

The information contained in Chapter Seventeen: Resurfacing, Restoration and Rehabilitation (3R) Projects, dated May 2022, has been updated to reflect the **May 2025 Errata**. The errata incorporates DES 22-03: “Practical Design: Bridge or Culvert Replacement Projects” (approved by the Nebraska Division of the FHWA on January 18, 2023), incorporates DES 23-02: “3R Standards for Expressways with Access only at Interchanges” (approved by the Nebraska Division of the FHWA on August 11, 2023), addresses errors, changes in procedure, changes in NDOT department titles, changes in other Roadway Design Manual chapters and other reference material citations occurring since the latest publication of this chapter.

Chapter Seventeen provides requirements and guidance unique or specific to the design of 3R projects and such requirements and guidance take precedence over those in other chapters. Information in other chapters may still apply to a 3R project, if not included in Chapter 17.

The arrangement of Chapter Seventeen generally follows the Chapter order of the Roadway Design Manual (RDM) (e.g. Earthwork is Chapter Seven of the *RDM* and Section 7 of Chapter Seventeen).

Chapter Seventeen

Resurfacing, Restoration and Rehabilitation (3R) Projects

Resurfacing, Restoration and Rehabilitation (3R) projects are generally undertaken to preserve and extend the life of highway assets. Most 3R projects are initiated because of a pavement condition that indicates a need for pavement resurfacing, or a bridge condition that indicates a need for bridge rehabilitation or repair. Generally, it is not the purpose of 3R projects to increase highway capacity. 3R projects improve the reliability of the transportation system, maintain the mobility of the highway user, and may mitigate highway operational and safety issues. A 3R project usually involves pavement resurfacing or rehabilitation, sometimes accompanied by cross-section or roadside improvements. These projects may include, but are not limited to:

- Improvements to grades, vertical curves and horizontal curves, including superelevation
- Improving intersections and railroad crossings
- Building or upgrading roadway appurtenances, such as guardrail
- Improving and/or widening through lanes and shoulders
- Flattening of sideslopes
- Removing, relocating, replacing or shielding roadside obstacles (e.g. culvert headwalls)
- Improving stopping sight distances
- Incidental improvements relating to safety or traffic operations (e.g. rumble strips, striping, beveled edge)
- Increasing pavement friction
- Short segments of roadway designed to New and Reconstructed standards (see Section Chapter One: Roadway Design Standards, Section 6.B, of this manual)
- Segments designated as maintenance activities
- Bridge work of all types
- Adding auxiliary lanes, including turning and passing lanes (e.g. Super 2 corridors, see Section 1.G of this chapter)

- 3R improvements adjacent to 2 new lanes (2 plus 2 strategy, see Section 1.F of this chapter)
- Restoring the surfacing base to the original condition
- Removing a portion of the existing base to accommodate the required pavement thickness
- Recycling strategies which incorporate the existing road surfacing or structure into the base
- Signing, reflexive guide posts, pavement marking and traffic signals
- Building or upgrading curb ramps

As a starting point, 3R projects shall solve the documented problem by updating pavement and/or bridge assets. As part of the design process, the **Roadway Design Division (Roadway)** will consider operational and crash mitigation measures, as recommended by the **Traffic Engineering Division (Traffic Engineering)**. Other improvements or changes to the existing highway may also be considered for inclusion in the work scope if the estimated benefits (e.g. reduced number or severity of crashes, reduced maintenance costs) over the anticipated life cycle of the project are more than the estimated extra costs of designing and constructing them. Conversely, if costs exceed benefits, a change being considered may not be included in the scope of work. The **Nebraska Department of Transportation (NDOT)** is required to evaluate compliance with the Nebraska Minimum Design Standards (MDS) (Ref. 17.1), found in Chapter 2 of the Nebraska Administrative Code, Title 428 ([nac-428-rules-regs-nbcs.pdf](#)), issued by the **Board of Public Roads Classifications and Standards (Board of Public Roads)**.

The NDOT Policy on The Predicted Safety Performance of 3R Projects

It is desirable that a 3R project will improve the overall safety performance of the highway, as estimated by a documented analysis during the design phase. It is required that a 3R project not reduce the overall safety performance of the highway.

Analyses of Benefits Versus Costs

A performance-based design process using benefit/cost analyses provides the basis for design of 3R projects, focusing on the decision whether to include improvements in the scope of a 3R project. They determine the cost effectiveness of crash mitigation measures, lane or shoulder widening, flattening of slopes and other scope-of-work decisions. The costs and benefits of alternatives are compared to achieve a practicable approach, without sacrificing the overall safety of the segment. **Benefits** are generally crash reduction savings or operational improvements. **Costs** to be considered include (but are not limited to) construction, permitting, National Environmental Policy Act (NEPA) compliance, Preliminary Engineering, Construction Engineering, Right-of-Way, Utilities, Contingencies, Mobilization, Temporary Roads and/or Detours. Roadway designers may also consider the project schedule and potential delay to the improvement. Analyses and decisions as a result of a benefit/cost analysis shall be documented in the project file, with approval by the **Roadway Design Assistant Design Engineer (ADE)**.

For additional guidance, see NCHRP Report 876, Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects (NCHRP Report 876) (Ref. 17.2) ([Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation \(3R\) Projects | The National Academies Press](#)).

1. 3R DESIGN STANDARDS AND GUIDELINES

Minimum design standards for 3R work on State highways have been issued by the **Board of Public Roads** in the *MDS* (Ref. 17.1). If these standards for 3R work cannot be satisfied, the procedure for the relaxation of the 3R minimum design standards must be followed (see Chapter One: Roadway Design Standards, Section 11.B, of this manual).

1.A 3R Versus Other Work Types

In comparison to New or Reconstructed projects, 3R projects generally have a shorter project delivery time, have fewer impacts on the environment, fewer and less extensive right-of-way acquisitions, and are less costly. Preventive Maintenance projects generally have even fewer impacts and lower costs. A reconstruction strategy is generally applied when an entire project segment needs to be completely re-built, including a new or modified base. For additional information, see Chapter One: Roadway Design Standards: Section 6, of this manual.

For resurfacing projects, the appropriate minimum design standards are applied to the project segment based on the expected service life. Each design standard and the associated project's expected service life are as follows.

- **PREVENTIVE MAINTENANCE:** A highway surface maintenance strategy which has an expected service life of up to 12 years
- **RESURFACING, RESTORATION AND REHABILITATION (3R):** A 3R resurfacing strategy which typically has an expected service life of up to 20 years
- **NEW AND RECONSTRUCTED:** A pavement strategy that typically involves construction or reconstruction of an entire pavement, base and subgrade system; these projects have an expected service life exceeding 20 years

For some 3R projects, it may be appropriate to apply New and Reconstructed standards to a segment (or segments) within the length of the project (see Chapter One: Roadway Design Standards, Section 6.A, of this manual). For any such segment, if these standards cannot be satisfied, the procedure for the relaxation of the New and Reconstructed minimum design standards will be followed (see Chapter One: Roadway Design Standards, Section 11.B, of this manual). It may not always be practicable to apply New and Reconstructed standards.

