Whitefish and Kalispell. Access drives and widely-spaced rural roads intersect the long rural segments between the two cities and south to the town of Somers serving agricultural lands, small businesses and residences.

The corridor is typical of many popular rural resort areas of the United States experiencing rapid increases in traffic demand resulting from increasing tourism and population shifts to these desirable but relatively remote locations. The rural two-lane highways serving these areas are being expanded to meet the increasing traffic demands. Subsequent development of lands adjacent to the improved highway places increasing pressure to provide direct highway access. This is particularly true in rural areas such as in northwestern Montana's Flathead Valley where the local road system is limited due to lack of local funds, physical constraints and relatively small lot development. Planning to accommodate existing highway access as well as for future access needs is critical to local economic development. It is also critical that the integrity of the highway network be maintained and that the investment in new highway capacity for through travel demands be maximized. These goals, often viewed as directly competing, were the focus of the US 93 access management study.

PROJECT BACKGROUND

Two Environmental Assessments (EAs)/Findings of No Significant Impact (FONSI) had been prepared for portions of the US 93 project: US 93 Somers to Kalispell (October 1991) and US 93 Kalispell to Whitefish (February 1988). Design plans for a five-lane highway improvement were prepared and utility relocation activities had been initiated for the Kalispell to Whitefish project. All but one land parcel needed for the improvements was acquired.

During 1989 through 1992, a substantial amount of public controversy was generated about these two projects. The basis for the controversy was:

- One element of the population was supportive of the Montana Department of Transportation (MDT) proposal of a five-lane cross-section, which generally provided full movement access to properties along the highway.
- A second element of the population felt that a five-lane non-controlled access highway would encourage strip development and degrade visual quality, and would not be as safe as a divided highway. There were also concerns that the EAs did not adequately document social, economic and environmental impacts.

As a result of public controversy about these projects, a decision was made by the MDT and Federal Highway Administration to combine the previous two projects into one project and to prepare an EIS for a combined Somers to Whitefish project. The basis for this decision was the need to more comprehensively address the social, economic and environmental impacts associated with the various alternatives for improving US 93. Included in the overall project were considerations for bypasses of Kalispell and Whitefish. The EIS was initiated in March, 1993.

OVERVIEW OF PURPOSE AND NEED

The primary purpose and need for improvements to US 93 is to reduce congestion on the existing facility, provide for planned growth and development, improve safety, and provide for enhanced scenic values.

US 93 currently operates at a level of service (LOS) of D or E in many locations. This occurs during peak time periods during the summer tourist season. Much of the 46 kilometers (28 miles) of US 93 is also designated as a no-passing zone and the higher than usual percentage of large trucks in some parts of the area exacerbates the no-passing conditions. LOS conditions are projected to worsen noticeably by the year 2015, with LOS E and F anticipated, resulting in significant delays to the traveling public. In addition to delays along US 93, left-turning vehicles attempting to enter the highway will experience long delays unless critical intersections are signalized.

The accident rate on the subject segment of US 93 is higher than the average State of Montana accident rate for similar-type highways in 26 locations. Accidents are significantly higher in the urban areas and in the areas where there are multiple access points. The frequency of access points and no provisions for speed change lanes at a majority of intersections and driveways contribute to the higher than average accident rates for intersection and intersection-related accidents.

ALTERNATIVES CONSIDERED

A range of alternatives were considered throughout the planning process for this project. The alternatives were initially grouped by similarities in function and/or location. The groups of alternatives that were considered include:

- Improving a parallel corridor to US 93.
- Providing bypasses of Whitefish and Kalispell.
- Improving the capacity of US 93.
- Making minor improvements to existing US 93.
- Improving mass transit opportunities.
- Implementing measures to reduce demand for traffic to drive on US 93.
- Making no improvements to US 93 (No-Build alternative).

Access management alternatives were also developed to define the basic improvement alternatives that were appropriate to the characteristics of the highway and adjacent development. These access alternatives are described below.

Access Management Alternatives

Three basic access management alternatives were developed for the US 93 project: limited access, restrictive access, and situational access control.

Limited Access

Limited access control allows access to the highway only at designated public roads or streets and at private driveways as specified in legal agreements or deeds. This level of access management is intended to give consideration to the movement of through traffic while also recognizing access needs to adjacent land use. The established public road and street system is given first priority in access to the highway. Direct private access is given secondary consideration. Limited access control includes design features which minimize conflict between traffic using at-grade accesses and the running speed of through traffic on the highway, such as auxiliary lanes and traffic controls.

Limited access control would be negotiated with and purchased from adjacent landowners at the time right-of-way purchase occurs for the proposed highway improvements. Since abutting property owners have no legal rights of access to highways constructed in new locations, such as for segments of the proposed Kalispell bypass, no compensation would be paid for imposing access control. Appropriate compensation would be paid for land and improvements acquired and for other legally compensable damages.

Existing access approaches would be eliminated or consolidated wherever practical and future approaches would be prohibited except by approval of the Montana Highway Commission after a review by the MDT considering safety, effect on highway capacity, legality and physical feasibility of constructing the requested access approach. Wherever practical, private access would be provided to other existing public roads and streets rather than directly to the highway. Compatibility with access control strategies proposed for other US 93 corridor improvement projects would also be considered in developing the proposed plan for the Somers to Whitefish segment.

This limited access management strategy would be most applicable in the long rural segments of the corridor and for the new bypass alignments being considered around Kalispell and Whitefish.

Restrictive Access

Restrictive access control would involve a strict application of access guidelines that would allow access at the following locations:

- Major arterial street intersections -- no turn restrictions.
- Minor collector/local street and minor driveway intersections -- limit to right-turn-only.
- Driveways serving major traffic generators (major shopping centers, major employers, special events centers or similar generators) -- no turn restrictions.
- Driveways near arterial intersections [less than 152.5 meters (500 feet)] - close driveway and provide connection to arterial cross-street where practical.

The restrictive access strategies would be most applicable for implementation with a physical (raised or depressed) median to limit unrestricted driveway and minor street turning movements. Without a physical median barrier, additional signage, driveway approach redesign and strict enforcement would be required. Flexibility in application of these guidelines would consider topographic constraints, existing intersection spacing, type of proposed adjacent development, and the supplementary city street or county road network.

Situational Access

Situational access control would provide the most lenient of the three access management plans, and could be implemented with either a physical median barrier or with a paved center median. The situational access guidelines are listed below:

- Arterial street intersection -- no turn restrictions.
- Collector/local street intersections -- no turn restrictions.
- Primary driveways serving major traffic generators -- no turn restrictions.
- Driveways serving minor traffic generators -- some turn restrictions depending on site layout and median/driveway design.
- Driveways near arterial intersections [less than 152.5 meters (500 feet)] - close driveway and provide connection to major cross-street/drive where practical.

The situational access guidelines would provide the greatest flexibility for application, considering the corridor's rural characteristics, topographic constraints and limited supplementary road network. This guideline would respond to concerns that right-turn-only access, as proposed under the restrictive access guidelines, would create an unsafe level of U-turning traffic at downstream intersections.

A no access control alternative was also considered for comparative purposes, although a minimum level of access control is inherent in all MDT design, per the guidelines of ***the MDT Access Management Plan,*** April 1992, and in Flathead Regional Development Office and local planning board's land use planning reviews to provide safe and efficient site circulation.

ALTERNATIVES ANALYSIS

Benefits would result from each of the access management strategies, although to varying degrees. Improved intersections would provide traffic with a safer haven by construction of turn bays at intersections, installation of traffic signals when warranted, and a lateral separation of the opposing traffic flows.

The Restrictive Access Control Alternative would improve through traffic operations and safety by reducing the number and frequency of conflict points, but would alter cross-street and intersecting driveway traffic flow. Traffic would no longer be able to enter or exit US 93 at the desired location, limiting the operational flexibility due to the physical median. Intersections with no turn restrictions would typically be spaced at minimally every 0.40 kilometer (0.25 mile) to 0.80 kilometer (0.50 mile) to minimize out-of-direction travel and yet still provide access to the highway. This design would require vehicles entering the highway from an intermediate right-turn-only access location to proceed in the adjacent flow of travel until an unrestricted turn intersection is provided. Traffic then desiring to proceed in the opposite direction could make a U-turn at the intersection, provided that sufficient geometry and traffic controls are in place. The U-turning traffic would increase the delay to other left-turning vehicles at the intersection. Unique design treatments for large trucks, especially logging trucks, and recreational vehicles at intermediate locations were also considered. Figure 2 illustrates several design concepts that were considered.

The Situational Access Control Alternative would allow for traffic to enter and exit the traffic stream at generally the desired location depending on the level of access control for driveway and minor street approaches. The design of intersections would minimize the potential for head-on conflicts in the continuous left-turn lane, but would increase accident potential over the Restrictive Access Control Alternative due to the greater number of conflict points associated with the driveway approaches. There would also be limited safe refuge area in the median for pedestrians.

The No Access Control Alternative would provide the least benefit to through traffic operations, dispersing turning traffic to frequently spaced access locations with the greatest accident potential. This alternative, over time, would limit the traffic-carrying capacity of US 93.

MONTANA ACCESS POLICY

The Montana Access Management Plan adopted by the State Highway Commission in April 1992 provides guidelines for establishing access limitations, generally as outlined above for the Limited Access Alternative.

However, the Plan does not contain any specific criteria or thresholds for application of access management policies or strategies, or system classification specifically for access management. In practice, the Plan is primarily a clarification of the process by which an existing access control regulation can be modified to allow access at points that were not granted at the time the access rights were originally acquired from the property owner. Because of the lack of specific threshold guidelines for access consideration, the Department's policies are only applied strictly when access rights have been purchased. Access management planning primarily occurs during the right-of-way acquisition process on a project basis. Significant modifications to the State's Access Plan are being considered in conjunction with the TranPlan 21 State Transportation Plan.

In general, the MDT has limited its role in planning, regulation and growth management. This is especially true along corridors outside of the major cities, where the state arterial highways serve as the principal route through town. In these areas, relatively easy and under-regulated access to the highway network is considered an assumed right by property owners. The State's Access policy has been found to be politically difficult to enforce without a clear safety problem which is directly addressed by the proposed control strategy. Denial or restriction of access is difficult if the principal benefits are preservation of capacity and functionality of the highway system.

Most access planning has been relegated to local agencies and is conducted reactively through local land use plans and development reviews. Like most western states, Montana has no enabling legislation that provides protection of land use at the state level. Therefore, the authority for land use planning rests entirely at the local level. Local jurisdictions can address land use planning through several means, including a comprehensive plan, subdivision laws, and zoning regulations.

Until the recent influx of new residents migrating to Montana, there has been little local interest in planning or regulating development outside of Montana's major cities. Many counties and cities have not prepared comprehensive plans, and those that have prepared a plan have not enacted comprehensive zoning ordinances to guide plan implementation. A major citizen initiative in Flathead County has focused on a performance-based permit system to better control previously unrestricted development. This citizen initiative was underway during the EIS process and considerable public input was received on the access concepts related to land use effects.

PUBLIC INPUT

Maximum opportunity for public input was provided during the 18-month long EIS process including several series of public workshops held at frequent intervals, numerous meetings with affected business owners and residents, utilization of a Citizen's Advisory Committee, project newsletters, a store-front project office and a local telephone hot-line to record messages. Comments received related to the access management proposals of the improvement alternatives included:

- Concern about the continued strip development along currently undeveloped agricultural lands.
- Concern about the increasing demands placed on US 93 as a result of new development.
- Recognition that current development patterns, access management practices, and lack of land use planning will reduce the effectiveness of the highway.
- Concern that access limitations will unfairly reduce the development opportunities of certain land parcels and add to development cost.
- Concern about the aesthetic nature of the corridor if unregulated access and development are allowed.
- Significant concern about the safety of a five-lane cross-section with unlimited access.
- Conversely, concerns were also raised on safety issues of a physical median related to winter snow plowing, maintenance through the year, added cost for construction and right-of-way.

RECOMMENDED IMPLEMENTATION PLAN

A combination of access alternatives was found to provide flexibility in tailoring the control of left-turn access to and from the highway consistent with local development, existing access and topographic conditions. Recommended roadway cross-sections by segment are depicted in Figure 3 and described in Figures 4 and 5. Some driveway and minor intersecting street traffic flow patterns would be altered, while through traffic would benefit from the decrease in conflict points. Restrictive access was generally recommended in the currently undeveloped rural segments between the more developed cities and town. Short frontage roads were required at a limited number of locations to enable closely-spaced existing residential and small business driveways to be combined. Special design treatments for U-turns by large trucks and recreational vehicles were considered and appropriate speed change lanes, pavement markings and signing are being planned to effectively implement the access plans. Situational access was recommended as a transition to the developed areas north and south of Kalispell and south of Whitefish. The bypass around Kalispell will generally be planned for limited access. Right-of-way is now being preserved for segments of the bypass as development threatens to encroach into the planned alignment.

As major side road traffic volumes increase in developing areas, traffic signalization will be considered. Potential major intersections where traffic signalization could be required were identified in the EIS. Signalization plans will include a progression analysis along the corridor to minimize the number of traffic signals and to properly space traffic signals to provide gaps in through traffic for intermediate unsignalized intersections. New developments along the corridor will be encouraged to develop access to the local street network via local subdivision review and the MDT access approval process. Concentrated traffic volumes on designated intersecting streets may help warrant traffic signals. Also, development of local street networks will be encouraged to offer an alternative for local traffic on short trips to avoid travel on US 93.

The compromise solution to corridor access management was well received by the public, landowners and local, state and federal officials. The EIS was signed in September, 1994 and portions of the project are now in final design stages.

CONCLUSIONS

Proactive planning for access management in conjunction with rural highway improvements in rapidly-growing resort communities is essential to maintaining future highway integrity. Lack of a comprehensive state access management policy and standards requires a concerted effort in establishing a corridor access management plan. Education of the public, landowners and local officials through a focused public involvement program was found to greatly assist in developing a workable access plan for the US 93 corridor. A compromise plan was found to provide the flexibility to accommodate access provisions for existing land uses, topographic constraints, and existing major road intersections. The compromise plan also accommodates the access requirements for future land plans recognizing the limitations of local jurisdictions and the MDT to implement supplementary road network connections without the active participation of the development community. By involving all affected parties early in the planning process, highway improvements are now underway in the Flathead Valley that will serve this resort community well into the 21st century.

North

Somers to Whitefish
Environmental Impact Statement

Figure 1
Study Location

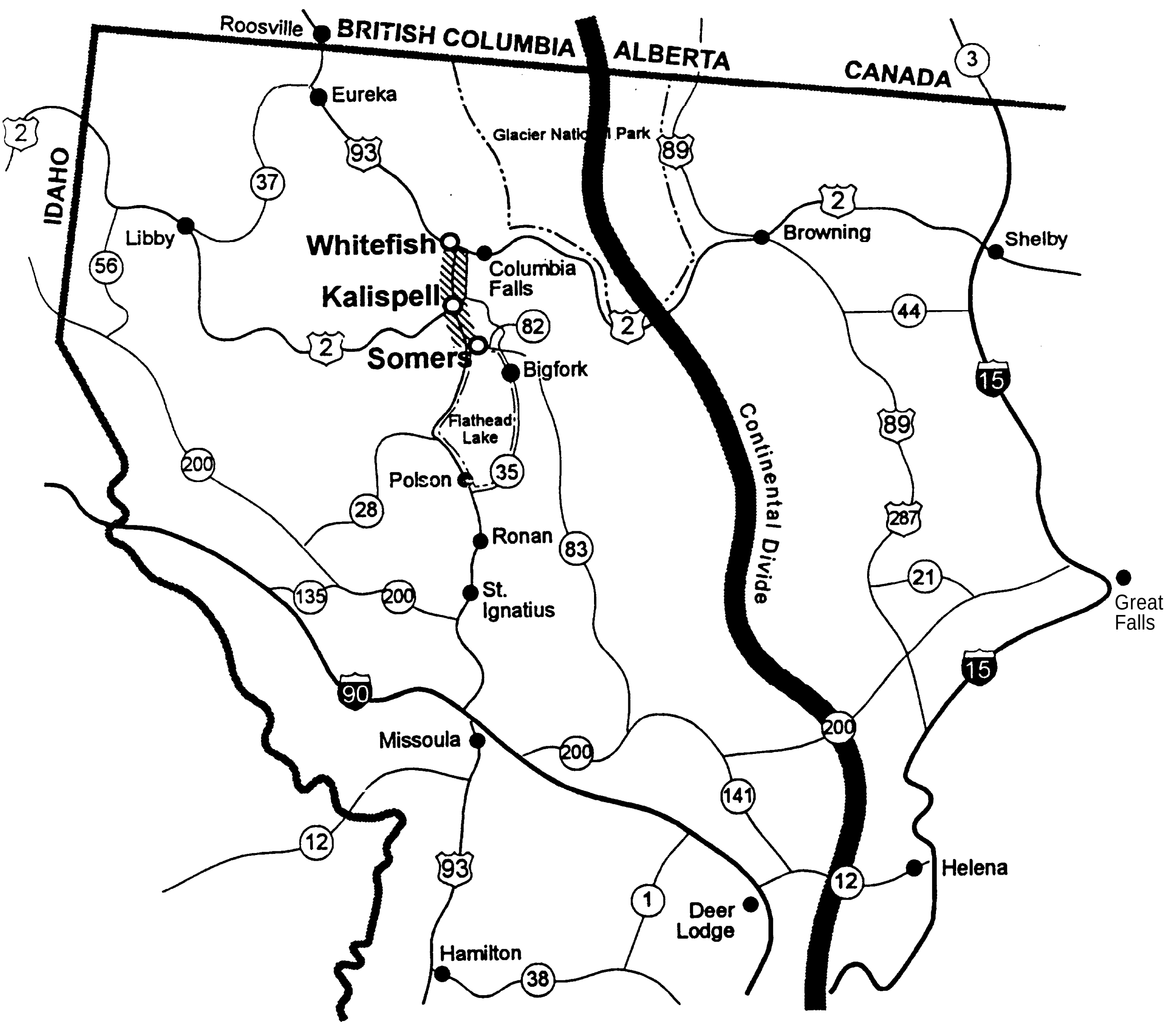
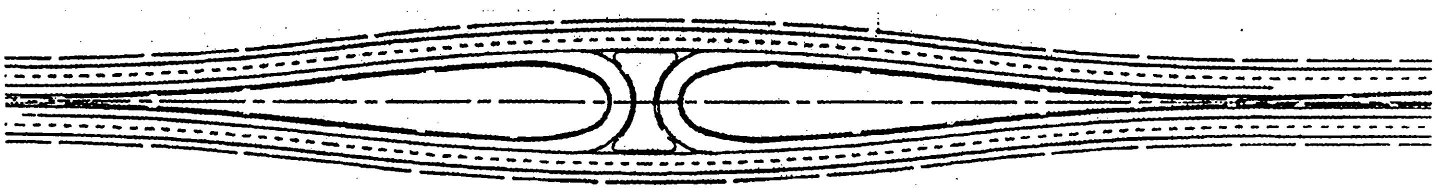
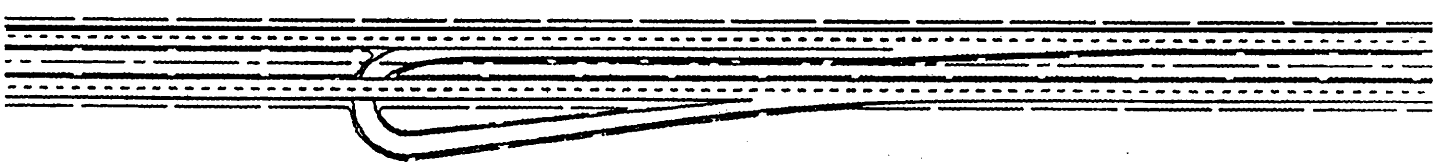


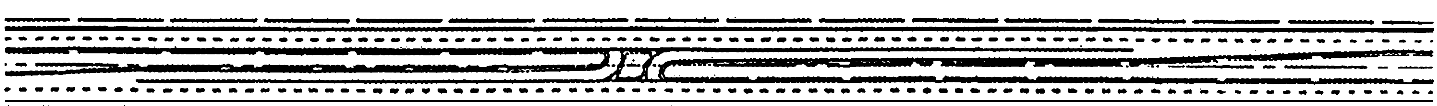
Figure 2
U-Turn Design Concepts



Alternative 1 - Accommodates WB-50

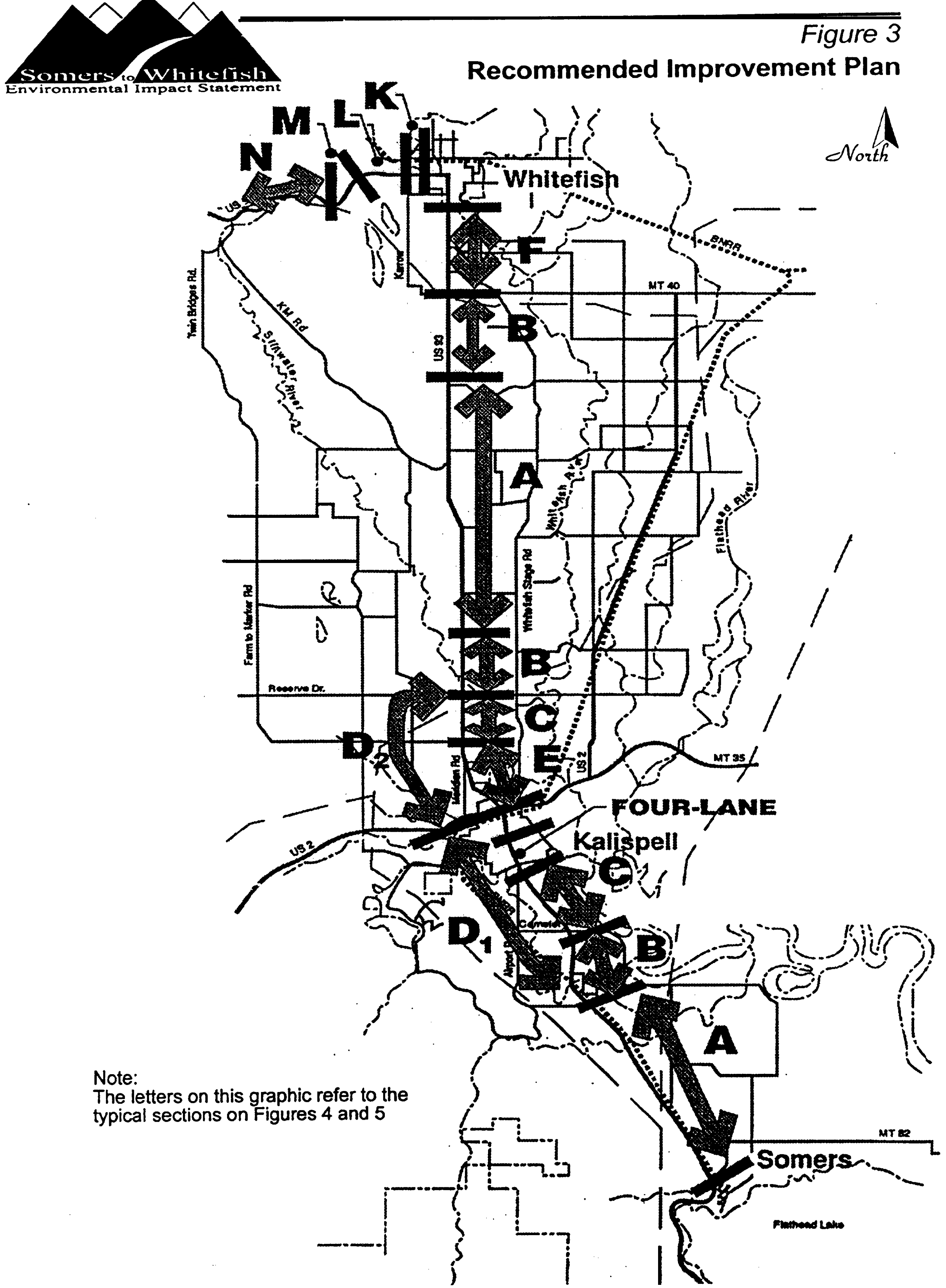


Alternative 2 - Accommodates WB-50



Alternative 3 - Accommodates Single Unit

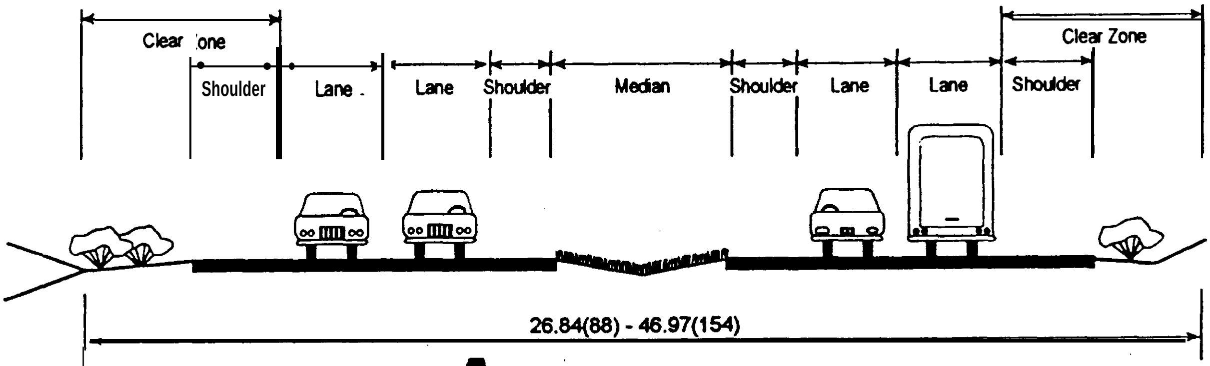
Figure 3
Recommended Improvement Plan



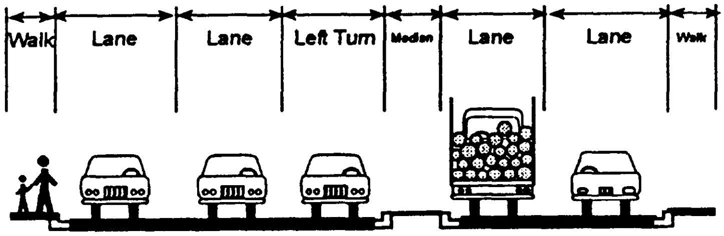
Note:
The letters on this graphic refer to the typical sections on Figures 4 and 5

Figure 4

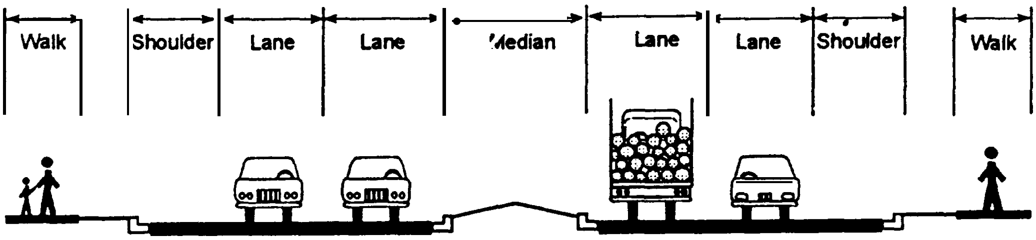
Recommended Cross Sections



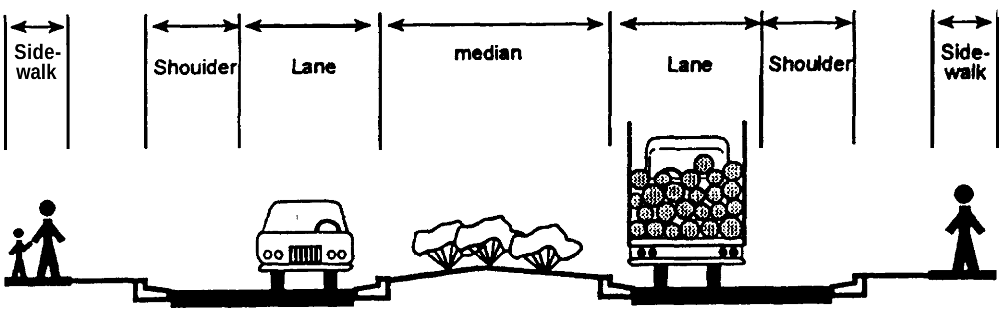
A Depressed Median



E Raised Median/Left-turn Lane • Urban Section



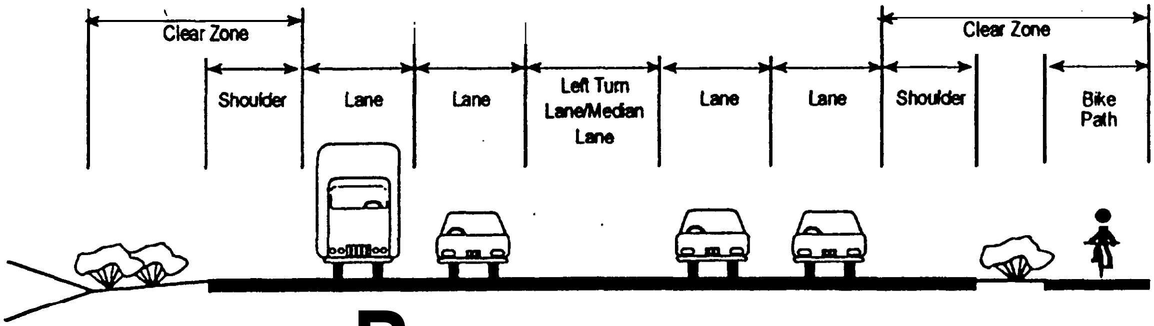
F Raised Median • Urban Section



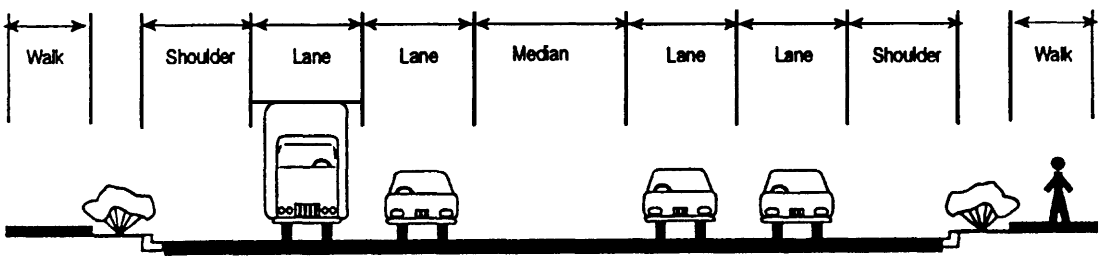
L Raised Median • Two-lane Section

Figure 5

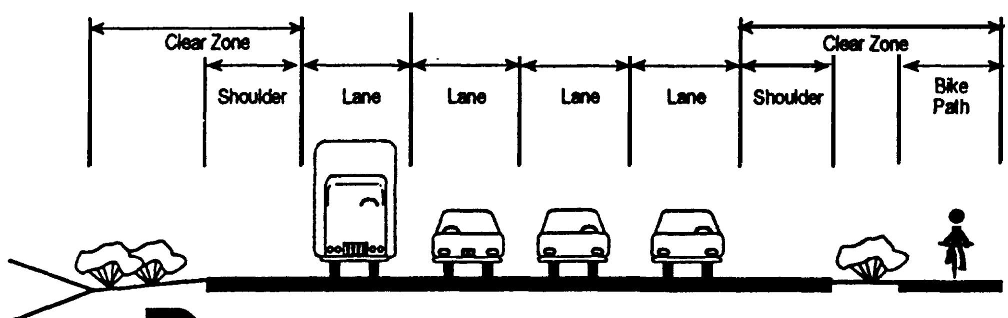
Recommended Cross Sections



B 5-Lane . Rural Section



C 5-Lane . Urban Section



**D Bypass
4-Lane . Rural Section (south of US2)**

Corridor Preservation In Delaware

Robert Kleinburd, Federal Highway Administration, Dover, Delaware

ABSTRACT

In 1990, the Delaware Department of Transportation (DelDOT), in conjunction with the Federal Highway Administration, began implementation of a project to protect and improve capacity on a 64 kilometer length of State Road I (SR-I), between Dover and Rehoboth Beach, Delaware. This roadway passes through mostly rural countryside, however, there are several pockets of residential and commercial development. SR-1 is the main access to the Delaware beaches form the North, and a new controlled access roadway is in various stages of completion between Wilmington and Dover. It is obvious that without counteraction, development adjacent OT SR-1 will result in continuing loss of capacity and related safety problems.

This paper will relate the actions that DelDOT and the two County governments have taken to control existing andproposed expanded access adjacent to SR-1, over the past several years. It will outline how cooperative actions have focused on controlling growth so that direct access onto SR-I can be diverted to side roads, that can feed into SR-I at prescribed locations. The paper will also describe a concurrent effort to purchase property rights that will reduce development pressures. The property rights under consideration generally involve access rights, but development easements and fee acquisitions are also open for consideration.

I. BACKGROUND

The primary 125 kilometer roadway between Interstate 95 near Wilmington, and the Delaware ocean beach resorts areas (incl. Rehoboth Beach), is a combination of US Routes 13/l 13, which is now known as State Route 1 (SRl). In the mid 1980's, it became obvious that the 75 kilometer segment from I-95 to South of Dover was suffering from considerable congestion, and that development adjacent to the roadway would make capacity improvements difficult and quite costly. Accordingly, a new controlled access roadway, to be known as the "Relief Route," was conceived and initiated. About 60% of this roadway is now open to traffic, and the total cost to construct the roadway is estimated to be close to $800 million, when completed.

In the late 1980's, interest focused on the remaining 50 kilometer road segment of SRl that existed from just South of Dover to the beaches. This was an existing four lane roadway, which at the time did not have any serious congestion problems. Although there were several pockets of residential and commercial development, for the most part, the land adjacent to the roadway was being put to agricultural use. In planning for the transportation future, it was quite obvious that there was going to be a dramatic push for residential and commercial development adjacent to the roadway. This roadside development would result from; (1) normal population expansion, (2) a dramatic growth in popularity of the Delaware beaches as a destination, and (3) the Relief Route allowing traveling motorists to bypass the existing roadside commercial activities between I-95 and Dover.

Not willing to sit back and watch as roadside development would increasingly diminish roadway capacity, the Delaware Department of Transportation (DelDOT), in cooperation with the Federal Highway Administration, initiated a corridor preservation project on SRl . The primary goals of the project are:

- Maintain or improve vehicular capacity of the existing roadway;
- Preserve long-term improvement capability;
- Continue to accommodate adjacent economic development; and
- Eliminate the need to build another Relief Route on new alignment in the future.

The SRl Corridor Preservation Project attempts to involve a variety of tools to accomplish its objectives, including:

- Apply local government land use controls;

- Restrict property entrances under DelDOT's police power;
- Acquire property interests;
- Provide engineering services to developers to ensure that proposed development is compatible with transportation needs; and
- Negotiate agreements with developers to provide access, and to preserve land adjacent to the highway for future construction needs.

The 1990 Task Force on Corridor Preservation, established by the American Association of State Highway and Transportation Officials, found that corridor preservation often enhances environmental interests instead of inhibiting them. By keeping undeveloped corridors open, or preventing development from occurring too close to existing facilities that are under consideration for expansion, State transportation agencies are not forced to consider construction in wetlands, parklands, and other sensitive areas. The success of corridor preservation depends, to a large degree, on the cooperation of several units in a State transportation agency. Administrators, planners, project developers, land acquisition personnel, and local government coordinators are all involved and essential to ultimate success. Further, corridor preservation must be addressed at each level of highway planning and project development.

II. PROJECT STRATEGY

As an initial step, DelDOT made an extensive effort to brief all interested parties of the intent of the project. DelDOT decided to go beyond the traditional public involvement process to create an extensive public involvement and interagency coordination program for the SRl corridor preservation project. The traditional engineering-oriented approach to project planning was abandoned in favor of a much more open process. Meetings were held with a variety of State legislators to outline project strategy. During regular meetings with Federal and State resource agencies, DelDOT presented the project concept and solicited feedback on the broad objectives. DelDOT sought out the information needs of the resource agencies, which would allow them to provide ongoing and meaningful input, and give them a stake in the outcome. Meetings were also held with a variety of local organizations utilizing a slide show presentation, and a project newsletter was established. The newsletter was mailed out on a broad basis, including all groups and individuals who owned or had an interest in property adjacent to the roadway. Overall, DelDOT made a conscious effort to create as many opportunities as possible to inform, educate, and involve everyone who could possibly be interested in the Corridor Preservation Project.

