

INTRODUCING THE NCHRP 15-49 IMPLEMENTATION GUIDE



15TH INTERNATIONAL CONFERENCE
ON MANAGED LANES

MAY 6, 2016

Presentation by:
NCHRP Project 15-49 Team

NCHRP 15-49 TEAM

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OVERVIEW OF NCHRP 15-49 RESEARCH

Develop *Guidelines for Implementing Managed Lanes*

- Draft is currently under NCHRP editor review

Phase II research studies:

- Roadway design decisions
- Lateral position of vehicles
- Practitioner preferences for geometric design tradeoffs
- Speed of vehicles in managed lane
- Access design study

Identify future research needs

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- Practitioner preferences for geometric design tradeoffs
- Speed of vehicles in managed lane
- Access design study **(was in Session 7)**

Identify future research needs

NCHRP 15-49 DELIVERABLES

Guidelines

Within NCHRP series

Available both hard copy and on web

Status = almost with NCHRP editors

Research Report

Description of research efforts

Available as a web-only document

Status = research team making final revisions

GUIDELINES FOR IMPLEMENTING MANAGED LANES

- 1. Introduction to Managed Lanes**
- 2. Planning Considerations**
- 3. Design Elements**
- 4. Traffic Control Devices**
- 5. Implementation and Deployment**
- 6. Operations and Maintenance**
- 7. Glossary**

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INTRODUCTION CHAPTER TOPICS

Orientation

- Legacy and growth trends

What's New

- Changes in selected applications

Decision Making Experiences

- Challenges, opportunities and suggestions for practice

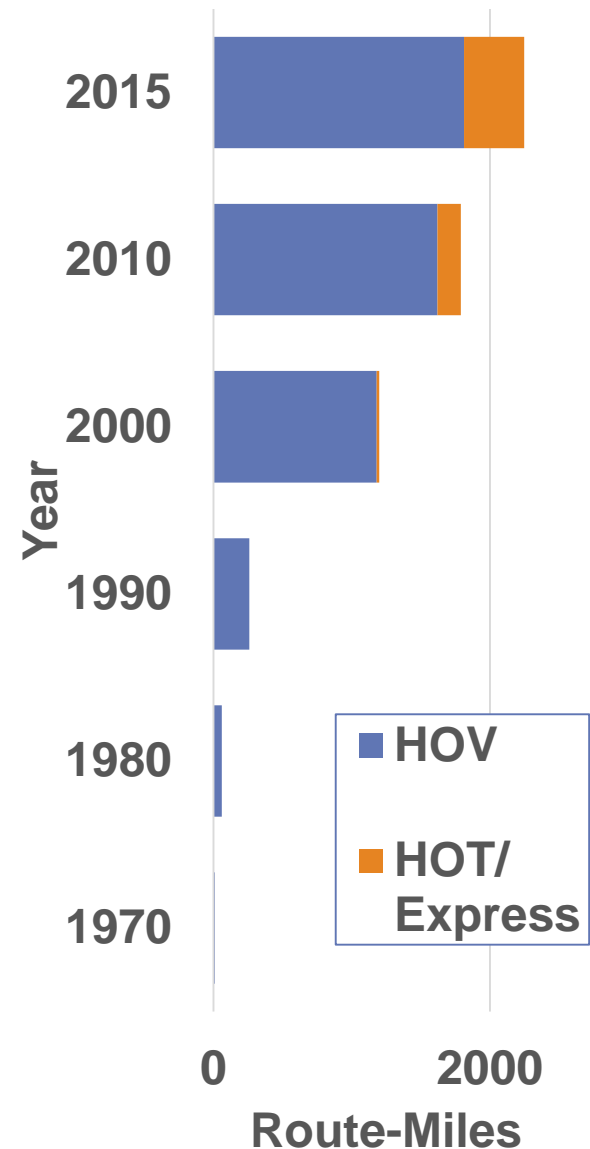
INTRODUCTION CHAPTER LEGACY

Evolved from busways to HOV lanes to HOT lanes to express lanes

Federal policies initially encouraged moving person movement

1970-2015: Projects expand to 2500 miles in 11 states

MLs serve millions of trips and save over 600,000 hours of delay daily

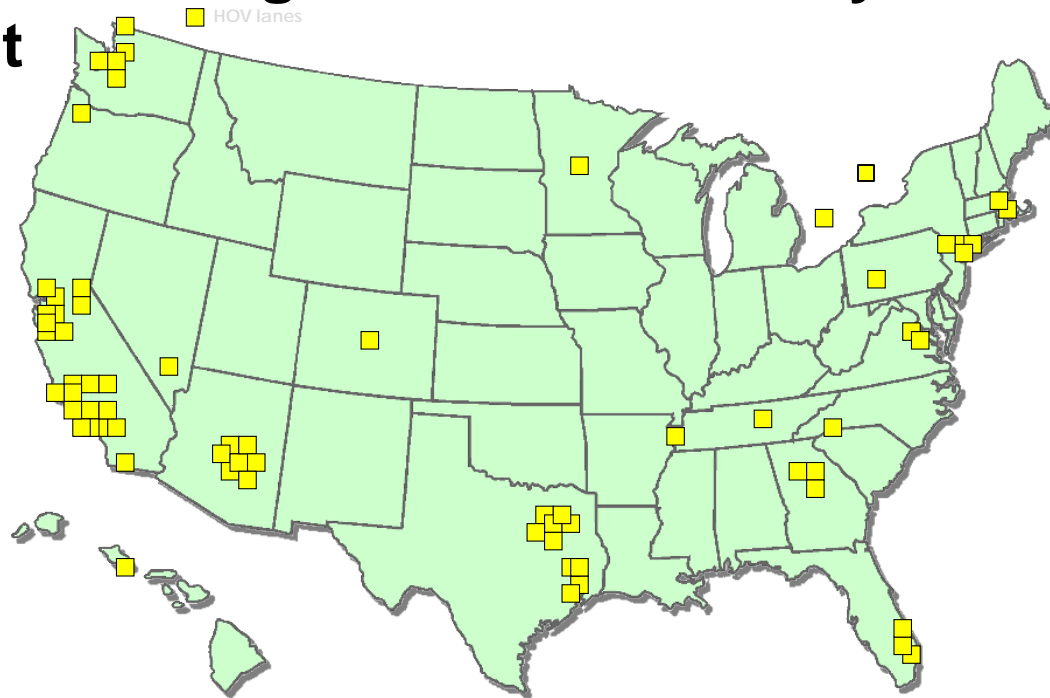


INTRODUCTION CHAPTER

WHERE ARE MANAGED LANES?

