GUIDE FOR

NHS Arterial (Non-Interstate)

4R-3R-2R-1R Criteria

WYDOT Design Guides 2008

WYOMING
Department of Transportation

Note: This guide is presented in the original format as it appeared prior to reformatting to the 5 1/2" x 8 1/2" published booklet. The information is the same.

GUIDE FOR NHS ARTERIALS (Non-INTERSTATE) 4R-3R-2R-1R CRITERIA

INTRODUCTION

This Guide is directed to developing transportation projects on the Wyoming National Highway System, non-Interstate roadways, functionally classified as Principal Arterials (this System will be referred as NHS Arterials). The Guide uses the generally accepted 4R-3R-2R-1R project-type definitions, extended from the traditional highway pavement improvement types to also address geometric design, bridge design, safety design/ hardware, capacity considerations and other highway elements.

The criteria presented in this Guide have been developed as recommended practice. Their use should become standard practice to best meet the Department's direction for project designs/contract documents. These criteria may be modified, if needed, to meet an individual project or location-specific situation. As a result, the use of words such as 'may or should' versus 'shall, will, or must' is intended to support presentation of the criteria, and is not intended to present a permissive condition versus a required condition.

The Criteria presented in this Guide were developed consistent with the WYDOT Mission "To provide a safe, high quality, and efficient transportation system" and related Goal to "Enhance safety on the transportation system." Management systems for safety, pavements, and bridges are used to provide systems-level data supporting project-level decisions. Project -level safety evaluations provide for a systematic approach to the collection of relevant data including crash history, predominant crash type, traffic volumes and vehicle classifications. Safety improvements, to be incorporated into the project design and construction, are evaluated to both improve an existing safety element or address a project purpose of lowering the potential for an identified crash type. Upgrading safety hardware to current safety design standards, constructing clear recovery areas, improved signing and pavement markings, correcting geometric deficiencies, and providing pavement/bridge deck skid resistence, are all considered during the process to develop project scopes that address identified needs and budget funds to construct highway system improvements.

These criteria should guide the initial scope/description of 4R-3R-2R-1R type projects. Changes to the project scope during plan development, to add additional work elements, or use design values higher than initially selected, will be evaluated by Project Development for added cost and overall benefit to the project design. Documentation of the evaluation and resultant change in project design will be included within an amended Project Reconnaissance Report.

GENERAL DEFINITIONS

1) Functional Classification: Classification of the system of highways by the character of service they provide. NHS arterials are functionally classified as Principal Arterials as this System provides for high levels of mobility and access control by 1) substantial trip lengths including regional, statewide, and interstate travel, 2) connected travel

movements between major urban areas, and 3) partial control of access to maintain the primary function of mobility while providing access from adjacent land uses.

2) Controlling Design Criteria: Controlling design criteria are Minimum Design Speed (MDS), Lane Width, Shoulder Width, Bridge Structure Width, Horizontal Alignment, Cross-Slope, Super-elevation, Vertical Alignment, Grades, Stopping Sight Distance, Horizontal Clearance to Obstructions (Lateral Offset), Vertical Clearance, and Structure Capacity (loading), from the WYDOT *Road Design Manual.* Horizontal Clearance to Obstructions may also be referred to as Lateral Offset, but its definition is not synonymous with the definition of clear recovery area/clear zone, although the design values for Horizontal Clearance to Obstructions may be based on the same computations as used to compute clear recovery areas/clear zones. Design exceptions may be processed, for 4R type projects, where it is not reasonable to achieve full compliance with AASHTO minimum design values for any of the controlling design criteria. For 3R type projects, design exceptions may be processed where it is not reasonable to achieve full compliance with the tolerable controls. The process for evaluating, justifying, and documenting (including signature authority) the need for a design exception is outlined in WYDOT *Road Design Manual.*

3) Design, Safety, and Bridge Standards: The standards current with development of this Guide are listed as References. The use of design standards in this Guide refers to the most current adopted version of the referenced standards.

4) Highway Capacity Analysis: This analysis will be completed for the selected design year using procedures in the TRB *Highway Capacity Manual*, or an adopted State analysis method. Interim years, such as 10 years from the year open to traffic, should be analyzed as a basis for decisions required for implementing the criteria in this Guide. For purposes of this Guide, the terms 'design year' and 'design life' represent the same future year, with that year selected from the anticipated year of project construction. A Level-of-Service (LOS) D has been chosen as the appropriate LOS to warrant capacity improvements for NHS Arterials within an urban area. Capacity improvements for NHS Arterials in rural areas will be warranted based on a LOS C for the selected design year.