For the design process, system preservation projects are initially separated into two categories, typically based on the equivalent thickness of the pavement strategy as recommended by the **Materials and Research Division (M&R)**:

- i. Two inches or less of surfacing or its equivalent¹ thickness.
 - a. Processed by **Roadway** as a Preventive Maintenance project.
- ii. More than two inches of surfacing or its equivalent¹ thickness.
 - a. Processed by **Roadway**.
 - b. Initially assumed to be a 3R scope of work, with the application of 3R standards.

¹ M&R has determined that two inches of in place recycle is structurally equivalent to one-quarter inch of Hot Mix Asphalt, e.g. a pavement determination of two inches of in place recycle followed by a one and one-half inch overlay is equivalent to a two-inch resurfacing.

During the design process, these initial assumptions need to be verified. For some projects, the scope may be adjusted and different standards than initially assumed may be applied. For resurfacing projects, consistency with the expected service life is an important factor. For example, a curbed segment has an initial assumption of Category ii, i.e. 3R standards (expected service life up to 20 years) but the design process leads to a full-depth pavement reconstruction and application of New and Reconstructed standards. That is outside the scope of the primary need, which is system preservation. The strategy therefore may be adjusted to fit a Preventive Maintenance scope (expected service life up to 12 years) to address the primary need.

Another possibility is adjusting the scope of a Category i project to more than two inches of equivalent thickness and the project remains as a Preventive Maintenance project (expected service life up to 12 years). In rare cases, for a variety of factors, it may be anticipated that the typical maintenance strategy will fail well before its expected service life. These factors include, but are not limited to the existing pavement condition, overall pavement thickness, heavy truck loading and environmental conditions. At the **Roadway Design Unit Head's (Unit Head)** request, the **Pavement Design Engineer in M&R** may evaluate the expected service life of a proposed maintenance strategy on a specific project. If the **Pavement Design Engineer** determines the strategy will not meet its anticipated service life, the equivalent surfacing thickness may exceed two inches and still be constructed to Preventive Maintenance standards as long as the expected service life does not exceed 12 years.

A pavement strategy that requires replacement of the entire pavement structure and construction of a new base or modification² of the existing base will generally be designed to New and Reconstructed standards. However, practical design considerations may allow deferment of widening the highway cross-section to a future New and Reconstructed project, and the application of 3R standards to the current project. Examples include reconstructing the pavement structure without modification of the existing base, and short segments built to New and Reconstructed standards.

If it is determined that *reducing* an existing geometric design feature is practicable, according to a documented benefit-cost analysis, it can be reduced. However, it cannot be reduced below the current 3R guidance in the *MDS* (Ref. 17.1) without first receiving a Design Relaxation of the *MDS* and/or Design Exception (see Chapter One: Roadway Design Standards, Section 11.B, of this manual) and, for shoulder width for a segment on the Priority Commercial System, below the Priority Commercial System policy (see Chapter Six: The Typical Roadway Cross-Section, Section 2.A.1, of this manual) without approval of the **ADE**.

² Modification of the base is defined as improving (addition of a foundation course) or strengthening the existing base through chemical (fly ash, lime, etc.) or mechanical (geofabric, geogrid, etc.) means. It does not include Subgrade Preparation of an existing base which is considered Restoration of the base to its original condition.

1.B 3R Design Controls

1.B.1 Design Year Forecast Traffic

The design year for all 3R projects is 20 years (the year of initial construction plus the expected life of the pavement).

1.B.2 Design Speed

The minimum design speed is the speed limit determined by **Traffic Engineering** to be posted at the completion of the construction of the 3R project. For segments within the termini of a 3R project designed to New and Reconstructed standards, the design speed of the segment will be the appropriate New and Reconstructed project design speed (see Chapter One: Roadway Design Standards, Section 7.B, of this manual).

1.C Bridge Rehabilitation (3R) Work

See Chapter One: Roadway Design Standards, Section 6.B.1, and Section 11.B of this chapter.

1.D Interstate NHS 3R Projects

The Nebraska criteria follows the **American Association of State Highway and Transportation Officials (AASHTO)** publication, A Policy on Design Standards - Interstate System (*I-State Green Book*) (Ref. 17.4). The minimum design standards used for 3R Interstate projects should be the **AASHTO** Interstate standards that were in effect at the time of the most recent New and Reconstructed project on the section of the Interstate or its inclusion into the Interstate system, and the 3R criteria described in the *MDS* (Ref. 17.1). Interstate design criteria that does not meet **AASHTO** guidance requires a design exception and a relaxation of the *MDS* (Ref. 17.1) (see Chapter One: Design Standards, Section 11, of this manual).

Interstate pavement replacement projects should be designed to *MDS* (Ref. 17.1). New and Reconstruction standards and are not addressed in this chapter.

1.D.1 **Wyoming to Big Springs (0+00 to 102+00)**

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1.D.2 **Colorado to Grand Island (102+00 to 312+10)**

For 3R improvements, the following policies should be applied. If not, document the circumstances and rationale for the decision and place in the project file, along with **ADE** approval.

- 1) Maintain existing outside surfaced shoulder widths
- 2) Trench widen inside surfaced shoulders to four feet with added beveled edge where needed
- 3) Add rumble strips to surfaced shoulders
- 4) Update guardrail to MASH criteria
- 5) Modify bridge buttress height to 35 inches
- 6) Maintain existing cross-section geometrics
- 7) For culverts large enough to be considered an obstacle and currently
 - a) protected with guardrail, extend the culvert to 35 feet from the edge of the traveled way and eliminate the guardrail
 - b) not protected with guardrail, but closer than 35 feet from the edge of the traveled way, analyze to determine the cost-effectiveness of extending or shielding

1.D.3 Grand Island to Lincoln (312+10 to 395+62)

For 3R improvements, the following policies should be applied. If not, document the circumstances and rationale for the decision and place in the project file, along with **ADE** approval.

- 1) Maintain existing outside surfaced shoulder widths
- 2) Add beveled edge to the inside shoulder
- 3) Add rumble strips to surfaced shoulders
- 4) Update guardrail to MASH criteria
- 5) Modify bridge buttress height to 35 inches
- 6) Maintain existing cross-section geometrics
- 7) For culverts large enough to be considered an obstacle and currently
 - a) protected with guardrail, extend the culvert to 35 feet from the edge of the traveled way and eliminate the guardrail
 - b) not protected with guardrail, but closer than 35 feet from the edge of the traveled way, analyze to determine the cost-effectiveness of using in place, extending, or shielding
- 8) Limit bridge improvements to 3R repairs (see Section 1.C of this chapter) or maintenance activities (see Chapter One: Roadway Design Standards, Section 6.C, of this manual)
- 9) Avoid lane closures for bridge work between 6 a.m. Friday and 9:00 p.m. on Sunday and during Holidays
- 10) Avoid bridge construction activities that require daytime lane closures
- 11) Limit lane closures for pavement repairs and overlays and shouldering work to nighttime hours
- 12) Request a design relaxation for Bridge widths that do not meet 3R *MDS* criteria (Ref. 17.1) for bridge width (see Chapter One: Design Standards, Section 11, of this manual)

