The New AASHTO “Green Book”

SPEAKERS:

R. Marshall Elizer, Jr., P.E., PTOE
Senior Transportation Engineer
Gresham, Smith and Partners, Nashville, Tennessee

Mr. Elizer has been involved in transportation planning and engineering for over 34 years. His professional experience includes 22 years of public service and 13 years of private sector practice. His responsibilities have included the management, planning, design and operation of street and traffic systems in Colorado, Tennessee, Texas and California.

The following is a summary of Mr. Elizer’s relevant education and experience.
« Bachelors and Masters Degrees in Transportation Engineering from the University of Tennessee.
« Continuing education from the University of Colorado, Pennsylvania State University, Northwestern University, and Georgia Technological University.
« Certified as a Professional Traffic Operations Engineer (PTOE).
« Eight years service on the National Committee on Uniform Traffic Control Devices (NUTCD)
« Past International President (1995) of the Institute of Transportation Engineers (ITE).
« Served from 1999-2005 as Director-at-Large for Transportation for the American Public Works Association (APWA) Board of Directors.
« Steering Committee Member of the National Transportation Operations Coalition (NTOC) since 2000
« City Traffic Engineer and Transportation Planner for the City of Lakewood, Colorado, a city of 130,000 in the Denver metropolitan area (1979-85).
« Director of Transportation for the City of Arlington, Texas, a city of 300,000 in the Dallas/Ft. Worth urban area (1985-91).
« Public Works and Transportation Director for the City of Modesto, California, a city of 210,000 in the central California San Joaquin Valley (1991-97).
« Principal transportation engineer with Gresham, Smith and Partners, a 600-person Nashville-based engineering, planning and architecture firm (1997-present).

Mark Taylor
Safety/Geometric Design Engineer
Resource Center Safety and Design Technical Service Team
Federal Highway Administration

Mark Taylor is a Safety/Geometric Design Engineer with the FHWA Resource Center Safety & Design Technical Service Team in Lakewood, CO.

He joined FHWA in 1974 and the Resource Center in 2008. He provides technical assistance and technology deployment on highway design as well as highway safety features. For most of his career,
Mark has focused on roadway design and preparation of plans, specifications and estimates; safety analysis and operational effects of geometrics; and project development.

In prior positions with FHWA, he served as the Design Discipline Leader for the Federal Lands Highway office, and as Project Development Engineer for the Central Federal Lands Division. He has a B.S. in Civil Engineering from Virginia Tech.

MODERATOR:

Jason Meyers, P.E., LEED® AP
Senior Transportation Engineer
Burns & McDonnell

Jason Meyers graduated with a Bachelor of Science in Civil Engineering from Kansas State University in 1999. Jason is a licensed professional engineer in Kansas and Missouri. He is also a LEED accredited professional.

His professional memberships include the American public works association (APWA) and society of American military Engineers (SAME). He is the chair of the local APWA transportation committee and past co-chair of the UMKC student chapter. He also serves on the government affairs committee for the Overland Park chamber of commerce and on the board of directors for the Local Kansas City SAME post.

His awards include the SAME Regional Vice President Medal, District Knight of the Year and the ACEC Kansas Emerging Leaders Program. His background includes municipal street design, highway design, construction inspection, site design, storm drainage design, roundabout design and traffic signal design.

Jason and his wife, Lisa, live in Leawood, KS. They have three children. He is also a member of the Knights of Columbus and volunteers as a track and basketball coach for CYO. He enjoys snow and water skiing, traveling and spending time with his family.

Projects of Note include
- Roundabout at 133rd and Lamar in Overland Park Kansas (APWA award winning Project)
- I-435 and 350 interchange for MoDOT
- Consolidated Rental Car Facility at KCI
- Command and General Staff College at Fort Leavenworth
- Red Bridge Road (Holmes to Blue River Road) in KCMO
- He is currently working on the first diverging diamond in Kansas for the Kansas Department of Transportation.
The Green Book….what it is and what it isn’t

- Policies for use and design exceptions
- Design flexibility in the Green Book
- Multi-modal accommodation and service
- What’s changed in the 2011 edition

Session Objectives

- Apply AASHTO’s latest design policy guidance
- Expand your knowledge about geometric design
- Increase your ability to perform geometric design and apply design flexibility
What is the AASHTO Green Book?