5) Rural and Urban Sections: Rural section refers to a typical section providing for shoulders and graded ditches based on a set of geometric design standards or practices. An urban section refers to a typical section providing a curb and gutter system based on a set of geometric design standards or practices. These terms should, but may not, coincide with the above designation for NHS Arterials within an urban area or NHS Arterials in rural areas. For example, an NHS Arterial within an urban area may be constructed using a rural typical section.

6) Project Scope and Funding: Project scopes will be determined at an early planning stage using established management systems for pavement, bridge, safety, and asset management. Early project scoping or the Reconnaissance Phase will develop a consensus on the project purpose, project type, limits, and all location-specific major elements. Projects meeting the 4R-3R-2R-1R criteria presented in this Guide are eligible for State and Federal funding categories.

7) 4R: New construction or reconstruction to provide for the full range of pavement design strategies for plant-mix asphalt pavements to include removal and replacement of a portion or all of the existing pavement structure and base materials. 4R includes construction of portland cement concrete pavements. This type of project will include improvements to address the need for additional continuous travel lanes for added capacity, auxiliary lanes, safety clear recovery areas, new or reconstructed bridge structures, and upgrading geometric and other highway elements to design standards. Project designs will meet a minimum 20-year design life.

8) 3R: Restoration or rehabilitation of an existing pavement structure using a full range of pavement design strategies. This project type may include widening to provide for standard shoulder widths or auxiliary lanes, safety improvements, reconstructed bridge structures, and upgrading geometric and other highway elements, below tolerable controls, to meet design standards. Project designs will meet a selected design life up to 20 years.

9) 2R: Resurfacing with additional pavement structure to extend serviceability of the roadway pavement. This project type may include minor widening to maintain the existing paved roadway width (travel lane plus shoulder widths), shoulder widening, minor safety, bridge, or geometric improvements, and other highway elements to address identified needs for a selected design life up to 15 years.

10) 1R: Preservation of existing pavement structure to extend the service life pending future pavement construction, and reactionary efforts to keep the highway system open to traffic. This type of project will provide a maximum 2" pavement thickness (including leveling thickness), and will not require the selection of a design life.

APPLICATION CRITERIA - NHS ARTERIAL 4R PROJECTS

Pavement Design Process:
NHS Arterial 4R projects provide for the full range of pavement design strategies for plant-mix asphalt pavements to include removal and replacement of a portion or all of the existing pavement structure and base materials. 4R includes the construction of portland cement concrete pavements. All 4R designs will meet a minimum 20-year design life. The pavement type determination will meet the procedures of WYDOT *Operating Policy 38-2, Pavement Type Determination.*

Rural multi-lane Arterials will be designed to meet the following criteria for the paved width of travel lanes, shoulders, and auxiliary lanes. The right lane and shoulder will be designed to a full-depth pavement structure for 14 feet (12 feet of travel lane plus 2 feet of right shoulder). The remaining right shoulder will be evaluated for a reduced-depth pavement structure, typically a minimum 4-inch plant-mix surface for the full width. The full width of the left lane will be designed to a full-depth pavement structure. The full left shoulder will be evaluated for a reduced-depth pavement structure, typically a minimum 4-inch plant-mix surface. Auxiliary lanes, including passing, turning and climbing lanes, will be evaluated for a reduced-depth pavement structure as they carry a differing volume and mix of traffic.

Rural two-lane Arterials and Urban Arterials will be designed to meet the following criteria for the paved width of travel lanes, shoulders, and auxiliary lanes. The travel lanes will be designed to full-depth pavement structure for the full width. Shoulders will be evaluated for a reduced-depth pavement structure, typically a minimum 4-inch plant-mix surface. Auxiliary lanes, including passing, turning, parking, and bicycle lanes, will be evaluated for a reduced-depth pavement structure as they carry a differing volume and mix of traffic.

Geometric Design Process and Standards:
Design Process: NHS Arterial 4R projects will be designed to meet design standards for controlling design criteria and best practice for non-controlling geometric elements.

Design Standards: Design standards are presented in the AASHTO *A Policy on Geometric Design of Highways and Streets,* and WYDOT *Road Design Manual*. The conversion of existing two-lane arterials to four-lanes on the WYDOT proposed four-lane corridors will follow Wyoming *Standards for Multi-Lane Rural Roadway* and the Operating Policy for non-Interstate multi-lane highways. AASHTO standards identify both minimum and desirable design values for Controlling Design Criteria and these values are presented in Table 1 for the ten Controlling Design Criteria relating to roadway design. AASHTO design values for the three Controlling Design Criteria relating to bridges are presented in Table 2 located in a following section, Bridge Design Process and Standards. These design values are applicable to NHS Arterial mainline sections and are not intended to guide the design of auxiliary lanes including interchange ramps.