Over 170 projects in 11 States + 3 Canadian provinces

Over 25 priced managed lanes with many in development



INTRODUCTION CHAPTER

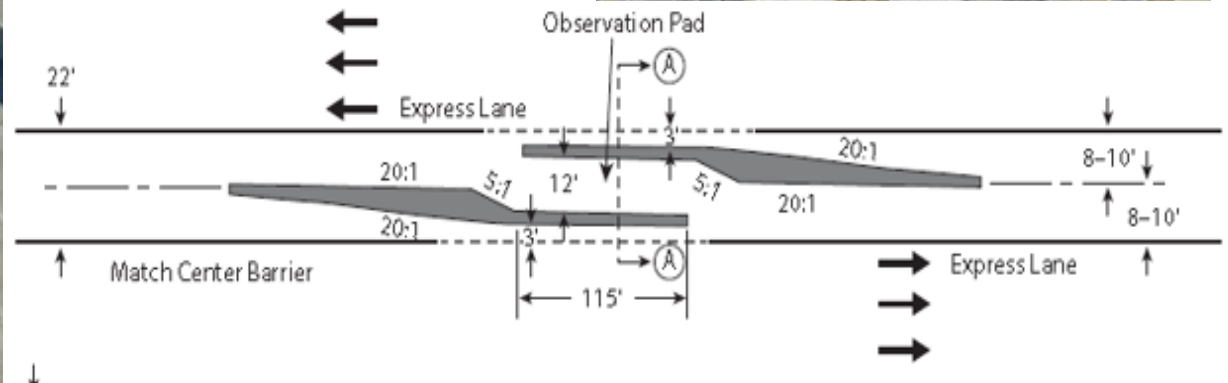
WHAT'S NEW

Access design

Toll technology

Traffic control devices

Enforcement



INTRODUCTION CHAPTER

ACCESS: OPEN OR RESTRICTED

Restricted: simpler tolling, improved lane management, easier to enforce

More open: preferred by users, more costly, not concentrate weaves, helps transit

Combinations being applied



Orange
Co, CA

Contra Costa
Co, CA



INTRODUCTION CHAPTER PYLONS

Soft barriers utilizing pylons are increasingly being applied to restrict access



I-10 Katy Tollway, Houston



SR 91, Orange Co, CA

INTRODUCTION CHAPTER, INCREASING ROLE OF ATM

HOT lane with lane controls and dynamic speed limits in Minneapolis



Source: MnDOT

INTRODUCTION CHAPTER

DECISION MAKING EXPERIENCES

Mature projects versus new capacity/construction projects. Guidance to date has focused on the latter.

Opportunities and challenges associated with P2 partnering and alternate project delivery.

Growing importance of financial feasibility.

Access plays a role in equity (it's not just toll equity)

“Best” practices and regional consistency

INTRODUCTION CHAPTER

PARTNERING

Most projects involved multiple implementation/operation partners from diverse local/state agencies

- State DOTs
- Regional congestion management agencies
- Toll and transit providers
- MPOs
- Police
- Private concessionaires

Public-public partnering is common

Financing/funding often relies on partnering

INTRODUCTION CHAPTER

IMPLEMENTATION APPROACHES

Conversions

- Examples surveyed: I-85 Atlanta, I-680 and I-880 Bay Area, I-10 and I-110 Los Angeles, SR 167 San Diego
- Generally added tolling
- Typically represented operational changes
- Some were UPA/CRD grantees

New Construction

- Examples surveyed: I-75S/N Atlanta, I-635 and SH 183/I-820 Dallas-Ft Worth, I-15 San Diego, I-405 Seattle
- Followed standard project development process
- Most got sidetracked/delayed due to funding/financing
- Tested new financing and delivery approaches

INTRODUCTION CHAPTER

GUIDANCE FOR PRACTICE

For operational changes (conversions):

- Frame process around the scale of investment/impact
- Recognize the shorter improvement life cycle
- Apply appropriate metrics: goals/performance measures
- Recognize constraints, avoid project “creep”
- Legacy operation/design heavily influence outcomes

For new construction

- Financial feasibility plays big role in the project
- Expect many changes throughout the process
- Opportunities for partnering, transit treatments, D-B and P3s
- Outcomes must be a win-win for all corridor users

INTRODUCTION CHAPTER

GUIDANCE FOR PRACTICE

For all types of projects:

- Develop Concept of Operations early, involving all players
- Let regional policies develop from pilots; let standards of practice evolve based on lessons learned
- Schedule busters: funding, innovative procurements, toll system field testing
- Public outreach must be extensive and ongoing
- Equity is key for tolling/revenue and access
- Results must represent a win-win for all users
- Keep business rules and protocols simple with measurable outcomes

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PLANNING CHAPTER OVERVIEW

Provides guidance for appropriate planning using experience from past projects and other guidance

- Planning and Programming
 - Goals and objectives
 - Corridor and regional planning
 - Conceptual feasibility
 - Funding and financing
 - NEPA, environmental review
 - Incorporating equity
- Policy and legislative considerations
 - Federal policies
 - State and regional policies
- Public Involvement and Support
 - Finding project champions
 - Engaging policy makers, media, public

PLANNING CHAPTER

CONCEPTUAL FEASIBILITY

Helps to evaluate alternatives through a defined lens, or framework

Implementation plan emerges based on findings, in concert with regional planning

- Institutional feasibility
- Design feasibility
- Operational feasibility
- Implementation feasibility
- Financial feasibility
- Public and political support