A Policy on Geometric Design of Highways and Streets 2004 (aka the “Green Book”)

https://bookstore.transportation.org/item_details.aspx?id=110

Who Develops the Green Book?

- AASHTO Technical Committee on Geometric Design (under AASHTO’s Subcommittee on Design and Standing Committee on Highways)
- A multi-agency working group to develop and recommend AASHTO geometric design criteria
- Formulates new and revised criteria to keep current all geometric design standards, polices, and guidelines
- Recommends research to improve knowledge of geometric design and its effects

AASHTO Technical Committee on Geometric Design Members

- 18 State Departments of Transportation
- National Association of County Engineers
- National League of Cities
- American Public Works Association
- Port Authority of NY, NJ
- Federal Highway Administration

Format

- Ten Chapters
- Text in dual units – Metric [US Customary]
  - Not an exact (soft) conversion; not a completely rationalized (hard) conversion
  - Units and values developed independently
  - Work in one system only; do not convert from one to other
- 418 Exhibits, tables, and drawings
- 8 ½ x 11 page size single bound volume
- Speed range 20 to 130 km/h [15 to 80 mph]
- References updated for each edition

How is Green Book Content Developed?

1. Subcommittee on Design and Technical Committee on Geometric Design develop draft materials
2. Research is commissioned and incorporated as appropriate
3. Working meetings resolve technical issues and result in consensus on content
4. Approval by 2/3 of State DOTs is required for acceptance and publication
Continually Updated With Research

- Research proposed by State DOTs and FHWA
- AASHTO Standing Committee on Research (SCOR) prioritizes research needs statements
- Competitive, peer reviewed research process (NCHRP) administered by the Transportation Research Board (TRB) of the National Academies

Design Controls and Criteria Reflect a Wide Range of Considerations

- Costs and cost effectiveness
- Traffic Operations
- Maintenance
- Constructability
- Safety
- Environment

What Are “Design Criteria”?

- A collection of design dimensional values or ranges, decision rules, and guidelines
- Based upon the collective knowledge from operational experience and application of research and typical driver/user expectations
- Intended to provide consistency in quality, appearance, and performance of the highway elements, features and systems

Why Use Design Criteria?

- Design criteria form a basis for trying to achieve an appropriate balance of competing interests
- The criteria are intended to deliver a generally acceptable, cost-effective level of safety and operational performance (traffic operations, safety, maintainability, and constructability)
- Facilities that incorporate generally accepted design criteria decrease the likelihood that safety or operational problems will develop

Criteria Incorporates Human Factors

- Pedestrian walking speeds
- Perception and reaction time
- Braking, acceleration and deceleration rates
- Passing maneuvers
- Decision-making / navigation time
- Visual acuity
- Driver expectations

Applications of the Green Book

- Applies to new construction (projects on new alignment)
- Applies to reconstruction
- Does NOT apply to resurfacing, restoration or rehabilitation projects (“3R”)*

*FHWA adopted the Green Book for NHS freeway 3R projects
The Green Book is a Policy on Geometric Design – not a standard

- Federal, state and local agencies establish “standards”
- Should not refer to the Green Book as “AASHTO standards”
- Should never refer to the Green Book as “safety standards”

Benefits of a National Policy

- Establishes the norm for professional practice
- Incorporates research and proven methods
- Supports public health and welfare (safety)
- Is adopted in whole or in part by many authorities
- Forms a level of quality and cost-effectiveness
- A “code” of sorts

Individual State or local agency policies and manuals apply

- Federal, State and local agencies may have their own design manuals and policies
- Some States and local agencies have adopted the Green Book as their geometric design standards or design manual
- FHWA adopted the 2004 Green Book as the basis for minimum standards for the National Highway System, regardless of funding
- A new rulemaking is anticipated for adoption of the 2011 edition