Except as footnoted, 4R projects will meet design values approaching the AASHTO minimums when the use of desirable values will result in unacceptable costs or social/environmental consequences.

Table 1. NHS Arterials, 4R Roadway Geometric Controlling Design Criteria			
Controlling Design Criteria	**Foot Note**	**AASHTO Minimum Design Values**	**AASHTO Desirable Design Values**
Design Speed (MDS) Rural Section Urban Section	1,6	 40 MPH MDS 30 MPH MDS	 70 MPH MDS 60 MPH MDS
Lane Widths	8	12 Feet	12 Feet
Rural Section Shoulder Widths: 2-Lane or Undivided Roadway Vehicles/day, under 400 Vehicles/day, 400--2000 Vehicles/day over 2000 Multi-Lane Divided Roadway Outside shoulder Inside shoulder	2	 4 Feet 6 Feet 8 Feet 8 Feet 4 Feet	 4 Feet 6 Feet 8 Feet 8 Feet 4 Feet
Urban Section Shoulder Widths: 2-Lane or Undivided Roadway Multi-Lane Divided Roadway	2	 Gutter Pan Width Gutter Pan Width	 Rural Section Width Rural Section Width
Horizontal Alignment Rural Section Urban Section	1,3	 40 MPH MDS 30 MPH MDS	 70 MPH MDS 60 MPH MDS
Cross-Slope		1.5%	2.0%
Superelevation	1,5	Superelevation Tables, emax = 8%	Superelevation Tables, emax = 8%
Vertical Alignment Rural Section Urban Section	1,4	 40 MPH MDS 30 MPH MDS	 70 MPH MDS 60 MPH MDS
Grades-Maximum (Ranges): Level Terrain Rolling Terrain Mountainous Terrain		 5% (40 MPH MDS) 6% (40 MPH MDS) 8% (40 MPH MDS)	 3% (60-70 MPH MDS) 4% (60-70 MPH MDS) 5% (60-70 MPH MDS)
Sight Distance (Ranges) Rural Section Urban Section		 305 Feet (40 MPH MDS) 200 Feet (30 MPH MDS)	 730 Feet (70 MPH MDS) 570 Feet (60 MPH MDS)
Horizontal Clearance to Obstruction Rural Section Urban Section	7	 Roadside Design Guide 1.5 Feet	 Roadside Design Guide Roadside Design Guide

Footnotes:

1--Design Speed should be selected with respect to anticipated operating speeds given the terrain type, adjacent land use and functional classification of the highway. The selected Design Speed should meet or exceed posted speed.
2--For rural sections, wider shoulder widths may be selected in consideration of *WYDOT Operating Policy 7-4, Bicycle Accommodation and Multiple-Use Transportation Facilities*. For urban sections, the shoulder width may be increased to provide for parking lanes, bicycle lanes, and/or turn lanes. Selected shoulder widths include the gutter pan width, measured to curb face.

3--Isolated horizontal curves can be considered to remain in-place when the combination of design elements--curve radius, super elevation, and stopping sight distance--meets a minimum 55 MPH design speed for a rural section. This footnote is only applicable when a 60-70 MPH design speed has been selected, and is not applicable for the lower range of selected design speeds. A Design Exception will be processed justifying the action to leave a horizontal curve in-place when this action is not consistent with the selected Design Speed.

4--Isolated vertical curves can be considered to remain in-place when the combination of design elements--vertical curve length, grades, and stopping sight distance--meets a minimum 55 MPH design speed for a rural section. This footnote is only applicable when a 60-70 MPH design speed has been selected, and is not applicable for the lower range of selected design speeds. A Design Exception will be processed justifying the action to leave a vertical curve in-place when this action is not consistent with the selected Design Speed.

5--The 6% Table may be used in mountainous terrain. The 4% Table may be used in low-speed urban areas. Tables are from AASHTO *A Policy on Geometric Design, 2004.*

6--On urban sections, Design Speeds greater than 45 MPH should use a mountable (sloping) curb type design.

7--On urban sections, the project design will use a minimum 2.0 feet clearance to obstructions, consistent with WYDOT practice. For these sections, dimensions are from curb face to obstruction.

8--AASHTO allows the use of 11 feet travel lanes for those arterials with a combination of lower design speeds, $\leq$ 55 MPH, and lower design volumes, $\leq$ 1500 vehicles/day. The WYDOT design standard, for State Highways, requires a 12 feet width for travel lanes.