PLANNING CHAPTER INCORPORATING EQUITY

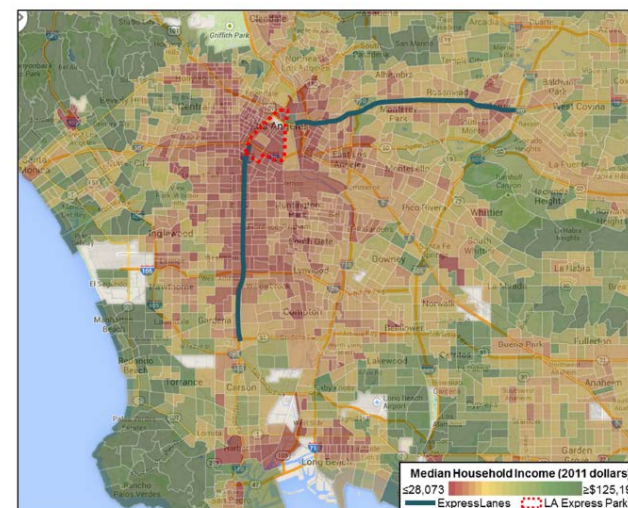
Several dimensions requires different mitigation approaches

- Common perception about unjust burden on low-income and underrepresented groups

Access equity a particular concern

- Location of entry and exits have a sociological impact, local communities concerned about traffic bypassing businesses
- Creation of an access treatment plan to formalize partnership with the different markets abutting and using facility

Median Household Income near I-10 and I-110 Metro ExpressLanes in Los Angeles



Source: Battelle Memorial Institute with information from U.S. Census and Google Maps

PLANNING CHAPTER

ENVIRONMENTAL REVIEW

Environmental review mandated if project involves use of Federal-aid funding or alters previous commitments

NEPA not required for:

- Camera installations, access treatments, changes in separation type, or changes in operational policy (2+ to 3+ carpools)

Challenge is timing and coordination

- Planning and linkage (PEL) studies can be used to reduce duplication between agencies and improve flow of information

Applied for specific projects or general corridor analysis

- Design typically done at a 30% preliminary level

PLANNING CHAPTER

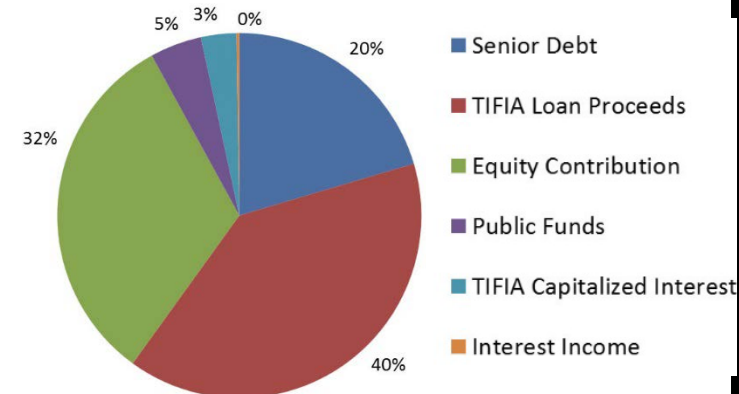
PROJECT FINANCE

Sponsors be flexible to adapt to changes in financial support

Revenue generated can be small or large

- SR 167 HOT Lanes (Washington State)
 - FY2015 net tolling revenue: \$1.67 million
 - FY2015 excess revenue (after expenditures): \$904,680
- North Tarrant Express (Texas), I-820 and SH 121/183
 - 52-year agreement with private concessionaire
 - \$2.05 billion to construct
 - First year : \$43 million in net revenue

North Tarrant Express 35W
Funding Sources
Source: FHWA



PLANNING CHAPTER

TRAFFIC AND REVENUE FORECASTING

For priced facilities, T&R studies assess ability to manage demand and raise revenue

Different from NEPA-style forecasts

- Investment-grade assumptions and values not appropriate for NEPA
- T&R results tend to be more conservative
- Provide explanation to the public for differences in NEPA vs. investment forecasts

Other guidance

- Using a single value of time is limiting since willingness-to-pay varies across an entire population
- Value of time not solely dependent on traffic, can be influenced by seasonal demand, school schedules, and radio reports
- Forming a peer review group is helpful to test assumptions

PLANNING CHAPTER

HELPFUL ENGAGEMENT TECHNIQUES

Outreach can be separate from NEPA

- Defining terms and describing concept

Should lead to managed expectations

- Should be done during all project delivery steps

Use market research to understand users

- Tie findings to the objectives for the project

Finding a project champion

- Champion could be an elected official, community leader, or individual from private sector
- Helpful to have someone not from transportation sector

Citizen Advisory Committee/Community Task Force

- Engaging stakeholders through a more formal body



Source: FHWA

PLANNING CHAPTER

LONG-TERM IMPLICATIONS



Source: WSDOT

Original goals could change after project opening

- Shifting user perceptions

Impact of maximum toll price limit and/or occupancy status

- Mitigates some equity concern, but restricts ability to manage congestion

Contrasting revenue vs. throughput goals

- Not the same goal!
- Facilities can generate more revenue by charging higher prices for fewer users

Effective messaging

- Saying that users can “but their way out of congestion” does not work
- If tolls exist, and reducing congestion is a goal, then explain how pricing actively manages congestion

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IMPLEMENTATION & DEPLOYMENT (I&D) CHAPTER, OVERVIEW

Provides guidance for design, installation, and delivery of system related components

- Design review / configuration management
- Scheduling, installation, testing, and acceptance
- Toll collection system considerations
- Upgrades and expansions
- Project delivery

I&D CHAPTER, STRUCTURING THE DESIGN PROCESS

Issue:

- Managed lanes are complex systems installed by disconnected entities
- Handoffs
 - Civil contractor
 - Toll systems integrator
- Example
 - Contractor installs power to common utility panel
 - Integrator pulls power to toll collection equipment
 - Contractor ties panel to utility cabinet with multiple points of access



Source: WSP | Parsons Brinckerhoff

I&D CHAPTER, STRUCTURING THE DESIGN PROCESS

Guidance:

- Use configuration management for design review process
 - Highlights points of demarcation
 - Identifies gaps / overlaps in separate contracts
 - Full requirements reflected in final design specifications as only consolidated document
 - Positive affirmation: readiness before deployment

“Configuration Management verifies that a system performs as intended, and is identified and documented in sufficient detail to support its projected life cycle.”

EIA / ANSI, Configuration Management Standard, 2011.