1.D.4 Lincoln to Omaha (395+62 to 455+31)

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1.E 3R Standards for Expressways with Access Only at Interchanges

In response to the January 3, 2022, amendments to 23 CFR 625 (see Chapter One: Roadway Design Standards, Section 1.A.1 of this manual), and in accordance with a Memorandum of Understanding between **NDOT** and the **Board of Classifications and Standards (Board)**, executed on August 22, 2023 ([ndot-practical-design2023-1.pdf](#)), Policy DES 23-02 will allow **NDOT** to use newly established 3R (Resurfacing, Restoration, and Rehabilitation) Standards for projects on highway segments functionally classified as Expressway, but limited to such expressway segments that allow access only from interchanges (the national functional classification is Freeway) (see EXHIBIT 17.1). For purposes of this policy, as noted in EXHIBIT 17.1, the design standard allowing “existing” refers to design features as per the most recent New or Reconstructed project on the segment of the expressway.

Policy DES 23-02 is expected to be an interim measure until completion of an expected revision to the *MDS* (Ref. 17.1) expressly allows 3R Standards for the applicable Expressway projects.

General Conditions applicable to this Policy

- (1) It is understood that it is appropriate to allow 3R Standards on Expressway Projects because the expressway segments on which the 3R projects will be constructed were initially designed and constructed to modern and well accepted design standards. Allowing 3R projects on these highway segments is also practical because it allows **NDOT** to extend the useful life of these modern expressway segments.
- (2) As a part of the development of a 3R Expressway Project, **NDOT** will complete a crash history review using a standard crash analysis model to determine whether there is any existing significant need for making additional improvements with the project related to any **Board** non-complying geometric feature. Any geometric change made from this analysis would meet or exceed 3R standards for that geometric feature.
- (3) Policy 22-03, “Bridge or Culvert Replacement Projects” (see Section 1.H of this chapter) may also be used to make bridge or culvert improvements as a part of an Expressway 3R Project.
- (4) If **NDOT** decides to replace a bridge or a culvert under Policy 22-03 on a State Expressway within the corporate limits of a **Municipality**, **NDOT** will coordinate with the **Municipality** through normal processes.

If the above conditions are not met, then **NDOT** would not move forward with an Expressway 3R project; in that case, **NDOT** reserves the right to request a relaxation of standards from the **Board** (see Chapter One: Roadway Design Standards, Section 11.B, of this manual).

State Functional Classification: Rural Expressway (Access Only At Interchanges)
National Functional Classification: Principal Arterial – Other Freeways and Expressways

| | |
|---|---|
| Design Speed | Posted Speed Limit |
| Lane Width | 12 ft. |
| Shoulder Width | 4-Lane: Lt. = 3 ft. pvd/Rt. = 8 ft. pvd ≥ 6-Lane: Lt. = Existing/Rt. = 8 ft. pvd |
| Horizontal Alignment | |
| Maximum Superelevation | 8% |
| Minimum Radius (Based on Maximum Superelevation) | Existing |
| Vertical Alignment | |
| Crest K Value | Existing |
| Sag K Value | Existing |
| Maximum Grade | Existing |
| Stopping Sight Distance | Existing |
| Cross Slope | |
| Lane | 1.5% to 2.5% (D) |
| Shoulder | 2% to 6% (B) |
| Clear Zone | |
| Fixed Obstacle Clearance | Existing (5) |
| Lateral Offset to Obstruction | Nominal Shoulder Width (P) |
| Vertical Clearance | 16 ft. (7) |

| | |
|---------------------|--------------|
| Bridges | |
| Clear Bridge Width | 37.5 ft. (N) |
| Structural Capacity | (F) |

Note: “Existing” refers to design features as per the most recent construction plans.

| |
|---|
| <p>(5) This area, measured from the edge of the through travel lane, may have crashworthy or break-away obstacles and shall be free of non-shielded obstacles except:</p> <ol style="list-style-type: none"> 1. Traffic signal poles, railroad signals, railroad tracks, bridge rails, ditches, side slopes, driveways, intersections, bike/pedestrian paths, earth dikes, parallel drainage culverts, curbs, raised islands, guardrails, median barriers, crash cushions, drainage inlets, drainage flumes, culverts with flared end sections, erosion control devices, fire hydrants, and traffic control devices; 2. Other obstacles if the NDOT, in its sole discretion, determines based upon an accident review and a Roadside Safety Analysis Program (RSAP) review or a comparable AASHTO approved economic analysis, that the cost to remove or treat such obstacle exceeds the benefits from such removal or treatment. <p>(7) Vertical clearance shall be provided over the entire roadway including traveled lanes and paved shoulder width. For sign trusses and pedestrian overpasses, the vertical clearance is 1 ft. greater.</p> <p>(B) The surfaced shoulder slope should not be less than the slope of the adjacent lane.</p> <p>(D) On roadways where there are more than two lanes inclined in the same direction, the cross slope may be increased by 0.5% to 1% for each additional lane, up to a maximum of 3%.</p> <p>(F) The Design Loading used shall be the original design loading or, if unknown, use HS20.</p> <p>(N) For rehabilitated bridges it is desirable to use the new and reconstructed clear bridge width.</p> <p>(P) The “nominal shoulder width” is defined as the shoulder width presented in this table.</p> |
|---|

Exhibit 17.1a 3R Standards for Rural Expressway (Access Only At Interchanges)

State Functional Classification: Municipal Expressway (Access Only At Interchanges)
National Functional Classification: Principal Arterial – Other Freeways and Expressways

| | |
|---|---|
| Design Speed | Posted Speed Limit |
| Lane Width | 12 ft. |
| Shoulder Width | 4-Lane: Lt. = 3 ft. pvd/Rt. = 8 ft. pvd ≥ 6-Lane: Lt. = Existing/Rt. = 8 ft. pvd |
| Horizontal Alignment | |
| Maximum Superelevation | 8% |
| Minimum Radius (Based on Maximum Superelevation) | Existing |
| Vertical Alignment | |
| Crest K Value | Existing |
| Sag K Value | Existing |
| Maximum Grade | Existing |
| Stopping Sight Distance | Existing |
| Cross Slope | |
| Lane | 1.5% to 2.5% (D) |
| Shoulder | 2% to 6% (B) |
| Clear Zone | |
| Fixed Obstacle Clearance | Existing (5) |
| Lateral Offset to Obstruction | Nominal Shoulder Width (P) |
| Vertical Clearance | 16 ft. (7) |

| | |
|---------------------|--------------|
| Bridges | |
| Clear Bridge Width | 37.5 ft. (N) |
| Structural Capacity | (F) |

Note: “Existing” refers to design features as per the most recent construction plans.