Fore-slope rates, the width of clear recovery areas, and median widths are non-controlling geometric elements for which best practice design values have been established by AASHTO. Fore-slopes are measured laterally from the outside edge of shoulder to ditch bottom or a point of slope selection for a cut section, and to a point of slope selection for fill sections. The AASHTO minimum fore-slope rate is 1V:4H, with an AASHTO desirable and WYDOT recommended rate of 1V:6H established for Arterial reconstruction projects. The first four feet, including the surfacing taper, will be constructed at a minimum 1V:8H using plant-mix or other consolidated and drain-able

materials. Design exceptions are not required, but project records should document when it is not reasonable to achieve full compliance with AASHTO minimum design values for this non-controlling design element.

The clear recovery area (clear zone) is measured beyond the edge of the travel lane. Arterial 4R projects will provide for safety grading to meet a project-selected clear recovery area. The minimum width of the clear recovery area is the same as the selected AASHTO design value for Horizontal Clearance to Obstructions, presented above for both rural and urban sections. 4R projects on rural sections of NHS Arterials, previously constructed with a clear recovery area, will not require grading to further widen the clear recovery area. Beyond the clear recovery area, selection of slope-rates will be based on fill-height tables. Design exceptions are not required for the clear recovery area as it is a non-controlling geometric element. Since the minimum design value for Horizontal Clearance to Obstructions and clear recovery area for Arterial reconstruction projects are the same, a project-selected horizontal clearance width/clear recovery width that does not meet the AASHTO minimum design value for Horizontal Clearance to Obstructions would require a Design Exception.

Median widths are measured between the edges of travel lanes and include the left shoulder widths. 4R projects should maintain the existing median width or construct a selected width from Wyoming *Standards for Multi-Lane Rural Roadway* and the Operating Policy for non-Interstate multi-lane highways. Based on the safety evaluation and resultant crash types required in the Highway Safety Improvement section existing medians should be considered for protection with a longitudinal guardrail barrier.

Bridge Design Process and Standards:
NHS Arterial 4R projects will provide for bridge structure replacement or reconstruction of any element that does not meet design standards. Design standards are presented in the AASHTO *A Policy on Geometric Design of Highways and Streets*. AASHTO minimum and desirable design values for Controlling Design Criteria are presented in Table 2.

Except as footnoted, 4R projects will meet design values approaching the AASHTO minimums when the use of desirable values will result in unacceptable costs or social/environmental consequences.

Table 2. NHS Arterials, 4R Bridge Geometric Controlling Design Criteria			
Controlling Design Criteria	**Foot Note**	**AASHTO Minimum Design Values**	**AASHTO Desirable Design Values**
Bridge Roadway Width		Approach Roadway Width	Approach Roadway Width
Vertical Clearance Structure Over Interstate Highway Structure Over NHS Arterial Structure Over Non-NHS Arterial Structure Over Non-NHS Collector Structure Over Non-NHS Local	1	 16 Feet 16 Feet 16 Feet 14 Feet 14 Feet	For All Structures, Add 0.5 Feet of Vertical Clearance to allow for Future Surfacing
Structural Capacity		HL 93	HL 93

Footnote:

1--The determination to replace an existing bridge overpass to meet vertical clearance will consider the functional and structural evaluation of the bridge. Bridge replacement to meet Vertical Clearance is not required. A Design Exception will be processed justifying the action to leave the bridge in-place.

Any bridge structure replaced, or proposed for reconstruction of major elements, will be evaluated for structure type, including location of abutments and piers, and length and width requirements. This evaluation will address future capacity needs of the roadway system, using a highway capacity analysis based on a minimum 20-year design life. The location of abutments and piers will consider design values for Horizontal Clearance to Obstructions, which vary by highway system crossed (Interstate, NHS Arterial, Non-NHS State Highways).

Highway Safety Improvements:

Early project planning for NHS Arterial 4R projects will include an evaluation of the safety elements of the roadway and roadside. Crash history, predominant crash types, traffic volumes and vehicle classifications, and project scope and budget will all be evaluated to determine the extent of safety improvements needed to improve the existing safety elements or address a project purpose of lowering the potential for a certain crash type. All roadside safety hardware within the clear recovery area, including bridge curb and railing, guardrail barriers and terminals, bridge-rail to guardrail connections, and sign support breakaway hardware, will be upgraded to meet safety design standards, NCHRP *Report 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features.*

Highway Capacity Improvements:

NHS Arterial 4R projects, based on a highway capacity analysis, will provide for additional continuous travel lanes needed to meet a 20-year projected travel demand. Auxiliary lanes, such as turn lanes and truck climbing lanes, will be included, as justified.