I&D CHAPTER, DEPLOYING TOLL COLLECTION SYSTEM

Issue:

- Combination of off-the-shelf equipment with customization of software, integration, and procedures
- Integrator timing is highly dependent upon...
 - Physical availability of facility
 - Administrative constraints (client staffing, funding, legislation)
 - Coordination with comprehensive stakeholders
- Visible connection to project
 - Signs, gantries, cameras, and readers make the project more tangible to the public



Source: WSP | Parsons Brinckerhoff

I&D CHAPTER, DEPLOYING TOLL COLLECTION SYSTEM

Guidance:

- Emphasis upon the systems engineering process for transportation operations
- Detailed task schedules (initial review, gap analysis, preliminary / final design, integration, testing, and deployment)
- Best practices
 - Maximize use of proven designs
 - Minimize development of new software
 - Determine phasing for additional system features
 - Iterative process with multiple internal peer reviews / tests



Source: WSP | Parsons Brinckerhoff

I&D CHAPTER

DETERMINING PROJECT DELIVERY

Issue:

- Establishment of separate and distinct work elements:
 - Civil construction
 - Toll system integration
 - Tolling operations and maintenance
- Separate and distinct delivery components
 - Design – bid – build
 - Design – build
 - Design – build – operate – maintain
 - Design – build – finance – operate – maintain

I&D CHAPTER

DETERMINING PROJECT DELIVERY

Procurement	Best For...	Concerns...
Design-Bid-Build	<ul style="list-style-type: none"> • Small-scale projects • Minimum-risk projects 	<ul style="list-style-type: none"> • Schedule length • Risk is on agency
Design-Build	<ul style="list-style-type: none"> • Cost efficiencies • Single point of responsibility 	<ul style="list-style-type: none"> • Less control over design • Responsive decision-making
Design-Build-Operate-Maintain	<ul style="list-style-type: none"> • Lower life-cycle costs 	<ul style="list-style-type: none"> • Defined performance requirements
Design-Build-Finance-Operate-Maintain	<ul style="list-style-type: none"> • Revenue and funding • Risk to private sector. 	<ul style="list-style-type: none"> • No control over design. • Greater political risk. • Expertise in finance

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DESIGN CHAPTER OVERVIEW

Focus on issues a designer considers in designing a managed lanes facility (cross-references to other chapters, and references to external sources)

Key topics:

- Design considerations for specific user groups
- Geometric design considerations
 - Consistency
 - Recommended values for specific elements
 - Issues related to HOV-to-HOT conversion
- Access considerations
 - Placement of managed lanes
 - Separation treatments
 - Access design and location
- Operational impacts

DESIGN CHAPTER CONSIDERATIONS FOR USER GROUPS

Design vehicle/eligibility

- Intended users
- Design characteristics

Transit considerations

- Design vehicle considerations
- Location of transit facilities

Truck considerations



Source: Kay Fitzpatrick

DESIGN CHAPTER

DESIGN CONSIDERATIONS

Key topics:

- Consistency
 - Design speed
 - Cross-section and alignment
 - ML orientation with GP lanes
- Separation between ML and GP lanes
 - Reversible lanes
 - Contraflow lanes
 - Pullouts (enforcement / refuge)
 - HOV-to-HOT conversion

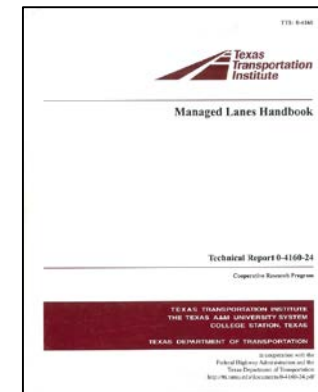
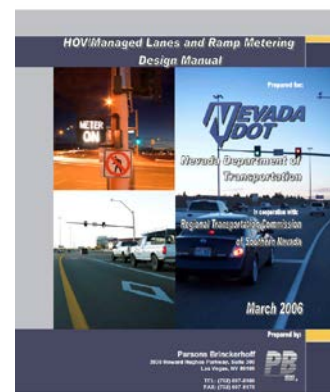
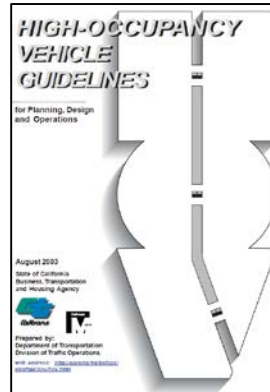
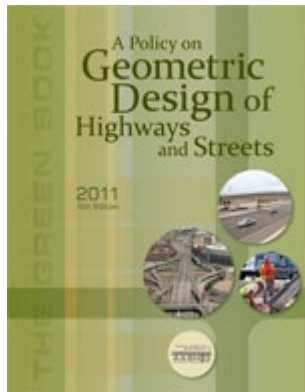


Source: Marcus Brewer

DESIGN CHAPTER CONSISTENCY

Key topics:

- System integration
- Local, regional, and state guidelines
- National guidelines
- Design variances and flexible design philosophies



DESIGN CHAPTER ELEMENTS

Key topics:

- Design speed
- Cross-sectional elements
- Operational effects of cross-section
 - Weather
 - Special events
 - Enforcement
 - Maintenance



Source: WSP | Parsons Brinckerhoff

DESIGN CHAPTER

CONTEXT OF GP LANES

ML orientation with respect to GP lanes

- Location of ML compared to median
- Part-time shoulder use (DSU)
- Consideration of contraflow