The next major step in the process was to prepare a map of the project, utilizing tax maps to overlay property ownership boundaries. All relevant physical features were added along with the primary environmental concerns, such as wetlands and cultural resources. Once all of this data was accumulated, a booklet was published for easy reference. The booklet is updated on a regular basis to take into account changes in property ownership and the refinement of other data.

The capacity protection project can stand on its own within the context of the National Environmental Policy Act because new roadway construction is not being proposed at this point. In fact, simply protecting the functional integrity of the existing highway facility may provide the needed transportation solution for a substantial number of years. However, DelDOT is considering a phased environmental process that would look at long-term needs in the corridor and establish the basis for beginning the protection or acquisition of rights of way for possible future construction for the entire project length.

III. PRESERVATION TECHNIQUES - CONTROL

To accomplish the goals of the Corridor Preservation Project, DelDOT took actions which can generally divided into the two separate categories defined as control and acquisition. The control aspect of the project uses police power as a base of action and relies heavily on a coordinated effort between local and State government. The Corridor Preservation Project passes through Kent and Sussex Counties, and these two Counties have primary responsibility to exercise zoning and other land use controls on property adjacent to the SRl roadway. In addition to recognized County land use authority, DelDOT also has the authority to issue driveway entrance permits.

In furtherance of the Project, DelDOT entered into separate agreements with each of the two Counties, which allowed for a cooperative approach to dealing with all proposed changes in land use adjacent to SRl. The agreement essentially called for the County to refer all land use proposals to DelDOT for comment before the County took action. DelDOT's Corridor Preservation Committee was allowed thirty days in which to review and comment on the various development proposals. In reviewing proposals, the basic goal of both the County and DelDOT, was to assure that roadway capacity would not be diminished. Each development proposal is unique in its own way, and solutions which could be accepted by all interested parties have been quite varied.

The converting of agricultural land into residential use, is not only one of the most significant land use actions, but also one of the most common. In most instances, these large agricultural sites already have legal access rights to enter the existing SRl . The goal of the Corridor Preservation Project would be to identify alternate access to the residential development off of secondary roads, and to facilitate an access situation which would not rely on a series of minor entrances onto SRl. Ultimately, grade separation entrances may have to be constructed when access from the secondary roads becomes warranted.

Another common occurrence is where an existing commercial activity wishes to upgrade and expand in intensity, thereby increasing the amount of anticipated in and out traffic flow. In an effort to deal with these situations, the applicant has typically agreed to a setback for any new structures which would accommodate possible frontage roads that could be constructed in the future.

In most cases, the two Counties have utilized their police powers via comprehensive zoning plans, to prevent the creation of any new commercial districts which would have an adverse impact on SRl roadway capacity. In addition, DelDOT encourages preliminary conferences of DelDOT and County planning officials with applicants for rezoning or subdivisions, to ensure compliance with corridor access goals. DelDOT will negotiate with land owners and developers to reserve or dedicate the right-of-way needed to upgrade the SRI corridor. The negotiations will attempt to allow property owners to proceed with their development plans while ensuring that any construction will be compatible with future transportation needs.

From the very beginning of the project concept, it was recognized that there would be instances where project considerations might place such extensive restrictions on a particular property so as to be considered a property right acquisition. In reviewing all development proposals, DelDOT seeks to provide alternatives which balance project goals with property owner development rights. To further this goal, DelDOT employs the services of engineering firms, and at no cost to the property owner, to provide a detailed analysis of any alternate proposal which may be suggested. This is to say that rather than simply rejecting development proposals, DelDOT will make a genuine effort to provide a reasonable alternative if there are serious problems with the submitted proposal. In those instances where the goals of the Corridor Preservation Project cannot be reconciled with a particular property development plan, DelDOT is willing to appraise the diminished property value, and pay for any damages which may be legally compensable. In the event that the parties are unable to reach agreement on loss of value, DelDOT will enter into a "friendly" condemnation action, whereby compensation will be determined through the Court system.

IV. PRESERVATION TECHNIQUES - ACQUISITION

In addition to the police power type control aspect of the program, it was also decided that DelDOT would actively pursue the purchase of property rights, where such acquisition would further the goals of the program. The acquisition policy allowed for a variety of acquisition techniques, including;

- Purchase of access rights across Route 1 frontage
- Purchase of development rights
- Purchase of easements
- Fee acquisition as a last resort

The types of properties that were considered to be prime acquisition targets, were unoccupied residential and commercial properties that were currently for sale, and large agricultural parcels that were being marketed for future development. The acquisition program is strictly voluntary, and almost all acquisitions that have occurred to date, have originated by request from property owners. DelDOT has allocated about one million dollars per year to the acquisition program, and is seeking the best possible return on investment. For this reason, DelDOT will not usually consider purchase requests where the acquisition involves the payment of relocation benefits. In those instances where DelDOT and the property owner agree on the acquisition, but cannot agree on the offer of just compensation, condemnation action will be employed in order that the matter of compensation be decided by the Court.

In the five-year activity of the program, DelDOT has completed the process of fifteen separate acquisitions, at a total cost of approximately three million dollars. These acquisitions include a wide variety of parcel type, with regard to both size and property interest. Since the ultimate goal of the program is managed access, rather than full access control, it is quite difficult to estimate any sort of total remaining cost to complete the program. At this time the most that can be said is that DelDOT will acquire as much access control as can reasonably be afforded in order to avoid the need to construct a bypass roadway. Much of the acquisition funding used to date, has come from the Federal Highway Administration's advance acquisition revolving fund,

V. FINDINGS - CONTROL

The police power control aspect of the Corridor Preservation Program is considered to be a complete and total success. The two County governments have joined in cooperation with DelDOT, to present a united front with respect to land development. Although DelDOT bears the burden of evaluating land use proposals, and is also responsible for developing reasonable alternatives, the Counties have been willing to stand behind the DelDOT decisions. The concept of corridor capacity protection is so sensible, that little opposition has been seen. The various land owners and developers also have seemed willing to make adjustments, in order to accommodate the program. Each and every case is different, and DelDOT hopes that by being reasonable in their approach to the program, that property owners will also be willing to make some minor sacrifices.

One key to the success of this aspect of the program, is the willingness to pay compensation if a supportable and measurable loss in value occurs as the result of complying with a DelDOT proposal. Two separate situations have occurred where DelDOT has recommended that access to a proposed residential subdivision be via a side road rather than directly onto SRl. In both cases, the redesigned development has suffered a slight loss of potential housing sites, and in each case DelDOT has paid compensation based on this analysis.

At the present time, there is still an abundance of agricultural land adjacent to the SRl corridor, and DelDOT is continually working with the Counties to help insure that the comprehensive land use planning process will take all possible steps to prevent future capacity pressures on the roadway.

VI. FINDINGS - ACQUISITION

The acquisition aspect of the Corridor Preservation Program has not been quite as successful as the control aspect. It had been anticipated that the purchase of access rights would be the primary acquisition mechanism. Under this philosophy, the property owner would then use some form of alternate access (possibly through a side road or in concert with an abutting owner), and the capacity of the roadway would be protected without the need to make fee acquisitions. What actually has occurred, is that most property owners are uncomfortable with any type of partial sale of property rights, and simply want to unload their property, in total, to the State.

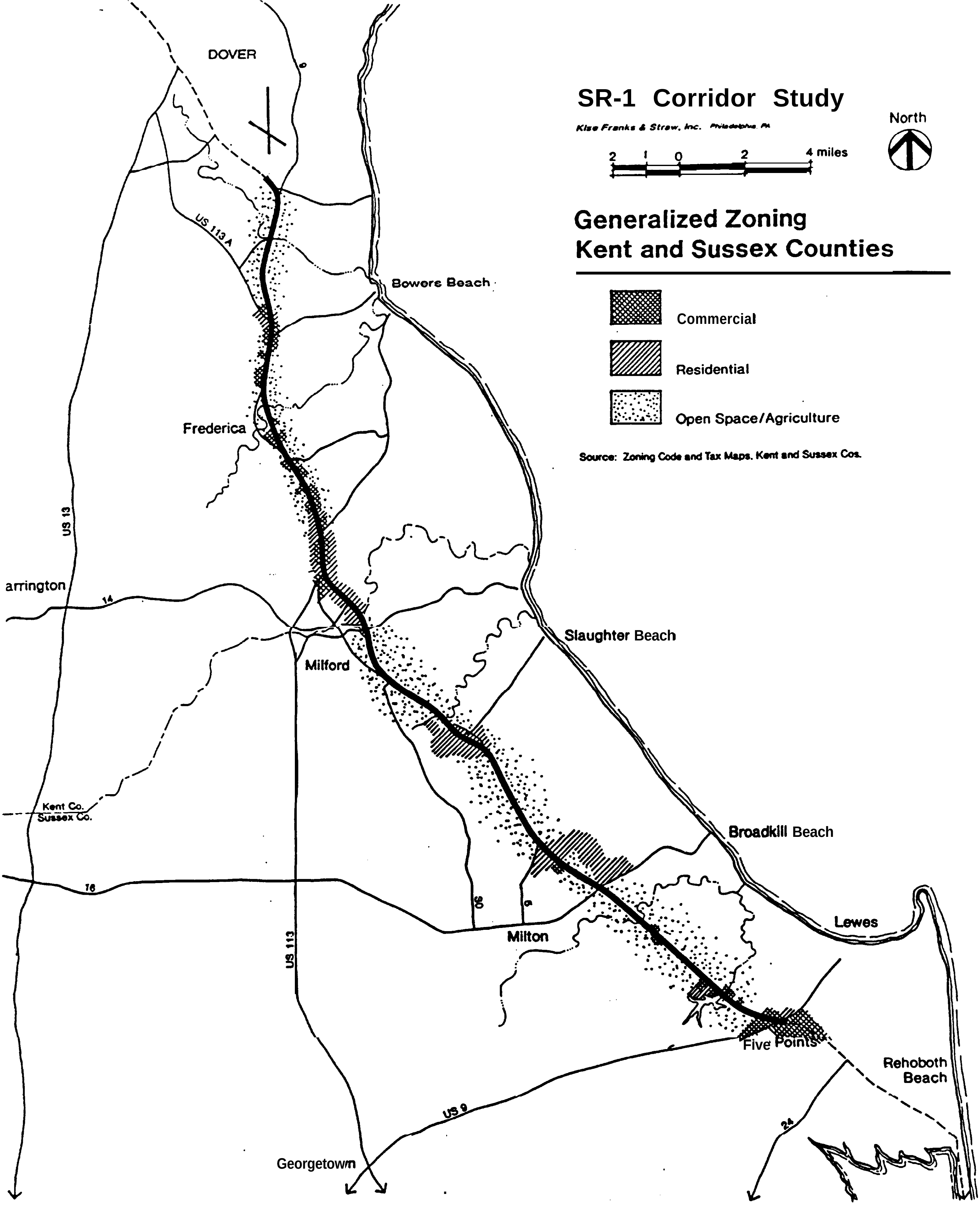
Numerous inquiries have also been received from individual residential property owners who have had their property for sale, and are seeking out any potential buyer. These types of acquisitions add little present value to the Program, and would leave DelDOT with the administrative burden of managing and disposing of the property.

To date, more than one half of the fifteen acquisitions have involved some element of fee title purchase. In those instances where a property is particularly attractive from an access management viewpoint, but is only available as a fee purchase, DelDOT may actually purchase the property in total. Access controls will be established, and the property will then be made available for resale in its diminished condition. While this approach involves a substantial amount of administrative effort, and is not the preferred access control technique, project goals are ultimately obtained.

VII. CONCLUSIONS

After the first five years of activity, the land use control aspect of the SRl Corridor Protection Program has been quite successful in preventing loss of roadway capacity. This level of success would certainly not have been achieved without the cooperative effort between DelDOT and the local planning agencies. Another key element that has contributed to a successful program, is DelDOT's willingness to provide engineering services to back up any redesign proposals that might be made. Overall, DelDOT strives to provide developers with reasonable alternatives for action, if submitted proposals cannot be accommodated under the philosophy of the existing plan for access control. As in any other project proposal, it is necessary to build upon a solid groundwork with interested parties, and to keep the lines of communication open.

The acquisition aspect of the Program can only be considered as a modest success. We have found that property owners are simply not comfortable with partial acquisition of property rights, and either want to maintain their property, or else sell it in total. We expect that selective acquisitions will be made in the coming years, however, it has become apparent that the voluntary purchase of strict access rights will usually be a hard sell, regardless of packaging.



SR-1 Corridor Study
Kise Franks & Straw, Inc. Philadelphia, PA
2 1 0 2 4 miles
North
Generalized Zoning
Kent and Sussex Counties
Commercial
Residential
Open Space/Agriculture
Source: Zoning Code and Tax Maps, Kent and Sussex Cos.
DOVER
US 113 A
Bowers Beach
Frederica
US 13
arrington
14
Slaughter Beach
Milford
Kent Co.
Sussex Co.
Broadkill Beach
16
30
5
Lewes
Milton
US 113
Five Points
Rehoboth
Beach
US 9
24
Georgetown

A Case Study of Access Control The History and Findings of Sheridan Boulevard Access Planning

Robert D. Reish, P.E., In Motion, Inc., Denver Colorado
Mike Normandin, City of Westminster, Colorado

ABSTRACT

In 1980, City of Westminster staff recommended that an access control plan be developed and adopted for the Sheridan Boulevard corridor. Staff came to believe that, considering the expected corridor development, an access control plan was the best way to protect the city investment in the corridor so that traffic flow and safety requirements would be best served.

In 1982 and after extensive planning studies, the city adopted an access control plan for 3.5 miles of Sheridan. The plan addressed the amount and location of access, turn restrictions, andpotential future signalization. Since 1982, both the development community and city staff have had to conform to the plan. This paper addresses five aspects of the history of the plan and its implementation.

I. *What are the apparent positives of the plan and would the corridor be different had there been no plan?*

2. *What aspects of the plan have been useful to the city and what has not been useful?*

3. *From the development community standpoint, what has been good and what has been difficult to deal with?*

4. *If the plan were done today, what would the access control planning team do differently?*

5. *Has this a good model and could it be used in other locations?*

The findings of the paper were based upon a series of interviews and discussions with staff the original planning team, and the development community.

INTRODUCTION

The mission of access control has taken many forms over the last decades. This is in response to patterns of over-stressed streets and to highway function bending and then yielding to ever more frequent driveway access and increased travel demand. In some examples, after streets or highways are already subject to too frequent access, efforts are made at great expense to collect drives and enhance operations by retrofitting access control devices. Thus, the best is made of the situation. In contrast, the City of Westminster, Colorado has taken a different path. The City began its planning for Sheridan Boulevard fifteen years ago and adopted an access control plan fourteen years ago. The key to the success of their planning for Sheridan was the development of their plan in advance of development.

Westminster, Colorado is a rapidly growing northern suburb of Denver. Growth has occurred in the community as a result of regional growth and in-migration of high-tech industry and its workers. Since Westminster offers fine schools, quiet suburban neighborhoods, varied housing types, and access to both the Boulder and Denver areas, growth has been almost continuous over the last twenty years. For the same reasons, growth is forecasted to continue for Westminster. Sheridan Boulevard is a transportation focus of this community growth. It is a north-south important roadway, classified as a principal arterial in today's functional classification and the same in the future. Sheridan Boulevard is continuous for many miles in the Denver Metropolitan Region.

In the southern (and older) part of Westminster, Sheridan Boulevard was constructed to a multiple lane configuration. Its typical section was compromised and there was little regard for access control. In much of this area, the arterial has frequent driveways and intersecting local streets. There is no pattern to the access except to say that it is frequent.

The 3.5 mile section of Sheridan Boulevard from 92nd Avenue north to 120th Avenue was originally constructed as an access road to local farms. By 1980, traffic growth in the area caused the City of Westminster to apply for federal funding to widen the roadway. Studies began that resulted in environmental clearances for widening. Over the years, the roadway expansion permitted in the environmental clearance documents has been incrementally funded. As part of the planning for the project, the City committed to developing an access control plan for the road from 92nd Avenue to 120th Avenue. The purpose of access control planning was to create a balance between the interests of development and the through traffic needs of Sheridan Boulevard as a principal arterial roadway.

This paper reports on the history of Sheridan Boulevard access control planning. The following pages describe the setting of Sheridan Boulevard when access planning began; the planning objectives for Sheridan Boulevard; and then reports on the implementation and use of the plan. The report concludes with lessons learned and what can be transferred to other locations.

Sheridan Boulevard

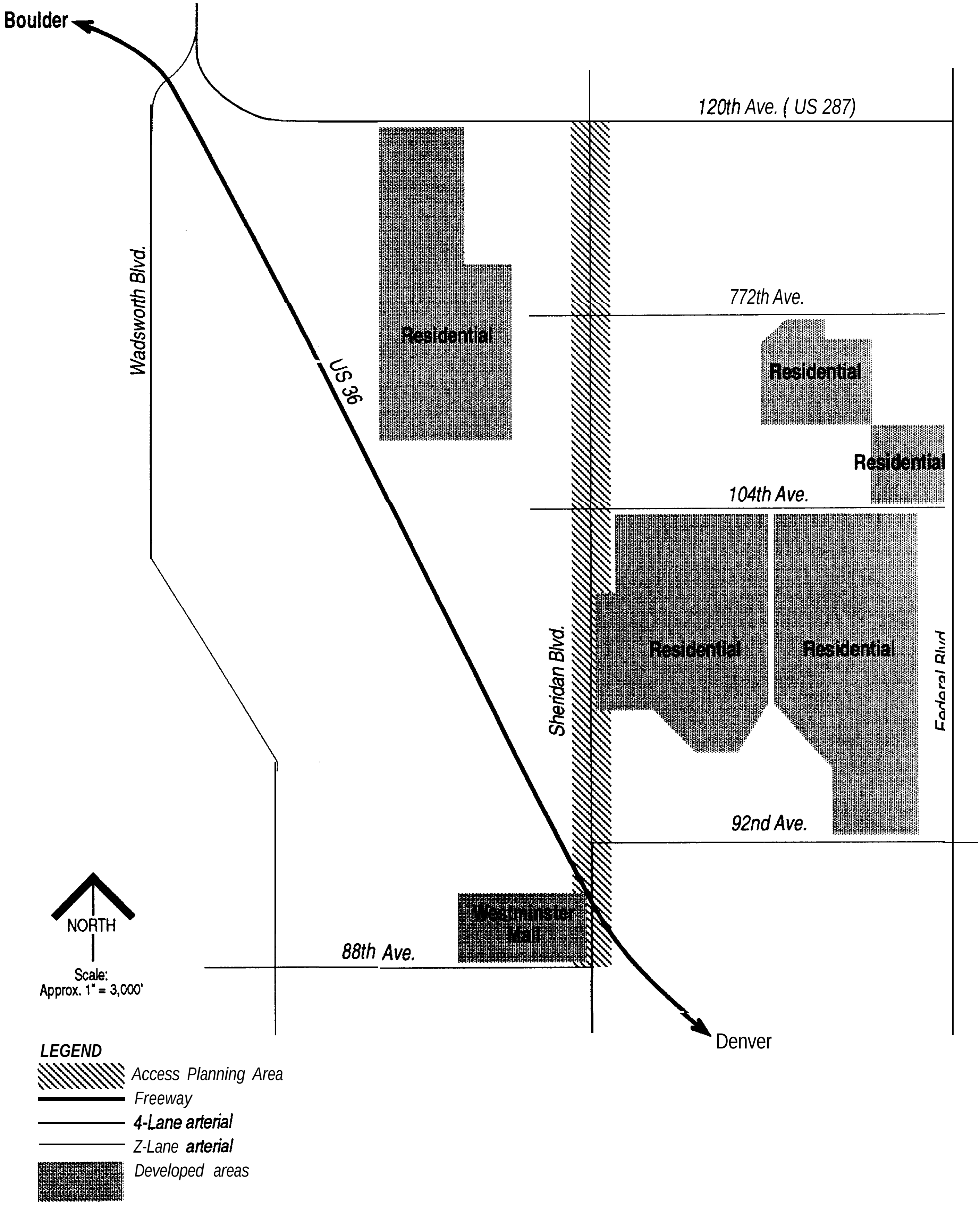
At the time of adoption of the Sheridan Boulevard access control plan, most of the adjacent land areas were in agricultural usage. Only one residential development was directly next to the roadway. Yet there was a sense of urgency that improvements were required to Sheridan Boulevard because of continued expectation of growth and ever increasing traffic volumes. It was this expectation that caused the city to act and plan to protect their investment in Sheridan Boulevard.

The section of Sheridan Boulevard having an adopted access control plan is shown on Exhibit 1. The exhibit illustrates the status of development and the road system in the area of Sheridan Boulevard in the early 1980's. As the exhibit shows, Sheridan Boulevard was a two-lane road from south of US 36 (Denver-Boulder Turnpike) to 120th Avenue. At that time, Sheridan intersected with 88th Avenue, US 36,92nd Avenue. (A two-lane road to the east only), 112th Avenue (A two-lane road to the east only), 104th Avenue (a two-lane road to the east only), 112th Avenue (a two-lane road to the east only), and 120th Avenue (US 287) which was a four-lane divided highway. A diamond interchange provided access to US 36. Signalized intersections were located at 88th Avenue, US 36 interchange ramps, 92nd Avenue, and 120th Avenue. Stop control was provided at 104th Avenue and 112th Avenue.

Parallel to Sheridan are two North-South principal arterials located about 1.5 miles east and west of Sheridan. These are Federal Boulevard on the east and Wadsworth Boulevard on the west. Both of these were two lane roads from 92nd to 120th Avenue.

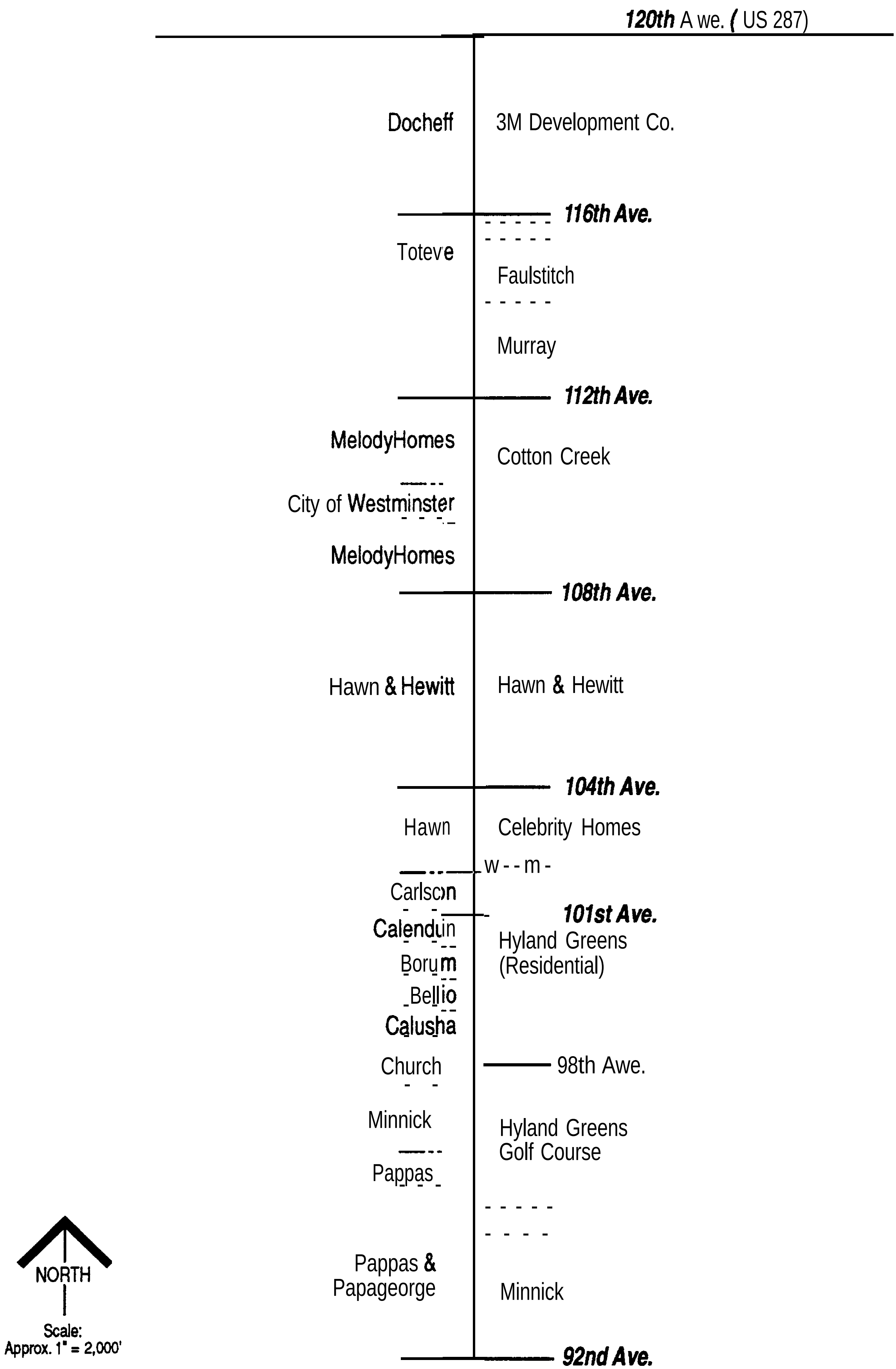
Exhibit 2 illustrates the general configuration of property divisions on the border of Sheridan Boulevard as they existed in the early 1980's. Near 92nd Avenue, property divisions were generally in smaller tracts with Hyland Greens on the east side of Sheridan an already success ful subdivision. Property parcel sizes typically were larger north from Hyland Greens to just south of 120th Avenue. Access problems were confronted with the smaller property parcels since, typically, these properties had existing access and were divided to be narrow fronting on Sheridan and deep to achieve acreage. As a result, few long term access options were available with the exception of turn restricted driveways.

Other features that defined Sheridan Boulevard for planning purposes included the planned crossing streets of 92nd, 104th and 120th Avenues. These streets have been constructed and now support the transportation system planned for the area. Additional considerations included existing access points to agricultural uses or to existing properties and residential subdivisions, and natural features such as streams that constrain boundaries and street networks.



Sheridan Boulevard
ACCESS CONTROL

Exhibit 1
Principal Roadways in Access Planning Area - 1982



Sheridan Boulevard
ACCESS CONTROL

Exhibit 2
1982 Property Divisions

The Plan for Sheridan Boulevard

In 1980 all day traffic volumes were growing at a high rate. Just north of 92nd Avenue, Sheridan carried approximately 22,000 vehicles per day. Just south of 120th Avenue traffic volume was between 8,000 and 10,000 vehicles per day. Long range plans for Sheridan Boulevard for the year 2000 forecasted the need for a four-lane principal arterial divided roadway continuous from 92nd to 120th Avenue. A raised 16 foot median was planned to divide traffic directions. Traffic volumes were forecasted to be about 40,000 vehicles per day in the year 2000.

Sheridan Boulevard was planned for a design speed of 50 miles per hour (about 80KPH). Speed limits on the road were planned for 40 MPH (about 55KPH). For access control planning, a 90-second signal cycle length was assumed. Intersection design was based upon level of service (LOS) D. Adequate margin width was provided for bike paths, and sidewalks to emphasize a safe environment compatible with the predominant residential land use.

The City developed a set of objectives for Sheridan Boulevard based upon a combination of different factors and inputs. As stated in the Access Control Plan City Council Resolution:

> "The major objective of the Sheridan Boulevard Access Control Plan is to establish effective access control measures which preserve the transportation characteristics, thus preserving the City's investment in the improvements of this major arterial street, while at the same time complementing the interrelationships between transportation and land use functions ."
>
> The plan of access "allows major access points at half-mile intervals. This coincides with the locations of the major public street intersections." The interrelationship of signal progression speed and cycle length "also allows for the location of minor access points 600 feet to either side of these major intersections."
>
> The use of minor access points was limited to the judgement of city staff through the plan goal of "Minor access points should be used as needed to provide reasonable access to adjacent land use functions." Feasibility, safety, and traffic operational considerations were provided as a guide to staff in granting additional access.

Exhibit 3 illustrates the major features of the access plan. The principal driving basis for the access plan was that when traffic flows smoothly in platoons through the signal system there is a fine balance of access type and location, signalization and capacity. As a result, there are good locations and poor locations for signalized access. The hope of the Sheridan access planning was to never allow for the creation of an access at a location that may cause the need for a signal. Exhibit 3 is a product of this simple access planning rationale.

City Adoption Process

Development and adoption of the access control plan was coincident with project planning and the environmental clearance process. The city investigated a series of strategies to address the rapid growth in corridor travel demand. In addition to the typical response of widening the road to four lanes, the city also came to understand the benefits of an access control plan. Once the commitment was made, the city undertook the following work program.

1. Develop appropriate access control goals for the corridor. These include a means for coordination of access requests; a means of achieving a balance between access requests and the need for through traffic movements; and the need to protect the investment in the corridor.

2. Develop an understanding of the guiding principals behind the plan. These include the need to keep the planning model simple and easily understandable; to base the access planning model on reasonable criteria; and to recognize existing commitments. Thus, conveying the simple message of the fine balance of coordinated signal systems, access, and sufficient capacity was stressed to the public and property owners.

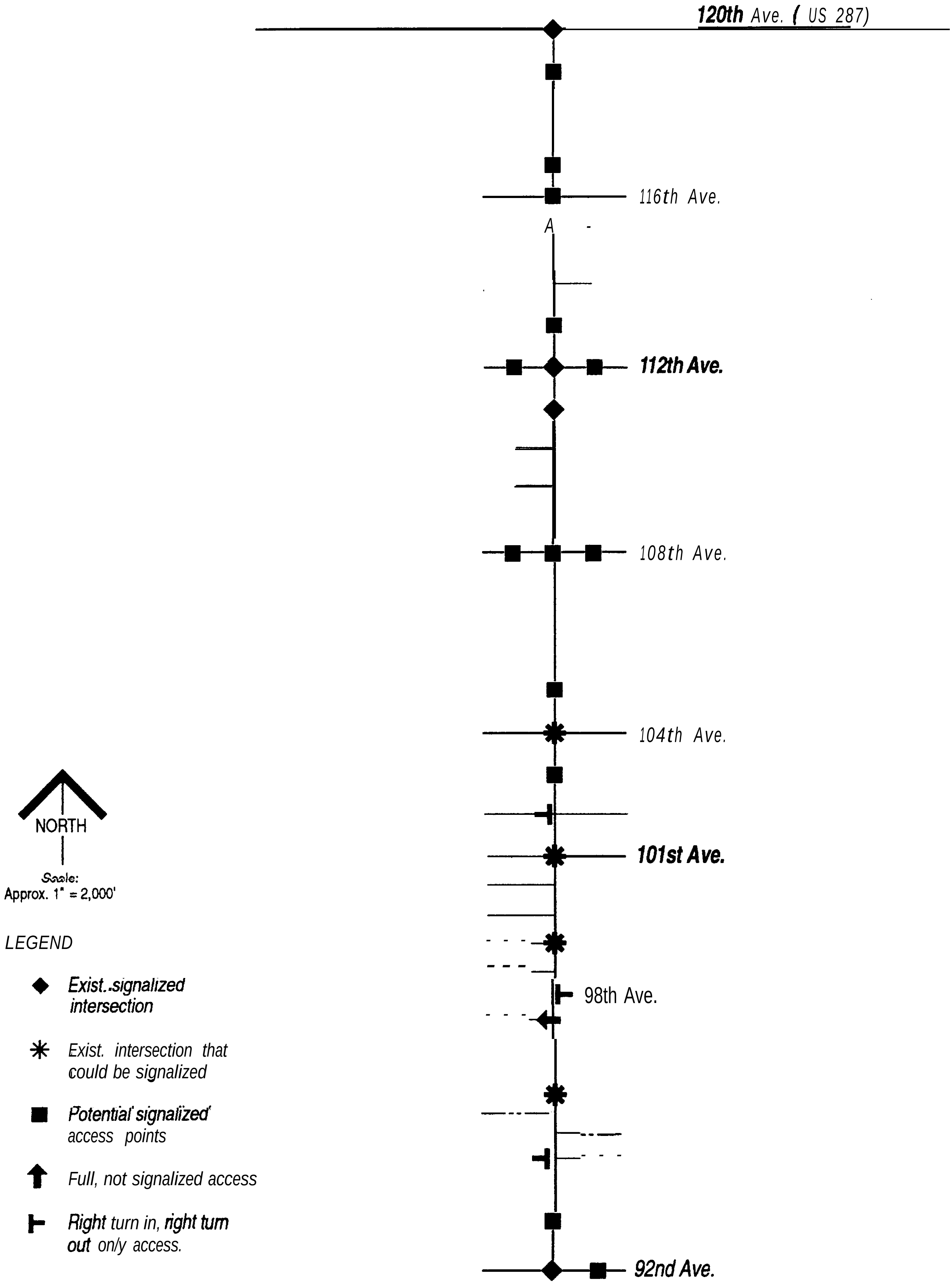


Exhibit 3

Sheridan Blvd. Access Control Plan

3. Prepare a model for the access plan based upon the determined criteria and then to examine each access throughly to make tradeoffs and exceptions if required.

4. Prepare for and conduct public meetings and hearings in accordance with regular city government procedures. These steps included hearings before the planning commission and city council.

5. Ask for and gain city council approval.

This process worked without any significant difficulties. However, it should be noted that step three as listed above was a significant effort. Each existing access point was examined and each property evaluated for future use and reasonable access. An individual response was organized for each existing access point. If such an comprehensive effort had not been undertaken, the process may have faltered during public meetings if challenges arose. It was apparent to participants that a fair and equitable analysis had been used for each access. Existing access points were typically allowed to continue given no change in use. Hence, agricultural or home access driveways were granted a continuation. Once a change of use occurred, rules of the access plan are then enforced. Also, with construction of widened and median separated roadways, certain of the access plan features were applied. Examples of application of these include relocation of access and turn restrictions on formerly full movement access points.

Implementation

In the intervening years since adoption, much has changed along the corridor. Commercial development has occurred along the southern reaches of the corridor and traffic volumes have grown to about 40,000 vehicles per day. In other sections of the roadway, traffic volumes have nearly doubled. Additionally, arterial roadways have been upgraded and the network extended and expanded.

Once the plan was adopted, it first was used as a means of guiding design and construction of the widened roads. This activity continues. The last section of roadway widening is scheduled for 1997. As development has occurred, the plan comes into play. Development groups, and their consultant's first would become aware of the plan at their visit with the city planning staff.

In cases where development proposals had been prepared and were in conflict with the access plan, the city staffs insistence on adherence to the plan caused the development interests to reformulate plans for access. In no recorded instances did the plan requirements cause development to stop. The access plan has proved to be a constraint within which development is possible. The plan has worked well as a tool for coordinating and influencing access development.

When the city has constructed portions of the project, they have taken a proactive stance on enforcing access requirements and the access plan. Their actions have included closure of access or construction of raised medians at existing access locations. This has been done regardless of the apparent present need. To the extent feasible, the city has taken the next step of constructing street openings at those locations planned to have future access. This action has created an image that there has been a final access decision. Additionally, this action has actually saved construction cost and potential disruptions to traffic.

Findings

The plan has been a substantial success in the view of the city. This has been enough of a success that the city has used the ideas in the Sheridan plan to develop plans for other street corridors. Each of these access plans has been straightforward and easy to understand like the Sheridan Boulevard plan. The following are some key findings of the experience of the city.

- The adopted access plan does not include routine traffic engineering design considerations. These could be included as an attachment to the plan or be referenced in the plan. This inclusion would have assisted the staff and development community in routine design issues.

- The very nature of having an adopted access plan, approved by city council appears to have quelled developer and city staff confrontations.