Interchanges and Intersections:
4R projects can include the evaluation of geometric design, capacity, and safety needs for interchange ramp connections to the NHS Interstate System. All improvements can be included in the project plan, based on a highway capacity analysis to meet a 20-year projected travel demand and design and safety design standards. Design criteria are presented in the WYDOT *Road Design Manual, supplemented by the* AASHTO *A Policy on Geometric Design of Highways and Streets, as needed.* The design values, presented in Table 1, are only applicable to NHS Arterial mainline sections and are intended to guide the design of auxiliary lanes including interchange ramps and acceleration/deceleration lanes. Improvements to the Interstate ramps may be delayed and programmed with a future Interstate-type project.

4R NHS Arterial projects will evaluate the geometric design, capacity, and safety needs for major intersections, including the intersecting road. All improvements will be included in the project plan, based on a highway capacity analysis to meet 20-year projected travel demand and design and safety design standards. Capacity improvements to the intersection and/or the intersecting road may be delayed, if not warranted within the first ten years of the selected project design life, and can be programmed for a future stand-alone project. As an alternative, the initially proposed 4R project, to include intersection capacity improvements, may be delayed and a different project type, such as a 2R, may be selected to extend the project life until the capacity improvements are warranted and programmed as a 4R project.

Special Studies:
Cost reduction studies, including Life Cycle Costing, Value Engineering, and Constructability Reviews, should be considered during the Reconnaissance Phase. Contract packaging by type of work or special construction requirements, and innovative contracting including Cost plus Time, Lane Rental, and Incentive/ Disincentive provisions should be evaluated for each project.

APPLICATION CRITERIA—NHS ARTERIAL 3R PROJECTS

Pavement Design Process:
NHS Arterial 3R projects will be designed to restore or rehabilitate the existing pavements using a full range of pavement design strategies, to a selected design life up to 20 years. The pavement type determination will meet the procedures of WYDOT *Operating Policy 38-2.*

Rural multi-lane Arterials will be designed to meet the following criteria for the paved width of travel lanes, shoulders, and auxiliary lanes. The right lane and shoulder will be designed to full-depth pavement structure for 14 feet (12 feet of travel lane plus 2 feet of right shoulder). The remaining right shoulder will be evaluated for a reduced-depth pavement structure, typically a minimum 4-inch plant-mix surface for the full width. The full width of the left lane will be designed to a full-depth pavement structure. The full left shoulder will be evaluated for a reduced-depth pavement structure, typically a minimum 4-inch plant-mix surface. Auxiliary lanes, including passing, turning and climbing lanes, will be evaluated for a reduced-depth pavement structure as they carry a differing volume and mix of traffic.

Rural two-lane Arterials and Urban Arterials will be designed to meet the following criteria for the paved width of travel lanes, shoulders, and auxiliary lanes. The travel lanes will be designed to full-depth pavement structure for the full width. Shoulders will be evaluated for a reduced-depth pavement structure, typically a minimum 4-inch plant-mix surface. Auxiliary lanes, including passing, turning, parking, and bicycle lanes, will be evaluated for a reduced-depth pavement structure as they carry a differing volume and mix of traffic.

Geometric Design Process and Standards:

Design Process: Early project planning for NHS Arterial 3R projects will include an evaluation of the existing highway elements against design values, for both controlling design criteria and other major criteria such as fore-slope rates. 3R projects will improve those highway elements related to controlling design criteria that are below tolerable controls, consistent with WYDOT *Operating Policy 7-1, Design Standards and Tolerable Controls*. Improvements will be designed to meet design standards for controlling design criteria and best practice for non-controlling geometric elements.

Design Standards: Design standards are presented in the AASHTO *A Policy on Geometric Design of Highways and Streets*. AASHTO standards identify both minimum and desirable design values for Controlling Design Criteria and these values are presented in Table 1 and Table 2. Tolerable controls, relative to those highway elements which can remain in-place for a 3R project, are generally defined as the design values that were in effect at the time of original construction of the NHS Arterial highway section proposed for improvement, or the design values for existing highway elements, related to controlling design criteria, if the roadway has been improved since original construction. These tolerable controls will be maintained during project design or improved as needed. Tolerable controls, applicable to NHS Arterial mainline sections, are as follows.

> Design Speed: 65 MPH is the selected design speed value. For a rural section, 55 MPH is the tolerable control, and this control can be reduced based on terrain type. For an urban section, a design speed consistent with the existing posted speed is the tolerable control. A corridor/project design speed will be selected for each project.
>
> Horizontal Alignment: The combination of design elements for the horizontal alignment of rural sections will meet a 55-MPH design speed as the tolerable control, and this control can be reduced due to terrain type. At the tolerable controls for design speed, the use of minimum values for curve radius, super elevation, and stopping sight distance (these values taken from design standards) should be avoided.
>
> Vertical Alignment: The combination of design elements for the vertical alignment of rural sections will meet a 55-MPH design speed as the tolerable control, and this control can be reduced due to terrain type. At the tolerable controls for design speed, the use of minimum values for vertical curve lengths, grade differences, and stopping sight distance (these values taken from design standards) should be avoided.
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> Lane Width: All traffic lanes, rural and urban sections, will be 12 feet wide.