Standards for Federal Projects

- Programmatic
  - National (NHS, Interstate)
  - State (non-NHS and non-freeway RRR)
  - Local agency (off-system)
- Project-specific criteria
  - Based on applicable highway function and design controls

Application of Standards

- Programmatic standards are applied to individual projects in establishing the:
  - Context and using it as a key design control
  - Geometric design controls (example: functional classification, design vehicle, LOS)
  - Design criteria values to choose for the project standards (example: design speed, maximum grade)

Authority for NHS Design Standards

- Under Title 23, United States Code (USC) Section 109, the Secretary of Transportation approves design and construction standards for the National Highway System (NHS) including Interstates.
- Title 23 of the Code of Federal Regulations (CFR) Part 625 designates those standards, specifications, policies, guides, and references that are acceptable to the Federal Highway Administration (FHWA) for use on the NHS.
FHWA Adopts AASHTO for the NHS
- AASHTO Policy is FHWA's standard for projects on the NHS (regardless of funding)
- For new construction or reconstruction
- For “3R” type of work on a NHS freeway

Designating Standards for Projects
- G.B. recommends a minimum (or maximum), and a range of design values for highway elements
- Establishes guidance for what is an “applicable” dimension based of the design controls and criteria (highway function, location/land use, ADT, speed, terrain, vehicle type/size, users, etc.)
- Recommended values and dimensions become the standard when they are determined to be applicable and are designated for the project
- The designated values and dimensions should be identified in the project decision document (NEPA)

Interstate Design Standards
- Interstate System warrants a higher benchmark for design
- FHWA adopted the AASHTO “Design Standards for the Interstate System”
- Green Book guidance and criteria apply if not otherwise described in the Interstate Policy

Design Standards for non-NHS
- States or local agencies are responsible for establishing their own design standards for non-NHS projects
- Federal projects must be designed and built in accordance with approved design standards
- Many states follow similar procedures for both Federal and non-Federal projects, to allow flexibility in funding options
- Most states offer technical guidance to local agencies for design of Federal projects

Other Design Related Standards
- American with Disabilities Act Accessibility Guidelines*
- Manual on Uniform Traffic Control Devices
- NCHRP

RRR Design Standards
- For non freeway RRR projects, States may develop separate design criteria with approval by FHWA in lieu of using the Green Book or other criteria applicable for reconstruction
- 42 States have opted to do so
- 8 States have similar design programs to achieve this purpose

*Proposed to be superseded by Public Right-of-Way Accessibility Guidelines (PROWAG)
3R Design Guidance

- TRB Special Report 214 is a commonly used reference for 3R criteria
- A “safety conscious” approach for improvement of safety performance
- Evaluation of existing
  - Geometric design
  - Roadside conditions
  - Traffic operations
  - Pavement and drainage structures

Other Guides and References

- Viewed as “best practices” but don’t rise to the same level of importance
- Listed in Federal Aid Policy Guide (FAPG) NS 23 CFR 25, para. 16
- Notable examples include
  - AASHTO Roadside Design Guide
  - TRB Highway Capacity Manual

Project-Specific Criteria Apply for:

- Roadway context
- Highway function
- Location/land use
- Terrain
- Design vehicle
- User and traffic characteristics
- Traffic volume

- Speed characteristics
- LOS and flow rate
- Level of access and management
- Surfacing type
- Max and minimum superelevation rates
- Environmental, social and economic factors

What is a Design Exception?

- A documented decision to design a highway element or a segment of a highway to a criterion that does not meet the minimum value established for that highway or project
- Allowance for exceptions is a valid aspect of the design process
  - Not an admission of failure
  - Not flawed design
  - A necessary and legitimate exercise of professional evaluation and engineering judgment

FHWA Policy – Title 23 Code of Federal Regulations

- PART 625—DESIGN STANDARDS FOR HIGHWAYS
  § 625.3 Application.
  (f) Exceptions.
  (1) Approval…may be given on a project basis to designs which do not conform to the minimum criteria…for:
  (i) Experimental features on projects; and
  (ii) Projects where conditions warrant that exceptions be made.