- Keeping the access plan basis simple served as a great advantage in adoption and in implementation. It is readily understood by all parties and yet carries sufficient detail to convey strongly its principal goals.
- Addressing access questions from the standpoint of planning has worked quite successfully as opposed to examples of retrofitting access control devices onto an existing street.
- The access control plan does not appear to have altered development patterns or the pace of development.
- Sheridan Boulevard has a very high standard of positive driver experience. High volumes flow with relative ease and accident experience has been favorable. From the standpoint of achieving the plan objectives, the record has been successful.

Overall the record of positives from Sheridan Boulevard is high. Much of what was done for Sheridan Boulevard could be adapted to other corridors. The key features that the authors believe are transferable include the following:

- Deriving the principal relationship between access and through movements from signal system optimization appears to be a simple and easily understood relationship. This could be applied to other locations.
- Even though signal optimization software is available to develop multiple "optimum" signal coordination plans, simple is better when it comes to developing the basis for an access plan and explaining it to the public and property owners.
- Adopting the plan well in advance of development pressure seems to be a key for achieving success. It allows cities or counties to get ahead of development pressure and to avoid compromises.
- Adopt a plan over a considerable length of roadway. Longer stretches mean that there is more commitment to the roadway and hence less ability for objections to be successful afterward.

Reference

"Sheridan Boulevard Access Control Plan" West 92nd Avenue to West 120th Avenue, City of Westminster, CO, Fe bruary 22, I982

Trials And Tribulations Of Enforcing A Locally Established, Corridor-Wide, Restrictive Access Plan Implementation Of The K-150 Study

Mark J. Stuecheli, Senior Transportation Planner, The City of Overland Park, Kansas

ABSTRACT

This paper willpresent the experience that the City of Overland Park, Kansas has had in enforcing an access management plan approved in I986 along a major corridor slated for intensive commercial, office and industrial development.

The street in question, K-150, is a major east-west arterial that runs through three cities in the southern portion of Johnson County, Kansas. Johnson County is the highest-growth area in the Kansas City metropolitan area and its growth is expected to continue at its currentpace well into the future.

In I984 the cities of Leawood, Olathe and Overland Park commenced a cooperative study of the area approximately one mile north and south of K-I 50. At that time the K-I 50 corridor was basically undeveloped but, because of its critical location in the path of development, was expected to be the next major development corridor in southern Johnson County. Using an early version of the Tmodel traffic simulation software, the K-I 50 Study analyzed combinations of both alternative land use and varying levels of street improvements and access restrictions to ensure that the street system would function well under ultimate development conditions. The approved design concept consisted of up to an eight lane divided section with full turning-movement access at half-mile locations. Right-turn only access was permitted at the quarter mile points between the median openings. To accommodate access needs for the higher intensity development abutting K-l 50 a system of reverse-frontage roads (now known as parallel access roads) were proposed one-quarter mile north and south of K-150.

Development activity proceeded more slowly than anticipated but over the last five years extensive residential development occurred near the corridor. Within the last year several commercial properties have commenced construction along the corridor.

As each rezoning application was submitted along the corridor, the developers of the projects tested the resolve of the City staff and the City Council to uphold the access concepts of the K-l 50 Study. Staff became adept atpresenting the importance ofprotecting the integrity of the corridor, especially for projects submitted before any significant development had occurred. In recent times the pressure of development has made it much more difficult to hold the line on access controls.

Enforcement of access controls at the local level is a quite different process than that used by State Departments of Transportation. The pressures of local politics dictate that each request for deviations from the access standards be vigorously opposed at a public hearing. The access plan must be defended before the City Council for virtually every development request. This paper will document both the successes and setbacks experienced by staff in enforcing the recommendations of the K-l 50 Study.

INTRODUCTION

For the last ten years, the City of Overland Park, Kansas has pursued a program of enforcing extensive access controls along K- 150 Highway, a major street corridor located in the rapidly developing southern portion of the City. Overland Park is a suburban community in the southwest quadrant of the Kansas City, Missouri metropolitan area with a population of over 130,000. The K- 150 Corridor, as discussed in this paper, is a nine-mile (14.5 kilometer) long section of 135th Street (until recently also known as Kansas State Highway 150) that extends west from the Kansas/Missouri state line. This paper will review the successes and setbacks that the City has experienced in attempting to enforce access restrictions along that Corridor.

BACKGROUND

In 1984, the three cities that K-150 Highway passes through (Leawood, Overland Park, and Olathe) commenced a cooperative study of the area one mile (1.6 kilometer) north and south of K- 150 Highway. **Figure 1** shows the general location of the study area in relation to the Kansas City Metropolitan Area. At that time the K-150 Corridor was essentially undeveloped. Because of its critical location in the path of development, the Corridor was expected to be the next major development area in southern Johnson County. K- 150 also functioned as a major east-west traffic way in the County and therefore carried a large amount of through traffic. The study provided the unique opportunity to balance land use and street improvements in a way that would provide for desired development but yet still would accommodate the through traffic function of the roadway and not overburden the street network in the area.

Using an early version of the TModel traffic simulation software, the consultant for **the K-150 Corridor Study,** over an 18 month period, analyzed several combinations of land uses and street improvements to determine the interrelationship between land use intensity and required street improvements. The goal was to ensure that the street network in the Corridor would function adequately under full development conditions. The approved design concept, adopted by all three cities in 1986, consisted of a multi-lane divided section with median breaks at half-mile (.8 kilometer) locations. Right-turn-only access was to be permitted at the quarter mile (.4 kilometer) points between the median openings. To accommodate access needs for the higher intensity development abutting K-150, a system of reverse frontage roads (now known as parallel access roads) were proposed one-quarter mile (.4 kilometer) north and **south** of K- 150. See **Figure 2** for a schematic drawing of the access scheme that was adopted for the Corridor.

It is should be noted that although K-150 was a Kansas State Highway in 1986, the Kansas Department of Transportation (KDOT) did not take an active role in the development of the access recommendations of the Study. KDOT staff did, however, endorse the recommendations of the study and in the ensuing years used its findings to reinforce recommendations on access within the bounds of the K- 150 Corridor. The highway was removed from the state highway system in 1996.

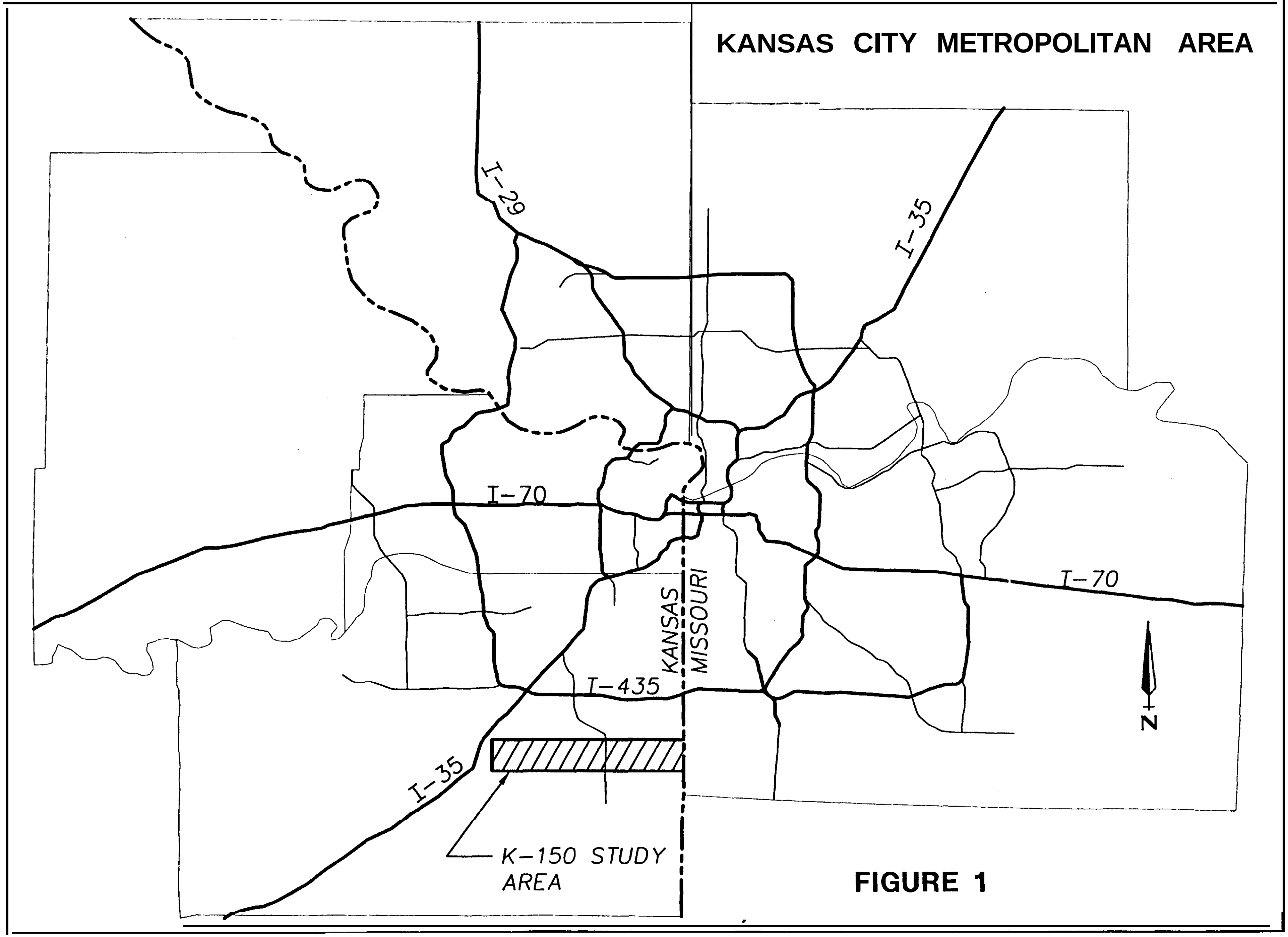
In 1987 the City of Overland Park retained a consultant to develop more detailed alignments for the parallel access roads and other connecting streets in the portion of the Corridor located within its city limits. Since that date, the Overland Park staff has used **the K-150 Corridor Preliminary Design Study** to provide a basis for desired locations for the parallel access roads, especially where they intersect major streets. **Figure** 3 depicts the portion of the K-150 Corridor in Overland Park, and **Figure** 4 shows one of the aerial photo-based maps contained in the study.

CASE STUDIES

Over the last ten years, The City of Overland Park Public Works Department staff has worked to apply the access restrictions adopted by **the K-150 Corridor Study.** During that time period staff has experienced a broad array of development proposals and a variety of developers interested in pursuing their own visions for development along K-150. As a way to analyze the development trends and the corresponding pressures on the access system proposed for the Corridor, I have divided those ten years into three different “eras”.

The “Gold Rush” Era (19864987)

During the nearly two year development period for **the K-150 Corridor Study,** the City of Overland Park established a moratorium on all new development proposals within the study area. A flood of speculative rezonings immediately followed the adoption of the Study. All of those rezonings were pursued by land speculators who were attempting to profit from the new land use designations established within the Corridor. In most cases, the applicants for the rezonings reluctantly agreed to conform to the access guidelines. In the few instances where applicants attempted to seek more access than had been recommended; their efforts were unsuccessful because the City staff forcefully advocated the limited access, and the City Council fully supported the recommendations of the recently completed Study.



KANSAS CITY METROPOLITAN AREA
I-29
I-35
I-70
I-70
KANSAS
MISSOURI
I-435
I-35
K-150 STUDY AREA
N

FIGURE 1

K-150
ACCESS DEVELOPMENT PLAN

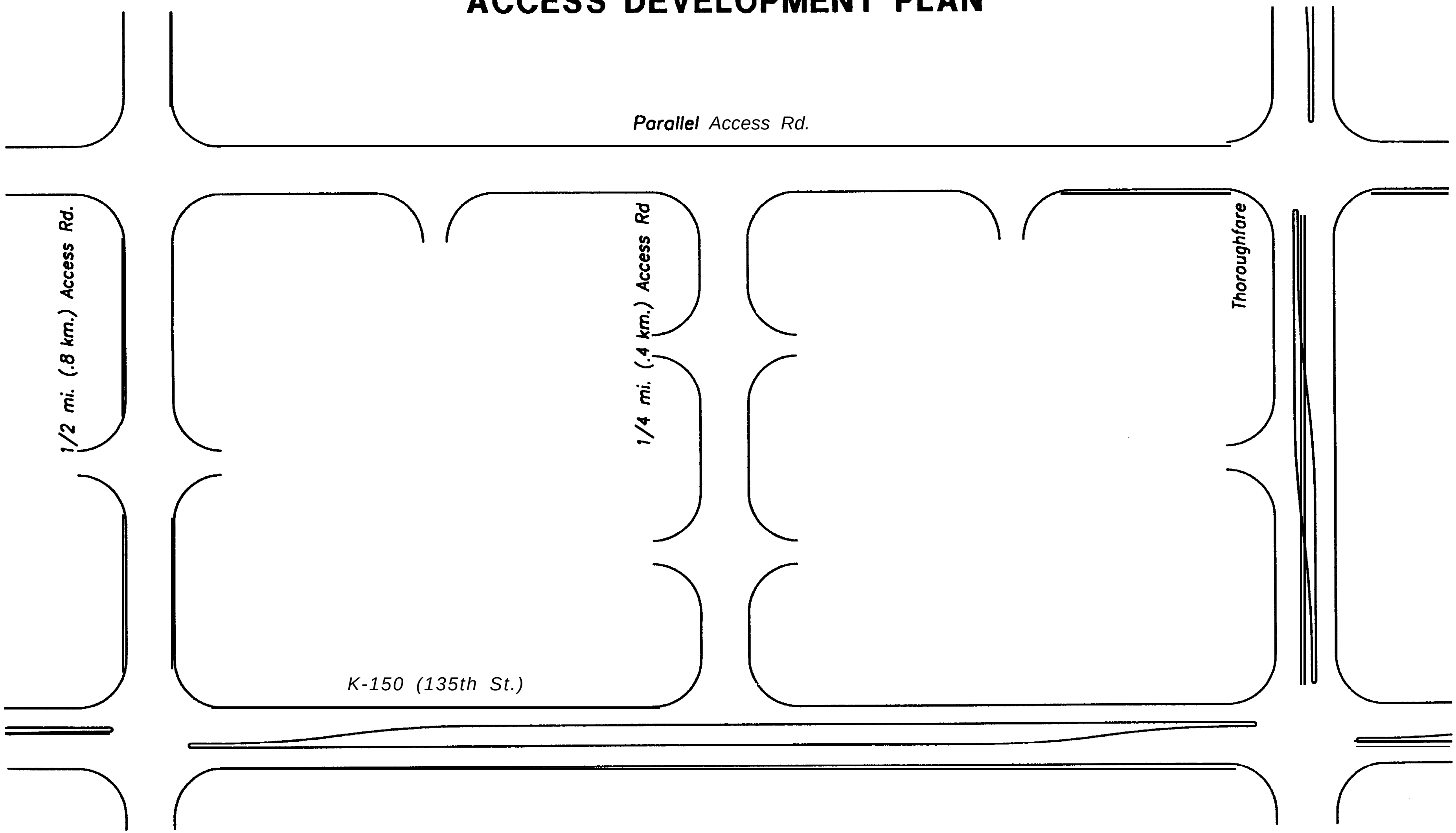


FIGURE 2

K-150 CORRIDOR
PROPOSED STREET NETWORK

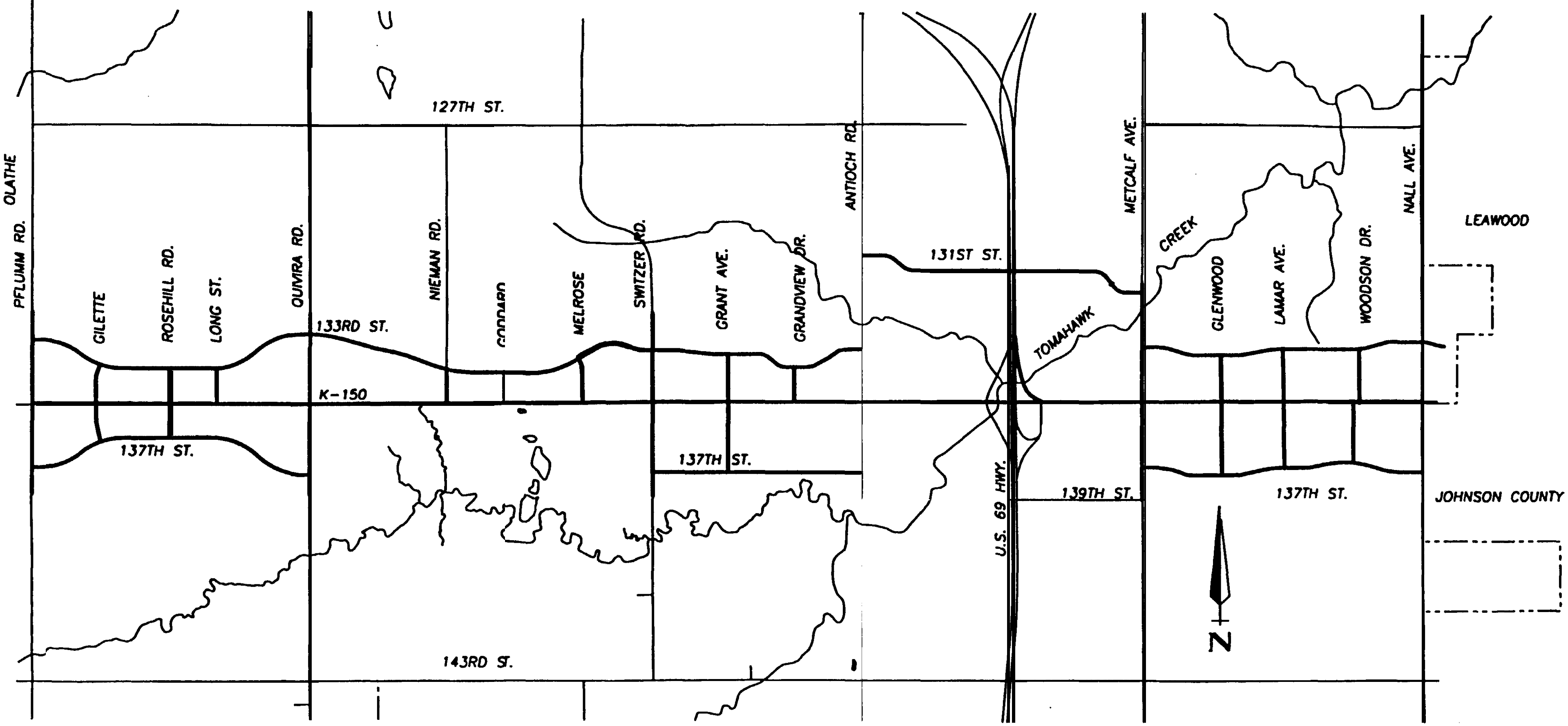
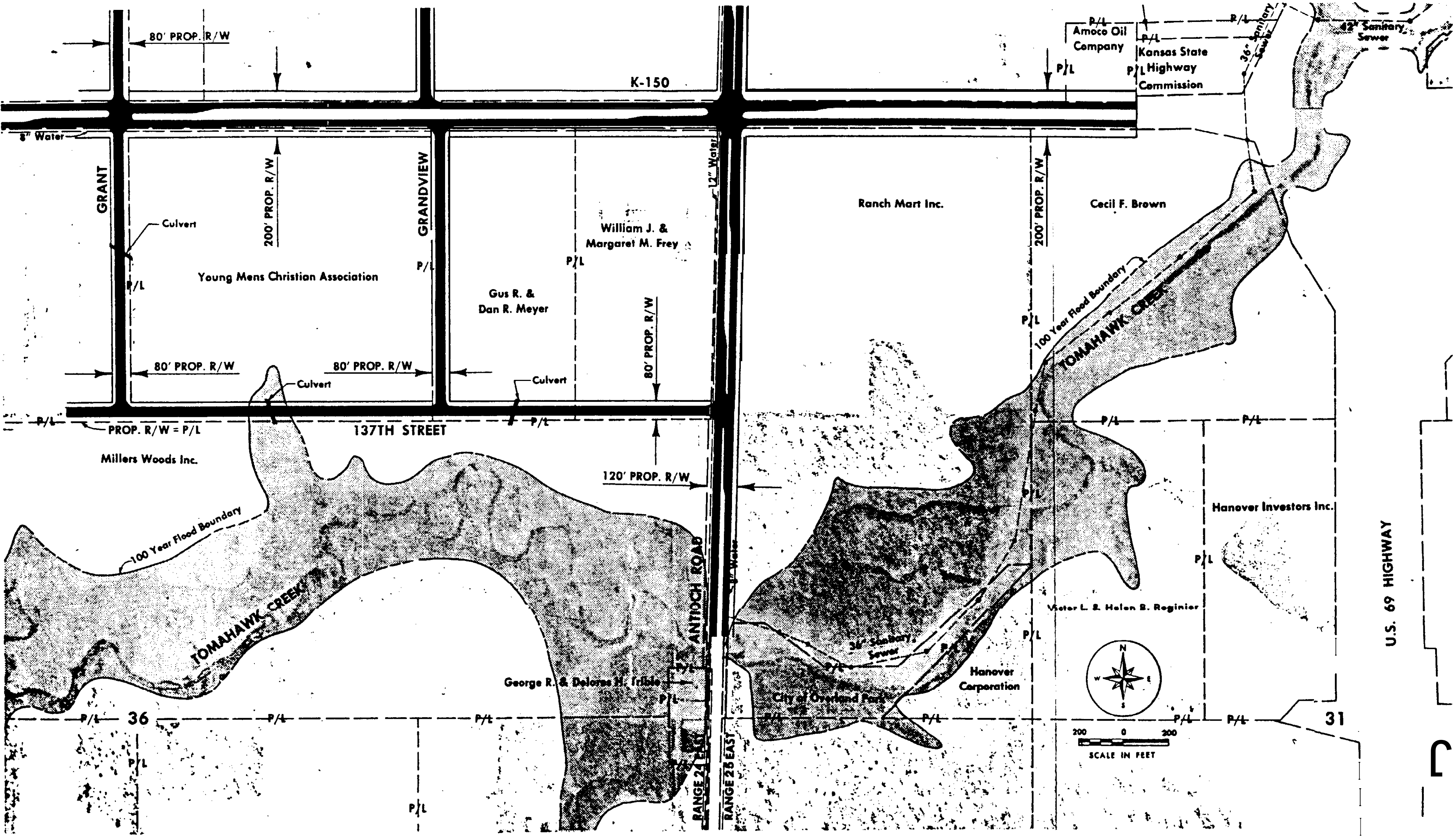


FIGURE 3


K-150
80' PROP. R/W
8" Water
GRANT
Culvert
200' PROP. R/W
GRANDVIEW
12" Water
P/L
Young Mens Christian Association
Gus R. & Dan R. Meyer
William J. & Margaret M. Frey
80' PROP. R/W
Ranch Mart Inc.
200' PROP. R/W
Cecil F. Brown
Amoco Oil Company
Kansas State Highway Commission
36" Sanitary Sewer
42" Sanitary Sewer
100 Year Flood Boundary
TOMAHAWK CREEK
80' PROP. R/W
80' PROP. R/W
Culvert
PROP. R/W = P/L
137TH STREET
Millers Woods Inc.
120' PROP. R/W
ANTIOCH ROAD
Hanover Investors Inc.
U.S. 69 HIGHWAY
Victor L. & Helen B. Reginier
George R. & Delores H. Trible
City of Overland Park
36" Sanitary Sewer
Hanover Corporation
36
31
RANGE 24 EAST
RANGE 25 EAST
N
E
S
W
200 0 200
SCALE IN FEET

Even though each of the applicants gave assurances that their development proposal was a "real" project and would proceed in short order, all of the rezoning requests were for land uses that could not be supported by the small amount of residential development in that portion of the City at that time, and as a result virtually no development took place. In retrospect, it is likely that those property owners were agreeable to the access restrictions because they would not be the ultimate users of the property and were looking only to increase the value of the land by having it rezoned. Most of the site plans were very generic with no specific users identified.

For the few years after the initial rush of rezoning applications, little rezoning activity took place. Once again, too few rooftops were in place in the area to support the commercial and office development planned for much of the Corridor.

The "Mall Wars" (1989-1990)

Increased residential development and the attractive "upper bracket" demographics of the southern Overland Park area attracted the interest of several developers interested in gaining a foothold in this rapidly growing area of Johnson County. One developer quickly located a site for a regional mall along the Corridor near U.S. 69, the major north-south highway in the area. The rezoning was approved with a street system and access scheme that conformed to the recommendations of **the K-150 Corridor Study.** Unfortunately, it shortly became evident that the developer of that project would be unable to fulfill his commitments; and the project fell through.

Within a few months of the demise of the first mall project, two national mall developers approached the City with plans to develop malls on adjacent sites that had been planned for much less intense development. For a period of time, the City was considering competing proposals that created intense traffic pressures on the street system that had been carefully planned to carry lower traffic volumes. In the end, one of the developers won out and the City Council approved his proposal.

The approved mall plan set up a major dilemma for the staff. The extensive traffic impact study required for the rezoning request showed traffic projections that greatly exceeded previous expectations for nearby intersections. One intersection in particular was projected to have left turn volumes that, in combination with extremely high traffic volumes on other legs of the intersection, would cause the entire intersection to break down and operate well within Level of Service (LOS) "F". If the restrictions on median breaks were followed, traffic flow in the area would be adversely impacted. But if the staff supported an additional median break that was shown to relieve the most heavily impacted intersection, that approval might jeopardize the access recommendations elsewhere in the Corridor.

Staff responded by recognizing the economic and political reality of the situation and supporting the additional median break but stating in very clear terms the uniqueness of the mall access situation. In our opinion, we were successful in making a clear distinction between the unusual traffic impacts of a regional mall and the lesser impacts of other forms of anticipated development. Ironically, the mall has yet to come to fruition. Because of retail development trends and other competing retail development in that portion of Johnson County (two miles to the north along a more mature retail corridor, 119th Street), the prospects for development of the mall project are presently slim, at best. As was the case earlier, the level of rezoning activity on K- 150 entered a lull after the mall rezonings. For a three year period after the mall applications, few commercial development proposals were brought forth.

"Real " Development (1994-Present)

Throughout the last ten years, single family residential development has occurred non-stop in the vicinity of the K- 150 Corridor. By 1994, enough residential development was in existence to support the first wave of commercial development. Since that time, developers have submitted plans for projects that actually are being and will be built.

Early on it became apparent that this group of developers had a different attitude about access control than the applicants for earlier rezonings. They were not always willing to accept the access restrictions called for by the K- 150 Study and aggressively pursued various approaches to obtain approval of additional access points.

Case One

This rezoning involved a shopping center with a supermarket as its major tenant. The developer tried different approaches to try to obtain an additional right-turn-only driveway onto K- 150. The first was the "unique case" scenario, where the developer attempted to make his site appear to be somehow different than other properties along K- 150. The assumption is that more access points are necessary for sites with "unique circumstances." The assertion was that the additional drive would improve the intersection LOS at a nearby intersection. Of course, every property is unique in the mind of its owner; but in this case no unusual circumstances surrounded the site. The developer also convinced residents in a nearby subdivision that the failure of the City to approve the additional driveway would result in a large amount of additional traffic passing by their homes on the parallel access road. As a consequence, some of the residents appeared at hearings to voice support for another drive on K-150.

Using the three-pronged approach of the unique circumstances argument, the enlistment of neighborhood support for the additional driveway to reduce traffic, and the threat that the project would not work without the driveway; the developer appeared to have a reasonable chance of achieving the goal of additional right turn access on K-150. City staff responded by arguing strongly against the proposed deviation from the K- 150 access guidelines. Staff prepared an extensive written report including a review of the history behind the original **K-150 Corridor Study** (which had been adopted eight years earlier), an analysis of the anticipated traffic patterns around the site, and a response to the applicant's assertions about traffic impacts of not approving the driveway. The most effective tool in the staffs efforts, however, was the audio-visual presentation at the public hearing. Staff presented slides illustrating the major recommendations of the **K-150 Corridor Study** and aerial photos of the site. That presentation served as both an educational opportunity for those City Council members who had taken office after the approval of the report and a "refresher course" for those members of the Council who were of longer tenure.

In the end, the vote came down in favor of the staffs position. While no one can provide a defmite explanation for that decision, the presentation by staff at the public hearing clearly was a major factor in the vote. The decision to deny the additional driveway sent a strong message to developers that the City was serious about supporting the access recommendations of **the K-150 Corridor Study.** Despite threatening to develop elsewhere if the driveway were not approved and following a second effort to request the additional driveway, the developer eventually constructed the project.

Case Two

During the early deliberations on the case mentioned above, another shopping center developer filed for the rezoning of a larger property located within about two miles of the first case. Once again, a supermarket was the major tenant. In this instance, the developer voluntarily conformed to the access scheme advocated by the City. However, when this developer discovered that the developer of the shopping center mentioned above was pursuing an additional driveway, he became very concerned and drafted a letter to the City Council making it clear that he expected equal consideration. If the City were to approve the additional driveway for the first developer, he would demand the approval of a similar driveway for his project. Although not orchestrated by staff, this developer's action probably assisted the staff in the first case. However, since the rezoning approval for the first case excluded the extra driveway on K- 150, the additional driveway did not become an issue for this second application. The shopping center was approved by the Council and subsequently was constructed by the developer.

Case Three

The most recent large site proposed for development along the K- 150 Corridor was a combined application for a national building materials store and an adjoining retail center. That building site was situated between U.S. 69 (a limited access highway) and the regional mall approved by the City at the end of the earlier described "mall wars". The traffic study submitted in support of the application presented a strong case for what the City staff had feared would occur: another unplanned median break on K- 15 0. Under full-development conditions the high traffic volumes that had been the basis for the extra median break for the mall also dictated that another median break with less than prescribed spacing be provided along the frontage of the new application. The staff was compelled to support the added median opening to maintain consistency with the earlier recommendation on the mall median break. Eventually the City Council approved the application despite opposition from residents in the area who presented concerns focussing mainly on design and land use considerations.

The building materials operation has been constructed and is open for business. An interesting footnote is that KDOT, which at the time of construction of the project had the final say over access to K- 150, did not approve the median break. They cited the recommendations of **the K-150 Corridor Study** and noted that the limited development proposed in the first phase of the project did not warrant the median break, since another full-turning movement access point was available onto an adjoining street. Since that time, the City has assumed control of the roadway and has approved the median break.

Future Possibilities

To date the City staff has had mostly success in holding to the access restrictions advocated by the **K-150 Corridor Study.** Considering that some of the recommendations of the Study have been implemented, such as the widening of K-150 to a four lane divided roadway with a limited number of access points and the construction of several sections of the parallel access road system, the Study has served a valuable purpose. The future prospects for holding as closely as possible to the K- 150 access restrictions will depend to a large extent upon the skill of the staff in convincing the City Council of the merits of restrictive access. The makeup of the Council also will be critical. Over time fewer of the council members who were in office during the preparation of the Study will remain on the Council.

The following factors will be important for the future success of the access restrictions called for by the **K-150 Corridor Study.** These strategies could be applied to similar situations in other communities.

Be Prepared

Be sure to be fully prepared, even if it is viewed as overkill. Staff must be diligent in pursuing all facets of a request for additional access so that the elected officials are provided with all of the information that they need to make a decision. Hopefully they will recognize the merits of controlling access as a way to avoid future traffic problems.

Provide Consistent Recommendations

Developers watch what is happening elsewhere along the Corridor and complain if unequal treatment is provided. Therefore, it is important to consistently apply the access guidelines established by the City Council. Even if the City Council does not follow the recommendations of staff for a specific project, the staff can point to the consistency of its recommendation.. Of course, the existence of written guidelines makes the staffs efforts much easier, so the potential for variations in interpretation are minimized.

Educate Public Officials

Educate new members of the Planning Commission and City Council (and reeducate old members) at every available opportunity. The transfer of information does not need to be in the form of a formal presentation. Staff can elaborate on access control considerations when answering questions brought up at public hearings. Informal conversations with Planning Commissioners and City Council Members sometimes can be the most productive way of getting a point across out of the glare of public scrutiny. At times a more thorough coverage of the topic is warranted. In that case be sure to use all available resources, both from national sources and from examples in the local community, to make the presentation.

Be Ready to Go to Battle

Each new application can be viewed as a new battle. Staff cannot assume a continuation of earlier positive decisions. One major area of concern is the setting of a bad precedent. If additional access were to begranted for one property without good cause, it could jeopardize the entire K-l 50 access concept. That is because developers and property owners are very much aware of competition, and any inconsistency can be exploited.

Encourage Good Access Design

Retail and office development must be properly designed so that customers and tenants are provided convenient access to the various land uses along the Corridor. It is important to encourage the use of common access drives across adjoining properties to maximize the usefulness of the limited number of permitted access points.

Roll With the Punches

If adversity strikes and the City Council approves undesirable median breaks and driveways, work to adapt to the situation as much as possible. Maintain a positive attitude. Don't keep track of "wins" and "losses", but learn from both.

SUMMARY

Applying restrictive access policies on the local level can be a challenge. Staff members are not policy makers, but can only make recommendations and steer elected officials in the proper direction to achieve the desired access control goals. Positive decisions made for one development proposal do not guarantee similar results for future projects.

In the case of the K- 150 Corridor, the Overland Park staff believe that we have had a reasonable measure of success in pursuing the access restriction goals contained **in the K-150 Corridor Study.** Clearly, not all decisions have been made in compliance with the K- 150 access guidelines, but the overall pattern of development has conformed to the street network established by the Study. The job is far from being done. Much more development will occur before the Corridor is fully developed. Even after the Corridor is mature from a development standpoint, pressures will exist to increase access to major streets, especially in areas developed with commercial land uses. We intend to continue to pursue the guidelines of the K- 150 Corridor Study with the knowledge that the implementation of those access restrictions will lead to better traffic operations and improved safety along the K- 150 Corridor

Does Access Management Improve Traffic Flow? Can NETSIM Be Used To Evaluate?

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ABSTRACT

The purpose of this study is to evaluate the impacts of access management on traffic flow and to determine whether TRAF-NETSIM, a microsimulation model, is an appropriate tool to model access management improvements. Access management is the control of the location, design and operation of the signalized and unsignalized intersections with stop and yield sign controls and driveways. Three different arterials (State Roads 5, 817 and 838) located in the City of Fort Lauderdale, Florida with varying length, traffic characteristics, land use and development densities were selected for the simulation of traffic flow using TRAF-NETSIM. All of these arterials are typical urban six-lane divided highways and consist of signalized intersections, unsignalized intersections (fu11 or directional median openings), and a number of driveways. Two of these arterials have been identified as high crash locations and safety improvement projects are scheduledfor construction in FY 1997198. Access management related improvements were also included as part of these projects to upgrade these segments of state roads to current access management standards.

Proposed roadway improvements include modifying signal phasing/timing, installing protected left turn phase at two major intersections, closing or channelizing median openings, extending left turn lanes and closing/consolidating some of the driveways. All the improvements proposed are based on intensive safety/operational analysis and access management standards. These access management standards were formulated as part of the Administrative Rule 14-97 developed in response to the State Highway System Access Management Act passed in 1988. This act is aimed at improving traffic safety and flow, reducing vehicle emissions and improving fuel economy.

Traffic flow was simulated using TRAF-NETSIM on all three state roads incorporating aforementioned improvements. The TRAF-NETSIM model was calibrated to represent local traffic conditions using parameters such as headway, vehicle length, gap distribution parameters, etc. Necessary data (traffic counts, queue length, delay/gap studies etc.) were collected to enable proper calibration. Variables such as discharge headway, gap distribution parameters and free-flow speed were found to have reasonable impact on the calibration of NETSIM Video tapes of the actual traffic flow were used to compare the simulated flow(animation)as a way to enhance the accuracy of calibration. Furthermore, U-turns resulting from channelization of median openings, a typical access management strategy, were also successfully modeled to simulate the impact of access management on traffic flow.