| |
|---|
| <p>(5) This area, measured from the edge of the through travel lane, may have crashworthy or break-away obstacles and shall be free of non-shielded obstacles except:</p> <ol style="list-style-type: none"> 1. Traffic signal poles, railroad signals, railroad tracks, bridge rails, ditches, side slopes, driveways, intersections, bike/pedestrian paths, earth dikes, parallel drainage culverts, curbs, raised islands, guardrails, median barriers, crash cushions, drainage inlets, drainage flumes, culverts with flared end sections, erosion control devices, fire hydrants, and traffic control devices; 2. Other obstacles if the NDOT, in its sole discretion, determines based upon an accident review and a Roadside Safety Analysis Program (RSAP) review or a comparable AASHTO approved economic analysis, that the cost to remove or treat such obstacle exceeds the benefits from such removal or treatment. |
| <p>(7) Vertical clearance shall be provided over the entire roadway including traveled lanes and paved shoulder width. For sign trusses and pedestrian overpasses, the vertical clearance is 1 ft. greater.</p> |
| <p>(B) The surfaced shoulder slope should not be less than the slope of the adjacent lane.</p> |
| <p>(D) On roadways where there are more than two lanes inclined in the same direction, the cross slope may be increased by 0.5% to 1% for each additional lane, up to a maximum of 3%.</p> |
| <p>(F) The Design Loading used shall be the original design loading or, if unknown, use HS20.</p> |
| <p>(N) For rehabilitated bridges it is desirable to use the new and reconstructed clear bridge width.</p> |
| <p>(P) The “nominal shoulder width” is defined as the shoulder width presented in this table.</p> |

Exhibit 17.1b 3R Standards for Municipal Expressway (Access Only At Interchanges)

1.F 2+2 Projects

This section defines criteria for a 2+2 Project (i.e. designing and constructing two new lanes adjacent to an existing two-lane highway facility to create a four-lane corridor).

The existing lanes along the corridor remain on existing alignment and will be preserved using a 3R strategy for the functional classification of the existing roadway. The new lanes will meet the New and Reconstructed Standards that apply to the functional classification of the roadway (see Chapter Six: The Typical Roadway Cross-Section, Section 8, of this manual).

1.F.1 **2+2 Project Safety**

In general, 2+2 projects increase the posted speed of the highway. This increase necessitates an evaluation of the geometry of the existing lanes for compliance with standards and guidance, to include crash mitigation measures as agreed to by **Roadway** and **Traffic Engineering**, and to evaluate the practicability of these enhancements. In addition to the evaluation performed by **Traffic Engineering**, **Roadway** shall review the following:

- Existing driveways will be considered for consolidation or conversion to right in and right out and should undergo review with the **District** as well as the **Access Control Team**. See Chapter 15, Right of Way, Section 3, of this manual for Access Control review
- New and existing frontage roads should be considered for design or modification, **District** should be consulted for the design and/or modification of frontage roads. See Chapter 4, Intersections, Driveways, and Channelization, Section 1.B.4, of this manual for design and use of Frontage Roads
- Existing intersections should be evaluated for intersection sight distance based on the proposed conditions (see Section 9.5 of A Policy on Geometric Design of Highways and Streets (*Green Book*), Ref. 17.5)

1.F.2 **2+2 Project Bridges**

Bridge and **Roadway** will coordinate to determine the scope of the bridge work. As part of a 2+2 project, existing bridges may be rehabilitated, repaired, widened, and/or replaced at the existing elevation based on the bridges in-service performance. The **Bridge Hydraulics Section** will be required to review the existing lanes and new lanes as a system to determine the appropriate bridge hydraulic conveyance needs and balance the bridge needs to the needs of the overall 2+2 project.

1.F.3 **2+2 Project Lighting**

Within the 2+2 project limits, lighting should be evaluated as if it were a New and Reconstruction Project for both the existing and added lanes. See Chapter Ten: Miscellaneous Design Issues, Section 13, of this manual for additional information.

1.F.4 2+2 Cross-Section Alternatives

The roadway designer shall develop two primary cross-section alternatives to determine the impacts of constructing additional lanes on either side of existing alignment. In the development of these cross-section alternatives, it is preferred to construct the additional lanes on a single side of the existing alignment and to minimize reconstruction and crossing over the existing lanes. Any alternative that necessitates the shifting of the new lanes from one side to the other will require additional analysis be conducted by the roadway designer. This analysis will include a recommendation from **Traffic Engineering**, geometric review, constructability review, associated cost comparisons, and other potential impacts (e.g. environmental, right-of-way, earthwork). The roadway designer shall prepare a decision document, for approval by the **Roadway Design Engineer**, for any shift in the new lanes from one side of the existing highway to the other.

1.G Super 2 Projects

Super 2 projects add passing lanes, in strategic locations, to an existing two-lane roadway. The objectives of adding passing lanes to an existing two-lane roadway are to reduce delay, improve overall traffic operations, and improve safety. The objectives are consistent with the objectives of Resurfacing, Restoration, and Rehabilitation (3R) projects, thus improving an existing two-lane highway to a Super 2 highway is defined as a 3R improvement.

1.G.1 Objectives of Adding Passing Lanes

Passing lanes are a unique improvement for two-lane highways because they can improve the level of service (LOS) for the roadway but do not increase the roadway capacity. The capacity of the roadway is controlled by the typical roadway segment, with only one lane for each direction of travel. In general, the Highway Capacity Manual (Ref. 17.6) specifies a maximum capacity of 3,200 passenger cars/hour for both directions combined on two-lane roadways, regardless of whether passing lanes are present.

1.G.2 Location Guidelines for Passing Lanes

Location guidelines for passing lanes are as follows:

- a. Passing lanes should generally be placed where traffic platooning is highest. It may be desirable to place passing lanes just downstream of a town, a major intersection, or a series of horizontal curves so that any platoons formed in those areas can be dissipated.
- b. Passing lanes should be placed, when practicable, at locations where there is a substantial length of uninterrupted roadway downstream where traffic operational benefits can be obtained. For example, it generally would not make sense to locate a passing lane just upstream of a town because the potential downstream benefits of the passing lane might be quickly dissipated as traffic passes through the town.
- c. It is also desirable in locating passing lanes to avoid sensitive environmental areas, such as wetlands, and areas of historical or archeological interest.
- d. The passing lane location should appear logical to the driver. The value of passing lanes is more obvious to the driver at locations where passing sight distance is restricted than on long tangent sections which already provide good passing opportunities.
- e. The choice of passing lane location should be designed with above-minimum stopping sight distance at the lane-addition and lane-reduction tapers.

- f. The location of major intersections and high-volume driveways should be considered in selecting passing lane locations to minimize the volume of turning movements on a roadway section where passing is encouraged. Where the presence of higher-volume intersections or driveways cannot be avoided, special provisions for turning vehicles, such as auxiliary turn lanes, should be considered. Low-volume intersections and driveways do not usually create problems within passing lanes; however, it is desirable to avoid locating the lane-addition and lane-reduction transitions near intersections or driveways, since turning movements are not desirable where drivers may be focused on changing lanes. Other physical constraints, such as bridges and culverts, should be avoided, where practical, if their presence increases the construction cost or restricts the provision of a continuous shoulder.