Evaluation of “Controlling” Criteria

- FHWA policy recognizes it is impractical to require a formal design exception evaluation for every design element
- Attention is focused on elements of most substantial importance to the safety and operational performance of any highway: what are commonly referred to as the “13 controlling criteria”
FHWA’s 13 “Controlling” Criteria

- Design speed
- Lane width
- Shoulder width
- Bridge width
- Horizontal
- Superelevation
- Vertical curvature
- Grade
- Stopping sight distance
- Cross slope
- Vertical clearance
- Horizontal clearance (lateral offset to obstruction)
- Structural capacity

Design Exception Research Findings

- The number of exceptions processed and documentation practices vary widely among States
- Design exception problems include lack of supporting information, inadequate guidance, limited resources, and requests made too late in the project development process
- Process improvements include improved guidance, clarification of controlling criteria, and training

Managing Design Exceptions

Design Practice Involves Risk

- Balances risk tolerance with benefit/reward
- Relies on awareness and knowledge
- Identifies costs and impacts
- Evaluates alternatives and options
- Assesses risks (known and unknown)
- Evaluates mitigation measures
- Documentation and approval
- Monitor in-service performance

Types of Risk

- Risks to users of the facility not performing as expected
  - Motorists
  - Bicyclists
  - Pedestrians
- Liability for engineering and technical diligence
  - Road owning agency
  - Engineer of record

Primary Risk Variables

- Exposure (frequency)
  - Traffic volume
  - Location of exception
  - Duration of the effect
- Extent
  - Degree of the deviation
- Severity
  - Degree of potential consequences
Risk Considerations

- What is the degree to which a standard is being reduced?
- What is the “exposure” of the design exception
  - Length of exception segment
  - Traffic volumes of the facility
  - Duration of time the exception will be in place
- Where is the exception relative to other risk factors?

Mitigation is a strategy to reduce risk

- Mitigate risks to the extent practical
- Countermeasures that are related to adverse effects can reduce their likelihood, extent, and severity
- Risks can also be mitigated by enhancing related elements

Tort Risks

- Adherence to standard does not automatically demonstrate reasonable care
- Deviation from standard does not automatically demonstrate negligence
- A structured process for evaluating, approving and documenting the rationale for key design decisions is necessary to address professional responsibility and tort liability

Flexibility in Highway Design

- Joint effort of:
  - FHWA
  - AASHTO
  - Non-traditional partners
- Central theme of Thinking Beyond the Pavement Conference in 1998

“Bridging” Flexibility in Highway Design

- Facilitates program/project delivery and achieving performance goals
- Allows consideration of a wider range of design options and alternatives to fit conditions
- Enables more cost-effective designs that improve safety and efficiency
- Promotes CSS principles (an FHWA and AASHTO joint priority)
**Flexible Design Philosophy**
- Recognizes that flexibility is a necessary and desired aspect of the design process
- Uses a risk assessment and risk management approach for all aspects of the design
- Apply performance criteria to evaluate flexible design decisions, as well as condition criteria
- Understand the risks and consequences for design decisions – this often requires more information and higher level analysis than simply applying criteria “by the book”

**Flexibility is Not a New Concept**
“...Sufficient flexibility is permitted to encourage...”
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**We routinely balance many factors in our design decisions**
- Tradeoffs we routinely consider:
  - Economics (agency or user costs/benefits)
  - Stakeholder or agency preferences
  - Environmental and social impacts or enhancements
  - Capacity, delay or speed
  - Ease of maintenance

**Design Quality and Standards**
Good design:
- Balances many factors including application of criteria and standards
- Will not necessarily result from ordinary application of the standard values or unskilled use of exceptions
- Engineering judgment is essential

**AASHTO Flexible Design Policy**
“...As highway designers, highway engineers strive to provide for the needs of highway users while maintaining the integrity of the environment. Unique combinations of design requirements that are often conflicting result in unique solutions to the design problems”
“...Sufficient flexibility is permitted to encourage independent designs tailored to particular situations.”