The networkwide Measures of Effectiveness (MOE's) for before and after conditions were compared to verify whether access management improves traffic flow. The simulation study for State Road 817 indicates that access management has positive impact on traffic flow. Improvements proposed for this arterial are purely access management related and consist of no signal phasing/timings modifications. On the other hand, the results of the simulation for State Roads 5 and 838 do not clearly indicate any substantial changes in traffic flow. This is not surprising since some of the improvements proposed for State Road 5 and 838 are safety oriented, such as protected left turn phase and median channelization, which, in general, will tend to cause more delay. It appears that access management improves traffic flow, if properly designed. However, similar analysis needs to be conducted at more locations (with varying ADT, turning traffic number of lanes, development density etc.)to increase the confidence level in the results and conclusions. Based on the results, it can be concluded that different locations require different access management strategies to achieve significant benefits. Each location needs to be analyzed carefully before reaching a decision on what improvements are appropriate. We believe that NETSIM is capable of simulating access management

improvements, and it can be used to estimate the impact of these improvements on traffic flow with reasonable accuracy.

INTRODUCTION

Traffic engineers have long recognized that the elimination of unexpected events and the separation of decision points simplifies the driving task. Since access control reduces the number and complexity as well as increases the spacing of events to which the driver must respond, it results in improved traffic operations and reduced accident experience(1). Access management is the careful control of the location, design and operation of all driveways, median openings, and street connections to a roadway. Comprehensive access management is a new response to the congestion, the loss of arterial capacity, and the serious access related accident experience that is plaguing our nation's roadways.

Various research efforts have explored the general relationship between accidents and access control(1). The Colorado Access Control Demonstration Project compared average travel speed, average daily traffic volume per lane, total accidents, rear-end accidents and broadside collisions for various roadways in the Denver Metropolitan Area (2)and found that average travel speed and daily traffic volumes per lane increased and accidents decreased as the degree of access control increased. This study utilized TRANSYT-7F to evaluate the effect of access management on a five-mile segment of roadway. However, very limited research has been done using TRAF-NETSIM to evaluate the impact of access management on traffic flow. The TRAF-NETSIM has the capability to simulate actuated signal control. Furthermore, the NETSIM has the ability to simulate U turns resulting from channelized median openings, a typical access management strategy, and the user has some degree of control on vehicle path, which is critical to accurately simulate access management strategies. Three different arterials located in the City of Fort Lauderdale, Florida with different length, traffic characteristics, land use and development densities were selected for the simulation of traffic flow using TRAF-NETSIM.

OBJECTIVES

The objectives of this study are:

1) To determine if TRAF-NETSIM is a proper tool to simulate access management improvements

2) To determine which input variables can be used to calibrate the TRAF-NETSIM model to match simulated flow to the actual flow observed in the field.

3) To evaluate the impacts of access management on traffic flow by comparing speed, queue time, stop time, travel time, percent stops, fuel consumption, pollution emissions for existing and proposed conditions i.e. with and without access management improvements.

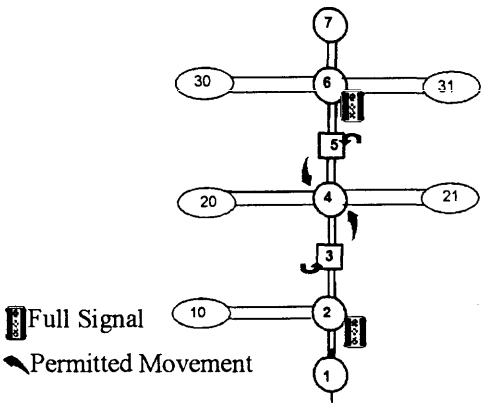
STUDY LOCATIONS

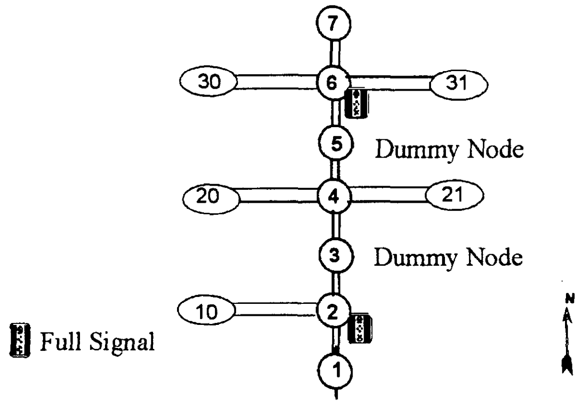
All three locations selected for the study are typical urban six-lane divided highways and consist of signalized intersections, unsignalized intersections(ful1 or directional median openings), and a number of driveways. Two of these three study sites have been identified as high crash locations and safety projects are scheduled for construction in 1997/98. The improvements proposed are based on traffic safety/operational analysis. Access management related improvements were also included as part of these projects to upgrade these segments of state roads to current access management standards. Access management spacing standards are based on the Administrative Rule 14-97 of the State Highway System Access Management Act passed in 1988. Proposed improvements include closing and/or channelizing median openings, extending left/right turn lanes, removing/modifying signals, phasing/timing changes **and** closing/consolidating the driveways.

Arterial 1 (SR 8 17 or University Drive) is approximately 0.6 miles in length and consists of two signalized intersections, an unsignalized intersection or full median opening, and has limited number of driveways (see figure 1). This segment of University Drive carries an Average Daily Traffic (ADT) of 50,30 1. The left turn and through traffic at the full median opening is in the range of 20-100 VPH. Land use along this segment of University Drive is mostly residential. Several requests were received for a traffic signal at the unsignalized intersection, i.e. University Drive at S. Marcano Boulevard. In response to these requests, two alternatives were evaluated using TRAF-NETSIM: 1)a full traffic signal and 2) a median island that restricts traffic from S. Marcano Boulevard to right turn only. Alternative 2 includes two left turn lanes in the median to facilitate U turns resulting from the access restriction to right turn only (see figure 1).

Arterial 2 (SR 838 or Sunrise Blvd)is approximately one mile in length and consists of three signalized intersections, nine directional median openings, and a number of driveways (see figure 2). Of these nine directional median openings, eight have flashing signals connected to delay detectors, which are activated when a vehicle waits for more than eight seconds to find gaps. This segment of Sunrise Boulevard carries an ADT of 58,768 and provides direct access to the businesses located along the corridor and serves the needs of residential areas beyond its commercial frontage. Heavy commercial use along this segment generates left turning traffic around l00-160 VPH at the median openings. This segment of Sunrise Boulevard has been identified as a high crash location. Proposed roadway improvements include modifying signal phasing/timing at node 2,9, and 13, installing protected left turn phase at node 9, closingkhannelizing median openings, and extending left turn lanes at several locations (see figure 2). All the improvements proposed are based on safety/operational analysis and access management standards. However, the public involvement meetings have resulted in some changes to the original design.

Arterial 3 (State Road 5 or Federal Highway)is one mile long and consists of five signalized intersections, five full median openings and a number of driveways serving businesses (see figure 3). This segment of Federal Highway carries an ADT of 4 1,265 and provides direct access to the businesses located along the corridor and serves the needs of residential areas beyond its commercial frontage. The left turn traffic at the full median openings is in the range of l0-80 VPH. This segment of Federal Highway has been identified as a high crash location. Proposed roadway improvements include modifying signal phasing/timing at node 4,6 and 9, installing protected left turn phase at Broward Boulevard (node 20), signal removal at node 2, closingkhannelizing median openings, and extending left turn lanes at several locations (see figure 3). All the improvements proposed are based on safety/operational analysis and access management standards. However, the public involvement meetings have resulted in some changes to the original design.

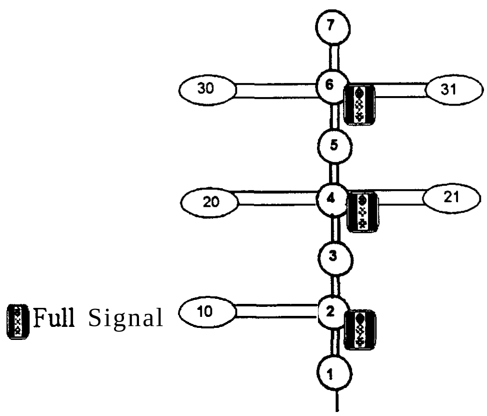




Alternative 1

Median Channelization at S. Marcano Blvd. (Node 4)

Existing Conditions

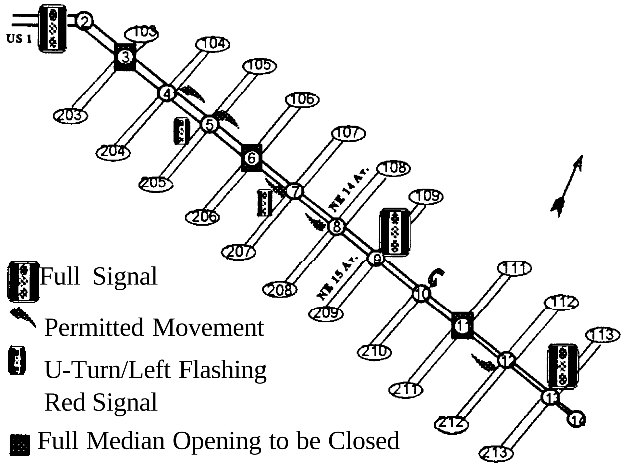


Alternative 2

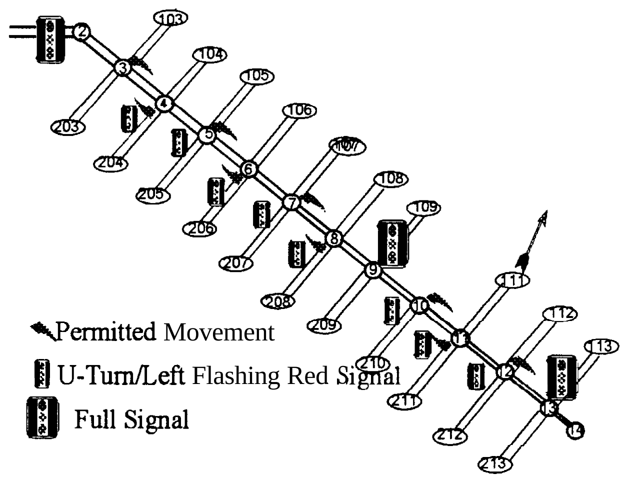
Full Signal at S. Marcano Blvd. (Node 4)

University Drive (State Road 817)

FIGURE 1



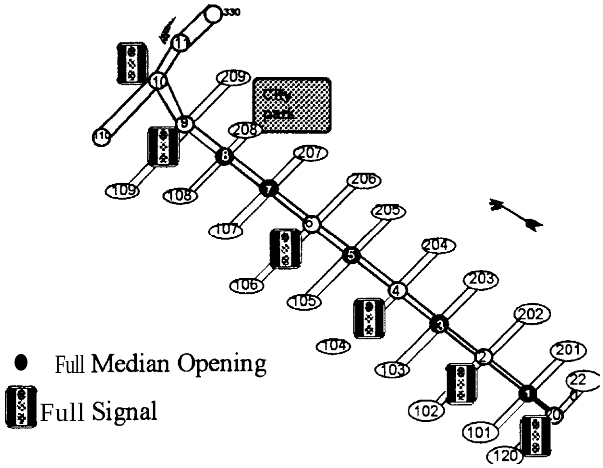
Proposed Conditions



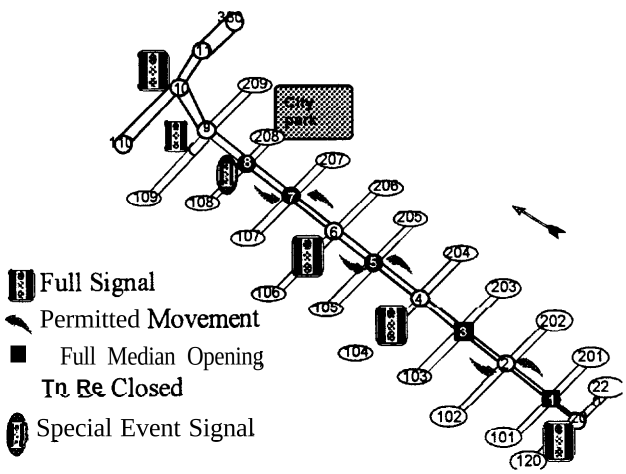
Existing Conditions

Sunrise Boulevard (State Road 838)

FIGURE 2



Existing Conditions



Proposed Conditions

Federal Highway (State Road 5)

FIGURE 3

METHODOLOGY

The study was conducted in five stages as follows:

1) TRAF-NETSIM analyses was conducted with existing traffic and geometric conditions in order to simulate traffic flow.

2) Measures of effectiveness (MOEs) such as delay, travel time, and queue length from the model were compared to the values measured in the field. These field values served as the basis for calibrating TRAF-NETSIM.

3) TRAF-NETSIM was calibrated by changing parameters such as speed, headway, gap acceptance and driver characteristics to represent local traffic conditions.

4) The geometric improvements including access management strategies such as median modifications, signal removals etc. were coded into the model to simulate traffic flow with modified conditions.

5) The total travel time, delay time, queue time, stop time, percent stops, speed, fuel consumption and pollution emissions (Hydrocarbon, Nitrogen Oxide and Carbon Monoxide) were compared for before and after conditions to evaluate the impacts of access management on traffic flow.

TRAF-NETSIM can simulate majority of the access management strategies and coding is relatively simple except for U turn simulation, which requires some extra effort. As some access management strategies create need for U turn maneuvers, the U turn simulation is critical to evaluate the impact of access management on traffic flow.

Restricting access from a side street or a development to right turn only at some locations may create demand for U turns at adjacent intersections. For example, as a result of median channelization(refer to figure 4)at intersection 2, motorists (who were making left turns before the restriction) have to make right turns at node 2 and make U turns at node 3 to travel back towards node 1. Simulation of this combination of vehicle path and U turn movement is critical to successfully model access management improvements.

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Figure 4

This combination of right turn and U turn movements has been simulated using card type 22(conditional turning movements)and 1 link characteristics). Card type 22 can be used to assign %of vehicles entering link 2-3 (see figure 4) via right turn make U turns at the intersection 3. U turns can be simulated by coding as left turns at node 3 with receiving node number 2. If there is left turn and U turn traffic making turns from the same lane at node 3, coding gets a little complicated. Entries from 11 to 17 can be used to channelize lanes appropriately to send U turn and left turn traffic out of the same lane. In addition, cards 35 and 36 have been used define sign or pretimed signal control.

The following table illustrates possible combinations of U turn/left turn traffic maneuvers under different traffic control devices. YES or NO in the following table indicates whether NESTSIM can or cannot model the combination of movements and traffic control.

	NO SIGNAL	PRETIMED SIGNAL		ACTUATED SIGNAL	
		Permissive	*Protected*	*permissive*	*protected*
U TURNS ONLY	**YES**	YES	YES	YES	YES
U TURNS+ LEFT TURNS FROM THE SAME LANE	YES	YES	NO	YES	YES

As can be seen from the table, NESTIM can not model U turn and left turn maneuvers from the same lane under protected phase(e.g. north and south simultaneous left turn phase) with pretimed signal. However, this problem can be solved by coding the signal as actuated (cards 43 thru 48) with minimum green equal to maximum green.

SIMULATION RESULTS

Table 1 shows the results obtained from the simulation of before and after conditions on University Drive. Refer to figure 1 for existing and proposed conditions. Existing full median opening at S. Marcano Boulevard is proposed to be channelized. As can be seen from table 1, median channelization is expected to enhance traffic flow along University Drive. The travel speed increased by 4.3 5 percent and Que time and stop time reduced by 15 percent each. Although the percent 'stops and pollution emission increased, the increase seems to be insignificant. The first column in the table indicates the ratio of move time to total time on the network. The results indicate that with the existing conditions, the traffic will move only 42.8 percent of the time as opposed to 44.8 percent without the signal.

TABLE 1

University Drive from Cleary Boulevard to N. Marcano Blvd

Median Channelization at S. Marcano Blvd.

	M/T	Total Time	Delay Time	Que Time	Stop Time	Stops	Speed	Fuel Cons	HC	CO	NOX
		Minutes Per Vehicle Trip				Percent	MPH	MPG	KG/Mile Hour		
Exist.	**0.428**	**1.910**	**1.092**	**0.658**	**0.626**	**112.10**	20.680	**10.140**	**0.659**	**40.572**	**2.089**
Prop.	**0.448**	**1.834**	**1.012**	**0.560**	**0.532**	**112.700**	21.580	**10.30**	**0.661**	**41.021**	**2.106**
% Change	**4.67**	**3.98**	7.33	14.89	15.02	-0.57	**4.35**	, **1.58**	**-0.30**	-1.11	**-0.82**

Table 2 provides a comparison of travel time, speed and pollution emission for SR 8 17 for the before and after conditions i.e. without(existing) and with signal (proposed) at S. Marcano Boulevard. Refer to figure 1 for existing and proposed roadway conditions. As can be seen from the table 2, signal at S. Marcano Boulevard is expected to substantially deteriorate traffic flow on University Drive. Results indicate the average speed is expected to reduce by 9 percent and percent stops expected to increase. The queue time and stop time expected to increase by 19 percent each. The first column in the table indicates the ratio of move time to total time on the network. The results indicate that with the signal, the traffic will move only 39 percent of the time as opposed to 42.8 percent without the signal.

TABLE 2

University Drive from Cleary Boulevard to N. Marcano Blvd

Traffic Signal at S. Marcano Blvd.

	M/T	Total Time	Delay Time	Que Time	Stop Time	Stops	Speed	Fuel Cons	HC	CO	NOX
		Minutes Per Vehicle Trip				Percent	MPH	MPG	KG/Mile Hour		
Exist.	0.428	1.910	1.092	0.658	0.626	112.10	20.680	10.140	0.659	40.572	2.089
Prop.	0.390	2.182	1.340	0.786	0.746	142.500	18.760	9.360	0.756	46.995	2.390
% Change	-8.88	-14.24	-22.71	-19.45	-19.17	-27.12	-9.28	-7.69	-14.72	-15.83	-14.41

Table 3 shows the simulation results for before and after conditions along Sunrise Boulevard(refer to figure 2). The results indicate that traffic will stop fewer times, but with slightly longer time per stop, which is an indicator of reduced potential for rear-end and sideswipe crashes. The networkwide delay and total travel time increased. This could be attributed to signal removals, protected left turn phase at NE 15th Avenue and longer trip lengths due to median modifications. Furthermore, as a result of the public involvement meetings, the original proposal, which was more restrictive, had to be modified. The combination of all these strategies may have caused additional networkwide delay. However, the delay to thru traffic on Sunrise Boulevard decreased and the delay to left turn traffic increased as expected. The fuel consumption per gallon is expected to improve by 2.3 6 percent and the pollution emission is expected to reduce by 3-4 percent, which may not be significant.

TABLE 3

Sunrise Boulevard from US1 to NE 17th Way

Protected Left Turn Phase at NE 15th Avenue and Median Modifications

	M/T	Total Time	Delay Time	Que Time	Stop Time	Stops	Speed	Fuel Cons	HC	CO	NOX
		Minutes Per Vehicle Trip				Percent	MPH	MPG	KG/Mile Hour		
Exist.	0.536	2.160	1.000	0.582	0.560	134.3	20.520	11.040	0.278	15.845	0.866
Prop.	0.530	2.212	1.036	0.630	0.610	126.600	20.380	11.300	0.272	15.288	0.841
% Change	1.12	-.2.41	-3.60	-8.25	-8.93	5.73	-0.68	2.36	2.16	3.52	2.89

Table 4 provides a comparison of travel time, delay time, speed and pollution emission for State Road 5 for the before and after conditions Refer to figure 3 for existing and proposed roadway conditions. Although, the total travel time and delay time decreased, the change seems to be insignificant. Pollution emission is expected to reduce by 2-3 percent, which may not be significant. The simulation results reflect the impact of access management, signal timing changes and other safety improvements. Further analysis is needed to isolate benefits related to access management.

TABLE 4

State Road 5 from Broward Boulevard to Sunrise Boulevard

Protected Left Turn Phase at Broward Boulevard and Median Modifications

	M/T	Total Time	Delay Time	Que Time	Stop Time	Stops	Speed	Fuel Cons	HC	CO	NOX
		Minutes Per Vehicle Trip				Percent	MPH	MPG	KG/Mile Hour		
Exist.	0.456	2.306	1.252	0.850	0.830	144.100	17.260	10.220	0.307	16.841	0.950
Prop.	0.458	2.262	1.222	0.846	0.826	145.200	**17..360**	10.360	0.301	16.424	0.932
% Change	0.44	1.91	2.40	0.47	0.48	-0.760	0.58	0.58	1.95	2.48	1.89

CONCLUSIONS/RECOMMENDATIONS

Based on this investigation, it does appear that access management improves traffic flow, if the improvements are properly designed. The conclusions are based on networkwide statistics for the three study locations. Due to time constraints and intensive data collection/analysis efforts, a thorough review of link-specific statistics was not done to isolate benefits to arterial through traffic The TRAF-NETSIM was found to be capable of simulating and estimating the impact of access management improvements on traffic flow with reasonable accuracy.

Simulation study for State Road 8 17 indicates that access management has positive impact on traffic flow. Improvements proposed for SR 8 17 are purely access management and no signal phasing/timings changes are included. The results of the simulation for State Roads 5 and 838 do not indicate any significant changes in traffic flow. This is not surprising since some of the improvements proposed for State Road 5 and 838 are safety oriented, such as protected left turn phase and median channelization, which, in general, will tend to cause more delay. The increase in travel time and stop time could be attributed to change of left turn phase to protected only phase at Sunrise Blvd/NE 15th Avenue and US 1 at Broward Blvd, longer trip lengths because of median modifications and removal of left turn flashing signals at several locations. Preliminary analysis of some site specific locations indicate that removal of left turn signals resulted in increased delay to left turn traffic and reduced delay to thru traffic. Furthermore, intensive public involvement meetings conducted have resulted in changes to the original design, and variance from the access management standards has been granted for some locations. The simulation results in tables 3 and 4 are combination of all the aforementioned strategies. A thorough review of results to isolate the specific benefits which can be attributed solely to access management was not done as part of this study.

From the simulations results, it appears that access management improves traffic flow, if the proposed improvements are properly designed. In cases where signalized intersections are part of the arterial being analyzed, strong consideration should be given to providing adequate U turn opportunities prior to the signalized locations. Otherwise, signalized intersections will degrade further and limit arterial through carrying capacity. The number of (acceptable) gaps available should be evaluated against the increased demand for turning traffic resulting from consolidating median openings. It appears that different locations require different access management strategies to achieve significant benefits. Each location need to be analyzed carefully before reaching a decision on what improvements are appropriate.

FURTHER RESEARCH

The results shown in the tables are networkwide averages. Due to time constraints and intensive data collection/analysis efforts, a through review of link-specific statistics was not conducted in order to isolate benefits to arterial traffic. In addition, further analysis is needed to isolate specific benefits resulting from access management, especially on state road 5 and 838 as the results shown in tables 3 and 4 reflect the impact of both access management and non-access management improvements. The above analyses are being conducted by the authors.

Further, this study is based on only three locations. To increase the confidence level in the results and conclusions, similar analysis needs to be conducted at more locations with varying ADT, turning traffic, number of lanes, development densities etc. In this respect, three more locations are being studied.

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Evaluating Driveway Access and Intersection Design With Multiple Measures of Effectiveness

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ABSTRACT

This paper presents a working model to improve roadway access intersection design during any stage of adjacent land development. A comprehensive model is proposed, consisting of several components: 1)an expert system to guide design in accordance with published criteria; 2)simulation models to test alternative designs: and 3)a graphical multi-criteria evaluation system which quantifies marginal impacts of changing design parameters across multiple objective functions including vehicular delay, traffic conflicts as a surrogate of safety, and capital cost.

Access intersection designs have been analyzed at several sites which exhibit different roadway characteristics. Measures of effectiveness, including delay, safety, and cost, of various design alternatives are presented in graphical format to permit trade-off analysis between the designs. By changing several design parameters (lanes, turn lanes, control devices, signal timing/phasing, and intersection spacing), alternative designs are easily evaluated.

The integrated model was developed at the Utah Transportation Center, Utah State University as part of continuing research into applying computer technology to improve transportation design and operation. The model features a standard PC Windows-based graphical interface, object-oriented modules for easy expandability, and simple user operation.

INTRODUCTION

One of the most pressing world-wide issues is managing the increasing traffic congestion and safety issues occurring in growing areas. Most of this congestion occurs due to conflicting traffic maneuvers at roadway intersections where design and operation is comprised of a complex set of parameters including number of traffic lanes, number and length of turning lanes, spacing between intersections, sign or signal control, and timing and phasing of signal controls. Often, congestion and safety issues are the result of inadequate design of the access and intersection points which is often established in the early stages of adjacent roadway development when such inadequate designs are not noticeable or given much importance.

Over 70% of the non-Interstate highway mileage on the proposed National Highway System (NHS) does not currently have any access control(l). Over 56% of the mileage is only 2-lane and likely to require capacity improvements to handle growing traffic volumes. As land develops along these roadways, there is a demand for ingress to and egress from the highway, which in virtually all cases, occurs at surface intersections.

When traffic volumes are low on the main roadway or adjacent land development is sparse, access intersections do not pose much of a problem and the need for adherence to design criteria is less apparent. However, as traffic volumes or land development increases, access intersections play an increasing role in the safety or capacity of the main roadway. In addition, when adjacent land parcels develop and access proliferates, highways often become multi-functional, serving both high-speed longdistance traffic and local access oriented traffic. This leads to traffic safety conflicts, traffic congestion and delay.

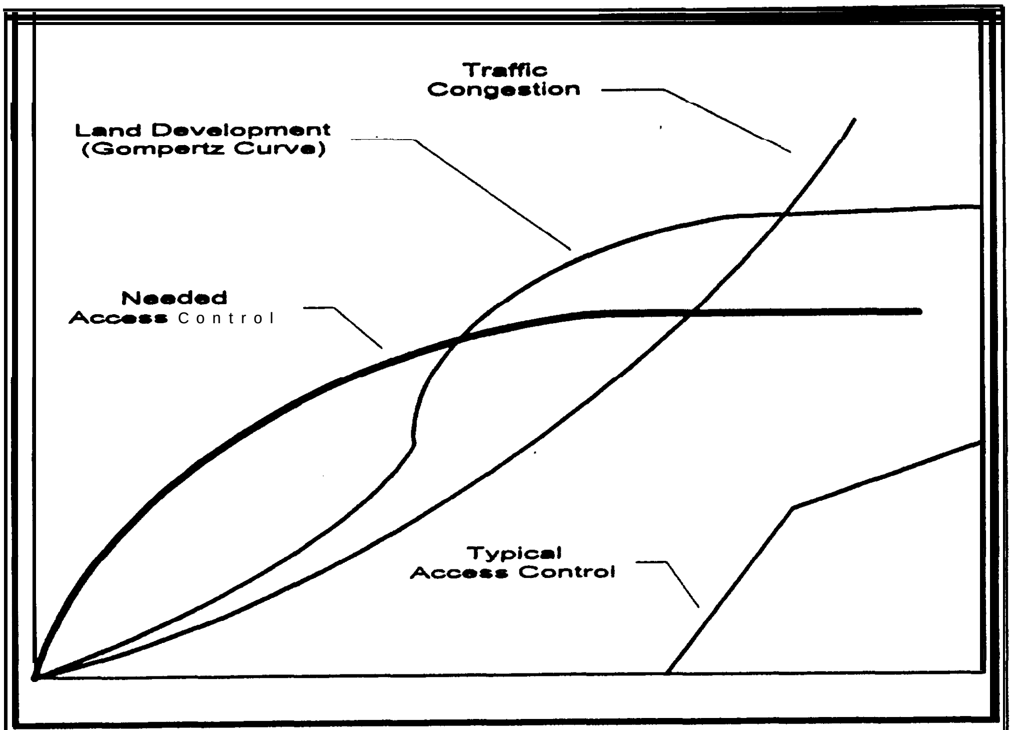

Figure 1
Relationship of Development, Traffic Congestion, and Remedial Highway Measures

Traditionally, most decisions for approval and design of highway access points and intersections are based on locally available criteria and analysis tools which are pretty limited in terms of evaluating site specific measures of effectiveness. Tradeoffs between measures such as motonst time delay, safety, air pollution, and cost are evaluated subjectively, if at all. Even though the costs of not selecting the optimal design may be extremely high, the current process all too readily accepts designs based on judgments by one or two individuals.

The typical site or driveway access review is generally pretty limited in scope, if even performed. This practice has several principal limitations:

(l)There is often an over-reliance on "experience" rather than documented criteria because published information is scattered, not always known, and not always easily accessible or retrievable.

(2) Most vehicle delay analysis procedures have been formulated for stand-alone intersections and do not account for stochastic traffic or geometric effects.

(3) Testing of "what-if' alternative designs is not always possible or easily accomplished due to limited or cumbersome models.

(4) Because of the many design parameters involved, most current procedures involve the use of simplifying assumptions which may compromise the optimal design for the specific site location. Even a simple 4-way signalized intersection can have over 10^{15} acceptable alternative designs.

The penalty for accepting sub-optimal designs can be large. Safety may be compromised, congestion and air quality worsened, and construction and maintenance costs increased.

This paper presents a working model to address the congestion and safety problems that can result from inadequate design of intersections and driveway access points along highways experiencing roadside development. It can improve intersection design and operation by utilizing several measures of effectiveness: vehicle delay, safety, air pollution, and capital cost. An integrated model has been developed, consisting of several components:

- a knowledge-based expert system which evaluates designs in accordance to published traffic engineering criteria;
- several simulation models including traffic delay, air quality, cost and conflict analysis.
- a graphical evaluation system which reveals marginal impacts of changing design parameters.

A case-study of a typical site development application along fast-growing roadways is presented to illustrate the model's operation.

BACKGROUND

An extensive review of previous research pertaining to expert systems, access management design criteria, arterial and intersection simulation modeling, capital cost analysis, intersection safety analysis, and multi-criteria decision analysis was conducted. A great deal of highway research has been focused on criteria in three nationally accepted publications: "A Policy on Geometric Design"(2) (herein referred to as the "AASHTO Green Book"); The 1985 "Highway Capacity Manual"(3) (HCM); and the Manual of Uniform Traffic Control Devices"(4) (MUTCD).

Much of the research work regarding the application of expert systems in the design of roadway intersections has principally concentrated on using heuristic rules based on deterministic equations, interviews with "experienced" engineers, and procedures and criteria from the AASHTO Green Book, HCM, and MUTCD reference manuals. Signalized intersections have received much attention due to the complexity in optimizing traffic signal phasing and timing. Research by Zozaya-Gorostiza and Hendrickson(S), Linkenheld(6), Pattnaik, et a1.(7), Chang(8,9), Morris and Potgeiter(10), Bryson and Stone(11) , Radwan et al.(12), Demetsky(13), Ritchie(14), Gupta, et al.(15), Chang and Huamg(16), Bielli et al.(17), Elahi,et al.(18), and Gal-Tzurll, et al.(19), has demonstrated various forms of knowledge-based rule systems for intersection and traffic signal control design. Unfortunately, most of the work has not been integrated into commonly used analysis tools used in everyday site review processes. Consequently, most of this previous work goes unused today.

Typically, state-wide access management programs include the following roadway design elements: driveway separation, comer clearances, median openings, signal spacing, turn movement restrictions, right-of-way purchases, land use zoning, interior site design as related to access, and improved intersection geometry. Access management design criteria was gathered from States already actively pursuing programs including Colorado(20), Florida(21), New Jersey(22), Oregon, and Wisconsin. In addition, several publications have addressed specific highway design criteria related to access management. Levinson and Kopeke(23) have established general principals for establishing control at access or roadway intersections. Stover(24) has proposed access intersection design criteria by functional classification and intersection functional boundaries.

Highway access intersections can be quantifiably measured using several factors such as vehicle delay, safety, capital cost, and air quality impacts. The 1994 Highway Capacity Manual provides deterministic procedures for determining highway capacities, including special procedures for signalized and unsignalized intersections.

Previous research in intersection safety analysis can be summarized in three categories: historical accident analysis with regression models; empirical traffic conflict analysis with regression models; and conflict opportunity models. Prior research has shown that historical accident analysis can be a poor predictor of future accidents(25).

Using traffic conflicts as a surrogate for traffic safety was presented by Pcrkins(26), Bakcr(27), Hayward(28), Allen et a1.(29), Glauz and Migletz(30), Zegeer and Deen(31). Research in Georgia(32), and by Hauer(33) have discussed the statistical problems measuring conflicts and relating to accidents. Council et a1.(34) developed a series of models based on total vehicle exposure and the number of conflict opportunities with other vehicles. Ha and Berg(35) expanded upon this work and demonstrated the use of kinetic energy calculations to represent severity levels. Fazio and Rouphail(36) used the Intras microsimulation model to examine both lane change and rear-end conflicts on freeway merge and weaving ramp areas using deceleration rates to classify conflicts into minor, moderate, and major severity classes. While use of a microsimulation model to generate conflicts is an interesting approach, it was beyond the scope of this research.

Costing intersection improvements was discussed by Witkowski(37). Procedures for determining air quality impacts have been developed by the U.S. Environmental Protection Agency(3 8).

MODEL FORMULATION

This research investigates the design (or design review) process with particular emphasis on the integration of the analysis, evaluation, and acceptance components. The proposed design model should integrate and automate the various procedures which are generally required during the design process. This entails the input of an initial design, generation of design alternatives, review of design feasibility, operational analysis of design, evaluation of alternatives, and acceptance of the best solution.

An intelligent, 4-component decision-support system is proposed that can assess or perform each of the design procedures. The system takes an initial design and applies a rule-based expert system to the design, testing for conditions which are totally unacceptable (fatal design errors); undesirable conditions (non-fatal design warnings); and possible design changes (suggestions). Fatal design errors result in rejection of the design and require an alternative design. Non-fatal design warnings allow for immcdiatc design modifications or provide intelligent information for future design modifications if required. The design can then be analyzed with a response function which utilizes a traffic operations simulation module, a safety conflict module, and a cost module. The response function produces quantitative measures of several objective functions: vehicle delay(seconds per vehicle); safety(number of conflicts); and capital cost(dollars). These measures are compared to alternative designs using an intelligent evaluation model which displays the marginal effects on each objective function with results plotted on a surface graph.

Review of Design Feasibility (Expert System)

Since it would be inefficient to evaluate invalid design alternatives, an expert system module and rule base has been developed to evaluate a design alternative's compliance with Federal, State, and Local statues and with industry accepted design criteria. The rule-based decision-support module, is based upon using **a** forward-chaining procedural approach with a knowledge database of if-then rules constructed from an exhaustive search of reference manuals, publications, and surveys of experienced traffic engineers. The expert system permits the option for an interactive approach, allowing manual design changes to be immediately checked against the rule-base with on-screen exception reporting. Options for both acceptance and exception reporting to a database has also been included, along with on-screen and printed output reporting.

The exception reporting system contains three levels of user messages: Stop, which implies **the** specified design value does not meet critical design statues; Warning, which implies the specified design value does not meet other accepted criteria; and Suggestion, which suggests recommended design criteria for the specific design. An example of the on-screen exception display is shown in Figure 2.

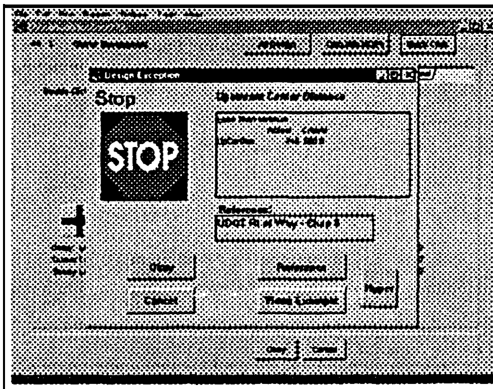

Figure 2
On-Screen Rule-Base Exceptions

The knowledge **rule-base** contains reference information for each rule which specifies the publication and location for the design criteria that the rule is based upon. A windows help file contains excerpts from prominent publications on access management and allows the user to read the context of the design criteria used in the rule. Capability is also provided for video clips to illustrate important criteria. A link to the metric/English calculator, Hypercalc, is also provided to assist in evaluating the design relative to the criteria.