1.G.3 Geometric Design of Passing Lanes

Geometric design of passing lanes should consider lane and shoulder widths, other cross-section elements, lane-addition and lane-reduction taper designs, and intersection treatments.

- 1) The width for all lanes on Super 2 roadways, including passing lane sections, should be 12 feet.
- 2) The surfaced shoulder width adjacent to passing lanes along Super 2 highways should be built to the following widths:
 - a) Design year ADT greater than or equal to 4,000 vehicles/day: six-foot minimum surfaced shoulder width
 - b) Design year ADT less than 4,000 vehicles/day: four-foot minimum surfaced shoulder width
- 3) The surfaced shoulder width adjacent to a Super 2 passing lane may be wider than the minimum shown above. For example, a wider shoulder may be considered for corridors with higher ADTs, for corridors with substantial pedestrian and bicycle volumes, or for Priority Commercial corridors. Also, the surfaced shoulder width may be designed to match the adjacent sections of two-lane highway. However, surfaced shoulders should be constructed to the minimum widths shown above if right-of-way constraints or potential environmental impacts justify use of the minimum width. Shoulders may be omitted next to passing lanes in curb-and-gutter sections. This shoulder width should be shown and labeled on the Typical Cross-Section Sheet(s) for the project (see Chapter Eleven: Highway Plans Assembly, EXHIBIT 11.3, of this manual).
- 4) The roadway designer should provide the fixed-obstacle clearance from the 3R MDS (Ref. 17.1) adjacent to a new passing lane. This distance should be shown and labeled on the main typical section for the project. A minimum 1:3 slope should be used for the new foreslope between the shoulder point and the existing embankment or ditch. Where practicable, based on right-of-way constraints and potential environmental impacts, the roadway designer may maintain the clear zone distance that was built in a previous New and Reconstruction project. Foreslopes steeper than 1:3 should be avoided, except where a traffic barrier is provided.
- 5) The recommended minimum length for a passing lane is 1,000 feet, not including the taper lengths.
- 6) The recommended maximum passing lane length is 2.0 miles, not including the tapers.
- 7) Based on current Nebraska practice for climbing lanes, the lane addition taper for passing lanes should use a taper rate of 1:50.

- 8) The lane-reduction transition area of a passing lane should use a minimum taper rate of 1:50. In most cases, the outside lane will be dropped, and traffic will move to the inside lane, but in specific cases where it is found to be appropriate, the inside lane may be dropped, and traffic will move to the outside lane.

| Directional flow rate (pc/h) | Optimal passing lane length (mi) |
|------------------------------|----------------------------------|
| 100 | 0.50 |
| 200 | > 0.50-0.75 |
| 400 | > 0.75-1.00 |
| ≥ 700 | > 1.00-2.00 |

NOTE: The units, pc/h, based on the Highway Capacity Manual (Ref. 17.6), represent passenger car equivalents per hour. The passenger car equivalent volume is the traffic volume in vehicles/hour, with greater weight given to trucks than passenger cars.

Exhibit 17.2 Optimal Lengths of Passing Lanes

1.G.4 Average Passing Lane Spacing

Average passing lane spacing tables are shown in EXHIBITS 17.3 AND 17.4. Highway Capacity Manual (Ref. 17.6) procedures were used to develop these values. These tables are typically meant for planning purposes. Traffic operations analyses should be conducted in conjunction with safety analyses for specific applications. Since these tables are recommended for planning purposes, interpolation of values in these tables should be done conservatively. The spacings shown are from the beginning of one passing lane to the beginning of the next passing lane, excluding the tapers. Tables are divided for different truck percentages, percent no passing zones, and terrain type.

| Target LOS | Percent Trucks | Two-Way AADT (veh/day) | | | | | | | | | |
|--|----------------|------------------------|-------|-------|-------|-------|------|------|------|------|-------|
| | | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 |
| 30% No Passing Zones, Level Terrain | | | | | | | | | | | |
| B- | 10% | No PL | No PL | No PL | No PL | >60.0 | 33.5 | 16.5 | 11.0 | 8.0 | 6.5 |
| | 20% | No PL | No PL | No PL | No PL | >60.0 | 31.5 | 16.0 | 11.0 | 8.0 | 6.5 |
| | 30% | No PL | No PL | No PL | No PL | >60.0 | 31.0 | 16.0 | 9.5 | 8.0 | 6.5 |
| B | 10% | No PL | No PL | No PL | No PL | 28.0 | 15.5 | 10.0 | 7.0 | 5.0 | 3.5 |
| | 20% | No PL | No PL | No PL | No PL | 28.0 | 15.0 | 10.0 | 7.0 | 5.0 | 3.5 |
| | 30% | No PL | No PL | No PL | No PL | 27.5 | 15.0 | 10.0 | 6.5 | 5.0 | 3.5 |
| B+ | 10% | No PL | No PL | No PL | 26.5 | 14.0 | 9.5 | 5.5 | 3.5 | | |
| | 20% | No PL | No PL | No PL | 26.5 | 14.0 | 9.5 | 5.5 | 3.5 | | |
| | 30% | No PL | No PL | No PL | 25.5 | 14.0 | 9.5 | 5.5 | 3.0 | | |
| A | 10% | No PL | No PL | 43.0 | 13.5 | 7.5 | 4.0 | | | | |
| | 20% | No PL | No PL | 41.0 | 13.5 | 7.5 | 4.0 | | | | |
| | 30% | No PL | No PL | 39.0 | 13.0 | 7.5 | 4.0 | | | | |
| 50% No Passing Zones, Level Terrain | | | | | | | | | | | |
| B- | 10% | No PL | No PL | No PL | >60.0 | 35.5 | 19.0 | 13.0 | 9.0 | 7.0 | 5.5 |
| | 20% | No PL | No PL | No PL | >60.0 | 35.5 | 19.0 | 13.0 | 9.0 | 7.0 | 5.5 |
| | 30% | No PL | No PL | No PL | >60.0 | 34.5 | 19.0 | 12.5 | 8.5 | 7.0 | 5.5 |
| B | 10% | No PL | No PL | No PL | 28.5 | 16.5 | 12.0 | 8.0 | 6.0 | 4.0 | 2.5 |
| | 20% | No PL | No PL | No PL | 28.5 | 16.5 | 12.0 | 8.0 | 6.0 | 4.0 | 2.5 |
| | 30% | No PL | No PL | No PL | 28.0 | 16.0 | 11.5 | 8.0 | 5.0 | 4.0 | 2.5 |
| B+ | 10% | No PL | No PL | 47.0 | 14.5 | 10.0 | 7.0 | 4.0 | 2.5 | | |
| | 20% | No PL | No PL | 45.5 | 14.5 | 10.0 | 6.5 | 4.0 | 2.5 | | |
| | 30% | No PL | No PL | 43.5 | 14.5 | 10.0 | 6.5 | 4.0 | | | |
| A | 10% | No PL | No PL | 16.5 | 8.5 | 4.0 | | | | | |
| | 20% | No PL | No PL | 16.5 | 8.5 | 4.0 | | | | | |
| | 30% | No PL | No PL | 16.0 | 8.0 | 4.0 | | | | | |
| 70% No Passing Zones, Level Terrain | | | | | | | | | | | |
| B- | 10% | No PL | No PL | No PL | 57.0 | 25.0 | 16.5 | 11.5 | 8.5 | 6.5 | 5.0 |
| | 20% | No PL | No PL | No PL | 56.5 | 25.0 | 16.0 | 11.5 | 8.5 | 6.5 | 5.0 |
| | 30% | No PL | No PL | No PL | 55.5 | 24.5 | 16.0 | 11.5 | 8.0 | 6.5 | 5.0 |
| B | 10% | No PL | No PL | No PL | 20.5 | 14.0 | 10.5 | 7.0 | 5.5 | 3.5 | 2.5 |
| | 20% | No PL | No PL | No PL | 20.5 | 14.0 | 10.5 | 7.0 | 5.5 | 3.5 | 2.5 |
| | 30% | No PL | No PL | No PL | 20.0 | 13.5 | 10.0 | 7.0 | 4.5 | 3.5 | 2.5 |
| B+ | 10% | No PL | No PL | 27.0 | 12.5 | 8.5 | 5.5 | 3.0 | | | |
| | 20% | No PL | No PL | 26.5 | 12.5 | 8.0 | 5.5 | 3.0 | | | |
| | 30% | No PL | No PL | 26.0 | 12.0 | 8.0 | 5.5 | 3.0 | | | |
| A | 10% | No PL | >60.0 | 13.5 | 6.5 | 2.5 | | | | | |
| | 20% | No PL | 58.0 | 13.5 | 6.5 | 2.5 | | | | | |
| | 30% | No PL | 55.5 | 13.0 | 6.0 | 2.5 | | | | | |