Separation between ML and GP lanes

- Barrier, buffer, pylon, pavement markings



Source: Marcus Brewer

DESIGN CHAPTER

ADDITIONAL FEATURES

Reversible lanes

Contraflow lanes

Enforcement pullouts

Refuge pullouts



Source: Beverly Kuhn



Source: TTI

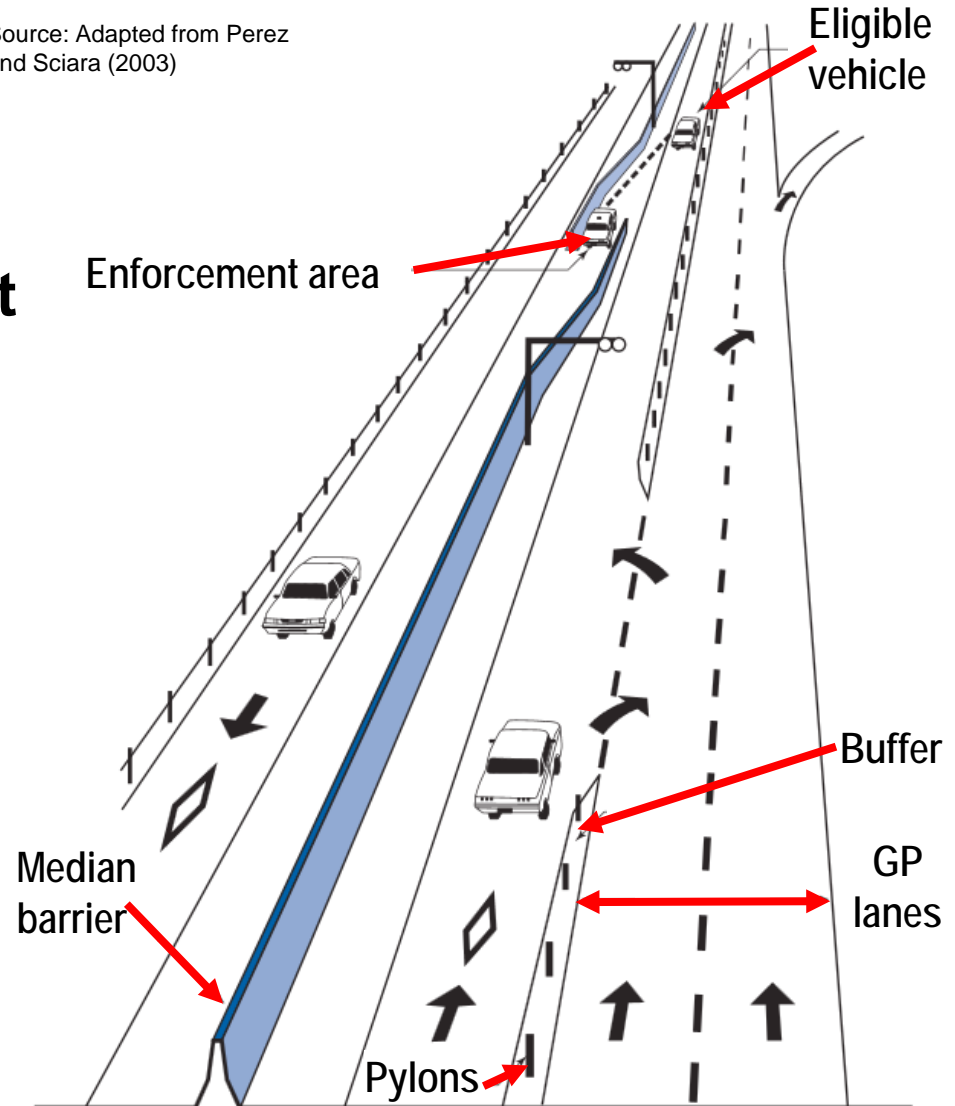
DESIGN CHAPTER, ISSUES: HOV-TO-HOT CONVERSION

General design considerations

Accommodating toll collection and enforcement

Access control and separation

Source: Adapted from Perez and Sciara (2003)



Source: Chuck Fuhs

DESIGN CHAPTER

ACCESS CONSIDERATIONS

Limited versus continuous

Continuous-access considerations

Frequency of limited-access points

Treatment for beginning a ML

Intermediate access

- Weave zones/weave lanes
- Auxiliary lanes
- Direct access

Treatment for ending a ML

(Covered in greater detail in Session 7)



Source: Darren Henderson

DESIGN CHAPTER, OPERATIONAL IMPACTS ON DESIGN

Tolling systems

- Selection of tolling system
- Providing for appropriate infrastructure, equipment, and devices

Enforcement systems

Incident management

Capacity

Drainage and hydraulic needs



Source: Chuck Fuhs

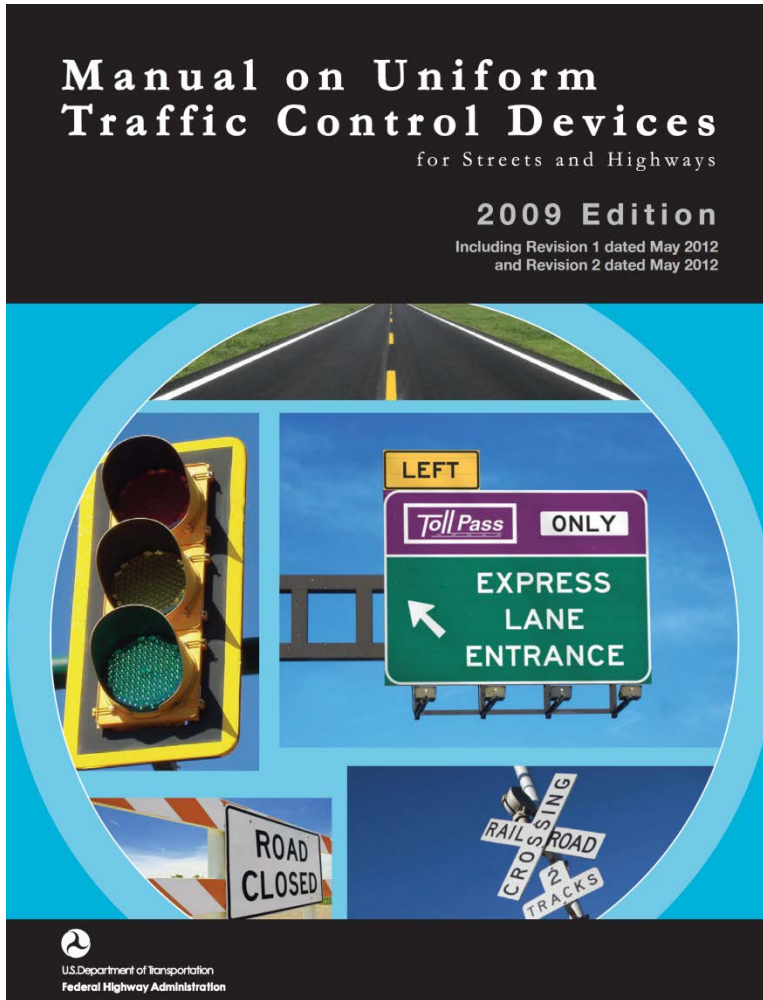
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TRAFFIC CONTROL DEVICE (TCD) CHAPTER PURPOSE



How to find relevant MUTCD sections

How to apply general MUTCD principles to new designs and operations

Identify needed research

2009 MUTCD Contains new Chapter 2G on Preferential Lanes but information is diffused throughout

Source: FHWA

 15TH International Conference on Managed Lanes
NCHRP 15-49: Guidelines for Implementing Managed Lanes