The rule base contains criteria specified in the Utah Department of Transportation(UDOT) Right of Way Manual, although any rules can be added as the principally governing criteria.

Operational Analysis of Design

For this research effort, several measures of effectiveness have been used as representative of traditional measures that are used throughout the traffic engineering profession. The measures to be used are: total average vehicle delay along the study corridor(which is the weighted average of average vehicle delay along each link), traffic safety based upon vehicle conflicts as a surrogate of safety, and construction cost of added geometric improvements. Although air quality measurements can be analyzed (and the algorithms for Cal3QHC are contained in the model, it was decided that if the study location was in an area of EPA designated “attainment” status, then air quality would not be an issue, while if the area was designated “non-attainment”, then the applicable air quality measure would be a binary accept/reject decision. The decision support system simply indicates acceptance levels of air quality and does not include such measures in the trade-off analysis.

Vehicle travel delay is estimated using the deterministic intersection procedures contained in the 1994 Highway Capacity Manual, including both signalized and unsignalized. Additional equations from Webster(39) are used to determine queue lengths at signalized intersections. Delay calculations for roundabouts has also been included in the model and is based on the Australian method(40).

Traffic safety was based on a determination of risk, based on conflict opportunities. According to Blockley(41), determination of engineering risk must consist of three elements: the likelihood, consequences, and context. Even a high incidence of one of these elements without the other two, the risk is still insignificant. For example, even if the likelihood of an accident is high, if the consequences are neglible or if people just don’t care, the risk is not great. Risk assessment can follow procedures set out by Bowles, et a1.(42).

While it is attractive to measure accident likelihood based upon historical information, previous discussion has shown that statistically significant predictions are not possible because of the random nature of the reported accidents. While conflict opportunities seem to be a better determination of likelihood, unfortunately, pure conflict opportunity measures for certain movements will dominate other movements and will unlikely be in proportion to risk. For example, as developed by Council, head-on collision opportunities will be the product of the total traffic on the main thru street, which can be a very large number, but the actual likelihood of cross-over collisions is very low compared to angle collisions whose conflict opportunities may be a much lower number. Council et al. tries to address this concern with a conflict type specific -weighting factor.

Using the three elements of risk analysis: likelihood, consequences, and context, a combined risk analysis equation can be formulated:

$$\text{Total Risk} = \Sigma\ (\text{Conflict Opportunities}) * \text{Likelihood} * \text{Severity}$$

With:

$$\text{Likelihood} = \text{Propensity} * \text{Accident Rate}$$

Conflict opportunities are based on the equations developed by Council, et al., using both the rear-end and side-angle equations. The likelihood of accidents occurring at intersections can be developed by identifying all conflicting movements and multiplying them by the propensity of each conflicting movement to be an accident. A four-leg intersection has a total of 40, possible conflict points with adjoining intersections within functional boundaries have additional conflict points (see Figure 3). Zegeer and Deen found that 3 types of conflicts: traffic backup, slow for left turn, slow for right turn (which are all mostly rear-end types) accounted for 80% of all conflicts(measured intersections were signalized). Because of permitted movement definition, unsignalized intersections will be more likely to have cross-traffic risk than signalized, thus, for this research, it was assumed that both rear-end and side-angle conflicts would bc

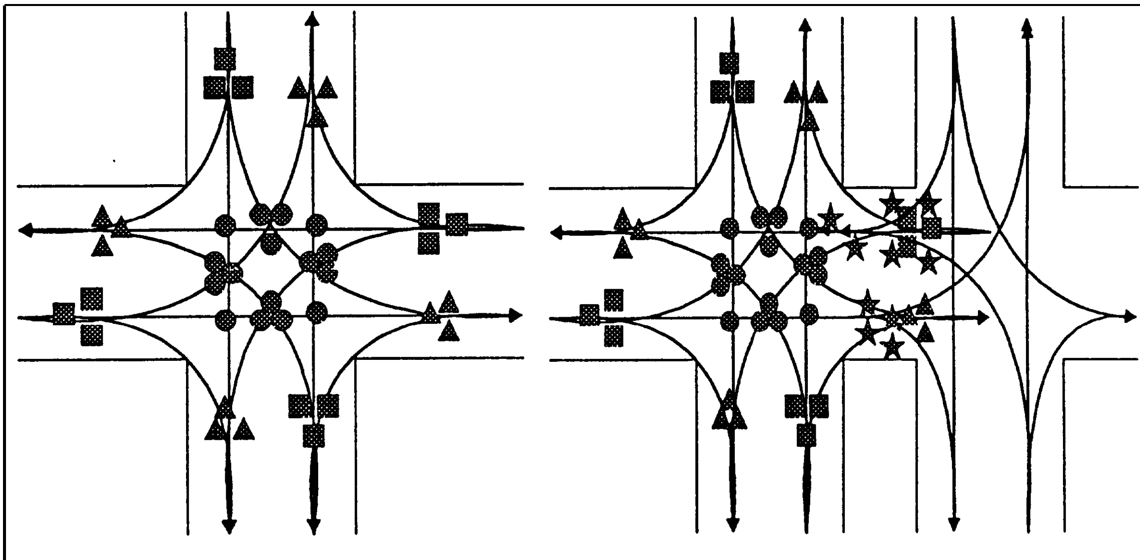

Figure 3
Conflict Points

included. Although pedestrian conflicts were not included in this research , the high liability exposure makes this category important in an overall risk calculation where pedestrian movements are allowed or frequently occur.

Since some conflicting movements are very unlikely to occur, a measure of propensity is based on professional judgements as to whether certain conflict points and movements are counted in the conflict determination. For example, at signalized intersections, movements that are stopped by a red signal are not counted as conflicting with green signal movements. Because there is always a very small possibility for erratic movements, (ie. a driver could pass through a red signal), a more thorough approach would be to use probability distributions for propensities, however, that approach is beyond the scope of this research. Accident rates relative to conflict opportunities were assumed from previous research by Ha and Berg.

Safety severity has been based on speed and mass determined by the particular conflict points and movements. Although heavy traffic, conflicts, and eratic manuevers can be stressful and increase driver workload, people just do not seem to be overly concerned until a physical accident occurs(see explanation of context). For purposes of this research, three levels of severity have been used: fatalities, injuries, and property damage.

Average capital improvement costs are accrued when certain design parameters are changed to add physical facilities to the system such as additional lanes, signal control devices, turning lanes, or channelization.. Costs are determined by simply multiplying the occurrences of the additional parameters times predetermined average unit costs. Average unit costs have been obtained from local cnginccring estimates.

Table 1

Unit Improvement Costs

Improvement Type	**cost ($)**
Right Turn Lane	$ 45,000
Left Turn Lane	40,000
Thru Lane	75,000
Signalization	100,000
Signal Phasing Changes	25,000
Restriping	5,000
Additional Travel Lane	75,000 / 305m (1000 A)

<u>Evaluation of Alternatives (Multi-Criteria Decision Analysis)</u>

There are many popular approaches to performing multi-criteria decision making analysis. Approaches most applicable to this research include: Scaling (which involves the translation of each criteria to a common denominator unit of measure); Weighting (which applies importance weights to each criteria); Decision Rules (essentially a weighting method); Exclusionary Screening (which excludes altcmativcs if one of the criteria fails pre-established boundary conditions); Concordance (whether weighted results exceed pre-established thresholds); Goal Programming (which uses initial weights to find a solution set, and then moves within the solution set to achieve pre-established goals); Compromise Programming (which seeks to minimize distance to the ideal point between criteria); Surrogate Worth Trade-offs (which measures secondary trade-offs, worth, to a primary objective for each alternative); and Computer Graphical Techniques (displaying the visual trade-offs between solutions).

A combination of several of the above techniques, (scaling, weighting, graphical analysis, and goal programming), appears to offer the best approach for conducting trade-off analysis. Within the traffic engineering profession, decision-making tends to utilize boundaries or thresholds rather than firm values. While measurements of delay can be firm, decisions are usually based on minimum levels of service. For the most part, safety decisions rely on overall levels, for example the potential for several accidents might be tolerated but the potential for multiple accidents or any fatalities might not be tolerated. This implies that using thresholds appear to offer the best means of evaluating multiple criteria for traffic engineering designs, leading to the applicability of goal programming. The objective function can be expressed as:

$$\text{Min } Z = \Sigma\,(Dw_d s_d p_d g_d + Sw_s s_s p_s g_s + Cw_c s_c p_c g_c)$$

where:

D = delay
S = Safety Risk
C = Cost
w = parameter importance weight
s = parameter scaling factor
p = penalty factor for exceeding goal
g = distance from goal

This formulation produces a trade-off analysis by seeking to minimize the distance from the established goals for each measure of effectiveness.

The measures being used in this research have a wide range of values (ie. delay time which can range from 0 to lOO+ seconds per vehicle, safety which can range from 0 to lOOO+ conflicts per day, and cost which can range from 0 to $l,OOO,OOO+. Thus, scaling factors have been developed to compare all measures on a single scale of O-100. The default scale factors are as follows:

Measure	Scale Factor
Delay	1 .00
cost	0.10
Conflicts	0 . 0 6

Weighting factors are also assigned to the three measures of effectiveness used in the trade-off analysis. The default weights used are subjective and represent the importance that each measure has to the public. The weights can be easily changed by the user of the computer program. The default weighting values are:

Delay	0.60
Safety	0.30
cost	0.10

Goals and their respective penalties must be determined by the user and may depend upon local conditions. It is reasonable to assume goals for average vehicle delay to correspond to levels of service as put forth in the 1994 HCM. Safety goals depend upon local preferences and decision-making. Goals for cost amounts will most likely be a local condition. For example, hypothetical goals could be 25 seconds or less of delay (LOS=C), less than 5 injury accidents per year, and construction cost of less than $250,000. Penalties are input as step functions since a small exceedance might be tolerable but at some higher level, no further exceedance would be tolerated.

Case Example

To examine the application of multiple measures of effectiveness in site access planning and design, a case example has been analyzed. A typical corner development site is shown(see Figure 4), bounded by intersecting high-speed minor arterials with ADT's of about 5,000 each. The proposed access point along the west arterial was for a two-lane, 9.2 m (30 ft) driveway, approximately 92 m (300 ft) center-center from the intersection of the two arterials and directly across from a driveway access to a grocery shopping plaza. A proposed 9.2 m (30 ft) wide access driveway along the north arterial was originally located approximately 75 m (245 ft) from the existing intersection of the two arterials.

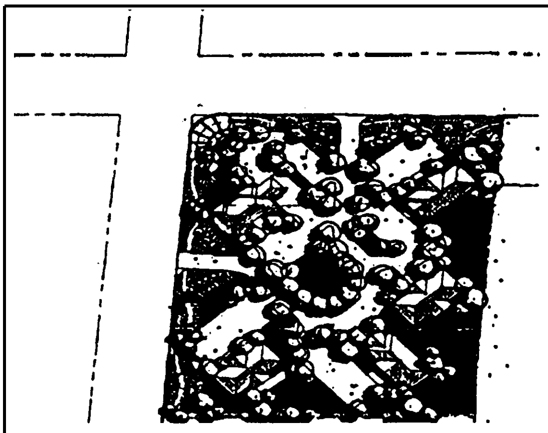

Figure 4
Proposed Site

The decision support model system was utilized to test alternative designs for the proposed development and access driveways. First, the original proposed site information was tested by the expert system module. This resulted in identifying several design exceptions:

- The proposed access point along the north arterial should be located a minimum of 84m (250 ft) for a design speed of 80Km/hr (50 MPH) from the intersection of the two arterials.
- Based on the arterial speed limits,

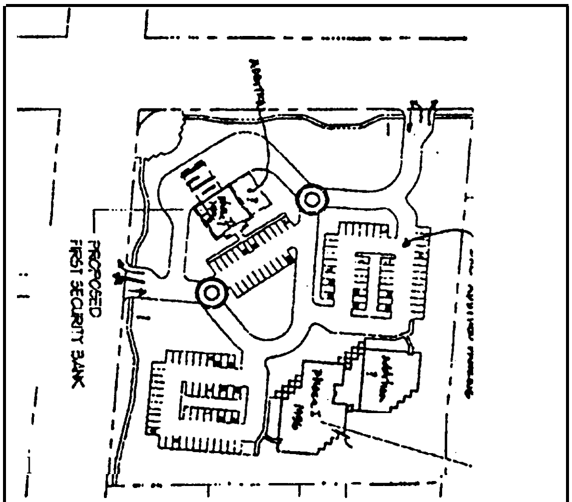

Figure 5
Improved Driveway Access

4.27 m (14 ft) wide deceleration lanes of 61 m (200 ft) should be employed for both access points.

The site access along the north arterial was relocated to accommodate the minimum comer clearance(see Figure 5).

Four different design alternatives for site access along the west arterial highway were analyzed:

- Alternative 1 was the original proposed site access, located directly opposite a driveway leading to a small shopping center. In alternative 1 both driveways were stop controlled.
- @Alternative 2 located the proposed site driveway south of the existing driveway to improve clearance to the comer of the two arterials. This design results in offset intersections.
- •Alternative 3 proposed the site driveway be located further away from the functional area of the existing opposite driveway. Unfortunately, this location did not meet strict criteria regarding distance to the property line.
- Alternative 4 assumed the same configuration of Alternative 1 except for adding signalized control.

Each alternative design was run through the decision support system and measures of effectiveness were determined for each alternative. A "z" score was determined by applying the modified goal programming approach with parameters for delay, injury risk, total risk, and cost. Hypothetical assumptions were used as goals and penalties.

Table 3
Evaluation of Alternatives

	Delay	Injury Conflicts	Total Conflicts	cost	Z value
1	5.4	443	630	50	2405
2	3.7	245	405	65	3.9
3	-----	----	-----	-----	-----
4	9.3	115	1281	50	2.1

Results were examined in both graphical form (see Figure 6) and in tabular fashion(see Table 3).

Because alternative 3 was a non-acceptable solution for the proposed site, MOE values for that alternative are show as 99 on a scale of 100. The MOE's reflect the different geometric and traffic operating conditions. Average delay is lowest among the unsignalized intersections (since thru traffic on the arterial roadway does not stop). Total accident potential is highest for the signalized intersection reflecting the increased risk of rear-end accidents because of the increased number of stops that vehicles must make. Yet, the unsignalized intersections reflect a much higher risk of injury accidents due to the higher speeds of the thru trips on the arterial and the unprotected turning maneuvers. In this example costs do not differ greatly although the offset intersection alternative has a slightly higher cost due to turning lane geometrics.

An analysis of the goal-oriented measure indicate the effects of the trade-off analysis between different measures of effectiveness. Alternative l(unsignalized 4-leg) shows a relatively low average delay and a moderate number of conflicts, however, because the number of projected injury conflicts are much higher than the goal for injury conflicts, the overall weighted "z" score is very high making this a much less desirable option (given the assumed goals and MOE weights).

Alternative 4(signalized 4-leg) shows the highest vehicle delay and the highest number of accidents, but the lowest risk of injury accidents reflecting the signal protected movements. With the assumed weighting and penalty factors, the signalized alternative yields the best "z" score and would be the preferred alternative (although signalizing this intersection would need to be analyzed in conjunction with MUTCD warrants and adjacent signalized intersections).

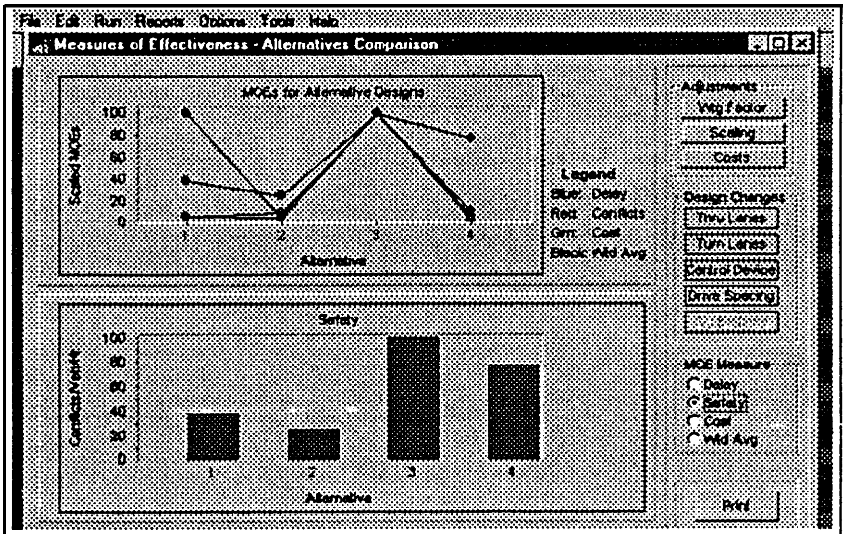

Figure 6
Alternatives Analvsis

The hypothetical resuits shown above indicate how a comparison of multiple measures of effectiveness can result in much different decision-making than if only single measures (i.e. delay only) are utilized. Further research is being conducted to determine sensitivity and thresholds for MOE goals and penalties for goal exceedance.

Conclusions

This paper has described a decision support system approach to improve access intersection design. Trade-off issues between different MOE's are difficult, especially when applying a highly sensitive subject such as risk management, however, the model framework presented in this paper allows engineering judgment to be utilized. Several issues have been addressed:

- Improved roadway access design can result by analyzing several measures of effectiveness instead of just vehicle delay.
- The use of goal programming is an effective way to compare several different MOE's and to relate to public tolerance levels
- Highly visual graphs can easily convey MOE trade-offs among design alternatives.
- Decision support systems can greatly supplement engineering judgment decisions with expert knowledge-bases.

Acknowledgments

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Interactive Intersection Safety Design and the *TRAF-SAFE* ™ Annual Accident Prediction Model

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ABSTRACT

The results of validation of the Probable Conflict Opportunity Models and ***TRAF-SAFE* ™** software to 65 two-way stop controlled (TWSC) intersections in the Florida Department of Transportation, District 7 (Greater Tampa Bay) are presented along with a summary of the PC0 Models. All data was collected by FDOT staff and included a random selection of intersections representing traffic volumes from 3000-7 1,000 entering vehicles per day, with geometries which ranged from 2-6 lane cross-sections, including protected turning bays. All sites were intersections of State Highways with minor three-leg and four-leg approaches with variable approach geometries. The performance test of the Probable Conflict Opportunity Model compared the model results to those of a standard exposure or rate-based regression model developed statistically from entering vehicles and prior accident history. The results indicated that the PC0 Models and ***TRAF-SAFE* ™** software predict annual accidents to an accuracy equivalent to that provided by a statistical exposure-based annual accident model with approximately 99 percent of the annual accident predictions less than 3 standard deviations from the "on-site" mean, 9 1 percent less than 2 standard deviation from the mean 72 percent less than 1 standard deviation, and 54 percent less than 0.50 standard deviation from the actual "on-site" mean annual accident record. More importantly, the Probable Conflict Opportunity Model and TRAF-SAFE™ software had no prior knowledge of accident history at any site, while the rate-based regression accident model had full knowledge of the site accident history.

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I. INTRODUCTION

Access Management is a unique blend of traffic and highway engineering which must operate in not only three typical design dimensions to achieve safety goals, but because access decisions are often made in the legislative zoning process and highway system political boundaries often adjoin, the dimensions of public perception and the political process must also be considered. Generally, to achieve safety goals in the access management of an intersection or corridor, either the administrative/legislative approach or a technical approach may be used. However while technical approaches such as the physics of vehicle movements or the Highway Capacity Manual provide a relative degree of stability to the traffic and design issues of access, the use of administrative approaches can lead to the adoption of exceptions and deviations from well-intentioned standards of safe performance which may generate both instability in the management of design and safety and the opportunity for favoritism in the administrative process.(1,2)

To alleviate these potential administrative problems, the preferred approach to access management is a technical methodology which is based on safety, and this approach has been an area of continuing research.(4) But to achieve this technical approach requires a) the development of a consistent, stable safety model for roadways and intersections over all typical volumes, geometries, and traffic control types; b) a defensible validation of the safety model, and c) the development of threshold safety performance levels which correspond to current safety criteria and which may be adopted by units of government responsible for the safe management of the highway systems. With an acceptable accident model and successful validation, a relative degree of confidence and defendability of the modeled values can be provided, and from this a stable platform is also available to examine and define threshold safety levels. Together with qualified engineering judgment, a well designed and defensible safety model and threshold safety levels can provide for the safe planning and design of access openings and intersections, and thereby minimize the likelihood of both accidents and injuries.

Annual accident modeling using Probable Conflict Opportunities is a new approach which relates the magnitude of statistically formulated probable opportunities for accidents (conflicts) to actual accident occurrence without specific regard to the character of the outcome of the accident which may be an angle, rear-end, sideswipe or fixed object/single vehicle involvement. Given that an accident will occur, it is assumed that individual human circumstances will select the actual involvement type from among available choices, with the goal of minimizing severity at the instant of impact, which is why the actual accident involvement types may be impossible to predict. However prior site testing of a probable conflict opportunity model has suggested that total annual conflict opportunities may be successfully related to total annual accident occurrences. (5) And using this approach in the safety modeling of a highway corridor, the following presents a finite-element analysis approach to Safe Access Management using Probable Conflict Opportunity Modeling to disaggregate multiple intersections, multiple approaches and multiple traffic movements to predict and manage annual accidents at either one or multiple intersections, or for an entire highway corridor .

The following presents the Probable Conflict Opportunity Model approach applied to safe access management and the *TRAF-SAFE*™ software used to implement the models, and the results of a validation for 65 unsignalized two-way stop controlled (TWSC) intersections. The validation is useful to test not only the Probable Conflict Opportunity software over a wide range, but to also quantify the performance in comparison to the most commonly used statistically formed exposure or rate-based accident model recognizing that an exposure-based annual accident model must have full knowledge of the accident history at each individual site, while the *TRAF-SAFE*™ Probable Conflict Opportunity Model has no prior knowledge of site accidents.

II. The *TRAF-SAFE*™ ANNUAL ACCIDENT PREDICTION MODEL

The modeling and predicting of accidents has been an area of research for many years, yet even today the best models are exposure-based statistical approaches which often include unknown data "outliers" which may skew the models and give rise to common-place non-transferability of the models.(6) Alternative approaches to exposure-based models using real-world conflict observation of brake lights and/or erratic maneuvers which are then related to accident formation is another approach which has been tired and abandoned simply because the surrogates of brake lights and/or erratic maneuvers were often found uncorrolated to accidents.(6)

In the formation of any modeling effort which predicts annual accidents, several basic assumptions are required to provide a conservative response to accident modeling including:

1. Each access opening is assumed to be sufficiently separated from adjacent access openings such that the driveway or intersection under study is an isolated, mutually exclusive entity,
2. The terrain is assumed as level on all approaches such that no driveway aprons, sidewalks, valley gutters, or other obstructions interfere with normal operational maneuvers, and
3. Sight distance is assumed as sufficiently clear on all approaches so as not to interfere with normal operational maneuvers.

In addition, the following assumptions permit the relationship between the human, vehicle and environmental variables, annual accidents and total annual probable conflict opportunities to be accepted as relatively stable and additive:

4. Drivers and passengers are normalized as typical drivers and passengers used in AASHTO design such that the intersections or driveways where the model is used have normal amounts of human induced accidents (no excessive human failures such as alcohol, age impairments, sign reading inability, etc. which produce significant non-normal accidents),

5. The Environment is normalized as the typical roadway and environment used in AASHTO design such that the intersections or driveways where the model is used have normal amounts of environmentally induced accidents (no excessive weather conditions such as icy road accidents, excessive fog, etc. which produce significant non-normal accidents),

6. The Vehicle is normalized as the typical passenger vehicle used in AASHTO design such that the intersections or driveways where the model is used have normal amounts of vehicle induced accidents (no excessive vehicle failures such as unsafe tires, broken headlamps, vehicle fires, etc. which produce significant non-normal accident responses).

7. In the formulation of a conflict opportunity/accident relationship, existing accident data bases generally segregate accident occurrence into four major categories which include angle, sideswipe, rear-end, and fixed object/other accidents (excluding pedestrians). Given this data base limitation, only these four accident types are assumed to represent all probable conflict opportunity scenarios and as such the fmal assumption is the additivity of each of the these independent elements as:

   Probable Conflicts/yr = Conflicts [P(Angle) +P(Rear-end) +P(Sideswipe)+ P(Fixed Object/other)]

   Each of the above probabilities (P) are calculated under the assumption that the arriving flows are random and at relatively low volumes where the Poisson (or Negative Exponential) distribution is the most commonly accepted distribution for accident estimation. Recognizing that alternate distributions may be appropriate for heavy flow and that the above assumptions may be location and/or time dependent, local calibration of the conflict opportunity and accident relationship is an essential element in model validation.

8. To be additive, the above probable conflict opportunity models should be based on a similar approach which makes the selection of any one conflict equally probable from among the other conflict types. To achieve this interrelationship, each of the above conflict opportunity models operate in a similar manner such that a probable conflict opportunity is defined as a statistical union of the probability of two assumed mutually exclusive events as:

   <u>P(Conflict Opportunity)</u> = <u>P(Vehicle Arrival)</u> ***** <u>P(Opposition to the Arrival)</u>
   where:
   <u>P(Vehicle Arrival)</u> = the probability that any vehicle arriving on any approach in any lane will desire to make (of arrive for) a particular movement,
   and:
   <u>P(Opposition to the Arrival)</u> = the probable arrival of one or more opposing conflicts (from angle, rear-end, side or fixed object/other) such that the opposing vehicle may not permit the completion of the intended maneuver <u>durine the time the arriving vehicle is exposed to conflict.</u>

In modeling probable conflict opportunities, the above is a unique formulation of probability between two <u>competing</u> entities and as such is a significant departure from such prior conflict/accident models. Each of the angle, rear-end and sideswipe models have uniquely independent surrogates of the exposure to conflict or clearance times in each probable conflict opportunity model. A perception/reaction time may also be added to the exposure times if vehicles are assumed as stationary for a particular movement, such as a stop condition.

The fundamental mechanism of the Probable Conflict Opportunity/Accident Model is the development of a calibrated relationship of the ratio of annual statistical conflicts to annual accidents which is stable over all geometries, volumes, speeds, and traffic control types from one site to the next regardless of the human decisionmaking relationship between accidents and probable conflict opportunities, and which with relative accuracy predicts annual accidents at any individual site. The general form of the probable conflict opportunity/accident model is:

Intersection Accidents@ = Annual Sum Probable Conflicts / [MODEL] Conflicts/Accident

where:

Annual Sum Probable Conflicts = a_1(P-Angle) + a_2(P-Rear) + a_3(P-Side) + a_4(P-Fixed Object or Single Vehicle).

The a,-a, coefficients are speed-based weights which have been calibrated to numerous national accident studies and are intended to replicate a weighting where the drivers attention may be more closely focused on angle conflicts in central vision as opposed to rear-end or sideswipe events in speed-dependent peripheral vision (central vision fixation as opposed to peripheral fixation), and where these weighting differences are intended to remain consistent nationally from one intersection or driveway to the next regardless of geometry, traffic volumes, traffic control types, or locations.

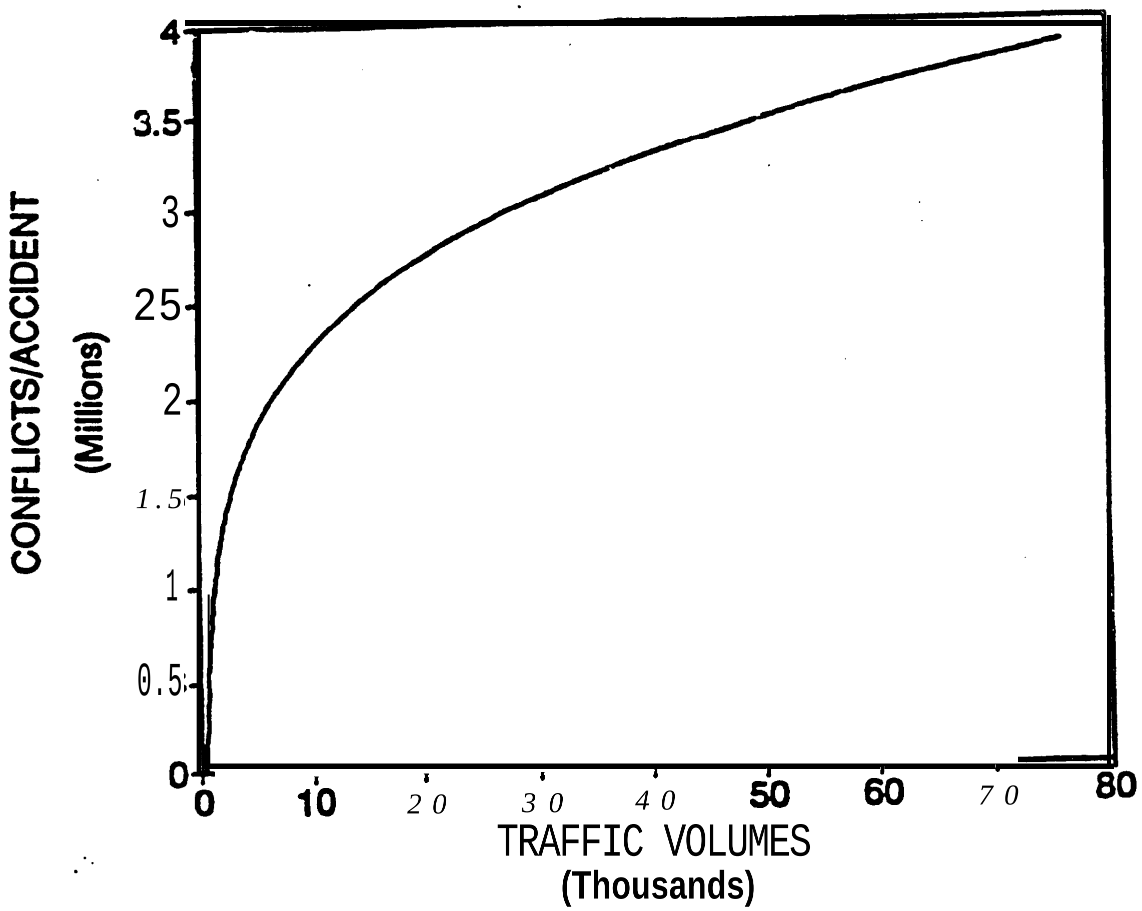
and:

[MODEL] Conflicts/Accident = The Probable Conflict Opportunity (PCO) MODEL itself is a complex, multiple linear, marginally decreasing relationship between annual accidents and annual probable conflicts opportunities for intersections which has been calibrated with numerous national exposure or rate-based models to produce total annual intersection accidents estimates over a wide variety of geometric configurations, traffic volumes, speeds and traffic controls including unsignalized (yield, two-way and all-way stop) and signalized with multiple phases, permissives, right-on-red and similar conditions. While the calibration has been full, it does not expect accidents with extraneous influences which may skew the relationships. One such skew may be a predominance of elderly drivers (as in Florida), and another may be the a predominance of ice related accidents (as in Alaska). Because of the potential for data skew, any probable conflict opportunity/accident model should be validated to individual intersections or to areas such as Cities, Counties, or State Highway Districts where the above assumptions are expected to remain relatively stable at the local level. Assuming proper local calibration, the general form of the MODEL of Conflict/Accidents is:

[MODEL] Conflicts/Accident = f(Minor Volume) - f(Major Volume) + Secondary Terms

The MODEL operates such that if there is no minor volume, there can be no accidents, and as thc major volume increases, the occurrence of accidents decreases marginally as presented in Figure 1 for a specific site. Figure 1 indicates the relationship of annual probable conflict opportunities to annual accidents ranges from approximately 500,000: 1 to over 4,000,000: 1 conflict opportunities per accident which compare reasonably well with another study which suggested ratios of approximately 1.4 to 4.4 million conflict opportunities per accident.(6)

FIGURE 1
EXAMPLE APPLICATION OF PROBABLE CONFLICT OPPORTUNITY RELATIONSHIP **TO ANNUAL** ACCIDENTS



III. *TRAF-SAFE*™ MODEL VALIDATION FOR TWSC INTERSECTIONS

A. General

In an effort to maximize the accuracy of the test procedures, the data collection was subdivided into three basic efforts. The first was the collection of detailed information by the Florida Department of Transportation, District 7, Tampa-Bay (FDOT-7) for 5 two-way stop controlled (TWSC) beta-sites each of whom had sufficient accident history to test the data demands. Although the first 5 sites were selected to represent accident sites with known histories (not randomly selected), this initial effort developed the data collection methodology and the detail required to provide the necessary accuracy. From this effort, a second set of randomly selected data for nine TWSC intersections was again collected by FDOT to refine and test the data collection methodology. Full 8 hour turning and 24 hour road-tube counts for all approaches were provided for these first 14 test sites. The third effort was the collection of 61 randomized unsignalized intersection site data sets by a third party Consultant to FDOT from sites throughout 5 counties surrounding the Tampa Bay area.

Using the 8 and 24 hour count data from the first 14 sites, ADT regression models were constructed from count data which permitted a significant cost reduction to the validation study while continuing to provide an acceptable accuracy. While accident data from each of the sites occasionally indicated ADT shifts from one year to the next, in general the most current 1995 eight hour volume counts collected for each site when converted to ADT's were found to adequately represent prior year and current year volumes. In addition, the use of monthly conversion factors to develop ADT's was also found to be unwarranted given the use of and variability associated with modeled ADT's on State highways and sideroads. The statistical form of these ADT models are:

1. ADT Model for State Highways
   24 Hr. State Highway (No-Stop) ADT(2-way) = 99 + 1.89(Total8 Hr.Approach Volume)
   R^2 = 99%; lStd=840 vpd; N=25 samples;

2. ADT Model for STOP Minor roadways
   24 Hr.Minor (Stop) ADT(2-way) = 3.79* (Average[AM/PM] 4 Hr. Approach Volume)
   R^2 = 96%, lStd=180 vpd, N=40 samples.

A comparison of the modeled "Average 2-way ADT's" to the actual on-site ADT recorded from the "Accident Data" indicated that with only several exceptions, the modeled ADT's conform to site ADT's from accident records within approximately l0- 15 percent over the full data set. Of interest is that several of the ADT volume counts contained in the accident records appeared substantially and repeatedly in error from the on-site volume data such that ADT errors were concluded to exist in the accident records. In general the formation of these ADT models from 8 hour turning movement counts permitted a significant cost reduction with an accuracy which is consistent with the monthly volume fluctuations and prior years ADT volume fluctuations.

Of the 75 test sites, five sites were at signalized intersections (non-conforming), and five other sites had data irregularities or missing data which excluded the site from the analysis, leaving a total of 65 sites available for inclusion in the overall data set. In general, the data variability for the TWSC intersections included total entering volumes ranging from 3000 - 7 1,000 vpd (2-way). Horizontal geometries ranged from 2-6 lanes on the major roadway with two lane approaches on the minor stop controlled roadways both with an without turning bays on each various approach, and generally flat vertical profiles for typical Florida West Coast terrain.

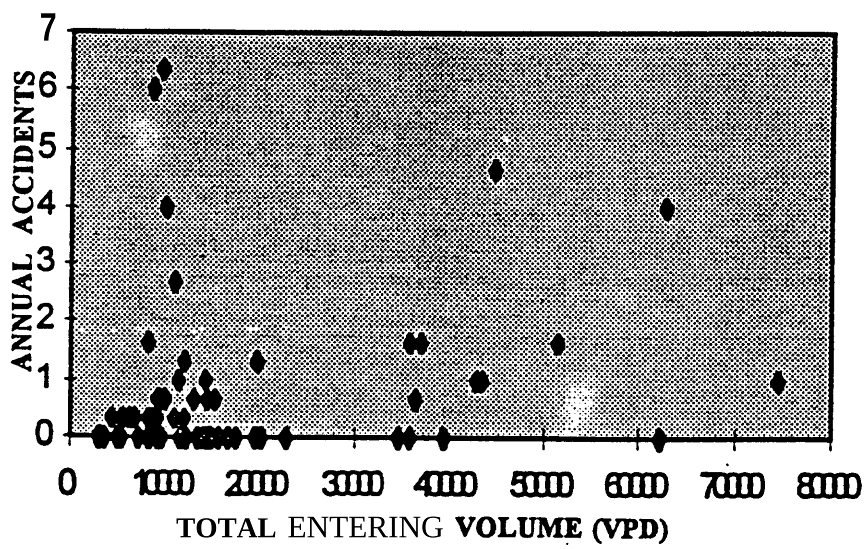
Accident data was collected by FDOT using the most current three (3) year history for each site and an approximate 200 foot radial search from the intersection which exceeds typical queue formations. Where an accident was recorded at a site, each involvement was examined in-depth to determine which of the accidents were representative. In general, accidents with pedestrians (not representative), accidents at driveways (non-TWSC), and older driver accidents (Drivers Age > 88), as well as selected accidents which violated initial assumptions (eg. alcohol involvement and vehicle fire) were eliminated from the accident data sets. In addition, the extent of non-typical environmental accident types (icy conditions) were found to be not over-represented in the accident statistics, and thus no accidents were excluded from the study based on environmental attributes. Less than 20 of 625 total accidents were excluded from the entire study set for violation of basic assumptions. Figure 2 presents the original data set of average (3 year) annual accidents over the full volume range of the validation study.