Assumptions:

- 1-mi passing lane length
- Percent of traffic in peak hour (k) = 0.09
- Peak-hour factor (PHF) = 0.90
- Directional split (D) = 0.50

Notes:

- No PL = no passing lanes needed to achieve target LOS
- Shaded area = target LOS cannot be achieved with passing lanes of specified length

Exhibit 17.3 Average Passing Lane Spacing (mi) Needed to Meet Specific LOS Targets on Two-Lane Highways in Level Terrain (Source: Highway Capacity Manual, Ref. 17.6)

| Target LOS | Percent Trucks | Two-Way AADT (veh/day) | | | | | | | | | |
|--|----------------|------------------------|-------|-------|-------|------|------|------|------|------|-------|
| | | 1000 | 2000 | 3000 | 4000 | 5000 | 6000 | 7000 | 8000 | 9000 | 10000 |
| 30% No Passing Zones, Rolling Terrain | | | | | | | | | | | |
| B- | 10% | No PL | No PL | No PL | >60.0 | 23.0 | 13.5 | 9.5 | 7.5 | 6.5 | 5.5 |
| | 20% | No PL | No PL | No PL | 37.0 | 18.0 | 11.0 | 9.0 | 7.0 | 6.0 | 5.5 |
| | 30% | No PL | No PL | No PL | 30.0 | 14.0 | 9.5 | 7.5 | 6.0 | 5.5 | 5.0 |
| B | 10% | No PL | No PL | No PL | 20.0 | 13.0 | 8.5 | 6.5 | 4.5 | 3.5 | 3.0 |
| | 20% | No PL | No PL | 54.0 | 16.0 | 11.0 | 7.0 | 5.5 | 4.0 | 3.5 | 2.5 |
| | 30% | No PL | No PL | 30.0 | 15.0 | 8.5 | 6.5 | 4.5 | 3.5 | 3.0 | 2.5 |
| B+ | 10% | No PL | No PL | 25.0 | 12.0 | 7.5 | 4.5 | 3.0 | | | |
| | 20% | No PL | No PL | 18.5 | 10.0 | 6.5 | 3.5 | 2.5 | | | |
| | 30% | No PL | No PL | 15.0 | 9.0 | 4.5 | 3.0 | | | | |
| A | 10% | No PL | 50.5 | 13.0 | 6.0 | 2.5 | | | | | |
| | 20% | No PL | 27.5 | 10.5 | 4.5 | | | | | | |
| | 30% | No PL | 20.0 | 8.5 | 4.0 | | | | | | |
| 50% No Passing Zones, Rolling Terrain | | | | | | | | | | | |
| B- | 10% | No PL | No PL | >60.0 | 25.5 | 15.5 | 11.0 | 8.5 | 6.5 | 5.5 | 5.0 |
| | 20% | No PL | No PL | 59.5 | 19.5 | 13.5 | 9.0 | 7.5 | 6.0 | 5.5 | 4.5 |
| | 30% | No PL | No PL | 39.5 | 18.5 | 11.0 | 8.5 | 6.5 | 5.0 | 5.0 | 4.5 |
| B | 10% | No PL | No PL | 27.5 | 14.0 | 10.0 | 7.0 | 5.0 | 3.5 | 2.5 | 2.0 |
| | 20% | No PL | No PL | 21.0 | 12.0 | 8.5 | 6.0 | 4.5 | 3.0 | 2.5 | |
| | 30% | No PL | No PL | 17.5 | 11.5 | 7.0 | 5.0 | 3.5 | 2.5 | 2.0 | |
| B+ | 10% | No PL | 53.5 | 14.5 | 8.5 | 5.5 | 3.0 | | | | |
| | 20% | No PL | 29.5 | 12.5 | 7.0 | 4.5 | 2.5 | | | | |
| | 30% | No PL | 22.5 | 10.5 | 6.5 | 3.0 | | | | | |
| A | 10% | No PL | 18.0 | 8.0 | 3.0 | | | | | | |
| | 20% | No PL | 14.0 | 6.5 | | | | | | | |
| | 30% | No PL | 12.0 | 5.0 | | | | | | | |
| 70% No Passing Zones, Rolling Terrain | | | | | | | | | | | |
| B- | 10% | No PL | No PL | 54.5 | 19.5 | 14.0 | 10.0 | 8.0 | 6.0 | 5.0 | 4.5 |
| | 20% | No PL | No PL | 36.0 | 16.5 | 12.5 | 8.5 | 7.0 | 5.5 | 5.0 | 4.5 |
| | 30% | No PL | No PL | 26.0 | 16.0 | 10.0 | 8.0 | 6.0 | 5.0 | 4.5 | 4.0 |
| B | 10% | No PL | No PL | 20.0 | 12.0 | 9.0 | 6.0 | 4.5 | 3.0 | 2.5 | |
| | 20% | No PL | No PL | 17.0 | 10.5 | 8.0 | 5.5 | 4.0 | 3.0 | 2.0 | |
| | 30% | No PL | 44.0 | 14.5 | 10.0 | 6.5 | 4.5 | 3.0 | 2.0 | | |
| B+ | 10% | No PL | 29.5 | 12.0 | 7.0 | 4.5 | 2.5 | | | | |
| | 20% | No PL | 21.0 | 10.5 | 5.5 | 3.5 | | | | | |
| | 30% | No PL | 17.5 | 9.0 | 5.5 | 2.0 | | | | | |
| A | 10% | No PL | 14.5 | 6.0 | | | | | | | |
| | 20% | No PL | 12.0 | 4.5 | | | | | | | |
| | 30% | No PL | 10.0 | 3.5 | | | | | | | |