 Texas A&M
Transportation
Institute

 WSP

 PARSONS
BRINCKERHOFF

TCD CHAPTER OVERVIEW

TCD Definitions and general sign design

Guide and Regulatory Signs

Changeable Message Signs

Lane Use Control Signals

Reversible and Contraflow Lane TCDs

Pavement Markings

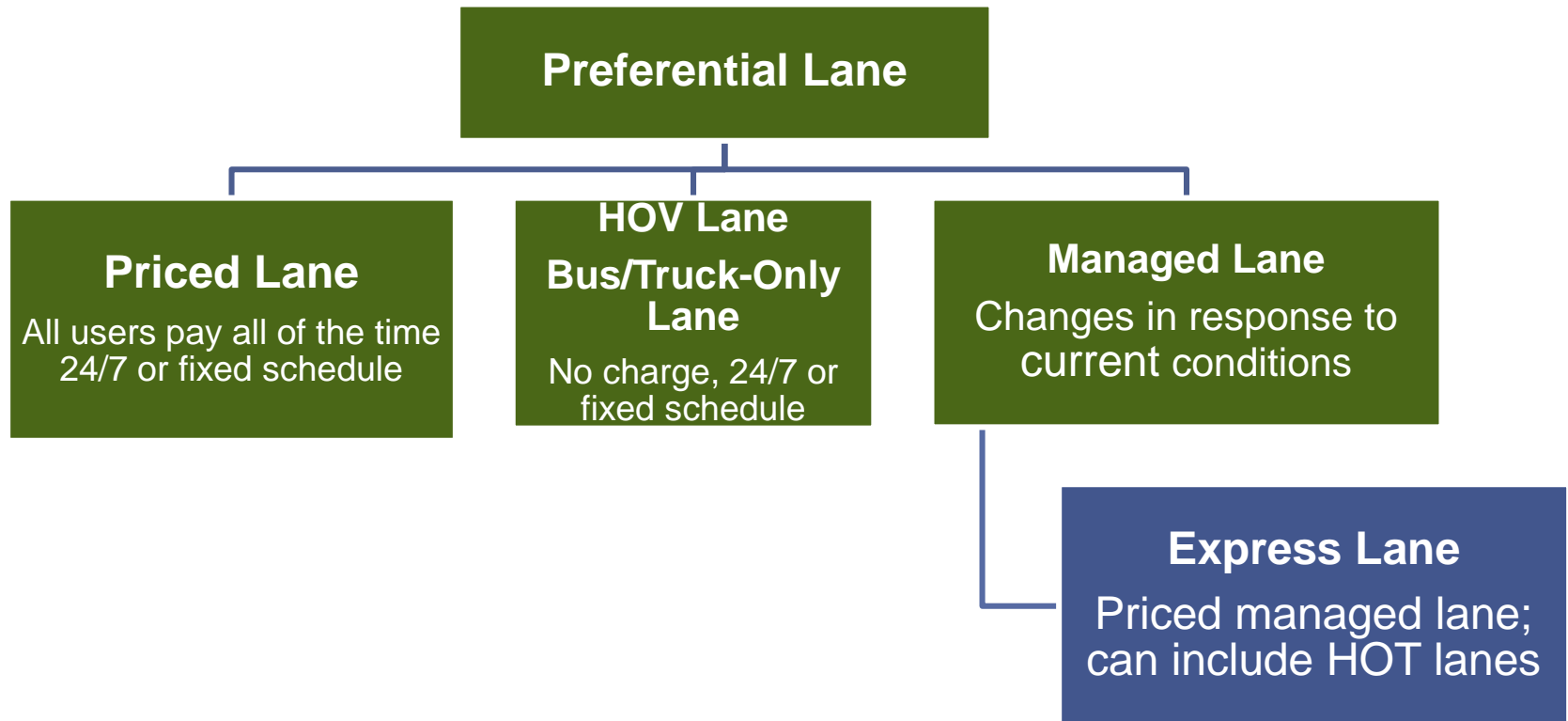
Other Information Dissemination Methods

Installation and Maintenance

Trade-offs in Constrained Designs

TCD CHAPTER

MUTCD TERMS



TCD CHAPTER GENERAL SIGN DESIGN RESOURCES

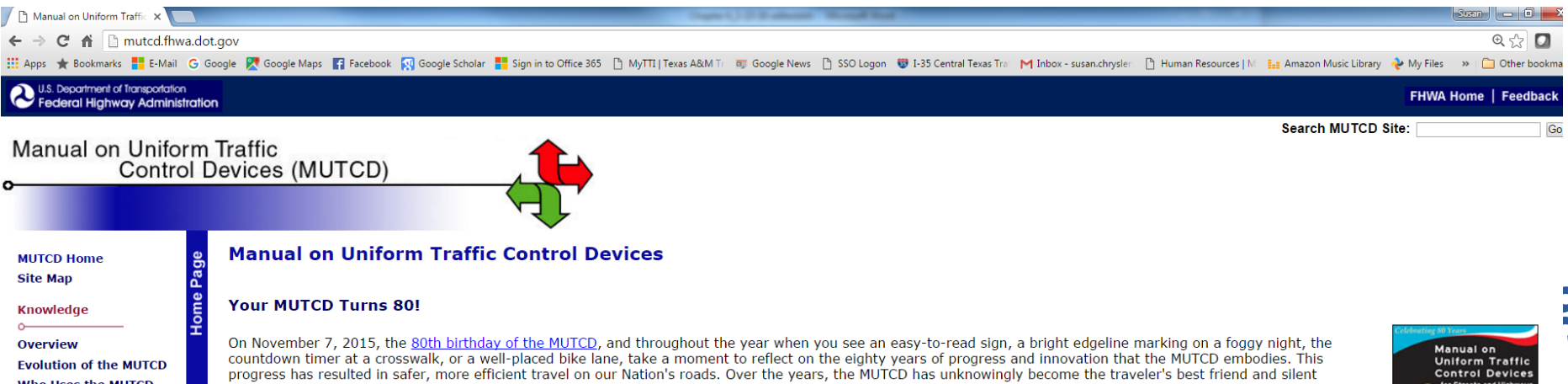
MUTCD applies to any road open to public travel