**What Flexibility is in the Green Book?**
- Many dimensions and values are shown as ranges
- Many criteria described as “guidelines” or “typical”
- Many concepts are not dimensioned and discussed only in functional terms
- In many cases, choices are offered for how to complete a design
- Solutions or concepts not specifically included are not precluded
- Specific solutions are not mandated
- Designer judgment is implied or explicitly suggested

Source: Foreword, p. xliii, 2004 Edition
Skilled Designers Minimize Risk

“The ability to develop a context-sensitive solution by working within and sometimes outside design criteria, while maintaining the safety and operational integrity of the highway, requires a broad and deep understanding of the operational effects of highway geometry.”


Know how to use the Green Book

“The intent of this policy is to provide guidance to the designer by referencing a recommended range of values for critical dimensions. It is not intended to be a detailed design manual that could supersede the need for the application of sound principles by the knowledgeable design professional. Minimum values are either given or implied by the lower value in a given range of values. The larger values within the ranges will normally be used where the social, economic, and environmental (S.E.E.) impacts are not critical.”

2004 Green Book Foreword, pg xliii

Flexible Design Key Concepts

- Achieving an appropriate balance requires information, evaluation, risk assessment, judgment, and a structured decision process
- Level of evaluation should reflect the scope of potential effects
- Design consistency and flexibility have different, but related, goals
- Consideration for both technical and non-technical factors

Applying inherent flexibility involves:

- Establishing the project context and using it as a key design control
- Determining appropriate design controls (example: functional classification, design vehicle, LOS)
- Choosing appropriate design criteria for the project standard (example: design speed)
- Selecting optimum design values within a range of acceptable values (example: curve radii)

Example: Lane Widths Vary by Type

**Rural**
- Freeways 12 ft
- Arterials 10 to 12 ft
- Collectors 10 to 12 ft
- 9-ft lanes can be used for low volume, low speed reconstructed roads with acceptable performance
- Low volume 9 to 11 ft

**Urban**
- Freeways 12 ft
- Arterials 10 to 12 ft
- Collectors 10 to 12 ft
- Local streets 10 to 12 ft
- 9-ft lanes can be used in residential areas where the available or attainable width of right-of-way imposes severe limitations

Other Lane Width Guidance

Advantages of narrower lane widths on urban arterials:
- Allow additional lane(s) in areas with constrained right-of-way
- Facilitate use of a wider outside lane or a designated bike lane
- Facilitate greater offset to parking lane
- Facilitate a flush or raised median
- Produce shorter pedestrian crossing times
- More economical to construct
- Contribute to lower speeds
Challenges to Design Flexibility Acceptance and Implementation

According to 2005 AASHTO survey:

#4: Liability concerns
- Solution = Documentation & Implementation
#3: Lack of understanding
- Solution = Training
#2: Perceived higher cost
- Solution = Training (long-term agency and user benefits versus up-front agency costs?)
#1: Resistance to change
- Solution = Leadership from us as engineers/planners

More About Flexibility in Design

AASHTO/FHWA Webinar on Geometric Design


Functions and Flexibility

- The hierarchy of functional classification also reflects the extent of flexibility in selecting project design criteria

Functional Roadway Types

AASHTO Functional Systems

- Rural
  - Principal Arterials
  - Minor Arterials
  - Major Collector Roads
  - Minor Collector Roads
  - Local Roads
- Urban
  - Principal Arterials
  - Minor Arterials
  - Collector Streets
  - Local Streets

Flexibility Allows Many Alternative Configurations and Trade-offs

The New AASHTO Green Book – What’s New in Geometric Design
Designing for Performance Goals

- Substantive safety performance (crash frequency and severity)
  - Current history
  - Future predictions
- Operational performance (current and future)
  - LOS
  - Corridor travel time
  - Delay
  - Congestion
- Serviceability (effectiveness)

Multi-Modal Accommodation/Service

“Emphasis has been placed on the joint use of transportation corridors by pedestrians, cyclists and public transit vehicles. Designers should recognize the implications of this sharing of the transportation corridors and are encouraged to consider not only vehicular movement, but also movement of people, distribution of goods, and provision of essential services.”