Assumptions:

- 1-mile passing lane length
- Percent of traffic in peak hour (k) = 0.09
- Peak-hour factor (PHF) = 0.90
- Directional split (D) = 0.50

Notes:

- No PL = no passing lanes needed to achieve target LOS
- Shaded area = target LOS cannot be achieved with passing lanes of specified length

Exhibit 17.4 Average Passing Lane Spacing (mi) Needed to Meet Specific LOS Targets on Two-Lane Highways in Rolling Terrain (Source: Highway Capacity Manual, Ref. 17.6)

1.H Practical Design: Bridge or Culvert Replacement Projects

Policy DES 22-03, January 2023, provides flexibility in the application of Nebraska's highway design standards in accordance with a Memorandum of Understanding between **NDOT** and the **Board of Public Roads**, executed on October 26, 2022 ([ndot-program.pdf](#)). This policy provides for (a) complete replacement of a single structure or multiple structures (bridges, non-buried structures, and/or culverts), or (b) for structure replacement(s) (bridges, non-buried structures, and/or culverts) done as part of a Resurfacing, Restoration and Rehabilitation (3R) work or project when the conditions of this policy are satisfied.

1.H.1 Standards and Intent

Unless stated otherwise, reference to the **Board of Public Roads'** standards or current standards refers to the *MDS* (Ref. 17.1) standards in effect during the design phase of a project or work. The intent of projects and works done under this policy is to design and build as close to the *MDS* (Ref. 17.1) New & Reconstructed geometric design standards as practicable – in the judgement of **NDOT** – but not to build below the *MDS* (Ref. 17.1) 3R geometric design standards. Under this policy, the design of the replacement culvert(s), bridge(s), or non-buried structure(s) shall be as follows (“existing” refers to design features as per the most recent construction plans).

General Conditions:

- 1) There has been a 3R or New & Reconstructed project completed that conformed to *MDS* (Ref. 17.1) standards, since 1985, at the location of each culvert(s), bridge(s), or non-buried structure(s) to be replaced, i.e., the highway has been previously improved, and
- 2) **NDOT** has completed a recent crash history review using a standard crash analysis model at and near each bridge or culvert location, and that study does not reveal a crash history related to a *MDS* (Ref. 17.1) non-complying geometric feature.

Replacement Bridges or Non-Buried Structures:

- A. Shall meet the *MDS* (Ref. 17.1) New & Reconstructed standard for structural capacity.
- B. Will meet current **NDOT** hydrologic and hydraulic conditions (not a **Board of Public Roads** standard), see Chapter One of the Drainage Design and Erosion Control Manual (*Drainage Manual*, Ref. 17.8) (<https://dot.nebraska.gov/media/qhubv1ji/d-chap-one-drainage.pdf>)
- C. Roadways approaching and adjacent to the bridge or non-buried structure within project or work termini will
 - Match existing lane width, shoulder width, and paved shoulder width (see I. in **Other Conditions and Clarifications**, below) and
 - Transition horizontal and vertical alignment from the replacement bridge or non-buried structure into (1) existing alignment, or (2) meeting or exceeding *MDS* (Ref. 17.1) 3R standards, whichever is the greater (either 1 or 2)

Replacement Culvert (Buried Structures, even if greater than the 20-foot span width):

- A. Shall meet the *MDS* (Ref. 17.1) New & Reconstructed standard for structural capacity.
- B. Will meet current **NDOT** hydrologic and hydraulic conditions (not a **Board of Public Roads'** standard), see Chapter One of the *Drainage Manual* (Ref. 17.8)
- C. Roadways within project or work termini will
 - (1) Match existing lane width, shoulder width, paved shoulder width, and fixed obstacle clearance or (2) meet or exceed *MDS* (Ref. 17.1) 3R standards, whichever is the greater (either 1 or 2), and
 - Transition horizontal and vertical alignment from culvert replacement into (1) existing alignment, or (2) meeting *MDS* (Ref. 17.1) 3R standards, whichever is the greater (either 1 or 2)

Other Conditions and Clarifications:

- I. For a bridge or non-buried structure replacing a bridge or non-buried structure, the clear bridge width shall at least match the approach geometry. For example, if lane widths are 12 feet wide, and shoulders are six feet wide, the design clear bridge width will be 36 feet (see the first bullet in C, above)
- II. There shall be no significant changes expected in the foreseeable future for (a) land use along the highway or change in highway functional classification, or (b) traffic volume, i.e., volumes are expected to stay within the highway segment's current ADT category within the *MDS* (Ref. 17.1) New & Reconstructed minimum standards.
- III. If **NDOT** decides to replace a bridge or culvert under this policy on a state or federal highway within the corporate limits of a **Municipality**, **NDOT** will coordinate with the **Municipality** through normal processes.
- IV. The **Board of Public Roads** will not require specifically and separately tracked documentation concerning the cost savings for use of this program, in part because **NDOT's** planning and design process has several built-in processes, reports, and documentation that will confirm that a project or work is eligible for this program, including the Plan-in-Hand decision making process of the **District Engineer**, **Roadway Design Engineer**, and other key staff. **NDOT** will include or add the savings from this program with or into the current practical design savings reports that are reported annually to the **Director** of **NDOT**. The **Board of Public Roads** may ask for a report on these savings periodically from **NDOT**.

If the above conditions are not met, **NDOT** would not move forward with a Bridge or Culvert replacement project or work under this policy; in that case **NDOT** may request a relaxation of standards from the **Board of Public Roads** and a design exception from the appropriate **FHWA/NDOT** level of authority (see Chapter One: Roadway Design Standards, Section 11, of this manual).

2. 3R DESIGN PROCESS

2.A Initial Processing of Asset Preservation Projects

System preservation projects are initially separated into two categories, Maintenance and 3R. The categorization is based on the thickness of the pavement strategy, as recommended by **M&R**. If during the design process it is determined that the project goals cannot be met within the defined category the roadway designer, with **Unit Head** approval, should request **M&R** provide for further processing:

- i) up to 12 years of pavement life
 - a) Processed by **Roadway** as a Preventive Maintenance project.
- ii) 12 to 20 years of pavement life
 - a) Processed by **Roadway**.
 - b) Initially assumed to be a 3R scope of work, with the application of 3R standards.

For additional information, see Section 1.A of this chapter.

2.B Asset Preservation Templates

In general, 3R projects are developed and assigned on three activity templates: the 3R with ROW template, the 3R without ROW template, and an M&R template.