Your state may have its own MUTCD

Standard Highway Signs has detailed layouts

Chapter 2F Toll Roads contains lots of relevant information

Check the Federal MUTCD website for interim approvals and interpretations



The screenshot shows the homepage of the Manual on Uniform Traffic Control Devices (MUTCD) website. The browser address bar displays "mutcd.fhwa.dot.gov". The page header includes the U.S. Department of Transportation Federal Highway Administration logo and navigation links for "FHWA Home" and "Feedback". A search bar is located on the right side of the header. The main content area features the title "Manual on Uniform Traffic Control Devices (MUTCD)" and a graphic of three interlocking arrows (red, green, and blue). Below this, the page is titled "Manual on Uniform Traffic Control Devices" and "Your MUTCD Turns 80!". A news item is visible, dated November 7, 2015, celebrating the 80th birthday of the MUTCD. The left sidebar contains navigation links for "MUTCD Home", "Site Map", "Knowledge", "Overview", and "Evolution of the MUTCD". A "Home Page" vertical label is positioned on the left. The bottom right corner features a "Celebrating 80 Years" logo and a link to the "Manual on Uniform Traffic Control Devices".

TCD CHAPTER

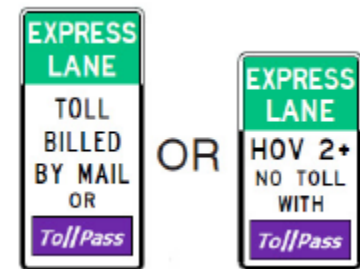
IMPORTANT GENERAL INFORMATION

Use a purple background on ETC payment panel only when registered ETC accounts are required.

If video tolling is in place, purple is not required.

Pylons are not considered TCDs in this application.

Roadside signs may not display internet addresses or phone numbers greater than 4 digits



Source: FHWA MUTCD

TCD CHAPTER GUIDE AND REGULATORY SIGNS

Chapter includes considerations for surface street access points

Driver information overload is a concern

Violations of driver expectancy in access design (e.g. left entrances, long collector roads) is a concern

Interchange sequence signs may help



Source: FHWA MUTCD

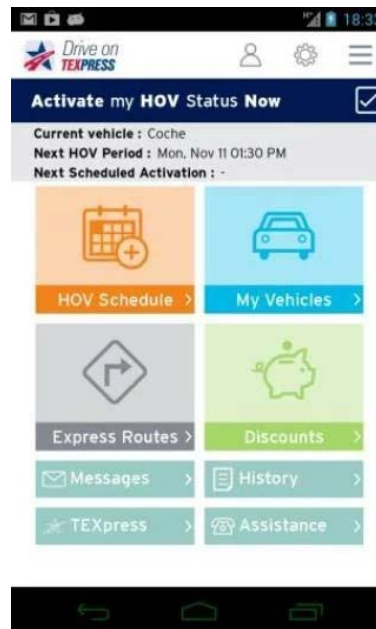
TCD CHAPTER OTHER COMMUNICATION METHODS

Local Media outlets

Virtual Drive-throughs used at public meetings and on websites

Billing inserts or websites

Apps



Source: DriveOnTexpress.com

TCD CHAPTER RESEARCH GAPS IDENTIFIED

Need for similar guide for arterial managed lanes

Public outreach, marketing guidance

Use of terms to describe facility types



Source: Washington's Top News wtop.com

TCD CHAPTER

RESEARCH GAPS IDENTIFIED (2)

Sign sequencing and priority

- “what is the highest to lowest level of information needed?”

Amount and type of information presented to motorists on one structure

Specific sign legends

- Pay by plate, Pay by Mail, Bill by Mail
- Express Lanes term comprehension
- HOV Symbols

TCD CHAPTER

RESEARCH GAPS IDENTIFIED (3)

Exit Numbering

Pavement Markings

- Access areas
- In-pavement lighting
- Pull-through pavement markings associated with left-side ramps

TCDs for Reversible Lanes

Toll rates

TCD CHAPTER EMERGING ISSUES & OPPORTUNITIES

Provision of comparative travel time information

**Communicating managed lane network
connections**

Transponder and in-vehicle technologies



Source: ExpressLanes.com



Source: FHWA MUTCD

TCD CHAPTER

LESSONS LEARNED

You can't sign your way out of a bad design

You can't sign your way out of a bad operational strategy

TCDs cannot be your only form of communicating with users

The Managed Lanes TCDs must work in concert with general purpose TCDs.

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OPERATIONS AND MAINTENANCE (O&M) CHAPTER, OVERVIEW

Provides guidance for desired characteristics, components, and requirements for the long-term function of managed lanes systems

- Concept of Operations
- Consideration for Toll Operations
- High Occupancy Vehicle Eligibility Considerations
- Ongoing Operations
- Startup / Opening of Facility
- Business Rules
- System Operations
- Performance Monitoring / Evaluation
- Maintenance

O&M CHAPTER, MANAGED LANES CONCEPTS OF OPERATIONS

Issue:

- Define design elements and operating parameters for policy establishment, stakeholder concurrence, and business rule development
- Address key questions...
 - **Who** are the stakeholders and users of the system?
 - **What** are the elements and capabilities of the system?
 - **Where** is the affected system?
 - **When** will activities be performed?
 - **Why** is the strategy being used?
 - **How** will the system be operated and maintained?

O&M CHAPTER, MANAGED LANES CONCEPTS OF OPERATIONS

Guidance:

- Use Systems Engineering Process for developing concepts of operations
- Regional network concept of operations
 - Address policy and operational concepts for system on whole
- Corridor concept of operations
 - Preliminary ConOps – establish guidance during conceptual design
 - Final ConOps – confirm parameters that serve basis for ongoing operations and maintenance

O&M CHAPTER, TOLL COLLECTION CONSIDERATIONS

Issue:

- Congestion pricing is a critical component towards the development, implementation, and operation of successful priced managed lanes.
 - MAP-21 / FAST Act mainstreamed priced managed lanes
 - Variable pricing is mandated to ensure performance is maintained
 - Limited guidance is currently available on how to choose between pricing systems

O&M CHAPTER, TOLL COLLECTION CONSIDERATIONS

Guidance:



Enhance Lane Efficiency and Utilization

- Expand use of capacity in underutilized lanes
- Efficiently allocate capacity in overutilized lanes