B. Performance Evaluation

The modeling of an "annual accidents" at any site is an attempt not only to estimate the mean (and confidence bounds), but also to create a model which is transferable to future traffic volumes and dis-similar sites. For intersections, the most commonly used accident models are exposure or rate-based regression models which USC approach or entering volumes as independent variables. While this approach may work well with an individual intersection which has already established an accident history, where multiple intersections are included in the model, such rate-base modeled annual accident estimates often have a poor relationship to the on-site annual accident averages at individual intersections. Prior accident studies have consistently shown low correlation coefficients (R^2 values) for modeling multiple intersection accidents, probably because such rate-based regression models (and statistics as a science) assume that all included data points are valid.(7) This inclusion of all data points, some of which may be erred and others which may be accurate but hazardous, can thus warp the true regression model to find the "best fit" for **all** data points including; **outliers**. Because of this, regression modeling is often incapable of identifying truly high accident/hazardous sites since all data points (even outliers/hazardous sites) are artificially forced within the requisite 3 standard deviations of the modeled mean. In addition, other reasons for this lack of compatibility between modeled and on-site accident data can easily rest with a variety of reporting, design, operations, maintenance, environment, human, and interacting and confounding factors all of which make the validation of any multiple intersection accident prediction model to real-life accident data complicated, confusing and puzzling.

Recognizing the above limitations, comparisons between means of different accident models at one particular site may be meaningless since neither the existing "On-site" estimate or an "exposure-based" estimate nor any alternative "better" model may represent the true mean accident response.

FIGURE 2
PLOT OF ACTUAL ON-SITE AVERAGE ANNUAL ACCIDENTS
v.s. ENTERING VOLUMES



Because of this, the validation and performance test of any new multiple intersection accident model such as "Probable Conflict Opportunities" may only be assessed in comparison to similar results from the most commonly used standard approach which are "exposure or rate-based" accident model estimates. And the only conclusion which may drawn in this performance test is that "the new model is as accurate as the best statistical exposure or rate-based model". However, as a starting point and for comparison purposes, the on-site mean (3 or more years) annual accident response (and standard deviation) for each site was regressed against the entering volumes for each intersection and the statistical "best-fit" Exposure or Rate-based accident model using stepwise and linear regression developed as:

Annual Accidents = 0.00000705 (Major volume-vpd) + (0.00121 (Minor volume-vpd)
[R^2 = 65%; 1Std = ± 0.9 acc/yr; both variables total entering vehicles]

Using this model, Figure 3 presents the exposure-based annual accidents estimate for each site over all entering volumes from the original data. Interestingly, this model does not contain some of the apparent "outliers" of the original Figure 2 data and an arbitrary removal of the apparent outliers identified in Figure 4 presents a new regression model in Figure 5 which has been corrected by removal of the "outliers". Clearly, the new regression form of Figure 5 is more logical and desirable than the original regression model of Figure 3, yet interestingly the R^2 for the Figure 5 model is only 48 percent which is even less than the original data (65%) because statistics as a science only examines correlation over the range of the data which in Figure 5 is O-2 and in Figure 3 is O-7. Thus an untrained statistician may conclude erroneously that based on the R^2 alone, the model of Figure 3 is superior to the model of Figure 5 which is clearly incorrect, and an example of how even statistics may mislead the formation of proper accident model conclusions. But even in the face of inexperienced statistical analysis, more clear is that any accident model simply cannot be explained by only two simplistic variables both which are volume based.

By contrast to the above exposure-based model, each of the 65 sites were input to the Probable Conflict Opportunity Models of the *TRAF-SAFE*™ software with the results presented in Figure 6 based on these additional assumptions:

a. Perception/reaction time = 1 .O second,
b. Vehicle Length = 20 feet,
c. Stop Sign Setback = 10.0 feet,
d. Through Saturation Flow Rate = 1990 vph (1.9 sec/veh),
e. Left Turn Saturation Flow Rate = 1400 vph (2.6 sec/veh),
f. Headway Required to Merge into adjacent lane = 1 .O second (Sideswipes),
g. Maximum Side Friction Factor (f) = 0.15,
h. Urban Area Population Greater than 250,000,
i. Conflict Exposure times consistent with 1985 HCM - Unsignalized Intersections,
j. On-site Average peak to daily ratios used to convert hourly to ADT volumes,
k. ADT volumes are unbalanced by approach for each of 365 days per year,

FIGURE 3
PLOT OF EXPOSURE-BASED REGRESSION MODEL ANNUAL SITE ACCIDENTS
v.s. ENTERING VOLUMES

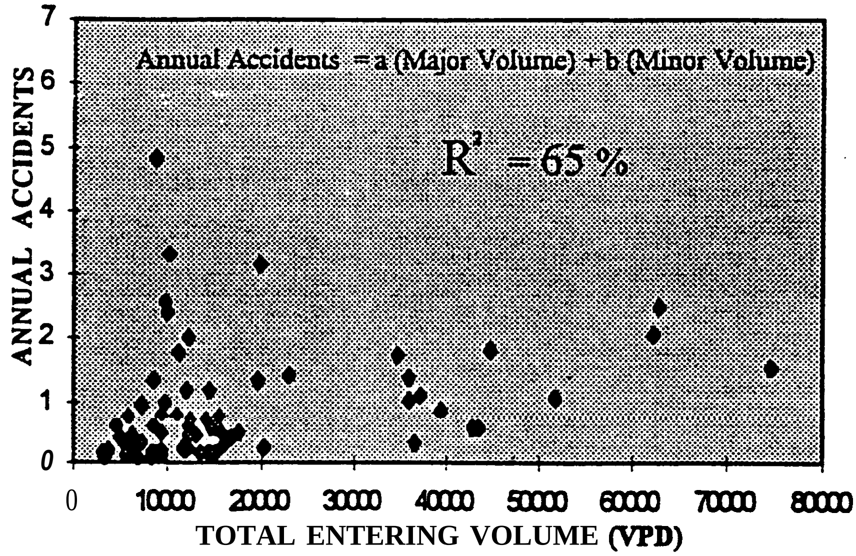


FIGURE 4
PLOT OF APPARENT "OUTLIERS" OF ORIGINAL ANNUAL SITE ACCIDENTS
v.s. ENTERING VOLUMES

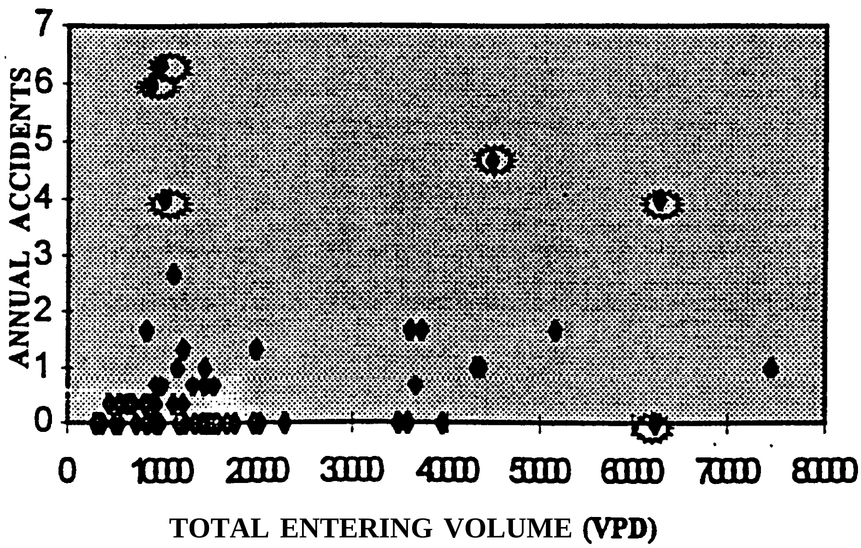
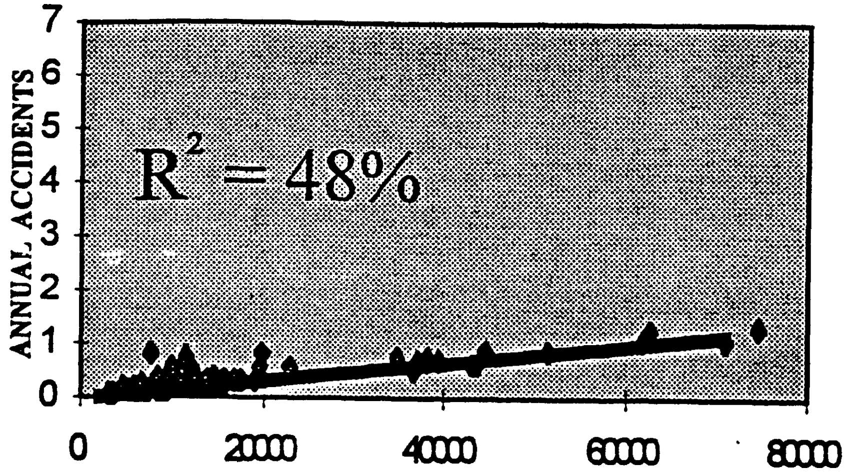
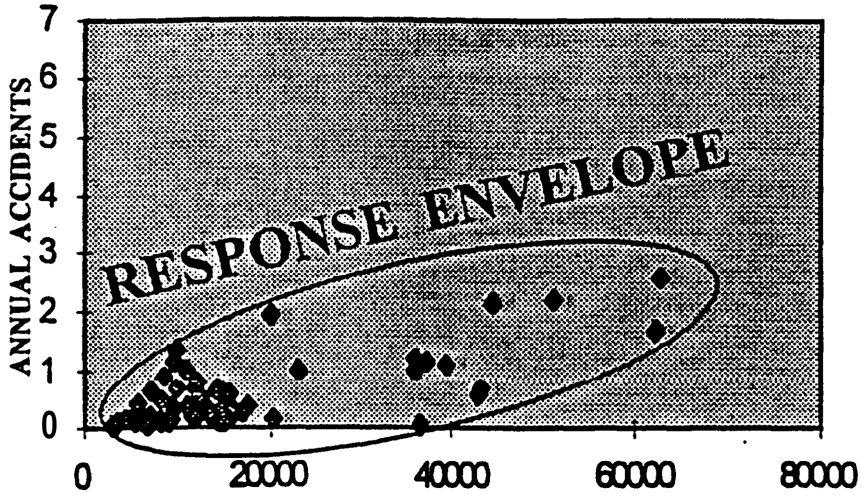


FIGURE 5
PLOT OF CORRECTED EXPOSURE-BASED REGRESSION MODEL ANNUAL ACCIDENTS
v.s. ENTERING VOLUMES



TOTAL ENTERING VOLUME (VPD,

FIGURE 6
PLOT OF *TRAF-SAFE*™ MODELED ANNUAL SITE ACCIDENTS
v.s. ENTERING VOLUMES



TOTAL ENTERING VOLUME (vpd)

Based on the results of the annual accidents predictions for each of the 65 sites from the *TRAF-SAFE™* software as presented in Figure 6, it appears clear that the data "outliers" of Figure 4 (which were also excluded from the regression model of Figure 3) have been removed from the response and that a "response envelope" has been substituted for the "corrected' linear representation of annual accidents as presented in Figure 5. More importantly, the Figure 6 "response envelope" of the *TRAF-SAFE™* software appeals to the logic that a true response to the accident events of life should have both highs and lows which the volume of traffic element alone cannot be expected to quantify.

Regardless of the model selected to estimate annual intersection accidents, the one statistic which should bear a reasonable and repeated resemblance to the true mean accident condition at a particular site is the historical "on-site" standard deviation. All typical intersections and many driveways have an accident at sometime in their operating life. Some intersections have accidents with high annual frequency and small standard deviation, others have low frequency with wide standard deviation and still others have exactly the opposite characteristics. But all will have an "on-site" standard deviation which, under the assumption of normality, will revolve about the true mean. Given an estimate of the mean and standard deviation of annual accidents from historical accident records, the test of any predictive accident model is not whether the predicted mean from the model aligns closely with the estimated mean from on-site data, but rather whether the modeled value falls within the sphere of the normal distribution of the actual on-site data. Clearly, if the modeled annual accident estimate falls more than 3 standard deviations from the on-site mean, then either the modeled value or the on-site accident value is non-conforming. And equally clear is that if the modeled value falls within approximately 1 standard deviation or less from the historical on-site mean response (using an on-site standard deviation), then there is good confidence to suggest that the modeled mean is well within the normal distribution of the true mean, and thus the modeled accident mean is an acceptable representation of the true mean, as is the existing "on-site" annual mean accident estimate.

Thus, it is not the comparison of a modeled annual accident average to the "on-site" average annual accidents which suggests the validity of any predictive model, but rather the number of independent test sites of the model which can be shown to be within a predefined proximity (such as 0.5, 1,2, or 3 standard deviations) of the mean of the actual "on-site" accident data and standard deviation from qualified accidents within the historical records. To test the effectiveness of this methodology, the on-site mean annual accident response (and standard deviation) for each site was regressed against the entering volumes for each intersection as previously described Where the historical site had no accidents within the prior three year period of the data collection, 1 accident was assumed to occur within the next three year period (total six years), thereby creating an assumed standard deviation for the site, with an assumed mean response of zero annual accidents. By placing confidence bounds to the on-site mean, multiple tests were performed to determine if the modeled mean accidents per year fell within various standard deviations of the on-site mean. The results of the regression modeling using the above regression model which created Figure 3 indicate that for the statistical rate-base model, approximately 93 nercent of the sites placed the Rate-based modeled mean within 3 standard deviations of the actual on-site accident mean, with 86 percent within 2 standard deviations, 74 nercent less than 1 standard deviation, and 49 nercent less than 0.5 standard deviation from the site mean. Interestingly, this rate-based regression model cannot place all of the sites within 3 standard deviations of the on-site mean which may be related to the inability of the statistical process to model properly (even with full knowledge of the accident history) since regression assumes all data points are properly within the data set, and in-fact some of the data points may be (and apparently are) outliers or hazardous sites and should have been excluded from the data set. Even considering the statistical weaknesses, the rate-based model is clearly providing a reasonable response with almost 95 percent and 74 percent of the modeled annual accident estimates less than 2 and 1 standard deviation respectively from the site mean, and with a relative degree of confidence this model may be transferred to other sites. However equally clear is that the selection of hazardous sites from within the model is questionable probably because the exposure or rate-based model is clearly limited to changes in only one variable which is entering volume.

As a relative performance test of the probable conflict opportunity models and the *TRAF-SAFE™ software* , a comparison identical to the above rate-based model was performed and indicated that approximately 99 nercent of the modeled annual accident estimates from the new model were within 3 standard deviations of the actual on-site accident mean 9 1 nercent were within 2 standard deviations, 72 nercent of the sites modeled annual accident predictions were within 1 standard deviation of the actual "on-site" mean and 54 nercent were less than 0.5 standard deviation from the historical on-site annual accident estimate. In addition, a comparison of absolute differences [(Model-Actual)/Actual] between statistically modeled annual accident estimates and the *TRAF-SAFE™* software indicated that on average the Probable Conflict annual accident estimate provided a response approximately 15 percent closer to the "on-site" annual accident estimate than does the exposure or rate-based regression model for each individual site.

IV. CONCLUSIONS

A performance test is a test of an alternative product in comparison to the most commonly used standard product. The results of this performance comparison indicate that for unsignalized two-way stop-controlled intersections, the-Probable Conflict Opportunity Model and *TRAF-SAFE™* software can estimate annual accidents to an accuracy equivalent to that provided by a statistically constructed exposure or rate-based model. In this validation, similar accuracies of less than 0.5 standard deviation from the "on-site" mean were provided approximately 50 percent of the time, accuracies less than 1 standard deviation approximately 75 percent of the time, and accuracies less than 3 standard deviations approximately 98 percent of the time indicating the Probable Conflict Opportunity Model and *TRAF-SAFE™* software is as transferable to other sites as is the traditionally constructed statistical exposure or rate-based accident model.

In addition' given that the first five sites (sites# 7 l-75) were not randomly selected but were selected for their high absolute accident involvement and that three of these sites are a part of the six suspected "outliers" identified in Figure 4, the removal of these three non-representative sites from the data would increase the overall accuracy of both the regression and Probable Conflict Opportunity model to approximately 99 percent of the predicted annual accident estimates within 3 standard deviations of the "on site" mean, 95 percent of the predictions within 2 standard deviations, approximately 80 percent within 1 standard deviation and 60 percent of the annual accident predictions within 0.50 standard deviation of the actual "on-site" annual accident mean.

More imnortantlv. the Rate-Based Regression Accident Model had FULL knowledge of the accident historv at each site. while the Probable Conflict Opportunity Model and *TRAF-SAFE™* software had NO prior knowledge of accident histories. Based on this comparison, it may be concluded that the Probable Conflict Opportunity Model and *TRAF-SAFE™* software have an accuracy which equals that provided by current statistical regression modeling techniques over remote sites and widely varying conditions with the capability to estimate future accident estimates based not only on volumes, but also upon other physical elements, without the need for existing accident history. However, It should also be recognized that engineering judgment will be required in the application of the Probable Conflict Opportunity Models and the *TRAF-SAFE™* software to individual sites, in selecting the appropriate typical daily and annual traffic pattern, and in assessing model output for conformance to input assumptions.

V. FURTHER RESEARCH

Based on the satisfactory performance of the model at numerous unsignalized sites in FDOT District 7, comparisons to other geographic locations and with other traffic control types would appear desirable. Ultimately the full validation of yield, two-way stop controlled, four-way stop controlled and signalized intersection models to confii the accuracy, precision and reliability in annual accident prediction may permit technically-based Safety Management on a Local and Statewide level, while also permitting more realistic accident, injuries and costs estimates within Urban Transportation Planning software programs as well.

This effort has concentrated.on the accuracy of the Probable Conflict Opportunity Model and *TRAF-SAFE™* software without regard to the severity of the individual involvements, without ranking each intersection as "Hazardous or Non-hazardous", and without considering the development of Safetv-based Levels of Service as opposed to the current emphasis on Delav-based Levels of Service. Further in-depth review of the existing 65 intersection data base may help to isolate the definition of “Hazardous”, as well as the development of Intersection and Roadway Safetv Levels Of Service.

The author wishes to acknowledge the assistance of the Florida Department of Transportation District 7 Access Management staff, as well the support and cooperation of the FDOT Central Office and the Federal Highway Administration.

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Insights Into Access Management Details Using TRAF-NETSIM

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ABSTRACT

Due to the variability offield situations, it is extremely difficult to observe the relative effects of driveway parameters (number, placement, volumes), arterial volumes, the presence (or not) of driveway decel lanes, and otherfactors. Fully recognizing that simulation results cannot be used without caution and care, it was still decided that simulation using a well-established model (namely, TRAF-NETSIM,) could provide some useful insights.

The simulation also made itpossible to focus on the average travel speed of the through vehicles only as the measure ofperformance, by adapting the TRAF-NETSIM statistics.

A series of situations were defined, generally with driveways only on the south side of an east-west arterial. Ranges of arterial volumes and driveway parameters/features were considered, generally with one hour simulation times and five replications.

The results highlight the effects of the driveways on even the westbound traffic (the "other" side), as well as the significant impact on the eastbound traffic Adverse impacts in the range of 5 to IO mph are rather common. Decel lanes at the driveway are an important mitigation measure. Left turns create major problems.

PRESENTATION

The number, location, activity, and design of driveways are perhaps the most discussed issues in access management. While there have been some studies, a decisive resolution of the effect of "just one more" driveway is elusive. This paper addresses the effects of unsignalized driveways on arterial thru traffic, by means of simulation. A number of aspects are considered.

This paper does not address the obvious adverse effects that signalized driveways have on arterial progressions if the driveways are poorly located. We feel that this is well known, and consider that an obvious step in the review of any driveway is the effect its location will have on the arterial traffic if and when it is ever signalized, immediately or in the future. Experience argues that driveways from any significant commercial or residential development "grow up" to become signalized intersections.

1. The Situations Considered

The base conditions for all runs in this paper are: six lane arterial with left turn bays, quarter mile signal spacing, 55 mph free flow speed, excellent progressions. The road is not divided, but some cases do not allow left turns in/out of the driveways. Unless otherwise noted, all runs and replications simulated one hour of traffic. This was found to be quite adequate for the present purposes.

A range of situations are considered:

- The effect of driveway .... number
  .... volumes
  .... locations
- The effect of driveway .... right turns only (in/out)
- The effect of driveway .... design (accel/dece1 lanes or not)

Over a set of conditions:

- Arterial flow rates .... 500 to 900 vphpl
- Arterial lanes .... 2 or 3 per direction
- Arterial left turn bays .... yes or no

with a default of quarter-mile signal spacings and four links included.

The speeds reported are all average travel speeds of thru vehicles only, except as explicitly noted.

As shown in Figure 1, driveways were generally located on the "south" side of the sample arterials, and the eastbound speed was labeled "S 1" and the westbound. speed was labeled "S2". Further, all driveway volumes are given as the "in" number, with the "out" equal to the "in'.

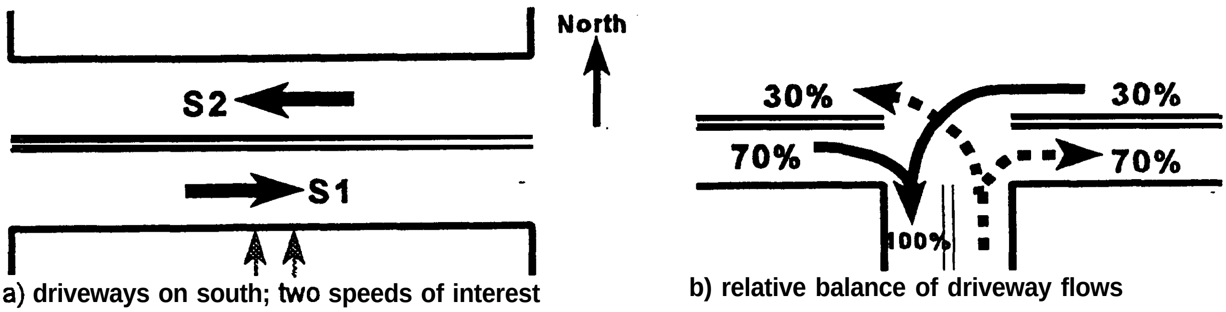


FIGURE 1
DEFAULT NOTATION AND VALUES FOR THE SIMULATION RUNS

In all cases when left in/out of driveways were allowed, it was assumed that 70% of the total driveway volume came from the side of the road on which the driveway was located and returned to that flow, and that the rest came from the other direction.

A total of 3 11 cases were executed, with an average of 7.7 replications with some cases used in more than one scenario, for a total of 1,3 82 distinct hours of traffic simulated.

2. Simulation: Advantages, Disadvantages, and Model Selection

Simulation models have the great advantage that they can allow us to change one key feature such as a driveway volume or location while holding all other things invariant. **We** can actually run the same traffic in different cases, thereby being sure that we are studying only the effect intended.

The risk in using such models is that while they try to emulate the real world, they do not do so perfectly. Therefore, while we can say "in the simulated case, the following happened.. .", the ultimate test of reality is the real world.

At the same time, a full investigation is very often not feasible in the field, simply because the variability cannot be controlled and/or because of cost. Consider the case at hand: we are interested in the effect of driveways on the average travel speed on an arterial, and wish to consider the number of driveways, their location, and various volumes both on the arterial and at the driveways.

TRAF/NETSIM is perhaps the most well used and completely tested microscopic simulation model which exists. It has evolved for over two decades, and now has excellent animation features which help ;the user understand what is happening, both in the real world and in the simulation (as one reality check).

We have two observations on whether it "completely conforms to the real world" based upon our extensive use of this tool:

1) when people have difficulties with the analysis which results from this tool, it is often because they did not make enough runs or make long enough runs;

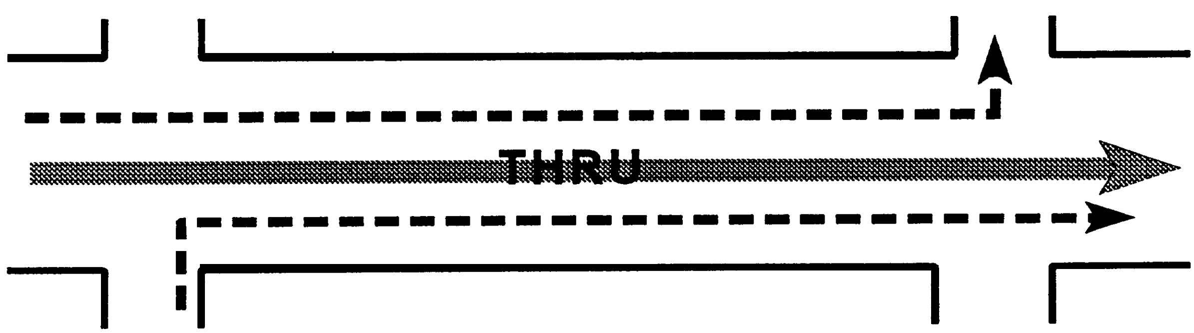
2) some of the individual mechanisms have limited validation, and if one intends to use TRAF/NETSIM to study a specific mechanism in great detail, one can get into both trouble and circular reasoning.

The lesson which is common to all such cases is simply, understand the way in which mechanisms are modeled into the simulation model and make sure that the "study" or "analysis" is not merely an exploration of the mechanism itself.

One of the most basic mechanisms revelent to the present work is that as vehicles enter driveways, they slow down and affect other vehicles. In the extreme, this can be a chain reaction, as those vehicles influence others, and so forth. The simulation model does not have detailed mechanisms for relating driveway design features (turn radii and such) to the way in which vehicles slow down, and we will not attempt such studies. Rather, we will investigate relative volumes, proximity to the intersection, spacing of driveways, and such. We recognize that the results will show relative magnitudes and might be subject to refinement based upon driveway design features. We will consider the absence or presence of accel/decel lanes at the driveways, but cannot attempt more detailed design features.

3. The Thru Vehicle Measure of Performance

The historic TRAF/NETSIM output is in terms of all vehicles, or certain subgroups by type or movement. For the purposes of this work, it was important to restrict attention to only those vehicles which entered and departed a link as a thru vehicle. These are the vehicles which are using the arterial for its defined purpose, namely the movement of thru traffic.



Vehicles which have just entered an arterial can expect a different (and poorer) treatment in the first arterial link, just as they can expect a different (and poorer) treatment in their last arterial link, as they seek to turn off the arterial. Therefore, the measure should reflect only the true "thru" portion of their trip.

There are two ways to adapt TRAF/NETSIM to this purpose; modify the source code itself, or extract information from the animation file on the individual vehicle trajectories, allowing the speeds of only appropriate portions of the trajectories to be taken into account.

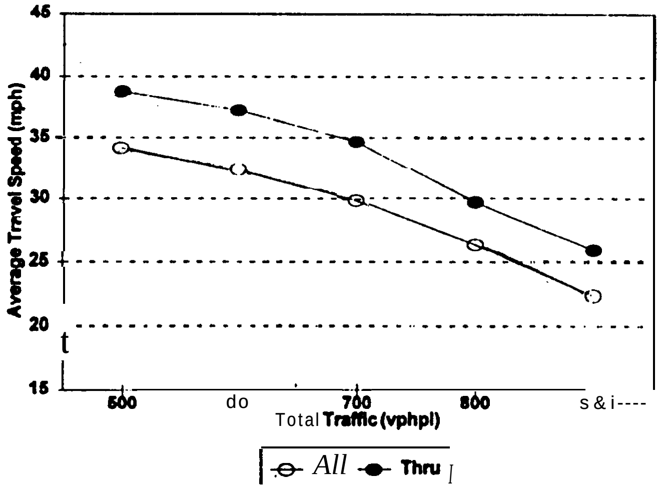
The differences are most interesting. As shown in Figure 2, the average travel speed of the thru vehicles even in a very simple case is some 4-5 mph higher than the average travel speed of all vehicles.

The implication for this study for the HCM is strong because the intent of the arterial quality of flow measure is to focus on the thru traffic the defined users of arterials. If the arterial users have an average travel speed some 4-5 mph higher than that predicted by the HCM, then they are in reality getting a better level of service than the

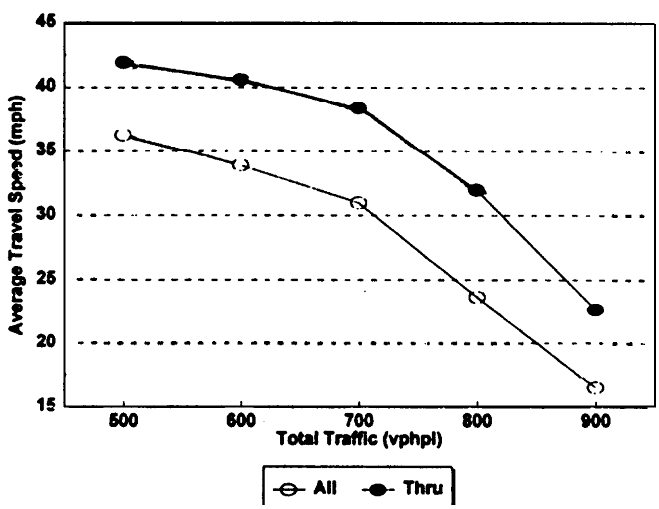
HCM predicts.

Looking at another way, if the intent is that the arterial users achieve a certain average travel speed (say 40 mph), then they can do this at higher flow rates than previously thought because they are traveling faster than the average as computed in the HCM or such tools as NETSIM.

Another immediate implication is that certain disruptions - driveways on the mainline - can cause the level of service to degrade even faster than previously thought because the average travel speed of the real thru (non-driveway, non-turning) traffic is very sensitive to these disruptions. After this work is digested, it may well be that more traffic is allowed on an arterial for a given level of service, but that disruptions in the form of poorly placed or too numerous driveways are even more strongly discouraged.



a) Quarter-mile signal spacing, three lanes in each direction, excellent progression, no driveways, adequate green time, left turn bays, 3% left and 7% right



b) Quarter-mile signal spacing, three lanes in each direction, excellent progression, no driveways, adequate green time, left turn bays, 7% left and 3% right

FIGURE 2
AVERAGE TRAVEL SPEED OF THRU VERSUS ALL VEHICLES, AN ILLUSTRATION

4. Effect of Rights Only

Left turns into driveways cause conflicts when they stop in a lane also serving thru traffic, and they degrade the arterial function by affecting the average travel speed of those thru vehicles. They also expose themselves and others to risk because of the speed differences. Recognizing that the tools at hand do not address safety and conflict analysis, attention was restricted to the question of the effect on the average travel speed of the thru vehicle.

Figure 3 shows the simple case in which 100% of the driveway traffic arrives by making right turns from the eastbound flow, and exits the driveway by making a right turn to return to that flow. Figure 4 shows the simulation results.

Clearly, there is benefit to the "other " direction, because none of its vehicles now interfere with its thru traffic. There is also benefit to the eastbound thru traffic by conflicts-being reduced. These benefits can be enhanced by driveway design features as simple as accel/dece1 lanes.

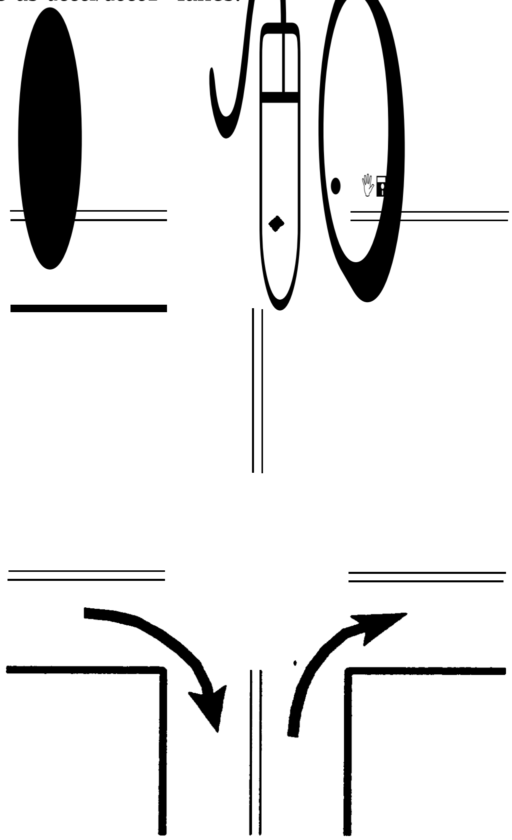
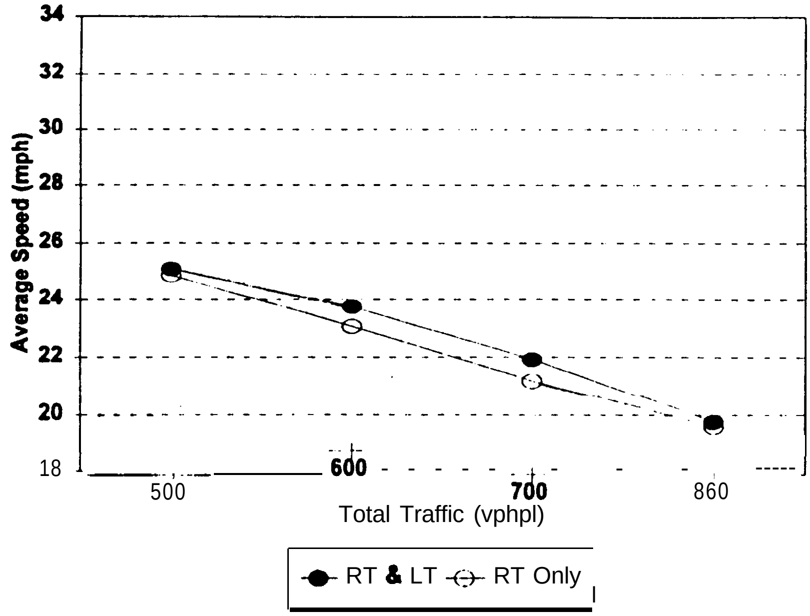
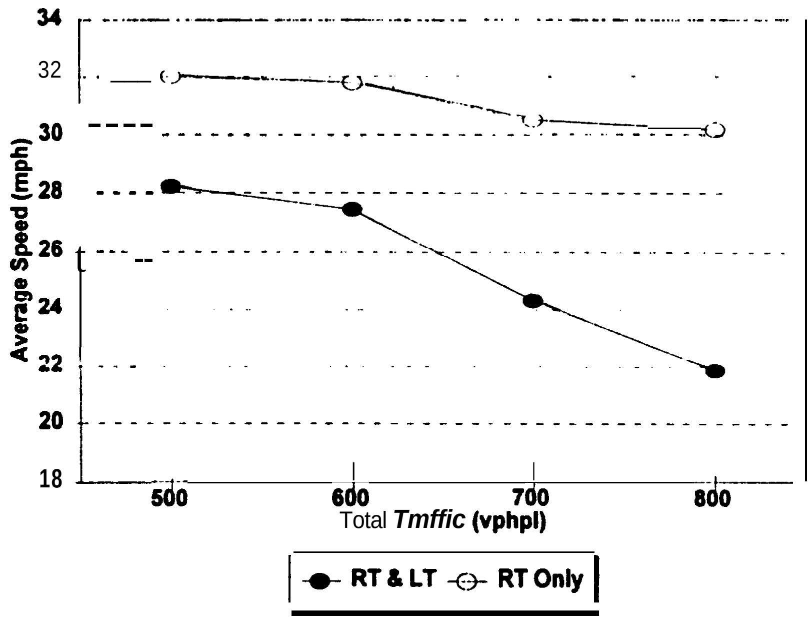


FIGURE 3
THE EFFECT OF ELIMINATING LEFT TURNS AT THE DRIVEWAY



a) thru vehicle speed, eastbound (S1)



b) thru vehicle speed, westbound (S2)

FIGURE 4
EFFECT OF ALLOWING RIGHT TURNS ONLY IN/OUT OF DRIVEWAYS

5. Driveway Accel/Decel Lanes

Consider four cases as defined below, where case 1 represents no driveway present.