2004 Green Book Foreword, pg xlv

Designing Walkable Urban Thoroughfares: A CSS Approach

- An ITE Recommended Practice
- Intended for application on arterial and collector roads in urban areas
- Has recommendations for accommodating all users
- Urges an interdisciplinary approach to project development

Purchase or download free at: http://www.ite.org/

ITE Context Zones and Levels of Development

- Context zones categorize a road corridor by typical land uses and development intensities rather than simply “urban” or “rural”

What’s Changed in the 2011 Edition?

General (throughout):
- Formatting: added numbered headings for Chapter, Section and Sub-sections.
- Sequence of content moved within Chapters.
- Photos updated showing modern facilities.
- Clear zone and lateral offset terms clarified
- Where curb is present, lateral offset is measured from the face of curb.
- Typically on facilities without curb and less than 4 ft shoulder, a minimum lateral offset of 4 ft should be provided.
Parking lanes defined measured to the face of curb and includes the gutter pan, if present
• Structures: AASHTO LRFD Bridge Design Spec's and HL-93 design vehicle live loadings for structural capacity for new or reconstructed bridges (HS 15 for bridges to remain in place)
• Typically vertical clearances to sign trusses and pedestrian and bicycle overpasses should be 1 ft greater than the minimum clearance for other structures

Design controls and lengths for crest vertical curves updated based on new passing sight distances consistent with the MUTCD minimum lengths between no-passing zones
• References added to consider alternative criteria from the AASHTO Guidelines for Geometric Design of Very Low-Volume Local Roads (ADT Less Than or Equal to 400) for roads with ADT ≤400

Emphasis on designer consideration of the context of the project area
• Highlights the flexibility available to encourage choosing design criteria:
  ▪ Consistent with the context of the project
  ▪ Needs and value of the community
  ▪ With respect to economic limitations

“Minor arterials therefore constitute routes that should provide for relatively high travel speeds and minimum interference to through movement consistent with the context of the project area and considering the range or variety of users” [emphasis added]

“Arterials are expected to provide a high degree of mobility for the longer trip length. Therefore, they should provide as high an operating speed and level of service as practical within the context of the project area” [emphasis added]
Selection of Design Speed: “Above-minimum design values criteria for specific design elements should be used, where practical, particularly on high-speed facilities. On lower speed facilities, use of above-minimum design criteria may encourage travel at speeds higher than the design speed.” [emphasis added]

Pedestrian walking speeds changed to be consistent with the MUTCD (3.5 ft/sec for pedestrian clearance (don’t walk), and total pedestrian crossing time based on 3.0 ft/sec)

References added to the PROWAG

Principles for Acceptable Degrees of Congestion – content removed (references to the TRB Highway Capacity Manual)

Multi-modal levels of service in HCM 2010

Consideration for higher truck power-to-weight ratios and speed profile calculation

References to “Safety” are commonly changed to “crash frequency and severity”

Updated safety resources added references to the AASHTO Highway Safety Manual, the NCHRP Report 500 series, and the IHSDM

Stopping Sight Distance tables clarified whether on level, wet weather, or grades

Passing Sight Distance for Two-Lane Highways revised based on NCHRP Report 605 and is now consistent with the MUTCD

Enhanced height of object discussion in the criteria for measuring sight distance rather than in discussion of its need

Optimal passing lane flow rates and design length values added

2+1 Roadways design guidance added based on NCHRP Research Digest 275

Revised method for “Lane Drop Taper Length” for passing lane sections is consistent with MUTCD

Design controls for crest vertical curves updated based on passing sight distance

Lighting – updated to conform to the AASHTO Roadway Lighting Guide and IESNA publications

Discussions of drainage, fencing and noise barriers moved to Chapter 4
Chapter 4 – Cross Section Elements

- Traveled Way definition revised to be consistent with Roadside Design Guide
- Lane widths: "In urban areas where pedestrian crossings, right-of-way, or existing development become stringent controls on lane widths, the use of 3.3-m [11-ft] lanes may be appropriate."