Shoulder Widths: See Table 3.

Table 3. NHS Arterials, 3R Shoulder Widths		
	Shoulder Width Tolerable Control	**Shoulder Width Current Standard**
Two-Lane Rural Section	Existing Width, with 4 Feet Minimum Width	4-8 Feet
Two-Lane Urban Section	Existing Widths	Gutter Pan Width
Multi-Lane, Divided, Rural Section	Existing Widths	8 Feet Right 4 Feet Left
Multi-Lane, Divided, Urban Section	Existing Widths	Gutter Pan Width, Minimum; Rural Section, Desirable

NOTE: For rural sections, wider shoulder widths may be selected in consideration of *WYDOT Operating Policy 7-4, Bicycle Accommodation and Multiple-Use Transportation Facilities*. For urban sections, the shoulder width may be contained within a gutter section, parking lane, turn lane, or bicycle lane; selected shoulder widths include the gutter pan width, measured to curb face.

Grades: The maximum tolerable grades are as originally constructed. Lessening or changing the profile grade to meet a design standard would typically be addressed as 4R Reconstruction.

Cross Slope: The current standard is 1.5 percent with a desirable rate at 2 percent. The tolerable control is 1.5 percent.

Horizontal Clearance to Obstructions: The width for horizontal clearance is determined through application of the procedures for establishing the clear recovery area from the AASHTO *Roadside Design Guide*. For a 3R project, the tolerable control for horizontal clearance will be the paved shoulder width for a rural section. The tolerable design control will be 2.0 feet beyond the curb face for an urban section. When this tolerable control is selected on a rural section that has not been safety-graded, all fixed objects outside of the paved shoulder width but inside a calculated design value for horizontal clearance, will be removed, made breakaway or shielded by crashworthy guardrail. The design value used to provide horizontal clearance on 3R projects should be coordinated with the evaluation of needed safety improvements to be completed during early project planning and further defined in the Highway Safety Improvements section of this Guide. Major safety grading on 3R projects is not required, but each project will be evaluated to determine if safety grading should be included in the project restoration/ rehabilitation effort. 3R projects, on NHS Arterials, for rural highway sections previously constructed to provide a clear recovery area will not require minor

grading to further widen the clear recovery area to meet the procedures of the AASHTO *Roadside Design Guide*.

Fore-slope rates, the width of clear recovery areas, and median widths are non-controlling geometric elements for which best practice design values have been established by AASHTO. Fore-slopes are measured laterally from the outside edge of shoulder to bottom of ditch or a point of slope selection for a cut slope, and to a point of slope selection for fill sections. The AASHTO minimum fore-slope rate and the tolerable control is 1V:4H. The AASHTO desirable and WYDOT recommended rate of 1V:6H are established for Arterial 3R projects. The first four feet, including the surfacing taper, will be constructed at a minimum 1V:8H using plant-mix or a consolidated and drain-able material. Design exceptions are not required, but project records should document when it is not reasonable to achieve full compliance with AASHTO minimum design values for this non-controlling design element.

The clear recovery area (clear zone) is measured beyond the edge of the travel lane. For Arterial 3R projects, the design value and tolerable control widths of the clear recovery area are the same values as presented above for Horizontal Clearance to Obstructions. Beyond the clear recovery area, selection of slope-rates will be based on fill-height tables.

There are a limited number of miles of 4-lane divided NHS Arterials. Design standards for median widths, from 8 feet paved to 76 feet depressed, are presented in the Wyoming *Standards for Multi-Lane Rural Roadways* and the Operating Policy for non-Interstate multi-lane highways. Existing median widths are acceptable as the tolerable control. Based on the safety evaluation and resultant crash types, required in the Highway Safety Improvement section, existing medians should be considered for protection with a longitudinal guardrail barrier.

Bridge Design Process and Standards:
Design Process: NHS Arterial 3R projects will evaluate bridge structures to determine elements in an advanced state of deterioration. The evaluation will review the roadway width (defined as the combined width of traffic lanes and shoulders) for improvements to ensure that the bridge width is consistent with the width of the approach roadway. Work needed to extend the functional life of the structure, including structure replacement, widening, or reconstruction of any element, will be addressed with a 3R project and meet design standards. Any bridge structure replaced or proposed for reconstruction of major elements will be evaluated for structure type, length and width requirements, with a capacity analysis based on a minimum 20-year design life. The location of abutments and piers will consider design values for Horizontal Clearance to Obstructions, which vary by highway system crossed (Interstate, NHS Arterial, Non-NHS State Highway).