Case	Volume (vph)	Decel Lane Present?	Accel Lane Present?
1	0	No	No
2	180	No	No
3	180	*Yes*	*Yes*
4	180	Yes	No

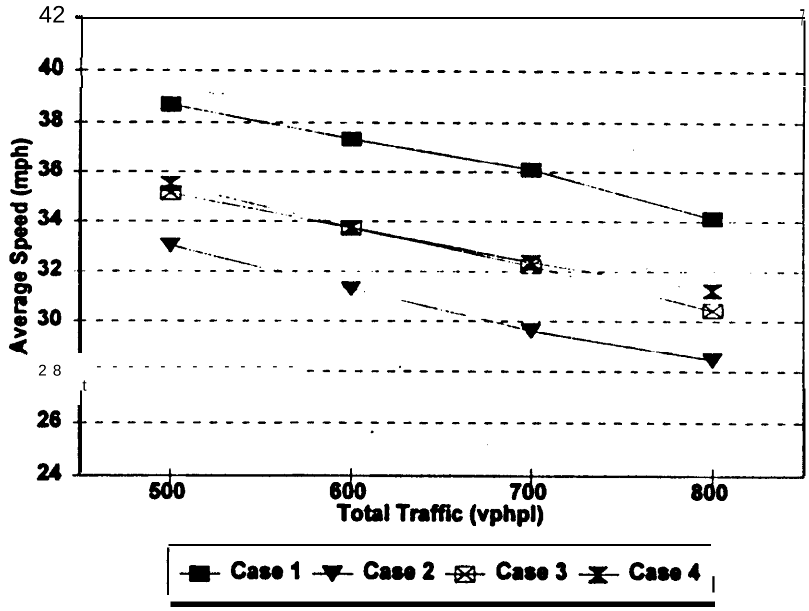
Figure 5 shows the effect of simple accel/dece1 lanes modeled using NETSIM, just to allow the distinction between "nothing" and "something". As shown in Figure 5, there is a discernable difference in both directions with the greater benefit being in the eastbound direction just as one would expect.

The test cases had free flow speed of 55 mph on a 6-lane arterial with 180 vph at each driveway with nine replications of each case.

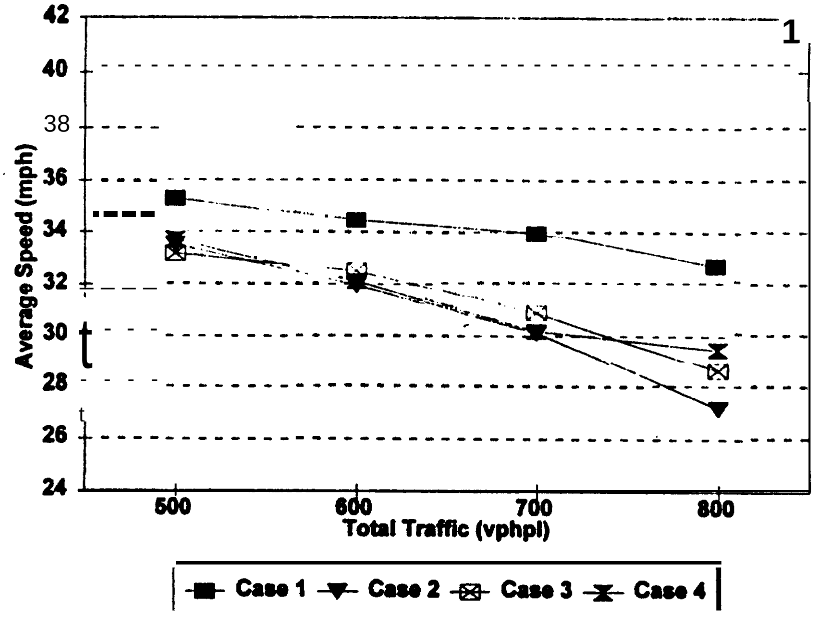
This brief analysis can confirm that the accel/decel feature has obvious benefit to the thru vehicles, which of course one would expect. To carry this analysis further would require a sensitivity to detailed design features (e.g. effects of turning radii on vehicle speeds) which does not exist in the particular tool being used, namely TRAF/NETSIM. Therefore, we will not overreach but will simply observe the importance of driveway design features.

Figure 5 shows that the presence of the decel lane is quite important, in that it mitigates the effect of the driveway traffic on the near-side thru vehicle travel speed by about 45% over most arterial volumes; rather than a 6.5 mph decrease in thru vehicle speed, there is a 3.5 mph decrease. Incidentally, the accel lane is not significant in its effect on the speed of arterial traffic.

The same figure shows that the decel/accel lanes have no consistent and notable effect on arterial traffic in the "other" direction. That is , the decel/accel lanes for the near side (eastbound) traffic does not help the westbound thru traffic.



a) **thru** vehicle speed, eastbound **(S1)**



b) **thru** vehicle speed, westbound (S2)

FIGURE 5
EFFECT OF ACCEL/DECEL LANES AT THE DRIVEWAY

6. Median Turn Bay

One other design feature can also be considered within the structure of the simulation tool being used, in another four cases for investigating the effect of a median turn bay accommodating the left turners into the driveway. Consider for example

Case	Volume (vph)	Eastbound Decel?	Westbound Median Left Turn Bay?
1	0	No	No
2	180	No	No
3	180	Yes	No
4	180	Yes	Yes

Figure 6a shows that the decel lane is the primary beneficial feature for the eastbound thru traffic, although the presence of the median opening without the accel lane at the high arterial volume does cause some degradation (see Case 4 versus Case 3 at 800 vphpl). The benefits of the median turn bay on the westbound thru traffic are clear in Figure 6b, where a 3-4 mph improvement in westbound thru vehicle speed is noted at higher volumes when the median turn bay is present.

To carry this analysis of design features such as decel lane, accel lane, and median turn bay any further would require a sensitivity to detailed design features (e.g. effects of turning radii on vehicle speeds) which may not exist or would need to be calibrated into the particular tool being used, namely TRAF/NETSIM. Therefore, we will not overreach but will simply observe the importance of driveway design features as just summarized.

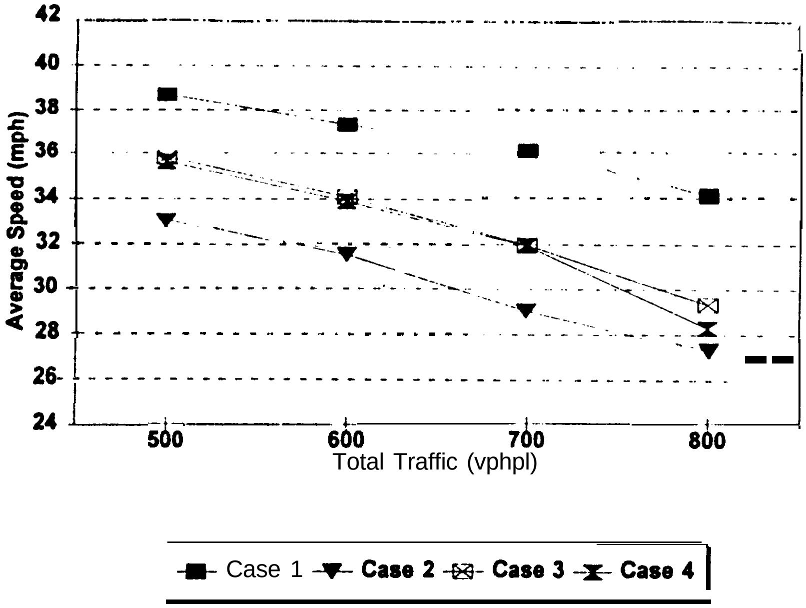
3.5 Number of Driveways

Figure 7 shows the effect of going from none to two to four driveways, each handling 180 vph and all located on the same side of the arterial, spaced 150 feet apart. The arterial has three lanes in each direction (six lane undivided).

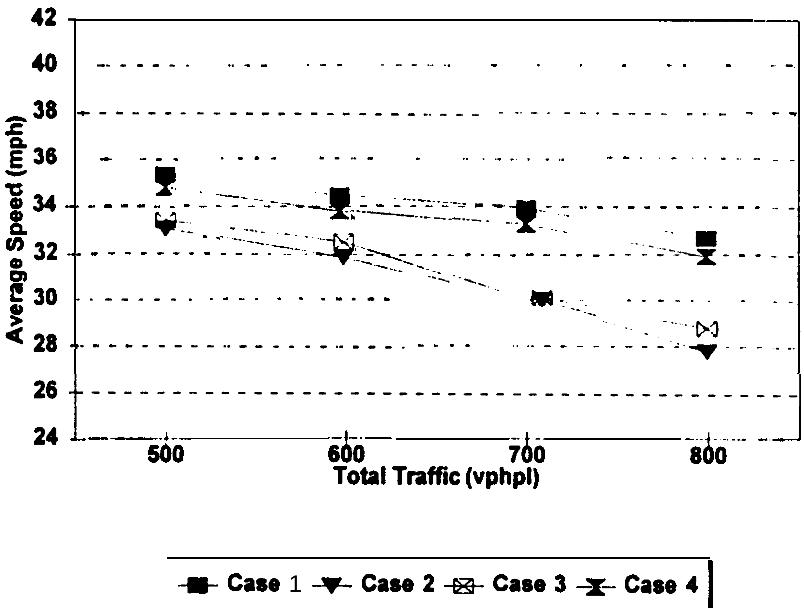
For the volumes investigated, and using 500 vphpl as the arterial flow, the effects which stand out are:

- the thru vehicle average travel speed in the eastbound (or same) direction drops by about 5 mph when the first two driveways are added, with the next two **driveways** causing another 2 mph impact;
- the impact on the thru vehicles in the other direction is not as severe, and does not drop as precipitously, but nonetheless is about 2-3 mph due to the four driveways.

At 700 vphpl, the effect of four driveways on the eastbound thru traffic is about 7 mph and of growing severity on the westbound traffic: the total effect is about 6 mph.



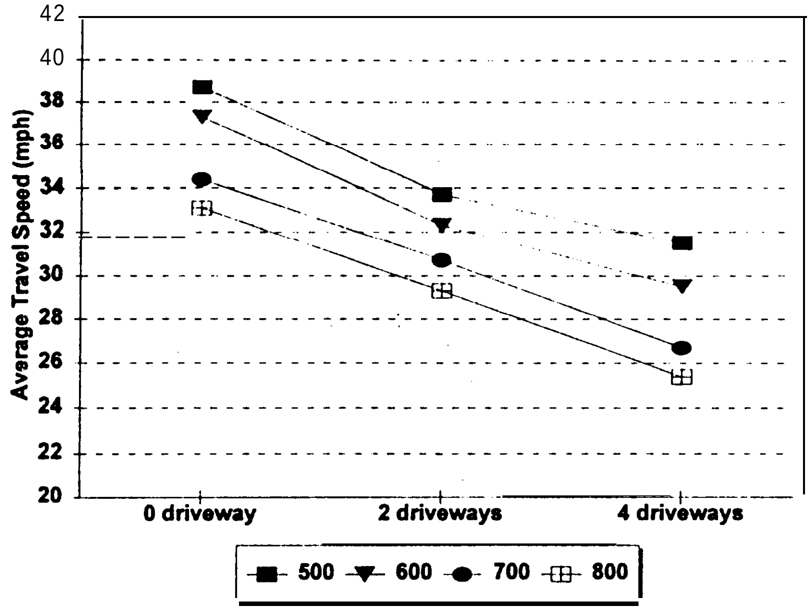
a) thru vehicle speed, eastbound (S1)



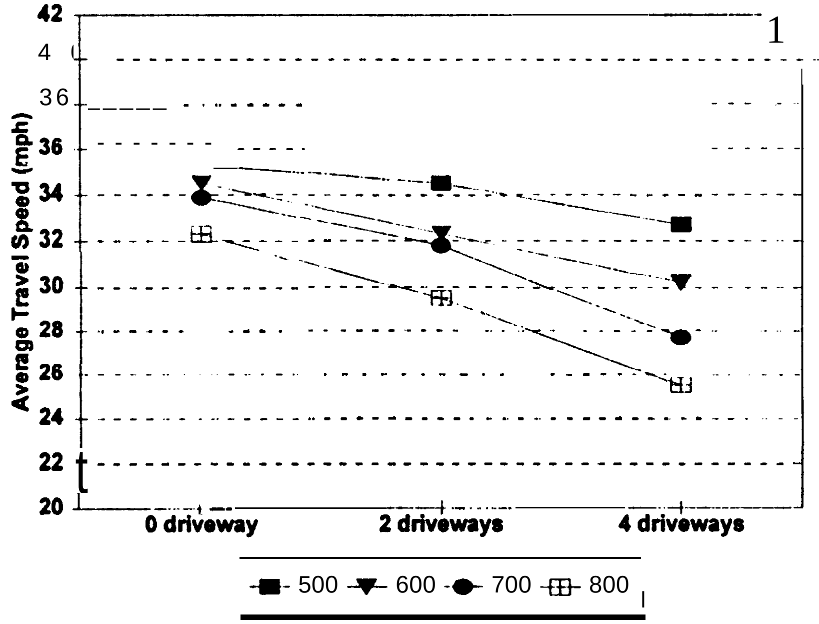
b) thru vehicle speed, westbound (S2)

FIGURE 6

EFFECT OF LEFT TURN BAY IN MEDIAN FOR WB TRAFFIC INTO DRIVEWAY



a) average travel speed eastbound (S1) with 180 vph per driveway



b) average travel speed westbound (S2) with 180 vph per driveway

FIGURE 7
EFFECT OF NUMBER OF DRIVEWAYS ON ARTERIAL AVERAGE TRAVEL SPEED

8. Driveway Volume

Returning to the illustrative case, consider two driveways on the south side of the road, with 700 vphpl along the arterial (both directions). The effect of adding these two driveways on the thru vehicle average travel speed can be estimated as:

DRIVEWAY VOLUME	THRU VEHICLE AVERAGE SPEED DIFFERENCE	
	EASTBOUND	WESTBOUND
60 vph	-0.7 mph	-0.8 mph
120 vph	-2.6 mph	-1.7 mph
180 vph	-3.7 mph	-2.1 mph

That is, there is considerable effect in the eastbound direction, but less in the westbound direction (i.e., the "other" side). For lower arterial volume, the westbound effect is <u>less</u> significant and the eastbound effect is <u>more</u> significant. This is reasonable, given higher eastbound speeds and more westbound maneuverability.

9. Other Situations

As part of the study (1) which led to this paper, other issues were considered: the effect of driveway location (midblock versus close to intersection): dispersed driveway volume (more traffic concentrated in fewer driveways, or less traffic per driveway in more driveways?); increased spacing between driveways.

Several interesting results were obtained:

1) as driveways moved closer to the intersection, we sometimes saw adverse effects on the "other" side. Upon reflection, these were due to the difficulty left turners had due to intersection queues, with consequent effects on the thru traffic:

2) as drivewavs moved closer to the intersection, the effect on queues within the driveway was significant, because these vehicles also got trapped by the intersection queues;

3) when a fixed amount of driveway traffic was dispersed amongst more driveways, the results were complex. It appears that several distinct mechanisms were at work.

10. Summary

What are the characteristics of the "model arterial" in the present context, and how much do deviations from the ideal compromise its effectiveness?

First and foremost, the model arterial must have the signal spacing to deliver excellent progression to traffic in both directions. Driveways and other features cannot be located so that they represent the next generation's problem intersections or queuing area.

This model arterial must also have the "side street" capacity to allow vehicles to cross the arterial (or enter it) without needing unreasonable portions of the green time.

When certain features - driveways in particular - are considered, they must be handled with great care. The access management literature advocates such basics as: no left turns across the centerline; fewer driveways; well-designed and smooth transitions fi-om the arterial; driveways away from intersections. This paper supports these positions by demonstrating that it is all too easy to degrade the average travel speed of the thru vehicles by 5 mph and that it is even possible to degrade the performance by up to 10 mph.

The paper and the related report (1) has also provided a special focus on the performance of the true, defined arterial user, namely the thru vehicles. The average travel speed of these vehicles is often 4-5 mph higher than the overall averages which has one set of implications. The thru vehicle average travel speed is also much more sensitive to degradation from adverse practices which has another set of implications.

DISCLAIMER

The opinions and findings expressed in this paper are those of the authors and not the Florida Department of Transportation (FDOT) nor any other organization. The work was sponsored by FDOT through a contract with Reynolds, Smith & Hill (RS&H).

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1. "Access Management and the Relation to Highway Capacity and Level of Service", Technical Memorandum on Activity 4: Final Report, Task Work Order 14F, RS&H Project 992- 1062-00 1, July 1996.

Questions and Answers
Corridor Case Studies

US 93, Somers to Whitefish Montana - Access Management
Protecting Capacity on an Arterial Roadway in Delaware
A Case Study on Access Management - The History and Findings on Sheridan Blvd Access Planning
Trials and Tribulation of Enforcing a Locally Established Corridor-Wide restrictive Access Plan - Implementation of the K-150 Study
Successful Access Management Planning Along a Commercial Highway, US 287, Fort Collins

Question 1: What was the basis of the safety concerns with regards to raised medians?

Joseph Hart: There were concerns over accidents caused or resulting from driving into a raised median area or depressed roadway section. These concerns were primarily related to white-out conditions where it is difficult to see the edge of pavement. There were also concerns regarding wrong way travel on the highway by tourists or residents that were unfamiliar with the divided highway.

Question 2: What determined that the area of influence of intersections, where access restrictions would be applied, was a distance of **500** *feet?*

Joseph Hart: The 500 foot distance was determined by the reasoning that if a major intersection, which might require signalization or left turn channelization, was set beyond this distance there would be sufficient distance to provide for back to back left turns within the median area. This distance was somewhat arbitrary, but it was chosen as a general distance for sufficient separation.

Question 3: Was there a great deal of concern over the possibility of stakeholders having there access restricted?

Joseph Hart: There was a great deal of concern over the possibility of access being restricted. There were some large parcels in the rural sections between towns where we were able to work in a significant number of access points that could be implemented. As we approached towns where the smaller lot development had begun to occur, we encountered more problems. This is the reason the compromise plan was recommended to accommodate more driveways. It became a consensus plan.

Question 4: Could you provide some details concerning the performance based permit system you mentioned?

Joseph Hart: The performance based permit system is an independent process which has been conducted separately from the EIS work. It has received a lot of public controversy. I am not sure of the status of the performance based zoning at this time. There was an article in Planning Magazine concerning the controversy surrounding the performance based system within the last year. At this point I believe the process has stalled.

Question 5: Does the Delaware DOT pay for access rights in other parts of the state?

Robert Kleinburd: The DOT will always pay if a highway action results in the loss of access rights. If the loss is measurable we will pay for it no matter what we are doing.

Question 6: Do you have any reasonability tests in Delaware or does the DOT automatically pay if you lose direct access to the highway?

Robert Kleinburd: If someone has the legal right to access to the roadway, which is taken away, they are paid for it.

Question 7: Is there a legal right to direct access in Delaware?

Robert Kleinburd: Based on the zoning and the type of roadway there is a legal right to access.

Question 8: What was the yellow stripe that ran along the side of the roadway in the slide of the redesigned subdivision?

Robert Kleinburd: The yellow stripe represented right-of-way along the side of the road that was preserved for the future expansion of the roadway.

Question 9: Is it possible that through the redesign of a subdivision someone could come to the table with excess access to the main road in order to receive additional compensation?

Robert Kleinburd: This is possible, but there would be a before and after appraisal. The reality is that there is not much loss in value for a subdivision for access onto a side road as opposed to access to the main road. We would also take into account how much reasonable access you would have onto the main road in the first place. When we do an appraisal there generally is not much loss in value with the elimination of some access to the main road.

Question 10: Is it not outside of the federal role to participate in these access issues?

Robert Kleinburd: This corridor preservation project was approved in the late 1980s. The FHWA authorized 5 demonstration corridor preservation projects, and this was one of them. The federal money which is being used in the acquisitions comes from the FHWA revolving fund's advance acquisition pool. So far $5 million of federal advance acquisition funds has been allocated to this project. Delaware will have to pay back this money in the future.

Question I I: Was there any stakeholder involvement in Steps 1 through 3, or did the stakeholder involvement not begin until Step 4?

Greg Walker: The stakeholders were notified ahead of time, but I am not sure if their input was requested until after the objectives had already been established.

Question 12: Was the corridor land use study adopted by each of the three cities and was there any provision for joint approval of amendments to the plan?

Mark Stuecheli: It was a major accomplishment to just get the three cities involved in this project. All the cities initially adopted the land use considerations, but the reality is that each of the cities operates on its own basis independent of the others and would resist an adjoining city telling them what to do. We do not have a situation where the land use restrictions were strictly followed. The street network and the street system has followed fairly closely in each of the three cities. There have been a few problems with some of the minor access points have a few problems. The Kansas DOT has been involved in cases where some additional minor access points were approved. For the most part the projects recommendations have been followed.

Question 13: What would have been the most ideal type of involvement in the project by the Kansas DOT in your opinion?

Mark Stuecheli: I do not know why the Kansas DOT was not more directly involved since it was a state highway, but the three cities pretty much did things on their own. KDOT should have been involved in the beginning of the study so they could have had input into the recommendations that came out of the study. I believe that the access controls are fairly extensive, so the results are still similar to what they would have been if the Kansas DOT had been involved.

Question 14: Why did the Kansas DOT decide to give the roadway back to the local government?

Mark Stuecheli: The Kansas DOT has a policy of giving cities control of any state highways that are actually located entirely within a local jurisdiction or incorporated area. In this particular case, the DOT was able to reroute a designation of a highway route so this route was not really necessary as a continuation of a state highway.

Question 15: Has there been any analysis of the accident rates on the parallel access roads?

Mark Stuecheli: There is yet not a continuous system of side access roads that have significant traffic on them. Some analysis should be possible in the future because very shortly we will have some segments that are continuous between the one mile thoroughfares.

Question 16: Do you think the study was more viable from the city council / local authority standpoint because the Kansas DOT did not have an active participation?

Mark Stuecheli: I believe that the involvement of the Kansas DOT was not related to the viability of this project. There is not any antagonism between the DOT and the cities. They work together very closely and always have worked together.

Question 17: Did the cities make the decisions concerning the median grades or was it under the Kansas DOT's jurisdiction?

Mark Stuecheli: The final control was in the Kansas DOT's realm of responsibility, but the way the system works any kind of rezoning activity does not involve DOT review and approval. When a rezoning takes place there is always a stipulation that the DOT has final say over any access issues or median breaks.

Question 18: Who funds the construction of the parallel access roads?

Mark Stuechelj: The construction of the parallel access roads is funded entirely by private development as their projects are developed. That has been the practice for many years in Overland Park, Kansas. The policy is that all collector streets, which is what the parallel access roads are considered, are built by the abutting property owners. We have had success with this policy and at this point the city has not been involved in any of the construction of the parallel access roads. In most cases we will eventually have a continuous system of parallel access roads, but if it comes to the point that a very important link is not available the city has the ability to use its power of eminent domain to acquire the right-of-way to build that section of the roadway.

Question 19: What are the access rights of the smaller developments which have right turn only access along K-l 50?

Mark Stuecheli: With the exception of a couple of service stations most of the parcels along the K- 150 corridor are held in large parcels. With the use of common access easements sufficient access is provided for the amount of frontage that the parcels have.

Questions and Answers
Models and Modeling for Access

Does Access Management Improve Traffic Flow? Can NETSIM Be Use to Prove It
Evaluating Driveway Access and Intersection Design With multiple Measures of Effectiveness
Interactive Intersection Safety Design and the AMA Model, and Practical Design Models for Safe-Intersection Spacings
Insights into Access Management Details Using Traf-Netsim

Question 1: Have you used the que statistic from the Netsim model as a reason for denying or restricting an access request?

Freddie Vargas: Yes, we have used this as a reason and this is the beauty of the program. It allows you to proceed link by link and it provides the que length on each segment and on each movement. It provides a strong justification to the public that the implementation of access management strategies are necessary.

It should be noted that the calibration of the model with existing conditions is vital. In our case, we collected traffic data on all of the corridors at the same time determining traffic volumes and que lengths simultaneously. It took approximately eleven people from our office to conduct these data collection efforts. If data is not collected properly and the model is not calibrated accurately you may have some misleading responses from the software.

Question 2: What kind of response do you get from the public when you use results from the Netsim model?

Freddie Vargas: At the present time we are not using Netsim as a tool to get the public to accept access management strategies. Most of our access management projects are safety oriented, and when safety is used as your rationale nobody can fight you.

SECTION VI

SEMINAR/WORKSHOP

Access Management

VI Seminar/Workshop

Optional Two-Hour Seminar. An introduction to access management issues for people new to access management. Conducted by: Philip Demosthenes, Colorado Department of Transportation, Gary Sokolow, Florida Department of Transportation; Arthur Eisdorfer, New Jersey Department of Transportation. This summary of the seminar on Sunday afternoon was transcribed from the recorded sessions.*

Mr. Philip Demosthenes

Access Management -You are looking for ideas as to how you sell it, how you talk about it and how do you explain it both on the political side and on the technical side. We want to give you a quick overview on principals and concepts, and why we feel this is so important.

The speakers serve on the TRB Access Management Committee. TRB is part of the National Research Council in Washington which is part of the National Academy of Sciences which is where all of this is coming out of. All of us, TRB and now AASHTO and soon ITE offer tremendous amounts of resources.

The purpose is improving what we have already built. The taxpayers gave us a tremendous amount of funds, we have built it and now we have got to maintain it. What access management concentrates on is managing vehicle conflict and arterial capacity. Those are two key words that we work on. Access management isn't how you get transit to access the downtown or any CBD, other business districts. Its simply the control of driveways, median openings where you have raised medians, intersections, public intersections and freeway interchanges.

There are two ways to approach the problem: 1) You can do it on a corridor specific basis, I. e. look at specifics; how you are going to improve driveways, what are you going to change/relocate or how are you going to fix things, 2) As a system base. Colorado has established the first Access Management program in the country. Through the legislative process we got authority to go forward and have what we call a comprehensive program that applies to every access decision made since 1979 onto the state highway system. That's more of a systems approach. If you don't get into the regulatory aspects, you will not be able to do a system approach solution to the problems in your state.

In 1978, I was in front of the Colorado State Legislature. Part of the issues we had already tied down. We had major congestion problems. We were trying to hit up our Legislature for a gas tax increase, and the concern was why are we hitting up the citizens for more gas tax increase if we are not taking care of what we have already built at great public expense.

I have a series of slides that were used back in 1979. Colfax Avenue, a typical downtown arterial and an old style arterial. The accident rates are four times higher than they need to be. The capacity on these roads are diminished because of the frictions and the conflicts. What we are doing in Colorado: we would have a pretty good road labeled as a future arterial for the greater expansion of Denver and then we would cut it up. So one of the problems is we are investing a great deal of money in widening and having it get cut up. Colorado Boulevard's lower end handles about 80,000 vehicles per day and at the upper end it drops down to about a low point of about 70,000 vehicles per day. These are major movers and very important for the economic viability of this corridor and also very important to move traffic.

If you all are going to get into showing access management as a problem in your state, I recommend you rent a helicopter at ***600*** dollars an hour, load up a lot of good film, get a good photographer (as those pictures are not easy to get), go out in your community and take pictures of the good, bad and the ugly. You will have an idea of what you need to do, and you have made some pictures of good things that have been done. Then you go to your policy makers, and you talk about it.

Absorption rate is like marketing that industrial office-industrial area which is Arapahoe Road in Denver. What is its ability to absorb new industry and put in Fed Ex now. So absorption rate is like the market - how quick is that area going to absorb new businesses. So, if you are chief of Fed Ex and you are looking for a place to establish your regional center, you want good transportation services to get employees there efficiently and you don't want accidents between the two points they are commuting from and to. So you look at that. If you find locations that aren't well serviced, already saturated, overloaded, would you be interested in putting more businesses in this area? You would find something else.

When Denver started having problems with Colfax and did not provide efficiency to service to downtown, the City established one-way couplets. I'm sure anyone from any urban area knows what a one-way couplet is. One-way out of town and next to it one-way into town. There are a total of seven pairs of one-way couplets in the Denver area because the arterials, that should have provided that service, no longer were able to function as arterials. So then you get this: where you once had a nice residential community you now have a small freeway going down your community street every morning and, if you are a block away, you have the same freeway going out in the afternoon. We have all seen this but the issue here is, when you don't take care of your arterials, you get neighborhood penetration, you lose values in your neighborhood, and you change the character of the neighborhood because you didn't protect your arterial.

Broadway was a two way arterial. Denver's solution was to make it a one-way southbound arterial as Lincoln was a one-way arterial inbound. So there are losses. The point here is traditional solutions are very expensive both socially and economically. You have to pay millions of dollars in ROW per mile and millions of dollars for construction per mile. What I want to get across is that we can't afford traditional solutions. They are very expensive. We only put them where we have to and, if we protect what we have already, we do not have to invest gobs of money it takes. Another example is a two lane road that now is expanding. The purpose is that this kind of construction is nice, and it is bringing a lot of value in but it is also a couple of million dollars per mile.

This is conflict. Here's a simple driveway. One way to quantify the impacts is from the driver's perspective. If you are pulling out, you worry about the people on the road. If you are pulling off the road, you worry about the people coming up behind you or, if you are coming this way, you worry about the person behind you. Who are you going to hit? This is quantified as 9 conflict points. If you put a driveway across the street, now you have an intersection. AASHTO defines a driveway as an intersection. The only difference is different volumes. Whether you have a county road connected to a county road or a state highway connected with a driveway, its an intersection. So heres an intersection. Now we are up to 24 conflict points. Its adding up to a lot more driver workload. Full movement on a four lane highway and you have 36 conflict points, if not signalized, and 22 conflict points if we do signalize and try to remove a few. That's where access management is coming from.

In 1994, there were almost 95,000 accidents with 175,000 vehicles involved and 45,000 injured. All states have these numbers or larger numbers. Look what's related to access. Access conflicts in Colorado add up to 52% of the total for all accidents or 49% out of that 95,000. There are probably another 20,000 accidents out there. These are conservative numbers. There were 25,000 access related injury accidents in Colorado last year. It will happen again. Colorado's 95,000 accidents resulted in 1.7 billion dollars in losses. This is a conservative number. Out of this is the access related 49,000 which is 0.9 billion dollars. In Oregon, you see the same numbers, on state highways only. Oregon had 0.7 and 0.3 billion dollars in losses, and they are driveway related only. Michigan had 1 billion dollars losses in a 2 year period.

What can we do about it? Here is a demonstration project, courtesy of the Federal government. construction. We looked at some arterials in Denver area; looked at accident rates per million vehicle miles and then looked at two access control section routes. You are getting 40% to 60% drop on those routes with greatest access control.

In New Jersey, when median barriers were put in, the accident rate dropped significantly. When there is a grass median out there, Colorado doesn't have too many of these, you get a better drop in the accident rate. In Connecticut they studied sections of highway, looked at curb cuts per mile and the accidents per mile. And when you look at it you get the same curves, I. e. when more curb cuts, there are more accidents. Florida looked at driveway connections per mile, medians per mile and signals per mile. Conflict analysis gives: as workload increases, accidents increase. In Oregon, they took a 25 mile section of highway and compared accidents to openings in the highway (access density). As access density in terms of frequency of driveways went up, accidents went up, except in the section where there was a raised median down the road in a commercial area. All left turns disappeared and, without left turns, the accident rate dropped off. Gary Sokolow indicated that in Florida they studied crash rates of urban multilane highways. They looked at the crash rates for the two way left turn lanes, multilane, the raised median and completely undivided (lines down the middle of the road). The crash rate for the undivided road were the same as what we call the 7 lane section. In Michigan's study for 1985 - 1987, there is the sarne relationship in the center lane, median situation, the accident rate drops off to more than 50%. On Memorial Drive in Atlanta, Georgia, since they put a median in the center of the road the fatality rate has gone away.

Going back to the Colorado study again, we will switch to capacity issues. You have good capacity traveling at 44 mph but at 25 mph you lose capacity. The major arterials in the Denver area are not doing their job. Look at a graphic from New Jersey. There are no signals, etc. Look at a lane, you get 2 100 cars per lane per hour. It costs 2 million dollars per mile and you get 700 cars per hour. There is an economic loss in terms of investment. Build a new highway? No. The access control demonstration project was used several times. Studies on travel speed showed that changes in speed reduced delay 42% and the loss in total delay was 60%. This was a tremendous return on investment. If you don't have a good transportation system, which America is built upon, you don't have good economic benefits. You can't build commercial areas if you have bad highways. In Florida and New Jersey have the same concept - improve arterials, reduce travel times, increase people movement.

The challenge is - how do you implement access management to get these wonderful benefits, significant reduction in accidents, significant improvements in travel time/capacity, and how do you balance that out with the issues that you and I need to get on the road to drive somewhere? You still need driveways, still need intersections, retail still needs to be able to connect, industry still needs to be able to connect. So the issue is: how do you connect them, where do you connect them to have the least amount of impact on the system, and so achieve these overall issues.

I didn't get very much into aesthetically pleasing. There are 3 towns in Colorado with which I am working that are redeveloping their whole approach in the town. They have better access control, have medians and have landscaping now. People are coming in doing 45 mph. The market is excellent. They have good pedestrian control, etc. They are getting rid of some of the driveways. The towns are looking nicer.

Mr. Gary Sokolow

In California people think everything is only 15 minutes away even if it is two hours away. That's how they have learned to live with the congestion.

In this seminar we will discuss the access management principals and strategies you can go home and use. First principal is functional integrity which is the concept that there is a range of highways, and there is a top range and a bottom range, and the top range is there for high speed high volume travel. The principal is that the access should follow the roadway function - the higher the function the less direct access, lower more access. Divide road system into these functions through movement mobility and access to property.

In the AASHTO's Green Book, "Roadway Function and Classification" is important. The concept here from Virgil Stover's teachings is that ideally this hiarchy works by making the connection not to abrupt, that your roadway should feed into minor collectors or major collectors, your major collectors should go into your minor arterials and major arterial and freeways should only be dealing with the major arterial. This is the concept of functional integrity and roadway hiarchy which I believe is the basis of access management.

(Slides showing various locations and accesses onto roadways were presented as examples .)

Joint access is providing access to a group of businesses rather than each business having its own driveway. Who maintains those interconnections? In Florida, usually it is by an agreement when they go through the permitting process. It is a written agreement on a maintenance agreement .

In Florida, there are land development regulations that support access management. Almost every county and city had an interconnection requirement between development and neighborhoods but was ignored in many cases. It was so easy for one neighborhood to say that it would depreciate the value of their neighborhood to be connected to another. In most cases, it was known to be a good idea to connect but there must be a will to use it more.

The goals of access management are to limit the number of conflict points, to separate the conflict points, and to remove the turning vehicles from the thru traffic. In Florida, we are trying to encourage more of the directional median openings rather than full median openings. There are a number of design issues that we are working on now because U-turns need to be designed into the system more than they have been in the past. When there is a restricted median, a driveway has a very simple driving solution with only two major conflicts. We are trying to reduce the number of conflicts.

Technics that we have to separate the conflict points are driveway separation, comer clearance, no spacing , etc. Florida measures distance between driveways and comer clearance from edge to edge. Some people measure from point of radius to next point of radius. Comer clearance is important to businesses because, if it is not far away, it gets in the way of customers coming.