Chapter 4 (continued)

- Rumble Strip section added based on State experience and TRB/FHWA research

Chapter 4 (continued)

- Clear zone and lateral offset discussion provided in a more consistent format with the Roadside Design Guide
- Curbs: for high-speed (≥ 50 mph) use sloping curbs; 4-in in rural or in urban/suburban areas with infrequent access points or streets, 6-in in urban/suburban areas with frequent access
- Sidewalks and Curb Ramps – updated discussion consistent with the AASHTO Pedestrian Guide and the PROWAG

Chapter 4 (continued)

- Discussion of driveway profiles to accommodate vehicle under-clearance, pedestrians, and drainage. References NCHRP Report 659 Guide for Geometric Design of Driveways
- Use of diagonal curb ramps discouraged
- On-Street Parking: added discussion of back-in, head-out diagonal parking

Chapter 5 – Local Roads and Streets

- Updated reference to AASHTO LRFD Bridge Design Specifications
- Clear zone and lateral offset discussion to be consistent with Roadside Design Guide
- Added discussion of Level of Service in Rural and Urban areas
- Chapter reorganized to generally follow other functional chapters

Chapter 5 (continued)

- Updated references to AASHTO Roadway Lighting Design Guide and ANSI/EISNA publications
Chapter 6
Collector Roads and Streets
- Chapter reformatted for consistency with other functional Chapters
- Added discussion about selection of LOS for collectors
- Added roadside design discussion to clarify clear zone and lateral offset
- Pedestrian, bicycle and sign structures should provide 15 ft minimum vertical clearance

Chapter 7 – Arterials
Rural: added discussion about use of minimum radii and lengths of horizontal curves
- Medians: “…multilane undivided facilities should be discouraged except where provision of a median or turn lane is not practical”
Urban: added discussion about:
- Characteristics: “The type of arterial selected is closely related to the level of service desired for all users and urban context in which it is located.”
- LOS selections

Chapter 7 (continued)
Added discussion about:
- Relationship between Design Speed and lane widths [10 ft < 35 mph]
- Benefits of parking lanes
- Benefits of medians to pedestrians in urban areas
- Offset left turn lanes when selecting median widths

Chapter 8 – Freeways
- Added discussion on superelevation rates considering snow/ice, viaducts, and section consistency
- Reformatted sequence of content similar to other functional Chapters
- Roadside Design: reorganized Clear Zone and Lateral Offset
- Shoulder width: where DDHV for truck traffic exceeds 250 veh/h, a paved shoulder width of 12 ft “should be considered” [previous “should be 12 ft”]

Chapter 9 – Intersections
- Chapter reformatted to provide a better sequence of content
- Added or updated discussions of:
  - Intersection capacity based on HCM
  - Roundabouts
  - Continuous Flow Intersections
  - Expanded discussion of Indirect Left Turns and U-turns

Chapter 9 (continued)
- Based on TRB Access Management Manual:
  - Definition of Functional Area
  - Components of Auxiliary Lanes
  - Deceleration Length Discussion
- Added design criteria for double/triple left turn lanes based on NCHRP 505
Chapter 10 –
Grade Separations and Interchanges

- Updated Exhibits and discussion for Directional/Semi-directional Interchanges
- Included an Exhibit for Diamond Interchange with Roundabout Intersection Control
- Added discussion about:
  - Roundabout ramp terminals
  - Ramp metering
  - Two-lane loop ramps
  - Left-side ramp terminals
  - Vertical clearance above RR’s

Chapter 10 (continued)

- Terminology for Single-Point Diamond Interchange (SPDI) [previously SPUI]
- Ramp shoulders and lateral offset: “The left and right shoulder widths may be reversed if needed to provide additional sight distance.”
- Procedure for measuring the distances between ramp terminals is given in the HCM 2010 new weaving methodology (measured between the painted noses)

Thank You

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Questions?

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