Design Standards: Design standards are presented in the AASHTO *A Policy on Geometric Design of Highways and Streets*. Tolerable controls, relative to those highway elements which can remain in place for a 3R project, are generally defined as the design values that were in effect at the time of original construction of the NHS Arterial highway section proposed for improvement, or the design values for existing highway elements, related to controlling design criteria, if the roadway has been improved since original construction. These tolerable controls will be maintained during project design or

improved as needed. Tolerable controls, applicable to NHS Arterial mainline sections, are as follows.

Bridge Width: Design standards for bridge structures provide for a minimum width to accommodate the travel lanes and shoulder widths of the approach roadway. These widths vary by roadway section and are presented above in Table 1. The existing roadway width is the tolerable control.

Vertical Clearance: There are a limited number of overpass structures on NHS Arterials, except for those structures that are a part of the Interstate System. As a result, meeting a vertical clearance design value for a structure over a NHS Arterial should not be a major system need. Design values for the for the clear height of structures over the entire roadway width of the NHS Arterial and intersecting roadways are presented in Table 2.

The tolerable control for vertical clearance of bridge structures is:

Over NHS Arterials: Original constructed clearances, minimum of 14 feet.
NHS Arterial over Interstate: Original constructed clearances, minimum of 15 feet.
NHS Arterial over NHS Arterial: Original constructed clearances, minimum of 14 feet.
NHS Arterial over Non-NHS Arterial: Original constructed clearances, minimum of 14 feet.
NHS Arterial over other Non-NHS State Highway: Original constructed clearances.

3R projects will maintain the existing clearances, with the noted minimums, and can include, if needed, grade changes and structure modifications. Raising structures or reconstructing mainline grades to meet the design value of 16 feet over the roadway width would typically be addressed as 4R Reconstruction.

Structural Capacity: The design value for new bridges is an HL 93 structural capacity. A bridge can remain in place if its inventory rating is 0.8 or greater.

Highway Safety Improvements:
Early project planning for NHS Arterial 3R projects will include an evaluation of the safety elements of the roadway and roadside, including the clear recovery area, median widths, existing fore-slope rates, and all existing roadside safety hardware. Crash history, predominant crash types, traffic volumes and vehicle classifications, and project scope and budget will all be evaluated to determine the extent of safety improvements needed to improve the existing safety elements or address a project purpose of lowering the potential for a certain crash type. All roadside safety hardware within the clear recovery area will be evaluated, including bridge curb and railing, guardrail barriers and terminals to include length-of-need, bridge-rail to guardrail connections, and sign support breakaway hardware. Upgrading roadside safety hardware to safety design standards, NCHRP *Report 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features,* may be included in the project plan or, consistent with the Safety Management System, be phased as a future programmed project or stand-alone safety project. As presented in an earlier section on Horizontal Clearance to Obstructions, a 3R project

design that uses the paved shoulder width for horizontal clearance on a highway section that has not been previously constructed with a clear recovery area must upgrade safety hardware to safety design standards.

Highway Capacity Improvements:
3R projects are not intended to provide for additional continuous travel lanes. Future year capacity needs on NHS Arterials would typically be evaluated as part of a 4R Reconstruction.

Interchanges and Intersections:
3R projects are not intended to include improvements to interchange ramp connections to the NHS Interstate System or other interchanges. A 3R project may include resurfacing of ramps and crossroads, maintaining existing widths.

3R Arterial projects will evaluate the geometric design, capacity and safety needs for major intersections, including the intersecting road. Improvements can be included in the project plan, based on a highway capacity analysis to meet 20-year projected travel demand and design and safety design standards. Capacity improvements to the intersection and/or the intersecting road may be delayed, if not warranted within the first ten years of the selected project design life, and can be programmed for a future stand-alone project. As an alternative, the initially proposed 3R project, to include intersection capacity improvements, may be delayed and a different project type, such as a 2R, may be selected to extend the project life until the capacity improvements are warranted and programmed as a 4R project.

Special Studies:
Cost reduction studies, including Life Cycle Costing, Value Engineering, and Constructability Reviews, should be considered during the Reconnaissance Phase. Contract packaging by type of work or special construction requirements, and innovative contracting including Cost plus Time, Lane Rental, and Incentive/ Disincentive provisions should be evaluated for each project.

APPLICATION CRITERIA—NHS ARTERIAL 2R PROJECTS

Pavement Design Process:
NHS Arterial 2R projects will be designed to resurface the existing pavement structure to a selected design life up to 15 years. Project types include level/mill and overlay, concrete pavement restoration and dowel bar retrofits.