Driveways are intersections, as stated in the AASHTO Green Book. Driveways need to be kept out of the functional area of intersections. What is the functional area of an intersection? This is an important concept in the placement of driveways both minor and major and on this portion of an intersection, you have queue distance, deceleration, and also some time for reaction. If possible conflicts should be kept away from this area as much as possible.

Another way of getting traffic off the thru movements is through the use of turn radius and driveway width. The problem then is to be more considerate pedestrian friends. In Florida, since 1992 or 1993, we have a policy at DOT that a multilane project which has a design speed of over 40 mph will have restricted medians. Even if it has a design speed of 35 mph there will be portions of restricted medians to help the pedestrians. We are a very "pedestrian aware" Department of Transportation.

Another thing that we feel is important and are trying to do more of in the Department of Transportation is to get rid of the old, what we call, bulletnose. We built all rural multilane highways throughout our state where you put a median opening which has no storage. What is the problem? The big problem is that, what we thought was going to remain rural in 1970, is now urban and what you have is no storage or protection for people. If you time it, in order to get into these rural bullet openings, you must slow down to about 15 mph. You do that while everyone else is going 55 mph as most are doing on a 45 mph road, and the potential for accidents is great. Georgia DOT, I believe, builds all its rural multilane with full turnbays. Georgia had the awareness even before Florida.

Another way to get people safely where they are going, out of the through movement as quickly as possible, is through good sight development. The idea that we try to get to the people who review plans is that you should be designing your sight from the outside in. Where is access the best? Then design your transitions, then design your parking and place your building. Unfortunately, a lot of the time it goes the other direction. So you design your internal circulation around your access points.

The three realms of access management that you could be working in are permitting through new development or expanded development, through road improvements whether its a new road or an improvement to an existing road and the one that we are getting more and more emphasis on is that the appropriate levels of government work together to assure safe transportation and good access management and good sight design.

The other things to mention are problems with access management strategies that we have tied to use in the past that don't always work out as they should. 1) Frontage roads is one of them - they work great when there is not a lot of traffic. They can work in residential or small business when they don't intersect with the major intersections. 2) Continuous right turn lanes - When people try to make turns into a driveway, the good Samaritans let them in but the free flowing right turn lane is moving into fast moving traffic. 3) Another problem is the use of directional deltas.

Arthur Eisdorfer

These are the goals that New Jersey came up with in 1989, and we have been relatively successful in implementing three of them. Regardless of what you do, it is important that **you** try to be **consistent .** Some states and organizations are centralized , others are decentralized and in either case it is critical that, if an issue comes up, it is decided the same way every time. That lends itself to the next goal which is **predictability.** If the outcome is the same all the time, the regulated community starts to know what to expect and it shouldn't matter to which person of the agency they speak to or what day of the week it is, they should get the same results all the time. And **timely** - someone wants an answer in a reasonable period of time. They don't want to wait a year to find out whether or not there is a possibility of them getting a driveway at a given location. They would like to know on the spot but that is not always possible but they would like to know in a reasonable period of time. The last goal is **simple. You** see a lot of access management features mentioned, and it is nice to try to manage or control each and every one of those features. The problem is that, if you do that, you end up with a set of regulations, which we have in New Jersey, which is in excess of 100 pages of fine print. Not everyone likes that but I do because it gets back to the first two goals, it's a lot easier to be consistent if the decisions have already been made. It is easier to be predictable if the information is already written down for somebody to read.

Putting together a program takes time. 50% of the time will be in education. The constituent that you are going to have to deal with may not know what access management is. They may not know about capacity. Everybody hears about safety but they don't know what it means in terms of on the highway. A lot of citizens are not fluent in that. A lot of time can be invested in education - getting everybody to speak the same language. Define the issues - what issues are going to be addressed in the program. Then, once they are defined, conduct some sort of research. While the physics of driving are the same regardless of where you go in the country, the people don't seem to be the same in every place, the conditions are not the same. What may be a very good standard in one location might not be an appropriate standard in another. There needs to be some regional perspective on what's appropriate for the area that you are trying to address. The part that is most distressing is when everything seems to be covered and someone comes up with "What if this happens". About 90% of energy can be devoted to addressing those things which will occur less than 10% of the time. It is something of which to be careful because one can become sidetracked and not really devote appropriate attention to addressing the issues that make the most difference.

Consider proposals. Everyone is not likely to come up with the right approach to every issue on the first try. People are going to try to suggest alternatives, and all of those need to be considered to make sure that everybody who wanted to contribute to the process does feel that they have been part of the process and that their prospective has been adequately considered.

Make the decisions part and make the decision as to what will be in regulations or guidelines that are to be implemented.

Access management provides an opportunity to implement some sound public policies. These are some of the transportation efficient land use patterns, mixed developments, and there is the opportunity to provide incentives or certain types of access arrangements and disincentives for others so there is the ability to encourage mixed use developments.

The roadway hiarchy. It is not appropriate to put a million square foot shopping mall on a collector street. Everyone will not be able to get in and out. Whatever is put together needs to recognize that there is some sort of hierarchy to the roadway system.

As a responsible public official, you should be looking out for the health, safety and welfare of the public. Regardless of the issue that you come up with, there is an opportunity to fill in a name or position, and we came across at least a dozen issues where the development community was trying to pull the DOT in one direction, tip the balance in their favor, whether it was the folks "not in my backyard', the environmental concerns, the planning concerns were pulling things out in the opposite direction. What was found was that in a lot of earlier discussions over here and talked of gravitating in a direction, then we saw that there was a larger constituency that then we had been dealing with and we started out some discussions over there. Then we tried to tell the people what the other people said and the other way around and it didn't work. What did work was putting everybody in one forum and having each person have the opportunity to hear what all the other view points were and then suddenly this looked like a good position. This manner is hardily recommended.

We are dealing with transportation, and there are a large assortment of sizes and types of land use that can generate 200 peak hour trips. There needs to be some sort of equity. The regulations that were in place in New Jersey in the early '80s didn't wholly account for trip generation so it was possible, for example, for someone to put in a very large supermarket that generated more than this amount of traffic and then not be responsible for any mitigation, whereas, someone else would be putting in a development that generated less trips and they would have some responsibility. A suggestion is to try to operate on a level playing field and in the transportation field the common denominator is trips.

One of the important lessons - Nothing is cast in stone, the best is you can hope to do is the right thing at the time you had to do it and, whether it is putting together guidelines, putting together regulations, there are provisions for making changes and that is something that should be woven into the fabric of whatever it is you are putting together so that everybody recognizes that there is that opportunity. At that point, it becomes incumbent upon the agency to monitor activities and, if things are not turning out the way they were supposed to turn out, go the second time around, make the changes and try to achieve the results that you set out to achieve.

There are a number of access management features that you have heard about, and you need to make a decision as to which ones are most critical to the area that you are trying to manage the access in. It may not be everyone. There also needs to be some sort of classification system so that you are not trying to treat the same roads the same way.

Handling variances - Whatever you come up with, someone is going to come up with a good reason why they feel it doesn't apply to them. You need to be prepared to be able to deal with that.

Who is going to administer the program? If you look across the country, you will see access management programs just for state highways that are administered by DOTs, some administered by counties, some administered by municipalities. There are some benefits and disbenefits for doing it each way but it's best to consider what's the most appropriate way for the area you are associated with.

Are you going to give this service away or are you going to charge for it? The way budgets are today, there will be a lot more people interested in charging.

Classification System - Each of the states we represent has classified their state highway network. Each has gone about doing it a different way. The way started in New Jersey was by considering the Federal funding classifications and that was good for giving out money. It was not the appropriate basis for managing access. From there, it was decided what appropriate boundaries were between different classifications of highways and then input was solicited from counties, municipalities, and citizens to see whether their vision for the future of every highway segment was at least similar to the state's vision. From there was built a classification system. Use as few as possible because the more classifications you have, the more boundaries you are drawing and the more opportunities there are for someone's opinion on where the boundary ought to be to be different from your opinion.

VI Seminar/Workshop

Optional Two-Hour Workshop - On Highway Capacity for Non-Signalized Intersections. Conducted by. Dane Ismart, Federal Highway Administration. This summary of the workshop on Sunday afternoon was transcribed from the recorded session..

Dane Ismart

How does unsignalized intersections deal with access management and what are the implications of access management.? Earlier procedures on unsignalized intersections dealt with the traditional two-way stop control and the four-way stop control intersections. The Highway Capacity Committee is considering changes. We can now have techniques for determining delay and and queue lefts. When consolidating driveways , traffic builds up on those facilities and the question is whether or not we can get a decent level of service out of the unsignalized intersections. When we can't, we begin to talk about signalization but realize that the more signals we put in, the lower the overall travel speeds will have on the facilities. The idea is to try to consolidate the access points and, at the same time, not require signalization.

The 1994 HCM procedure for unsignalized intersections considers the mainline traffic. When we are begin to look at left turn lanes, we assume that an exclusive left turn lane on the main line will not cause any interruption to the mainline traffic That's not always true. There are methods to estimate what is the delay being experienced by the mainline thru traffic because of a left turn from the major street to the minor street. We can also look at the right turn lanes as well. Looking at the Capacity Manual, there is only one place where, other than the unsignalized intersections, that uncontrolled access along the roadway is actually part of the analysis. In the multilane highways procedure of the HCM, the number of access points that are along that multilane facility will impact the overall freeflow speeds on that highway. For example, if you have ten right turns along the main line, that is going to lower your overall freeflow speeds by 3.5 mph and, if you have 40 right turns, you will lower overall speed by 10 mph.

The HCM assumes that the capacity of that unsignalized intersection is going to be controlled by the gaps in the major stream traffic stream. It will also be based on the driver judgement. What do we mean by a critical gap? A critical gap is the timespan that an individual driver is going to accept and move through. If you have 20 seconds and go ahead and move through, that doesn't mean the 20 seconds is the critical gap. It is the lowest timespan that you are going to accept to make that movement into that uncontrolled intersection. Everybody has different critical gaps but we will be looking for that average gap.

What is the approach that we are going to take? Remember that the whole idea of analyzing unsignalized intersections relative to access management is to establish the delays and queues that will result from implementing an access control strategy. Thus, when someone proposes a major shopping center, we can ask how much time is it going to take at the intersection and what kind of queues will we see. Knowing that, we can go back and determine whether or not we need signalization. Of course, we have the MUCTD and the warrants for the signals that we can apply.

The conceptual approach is this. Every controlled movement at an unsignalized intersection has a rank. For example, right turns from the minor street will have the highest rank. In other words, no one is going to be interfering with right turns from the minor street. The second highest rank that we are going to evaluate is going to be left turns from the major street. None of the other movements that we will be evaluating, except the thru movements, will interfere with the left turns from the major street. The third highest rank is thru movements from the minor street, and the lowest rank will be the left turn from the minor street.

When looking at a left turn analysis, it will be found that the analysis procedures that we have are generally going to be controlled by the left turners from the minor street. It doesn't take a lot of left turners from a minor street to come up with a level of service "F".

When we look at levels of service when dealing with unsignalized intersections, it is a concept of a fixed critical gap. If you are willing to accept a lower critical gap, what happens to the real capacity of the unsignalized intersection? It goes up; however the HCM procedure will not indicate that. If I'm on an unsignalized intersection and have to wait 20 or 25 seconds, I start to get discouraged. What do I do? I want to make a left but I decide why don't I go ahead and make a right and then I'll make a U-turn. That is exactly what a lot of people do. When we work on the models, we say this is the number of people who will turn left, it doesn't account that the critical gaps may be reduced because of social pressures. It may not account for the people who make a right and go down and make a U turn the signalized intersection. These are some of the reasons we get critized when we start modeling unsignalized intersections. A number of issues need to be considered when we start looking at a model and when we look at the implications that it may have for access control.

What are the data requirements that we will deal with? We need a number and uses of the lanes on all legs of the intersection, we need channelization, we need per cent grade. The curve radii and approach is something we may need in the future because we may have a flared shoulder.

When doing an unsignalized intersection, consideration will have to be taken on the arterials and overall transportation system, take into account platoons and gaps.

In 1994, HCM procedures, grades and trucks are not used to boost up the amount of passenger cars rather at traffic ranks. In passenger car equivalence peak hour is considered, adjustments for grade, mode of vehicles. In the new procedure, grade and trucks are not used to boost up the amount of passenger cars but critical gap is changed. Potential capacity, the amount of vehicles that can move through a gap is calculated. Delays and level of service can then be determined.

We are becoming more sofisticated when we talk about unsignalized intersections and the delays that will be incurred, Access management impacts on unsignalized intersections were difficult to assess when level of service was based on reserve capacity back in the 1985 HCM. We could not tell what the operational impacts would be on the mainline of traffic. Now, you will be able to take your access management plans and at least come up with some estimation as to what will actually occur.

Note: Mr. Ismart used many charts, overhead, and equations for his presentation, especially, on two way and four way stops. These could not be transcribed.

SECTION VII

LUNCHEON SPEAKER

Access Management

VII Luncheon Speaker

"Reauthorization of ISTEA" presented by Francis B. Francois, Executive Director, AASHTO

This summary of the luncheon speaker on Tuesday was transcribed from the recordedpresentation.

Lets talk transportation. I will cover three issues:

1) Transportation today and some of the issues we face,
2) What's happening in Washington with respect to funding and with respect to the reauthorization process
3) Some of the trends that we are going to be working with tomorrow and on into the future

(1) Transportation today and some of the issues we face

Transportation today remains vital to all that we do. It takes approximately 18% of the household budget. That's more than we spend on food. All modes of transportation are important. What holds it all together are the 3.9 million miles of streets, roads and highways. All air travel accounts for about 6% of total person travel. 2.5% of personal travel is on transit. 88% of all personal movement is in private vehicles on roads. 29% of goods movement is provided by rail and 23% by water. With trucks providing the rest. 3 1.6% and growing is on the highway system. There are over 40,000 miles of interstate highways now. That is what changed America more than anything else. The system is 50 years old. The GNP has gone up and running parallel with it (the same curve) is VMT on the nations highways.

Safety - 40,000 people are killed each year. More needs to be done through access management to reduce accidents.

Environment - Air quality and noise pollution are the major factors. Transportation planners and highway engineers must work together . AASHTO must respond and will respond to the state(s).

We have moved from a period of constructing new highways on new land to reconstruction of urban freeways under heavy traffic. This is a change that has occurred and gives us a whole new set of challenges. There is inadequate funding to meet these challenges.

AASHTO started out as a highway organization in 19 14 and remained so until 1970. It came into being for a lot of reasons, not the least of which was that the highway engineers thought that they should talk with each other. One of the first things AASHTO did was to look at the possibility of creating a Federal-State partnership. AASHTO wrote a draft of the first Federal Aid Highway program, in 1916.

Changes are taking place. We are becoming intermodal in all of the states. Reorganization is occurring because of the ISTEA bill of 199 1. Two examples of this are: 1) In the State of Iowa the separate transportation offices are consolidated into one Office of Transportation and 2) In the State of Maine, both freight and people movements are analyzed regardless of how they occur.

Downsizing is occurring because computers are being used more to take up slack. The workload has gone up. AASHTO is deeply involved in developing software with ten million dollars being allocated this year. Customers are demanding quality, and we must give it to them.

Research & Development. AASHTO is the organization that puts together the NCHRP. The fact that there is state attention on access management is underlined by the fact that you have NCHRP reports available here and others that are being worked on in access management. Those research projects had to be approved by the AASHTO Standing Committee on Research. Research is going on in work zones. Life cycle costing is being looked at. It has a direct relationship to access management. Intelligent Transportation Systems (ITS) is a new activity. AASHTO helped create ITS America. We are a standards development organization, and we will be doing more in that regard.

Access management fits into all of these activities. Access management is a concept whose time has come. It is not mainstream within AASHTO but it is there. Yes, the Green Book is under constant revision, and it is one of those things that we will have to look at. The new Green Book, of course, is in metric. AASHTO is going metric, inch by inch. We will get there, and we will get there with access management too. It just makes so much sense from a standpoint of safety. Access management offers Americans an awful lot, but it is not easy. It requires a new kind of cooperation between states and local planning organizations. To develop the American transportation system, the private sector also must be involved. We must talk to ordinary citizens, land owners, commercial-industrial activities people, and environmentalists. All people must be involved in the decision process. That's what ISTEA legislation is meant to encourage - citizens' involvement. Decisions made in the state and at the metropolitan area level need to be made by a planning process. The planning process should include access management. It is mandated to some extent at least in large metropolitan areas. Doing retrofit is the real challenge.

(2) **What's happening in Washington D. C. with respect to funding?**

Thankfully nothing is happening right now. As for money- the appropriations process for fiscal year 1997 is moving along relatively well for transportation. The House passed a transportation appropriation bill totaling 33.67 billion dollars and the Senate 35.3 billion. Last year it was 3 5.64 billion. Transportation has survived at relatively the same level as in 1996 and 1997. The highway obligation ceiling in the Senate is 17.6 billion and in the House it is 17.5 billion. For transit there is quite a bit of difference, I. e. 4.38 billion in the Senate and 4.0 billion in the House. All of these things are relatively close and it should be possible to put together a conference committee to put a bill together for the floor in mid September that would receive President Clinton's signature. Now if that doesn't happen we would fall into that massive continuing resolution that would take in everything that isn't approved. It is an interesting one. Continuing resolutions are typically for a month or two. The one they are talking about would run until next March. Whether or not that will actually happen, we do not know.

Buried in things that are happening in Congress that also effects money is the future of the 4.3 cent fuel tax (levied in 1993 for general fund purposes). There are many organizations including AASHTO that want that 4.3 cents moved into the Highway Trust Fund. There are other people who simply want to repeal it outright. Among those was Senator Bob Dole. The House passed a bill that would do that through the end of this year and then the tax would go back to its original level. This bill is pending in the Senate. Now what the Senate does with it we don't know. Former Senate majority leader Robert Byrd (West Virginia) has a bill that would put it back into the Highway Trust Fund now. Before he left Congress to go to the Republican National Convention, majority leader Trent Lott said "I kinda like that bill. When we come back in September I think we are going to vote on it and see what happens." So we stand a reasonable chance of the Senate taking up that 4.3 cent bill with the money being put into the Highway Trust Fund. What the House would do if the Senate does that we don't know, but there are people who believe that too might come out of conference committee. Part of the price of coming out of the Senate has Senator Roth of Delaware saying that some portion of tax should be devoted to AMTRAK, probably 0.5 cents.

What is reauthorization? In order for there to be a program the authorizing committees in Congress must develop and pass an authorizing bill which is then funded by the appropriations committee on a yearly basis. The last reauthorization we had was in 199 1 was ISTEA of 199 1. That bill expires on September 30th of 1997.

The House has held a number of hearings on reauthorization. The Senate has held no hearings, so far, but is planning to hold hearings in September but the fact of the matter is this: the Congress and the President that will approve the next reauthorization bill have yet to be elected. Depending on how the election turns out will have a large impact on what actually happens next year.

Looking at the house. If Republicans retain control of the House, we can expect things to move fairly rapidly. Representative Bud Schuster will probably remain chairman, and he has already held hearings and will be ready to introduce a bill in early 1997. If Democrats win the House back, we will have to start all over. Representative Overstar would be chairman of the committee. He doesn't like the hearings held so far. He will start all over. In the Senate, if John Warner of Virginia is elected he will hold hearings and move things. If the Democrats win then we will start all over. At the White House (Administration) the USDOT has been busy this year. They have held

13 secretarial hearings all over the U.S. on a wide range of issues on surface transportation. FHWA has held 90 focus groups on a whole set of issues. If President Clinton is reelected there will be a reauthorization bill in late January - February. If Clinton is not reelected there will be a new Secretary of Transportation and we will start all over.

What kind of bill can we expect? As of now there are at least 2 **1** organizations that have put their ideas on the table. Overall what is reauthorization about? Basically it is about three things. Money, money and money. How much money, who gets it and how can you use it that's really what the reauthorization bill is. Currently, the following ideas are on the table: 1) ISTEA II, or next tea, that is an extension of ISTEA; 2) HOTTEA, that is a highways only TEA; and 3) NOTEA or Turnpike. Lets talk briefly about each of these.

ISTEA II

There are those in Congress that feel that this is a pretty good bill. Therefore, lets keep it with a few little changes here and there. This is basically where AASHTO is, and I think that's really the mainstream. What kind of changes can we expect? Well, there are those that say we can get rid of the transportation enhancement program. I don't think so. It is very popular in Congress. There are those that say we can change the planning process. It can probably be simplified some, and that will probably happen. There are others that say there should be more safety emphasis in the bill. That probably will happen but the real argument is going to be over who gets it.

As Mort Downey, the Undersecretary of Transportation, calls it the "formula food fight" and it's already well under way. There are those that want a larger share or their share in a different way. One of the splits that is occurring is between urban and rural interests. The Surface Transportation Policy Project is leaning in this direction and believes that transportation funding should go out strictly on the basis of population. Urban areas should get more, rural areas should get less. That's one approach. Now that, of course, if you want to get food across this country, doesn't work too well; this will be one of the arguments. There are a group of about 22 or 23 states that have a bill known as STEP2 1 (Surface Transportation Efficiency Program for the 2 1st Century). The heart and soul of that bill is to guarantee 95% return to every state of the dollars that go to Washington. Now, if you have a rising ship and a rising tide, I. e. more money, that's relatively easy to do. If you have the same or less money, which is apparently where we are, then obviously to give those states more you have to take away from somewhere else. Somewhere else is called New York, Connecticut, New Jersey - places that have Senators and Representatives who will strongly fight this issue. Now STEP2 1 gas had their bill introduced. Within hours of being introduced, Nick Rayhall a Representative from West Virginia who, if the Democrats win, will probably be the next chairman of the Transportation Subcommittee attacked the bill heavily. It is not universally popular within Congress but, nevertheless, it is a bill.

HOTTEA

Who's behind this? Well, it's the American Highway Users Alliance. You used to know them as the Highway Users Federation. They believe that transit's nice but it shouldn't be paid for by the Federal government., that's a state and local proposition. They also believe that most of the funding should be concentrated on the National Highway System. There is another organization that is heavily involved in their policy making known as the American Trucking Associations which fully agrees that almost all of the money ought to go to the Highway System. So that's another viewpoint.

NOTEA

This was talked about in past years. This year it is more serious than its ever been. NOTEA is championed by those people that say the Federal program has served its purpose. They say close down the FHWA, get rid of the Federal taxes, let the states reimpose whatever taxes they want back home and get the Federal government out of the business. This is a serious movement. It is sponsored in the Senate by Senator Connie Mack of Florida and in the House by Representative John Cassick of Ohio. A bill was introduced a week and a half ago called the Transportation Empowerment Act which would carry this concept out. It is now pending in both bodies this year. It will not be voted upon this year but you can be certain it will be reintroduced again next year. What it does basically is this, it looks at the 14 cent gasoline tax that goes to support the program and the corresponding diesel fuel taxes. Collectively there are about 21 billion dollars of the total 24 billion dollars that's funded in the

Highway Trust fund. The other 3 billion dollars comes from vehicle related taxes, heavy trucks, etc. What they would propose is that for fiscal year 1998 a block grant equivalent to 7 cents would go to all the states; the following year that block grant would go to 12 cents a gallon; the following year the Federal Fuel Tax would be cut to 2 cents a gallon and the States are on their own. They would keep the little money that's left at the Federal level, about 5 billion dollars, to support maintenance of the Interstate system, several Federal programs and a little bit of research.

Now where is AASHTO in the middle of all this? Well, AASHTO believes strongly that there is a Federal role that needs to stay in place. That it is a Federal-State-Local partnership. We believe that issues of national significance need to be dealt with including research, National Highway System, rural/urban connectivity; a whole host of issues. AASHTO as an organization has decided not to get involved in the "formula" fight.

We have turned our documents into two reports which are now available from AASHTO. The first of those is the bottom line report which looks at the needs of the nation's highways and transit systems. Those needs far exceed our current level of resources. We could come fairly close to meeting those needs if we could get those 4.3 cents over into the Highway Trust Fund. Now there is a lot of recommendations we have but there are four summarized in this book. 1) that the maintenance needs of the nation's highways and transit systems outstrip the funds currently available; that the 4.3 cents per gallon of users fees should be put in the Highway Trust Fund., 2) that state and local governments should be given more flexibility in determining how, when and where transportation resources are spent, to maximize benefits to mobility, safety and the environment, 3) many of the key concepts of ISTEA such as state and local cooperation, intermodal planning and public participation should be retained and 4) that burdensome and unnecessary provisions imposed by ISTEA and earlier laws should be eliminated or reduced.

Overall, AASHTO is working toward keeping a Federal Program in place.

Now what's the outcome of all of this? Well, of course, no one knows at this point but, I think, most likely something like ISTEA will be reenacted and we will keep going with probably about the same money as we have now. The money issue resolves to a very great extent about how serious we are about the balanced budget amendment. Last year the budget resolution that was passed said that we were going to be on a glide path between now and 2002 where transportation funding in total would go from 38 billion dollars to 32 billion dollars. Now if that's true we will have less money then than we do now. We will have to see how that plays out after the election. The one thing it does promise to be is a very exciting time.

(3) **Some of the trends that we are going to be working with tomorrow and on into the future**

Now what are some of the other trends. Looking ahead 10,15,20,30 years, one thing I think is very clear and that is that our highway and road systems will remain the key to mobility in this nation. The reality is that that's how America has been built even if we wanted to change it. You cannot change it in a very short period of time; decades would be involved. But we are there and it is going to be an intermodal system. We are going to be moving more and more toward the system concept involving all levels of government, and all components of the system linked together to each other through the planning processes. We are not there now but we are certainly moving in that direction. Money; money is always going to be tight. We are going to be looking at public-private partnerships, tolling concepts and other ways of trying to raise money and yes, state and local governments can expect that if they want facilities built the help we used to get from Washington is not going to be there. We are going to have to find ways to do it ourselves or to reduce costs or to find better ways to utilize what we already have. We have an aging population that's going to change demands on this transportation system and how we move about. We really don't understand how yet. There are studies looking at that now but eyesight is different, reaction time is different and a lot of these aging American live in those suburbs and rural areas where they moved years ago. How do we meet their transportation needs in that kind of setting? It is one of the issues that we will have to face in the next 5 to 10 years and it probably means more transit but of a different kind; on-demand transits, smaller buses, smaller vehicles moving across rural America and into the suburbs.

The transportation work force of tomorrow is another worry. We have so many people retiring now with thousands of years of experience. How do we replace that? Computer expert systems may help, but ultimately you must have people that make decisions and understand the processes. Getting them through colleges and into employment is a problem we all face. We want employ a more diverse work force. Most Americans are women. Show me any DOT where we approach that kind of split in the work force; there are none. We need to work a lot more on that issue and we will have to as time goes on. We are going to face new vehicles, much lighter vehicles as far as passenger vehicles and much heavier vehicles as far as trucks. As we look at the Green Book and other issues how do we design the highway system that will accommodate 130,000 - 140,000 pound trucks and 2,000 pound automobiles? With great difficulty. Maybe you need to start to think about separating them and it is being talked about in some areas. Maybe we need truck highways which we will automate. Where does ITS takes us? Is it the answer? No. Is it part of the answer? Probably. We have a lot to think about and to do there yet, and we have a change in paradigm. Now paradigm is not 2 dimes its a concept as to how we do things. A paradigm shift is that we are moving from new development to maintaining the transportation system that we have built over the last 100 years, and that means new kinds of thinking, new kinds of managers and its going to mean the kind of employees we need are going to have to be different. Yes, we are still going to need civil engineers but those engineers are going to be managers of resources and they had better be public relations people and superb communicators.

SECTION VIII

CLOSING REMARKS

Access Management

VIII Closing Remarks

Phil Demosthenes
Conference Chairman

Mr. Demosthenes extended his appreciation to the speakers, moderators, attendees, the conference committee and the conference crew. He stated that this would wrap up his tenure as conference chairman and that he is turning that role over to Mr. Gary Sokolow of Florida DOT for the 1998 conference.

He mentioned that there would be a mid-year meeting of the TRB Access Committee that afternoon for the purpose of working on the program for the 1998 Conference . He felt that the conference would only be as good as the speakers that participated. The committee will be making a formal call for abstracts next summer.

Mr. Demosthenes indicated that there were good real estate people at the conference but there was little real estate content in the program. He stated that we needed to fix that in 1998.

Mr. Demosthenes concluded his remarks with thanks for attendance at the conference.

Ron Giguere
Chairman, TRB Subcommittee on Access Management

Mr. Giguere thanked Phil Demosthenes for his work in the last two conferences. He felt that this conference was a good forum to talk about access management and it was information rich. He additionally thanked the Colorado Department of Transportation and the Conference Committee. He recognized TRB, particularly Jim Scott, and the FHWA . He also recognized two TRB committees, the Operational Effects on Geometrics Committee and the Geometric Design Committee. Each of these committees sponsored a session.

The Chairman formally announced that the 3rd National Access Management Conference will be held in Ft. Lauderdale, Florida in October 1998. FHWA and TRB will sponsor the conference. Florida DOT will be the hosts with Gary Sokolow and Bob Krzeminski of Florida DOT serving as leads.

Mr. Giguere lauded the presenters and the speakers for their good work. He said that the conference proceedings would probably be available for distribution by the end of the year. He speculated that they (FHWA) may have several printings depending on demand. Mr. Jerry Faris (Transportation Support Group) will be preparing the conference proceedings.

Mr. Giguere featured some national level activities related to access management. For example, NHCRP is funding several ongoing studies. One, entitled Project 3-52 "Benefits of Access Management Techniques", is collecting data and developing techniques to help us better assess the impacts of selected access management strategies. He indicated that FHWA is focusing on outreach activities such as: 1) a multi-media presentation (video) - to be distributed to FHWA field offices, DOTs and some MPOs (contact Mr. Giguere if you wish a copy), 2) a web site dealing exclusively with Access Management , ***3)*** a three day short course on Access Management. The current course is presented regularly to State and local agencies. FHWA is planning on updating the course in early 1997.

The Chairman then focused on the TRB Access Management Committee (A1D07). By design the committee is meant to be very proactive and product oriented. A 1 DO7 is entering its third year as a full standing committee. Mr. Giguere highlighted some of the committee's goals and major accomplishments to date. The committee does not want to rest on its laurels. There are a number of future activities planned for A1D07 with the most ambitious being the development of a comprehensive Access Management manual.

Regarding the access management manual, a technical working group met in Washington in February 1996 to discuss the structure and content of such a manual. The meeting provided very definitive ideas -as to what the access management manual ought to look like. The goal for the manual is to produce something very comprehensive that can be conveyed via hard copy, CD ROM and the Internet. Mr. Giguere hopes to complete the entire access manual in the space of 3-5 years; with some intermediate products available even before then. This is an ambitious undertaking for a TRB committee. The committee will receive contractual help that will be funded through FHWA and NCHRP.

Mr. Giguere indicated that they are looking for people who have a lot of energy and a lot of interest to be friends of A 1 DO7 and to serve on one of the subcommittees and task forces.

He indicated that this was one of the best speciality conferences he has attended. One reason was the good participation on the part of the attendees. The Chairman concluded by thanking the attendees for coming. He hoped to see everyone in Ft. Lauderdale in 1998.

SECTION IX

ATTENDANCE LIST

Access Management

IX Attendance List

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SECTION X

INFORMATION ON 3RD CONFERENCE

Access Management

X Information On 3rd Conference

TRANSPORTATION RESEARCH BOARD
National Research Council
presents

3rd NATIONAL CONFERENCE ON ACCESS MANAGEMENT

Fort Lauderdale, Florida - October 4-7, 1998

Advance Announcement

What is Access Management?

Comprehensive access management is a new response to the congestion, the loss of highway capacity, and the serious access related accident experience that is plaguing our nation's roadways. Access Management is the careful control of the location, design and operation of all driveways, median openings, and street connections to a roadway. This control achieves a significant improvement in traffic safety and operation. The lack of access control has been identified as the largest single cumulative design element reducing roadway safety and capacity.

Access Management is an important element in the Federal ISTEA Management Systems for safety and capacity.

The challenge is to develop effective access policies and standards that find a balance between land development plans and the preservation of the functional integrity of the roadway. As urban and suburban land use densities increase, as traffic volumes and trip generation increase, and the influence of the frequency, location and design of driveways and intersections become a critical factor in the performance and safety of the arterial system.

Access Management is emerging as a systems management and design program that is clearly one of the most cost effective techniques that achieve crash rate reductions and improves capacity and traffic flow.

What You Can Learn From This Conference?

- How Access Management saves lives and also reduces the frequency of injury and property damage.
- How Access Management prolongs the functional life of existing highways, maintains or increases capacity.
- How finalized Access Management programs that establish uniform standards and promote fair and equal application.
- How Access Management requires cooperation among all agencies making land-use and transportation decisions thereby achieving improved planning and transportation integration.
- How Access Management foster economic prosperity and promotes efficient travel.
- How Access Management promotes Corridor Preservation

Sponsors

The Transportation Research Board and its Committee on Access Management (A1D07), the Federal Highway Administration, Office of Technology Applications and the Florida Department of Transportation are working together to provide this National Conference on Access Management.

Conference Location: Fort Lauderdale

The Third National Conference on Access Management will be held at Fort Lauderdale, Florida on October 4-7, 1998. Fort Lauderdale is famous for its magnificent beaches, beautiful sunshine, blue skies and a 75-degree average annual temperature.

The conference site will be the beautiful Fort Lauderdale Marriott Marina Hotel. The hotel, with 580 spacious rooms, is situated on the famous Fort Lauderdale Intracoastal Waterway at Port Everglades, just 3 miles from the Fort Lauderdale/Hollywood International Airport.

Access to dining and shopping by walking, water taxis, city bus, rental bikes or other ground transportation. Only minutes away from the beautiful Las Olas Boulevard with block after block of boutiques, art galleries, speciality food shops and many fine restaurants. Just 25 minutes from the world's largest outlet mall, Sawgrass Mills Mall, with over 250 outlet shops.

Advance Announcement

Preliminary List of Conference Topics

Listed below is a preliminary list of conference topics. The topics are broken into three primary and secondary topics. The primary areas include General, Administrative, and Technical. The secondary topics include case studies, success stories, and workshops.

General

- What is Access Management?
- Legal Issues
- Administration of an Access Management
- Programs at State and Local Government Levels

Administrative

- Public Involvement
- Establishing an Access Management Program
- Program at State and Local Government Levels
- Local Government Approach to Access Management
- Access Management Practices

Technical

- Corridor Specific Access Management Plans
- Arterial Driveway Spacing Issues
- Turn Restrictions
- Geometric Design
- Median Opening Decision Process
- Capacity Issues
- Operation
- Safety
- Project Evaluation
- System Planning
- Models and Modeling for Access
- Site Distance
- Freeway Interchange Analysis

Corridor Case Studies

- Selected Case Studies From States

Success Stories

- Progress Reports From Agencies Who Have Implemented Access Management Programs

Administrative and Technical Workshons

- Mock Trial
- Access Management Basics
- Technical Workshops (Capacity, NETSIM, AMA Model, Simulation)

History

The first two National Conferences on Access Management were held in Vail, Colorado in 1993 and 1996. Over 150 professionals attended the first conference. While this conference was considered a success over 235 professionals attended the second conference.

Consider Access Management as a new solution to many of your highway problems. Plan now to attend the 1998 National Conference in Fort Lauderdale and learn more about this solution.

Conference and Abstract Information

Abstracts for papers or presentations are now being solicited from professionals for the 1998 National Conference on Access Management. If you have or will have an administrative or technical subject related to Access Management that you would like to present at the conference please contact the Conference Chairman:

Gary Sokolow
System Planning Office
Florida Department of Transportation
605 Suwannee Street, MS 19
Tallahassee, Florida 32399-0450

Phone: (904) 488-9747
Fax: (904) 92 l-636 1
E-Mail sokolog@dot.state.fl.us
(E-Mail is preferred)

Registration Information

Conference registration will begin in early 1998. Conference capacity is limited to 350 people. To be placed on the mailing list for 1998 registration materials, mail or fax your name, title, organization, full address, phone and fax numbers to the Arrangements Chairman:

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