Provide Travel Time Reliability

- Maintain reliable speeds
- Sustain unimpeded travel for transit



Yield Revenue to Offset Lifecycle Costs

- Enhance financial resources for new capacity
- Sustainable compensation for long-term O&M costs

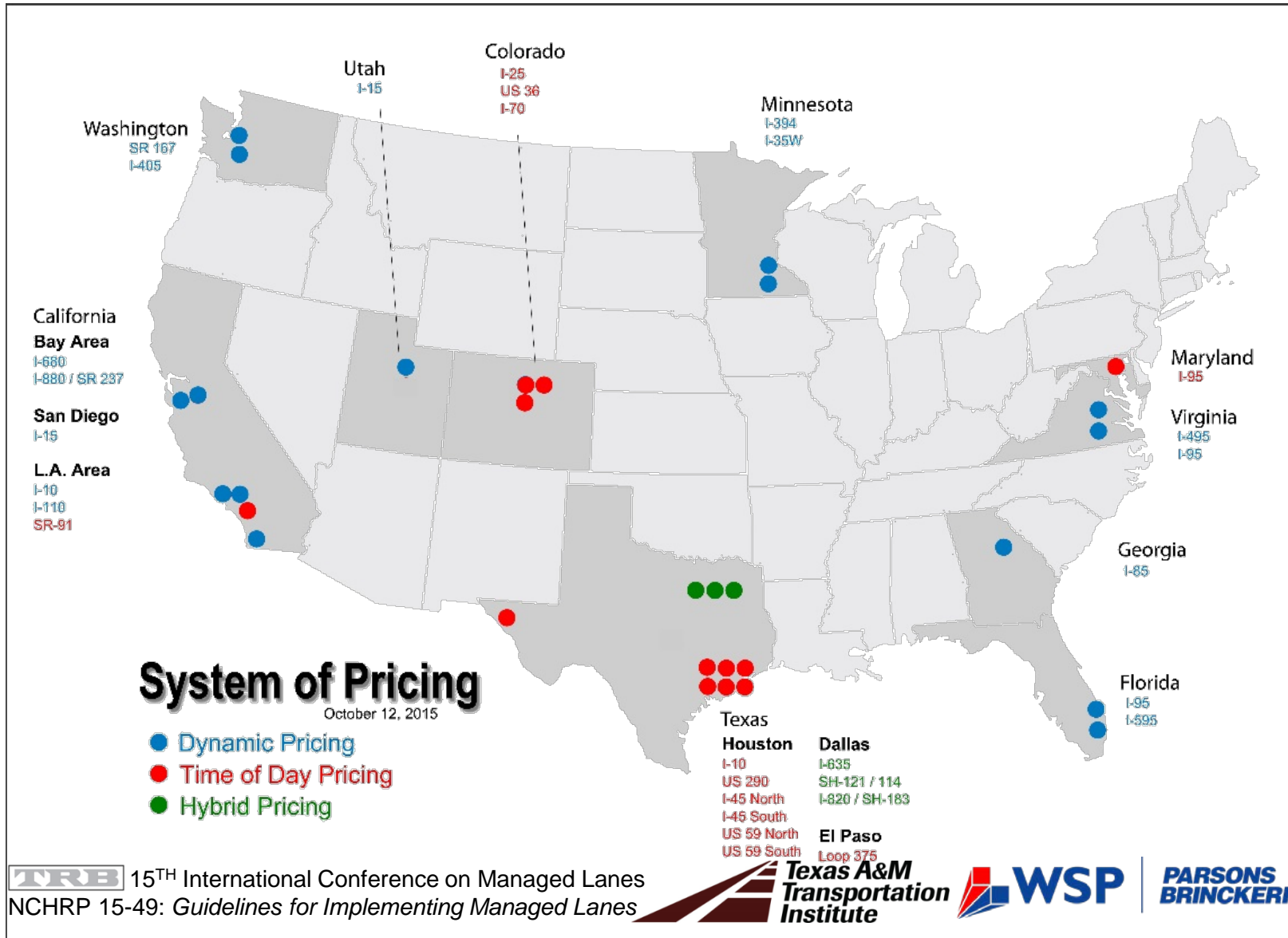
O&M CHAPTER

TOLL COLLECTION CONSIDERATIONS

Guidance:

- Simplicity.
 - Easy to understand and use by the traveling public
- Effectiveness.
 - Optimization of person and goods throughput, vehicular speed reliability, travel time performance, revenue generation, and/or providing priority for transit and HOV.
- Flexibility.
 - Scale to accommodate multiple interconnected facilities
- Integration.
 - Integrate with complementary operational treatments

O&M CHAPTER, TOLL COLLECTION CONSIDERATIONS



O&M CHAPTER, HIGH OCCUPANCY VEHICLE ENFORCEMENT

Issue:

- Validation and enforcement of HOV customers is key to maintaining managed lane performance
 - Desired operation of the facility is jeopardized
 - Violation rates of greater than 50 percent in extreme
- Occupancy enforcement remains a primarily manual process.



Source: WSP | Parsons Brinckerhoff

O&M CHAPTER, HIGH OCCUPANCY VEHICLE ENFORCEMENT

Declaration mechanism	Pros	Cons
Switchable transponder	<ul style="list-style-type: none"> • Simple communication • Easy to use 	<ul style="list-style-type: none"> • Costly device • Willful violators • Driver distraction
Account declaration	<ul style="list-style-type: none"> • Inexpensive • No capital 	<ul style="list-style-type: none"> • Cumbersome • Inadvertent violators • Driver distraction
Declaration lane	<ul style="list-style-type: none"> • Simple for the driver 	<ul style="list-style-type: none"> • Expensive • Permanent

O&M CHAPTER, HIGH OCCUPANCY VEHICLE ENFORCEMENT

Enforcement Mechanisms	Pros	Cons
Toll paying vehicles only	<ul style="list-style-type: none"> • Simple • Easy enforcement • Greatest revenue 	<ul style="list-style-type: none"> • No HOV incentive
Declaration with in-field validation	<ul style="list-style-type: none"> • Common practice • Mature technology 	<ul style="list-style-type: none"> • Enforcement required • Difficult to validate
Mobile enforcement	<ul style="list-style-type: none"> • No enforcement zones • No need for separation 	<ul style="list-style-type: none"> • Enforcement required • Cumbersome interface

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2. Planning Considerations
3. Design Elements
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