Geometric Design Process and Standards:
Design Process: Early project planning for 2R projects will include an evaluation of the horizontal alignment for existing curve radius and super-elevation, and the resultant design speed. The evaluation will determine if either of those highway elements is below tolerable controls defined in the above Application Criteria—NHS Arterial 3R Projects. If the horizontal alignment warrants improvement, the selected improvements will meet design values in Table 1. 2R projects are not intended to improve all highway elements that do not meet tolerable controls. Project records such as a Project Evaluation Report will document the evaluation results and justify delaying the improvement of highway

elements that do not meet tolerable controls. The formal Design Exception process is not applicable to 2R projects.

Design Standards: 2R projects will maintain the existing roadway width. For those highway segments where the existing roadway width exceeds the design values presented in Table 1, the roadway width may be reduced to meet design values in Table 1.

Bridge Design Process and Standards:
Bridge structures will be evaluated to determine elements in an advanced state of deterioration. Work, generally defined as bridge preservation to extend the functional life of the structure, may be included with a 2R project, to include bridge deck repairs and overlays.

Highway Safety Improvements:
2R projects are not intended to improve all roadside features.

Early project planning for Interstate 2R projects will include an evaluation of existing roadside safety hardware. Upgrading roadside safety hardware to safety design standards, NCHRP *Report 350 Recommended Procedures for the Safety Performance Evaluation of Highway Features* may be included in the project plan or, consistent with the Safety Management System, be phased as a future programmed project or safety project.

Pavement edge drop-offs, that result from the constructed project, will be corrected on a 1V:4H or flatter.

Highway Capacity Improvements:
2R projects are not intended to provide for additional continuous travel lanes or auxiliary lanes. Future year capacity needs would typically be evaluated as part of a 4R Reconstruction.

Interchanges and Intersections:
2R projects are not intended to include improvements to interchange ramp connections to the NHS Interstate System. A 2R project may include resurfacing of ramps and crossroads, maintaining existing widths.

Modifications to intersections, including turn lanes, should be evaluated and included in the project plan, if justified.

APPLICATION CRITERIA—NHS ARTERIAL 1R PROJECTS

Pavement Design Process:
NHS Arterial 1R projects are defined as those pavement preservation strategies and reactionary efforts designed for a maximum 2" pavement thickness (including leveling thickness). Project types include overlays, partial width mill/fills, chip seals, micro-surfacing, crack seals, wearing courses, grind and reseals, and slab repairs.

Geometric Design Process and Standards:

Design Process: Arterial 1R projects, structured to solely address mainline pavement preservation needs, are not intended to improve the existing mainline geometric design elements.

Design Standards: 1R projects will maintain the existing roadway width. For those highway segments where the existing roadway width exceeds the design values presented in Table 1, the roadway width may be reduced to meet design values in Table 1.

Bridge Design Process and Standards:
Work, generally defined as bridge preservation to extend the functional life of the structure, may be included with a 1R project, to include bridge deck repairs and overlays.

Highway Safety Improvements:
1R projects are not intended to improve roadside safety features.

Pavement edge drop-offs, that result from the constructed project, will be corrected on a 1V:4H or flatter.

Highway Capacity Improvements:
1R projects are not intended to provide for additional continuous travel lanes, or auxiliary lanes. Future year capacity needs would typically be evaluated as part of a 4R Reconstruction.

Interchanges and Intersections:
NHS Arterial 1R projects are not intended to include improvements to interchange ramp connections to the NHS Interstate System.

Modifications to intersections, including turn lanes, should be evaluated and included in the project plan, if justified.

REFERENCES

The References presented in this Guide are current and adopted editions. As these references are revised and new editions adopted, all references in this Guide are intended to refer to the most current and adopted edition. For example, NCHRP Report 350, when updated, may be renamed or have a different sponsoring agency, but when adopted, will be the edition required for use by this Guide.

AASHTO: *A Policy on Geometric Design of Highways and Streets, 2004.*

AASHTO: *Roadside Design Guide, 2002.*

AASHTO: *Highway Safety Design and Operations Guide, 1997*.

TRB: *Highway Capacity Manual Special Report 209, 2000*

NCHRP: *Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features*

WYDOT; *Road Design Manual & Road Design Manual Memorandums (RDMM)*

WYDOT: *Operating Policy -*
Policy Number 38-2 Pavement Type Determination
Policy Number 7-1 Design Standards and Tolerable Controls
Policy Number 25-1 Traffic Control and Roadway Lighting Devices
Policy Number 7-4 Bicycle Accommodation and Multiple-Use Transportation Facilities

WYDOT: *Standards for Multi-Lane Rural Roadways* and the Operating Policy for non-Interstate multi-lane highways.

WYDOT: *Wyoming Bicycle & Pedestrian Transportation Plan*.