1. The 3R with ROW template is used for projects which require a substantial level of design and where updating the roadway to 3R standards will require the purchase of right-of-way. These projects are usually assigned to a unit in **Roadway** or to a **Consultant**.
2. The 3R without ROW template is used for projects which require a substantial level of design but where updating the roadway to 3R standards can be accomplished within the existing right-of-way. These projects are usually assigned to a unit in **Roadway** or to a **Consultant**.
- 3.a Roadway Design Preventive Maintenance template projects (see Chapter One: Roadway Design Standards, Section 6.C.2) maintain the existing roadway to its original condition, maintain a minimum condition of bridges, maintain, and in some instances upgrade, roadside appurtenances such as guardrail, and may include ADA accessibility work. These projects do not typically require a substantial level of design, are accomplished within the existing right-of-way, and are usually assigned to a unit in **Roadway**.
- 3.b The M&R Maintenance Template is used for those projects that have primarily asset preservation needs where repair is needed to maintain the mobility within the highway corridor. These projects generally do not require guardrail updates or ADA work and do not require a **City** or **County** agreement. The activities for these projects will be assigned to **M&R**. The title sheet of the plans will indicate Maintenance and will be signed by the **M&R Division Engineer** as Coordinating Professional. For additional information, see Chapter One: Roadway Design Standards, Section 6.C, of this manual.

2.C Preliminary Roadway Design

The preliminary design phase develops the engineering design and evaluation, defined by the project's description and scope, in collaboration with other stakeholders within **NDOT** (e.g. **Right-of-Way Division (ROW)**, **Utilities Unit in Roadway (Utilities)**, **Project Development Division (PDD)**, **Program Management, M&R, Construction Division (Construction)**, **Traffic Engineering**). Such collaboration will support and identify the best decision-making process and preferred design alternative. Preliminary design is instrumental to time-effectiveness and cost-effectiveness, impacting highway planning and design.

During the preliminary design process, the project schedule and milestones should be monitored. The environmental process is a critical step in keeping a project on schedule throughout the preliminary design phase. Close coordination is important for a complete evaluation of a project in order to avoid the need for environmental re-evaluations, which could delay a projects' schedule.

Roadway Design will hold Project Coordination Meetings (PCM) during the preliminary design phase (see the Design Process Outline (DPO), Ref. 17.7 ([Design Process Outline](#)), and Chapter Thirteen: Planning and Project Development, Section 4, of this manual). The participants of these meetings will review, identify and address a projects' scope, traffic maintenance and phasing, environmental class, NEPA, environmentally sensitive areas, mitigation measures, and environmental commitments.

Once all the issues have been addressed and there are no more changes to the scope or design of the project, the NEPA process can be finished and the Roadway Design Details process can begin. A final PCM is held to review all the environmental commitments and the projects' ultimate design.

2.D Plan-in-Hands

The roadway designer will notify **District** that the Plan-in-Hand Plans and the "Plan-In-Hand Checklist" are available in OnBase (see Chapter Eleven: Highway Plans Assembly, EXHIBIT 11.2, of this manual). The need for **Roadway** participation on a plan-in-hand will be determined on a project-by-project basis by the **Unit Head** in conjunction with the **District**. In general, plan-in-hand inspections will not be required on projects being developed with a M&R development schedule. Individual projects may dictate a need to visit a project or to have the **District** conduct an inspection. If a plan-in-hand is held, the roadway designer should request the **District** to provide a list of issues to be considered on the plan-in-hand visit including hydraulic, traffic operations, and maintenance issues.

Work beyond pavement preservation on a 3R project (e.g. added turn lanes or spot safety improvements) which was not included on the NDOT Form 73 should be noted as a change in the plan-in-hand report and requires the approval of the **Roadway Design Engineer**. The roadway designer is responsible for writing the plan-in-hand report.

For additional information, see the *DPO* (Ref. 17.7), Phase 3: Design, Activity 5300, Clarity Task Codes 5380 and 5388.

3. ROADWAY ALIGNMENT

3.A Vertical Alignment Design

3.A.1 Vertical Curve

Improving vertical curvature is not typical on a 3R project. An improvement may be considered if there is relevant crash history (the roadway designer will review recommendations provided by **Traffic Engineering**). Improving a vertical curve should have a greater benefit than cost, as documented by a benefit/cost analysis (see the introductory commentary “Analyses of Benefits Versus Costs” of this chapter).

The roadway designer will use the K values from **TABLES 3-35** and **3-37** of the *Green Book* (Ref. 17.5) when checking the existing vertical alignment against the 3R standards in the *MDS* (Ref. 17.1) for stopping sight distance. If the determination is to improve the vertical curve, the re-designed vertical curve shall meet (or exceed) the 3R standards in the *MDS* (Ref. 17.1).

If the existing vertical curve is perpetuated, and does not meet the 3R standards in the *MDS* (Ref. 17.1), a design relaxation must be obtained (see Chapter One: Design Standards, Section 11.B, of this manual).

If a vertical curve is perpetuated at less than the posted speed limit, the **District** and **Traffic Engineering** will be advised, through the PIH Report, of the computed maximum allowable speed.

3.A.2 Grade

The existing vertical grade should not be modified unless an improvement is made to the vertical curve (see Section 3.A.1 of this chapter). The existing grade should be evaluated to determine any locations where a horizontal grade and superelevation may not provide adequate slope (cross slope and running slope) for roadway runoff (see Chapter Three: Roadway Alignment, Section 3.A.2, of this manual).

Before the plan-in-hand field inspection the roadway designer should:

1. List segments of the roadway which are on the low side of superelevated curves and/or which have grades between 2% and 3.5% and a list of all roadway grades greater than 3.5% and evaluate erosion control techniques for these segments with the **Roadside Development & Compliance Unit Supervisor** in **PDD**.
2. Review grades over 3.5% for the inclusion of curb and flume. See the *Drainage Manual* (Ref. 17.8), Chapter Two: Erosion and Sediment Control, Section 7.E.
3. Avoid installation of new curb and flume locations on 3R projects when it involves acquiring environmental permits and the acquisition of property rights on a project where right-of-way activities are not included. For additional tactics to mitigate erosion, contact the **Roadside Development & Compliance Unit** in **PDD**.
4. Evaluate new and existing curb locations for potential ponding on the traveled way. If ponding is identified as a potential occurrence, consider remedial actions consistent with the *Drainage Manual* (Ref. 17.8), Chapter One: Drainage, Sections 9 and 10.

The roadway designer should consider adding passing lanes on 3R projects if warranted by a safety analysis and recommended by **Traffic Engineering**. The passing lane should be designed using the criteria presented in Section 1.G of this chapter and in Chapter 3: Roadway Alignment, Section 3.A.4, of this manual.

3.A.3 Vertical Taper Rates

The Vertical Taper Rates for overlays and transitions shall be consistent with Chapter Eight: Surfacing, Section 5.D, of this manual.

3.B Horizontal Alignment Design

Horizontal alignment design speed will be reviewed for the degree of curve and the superelevation rate. The horizontal degree of curve is typically not improved on a 3R project, increasing the superelevation is more likely to occur (see Section 3.B.1 of this chapter). An improvement to the horizontal alignment may be considered if there is relevant crash history (the roadway designer will review recommendations provided by **Traffic Engineering**). Improving horizontal alignment should have a greater benefit than cost, as documented by a benefit/cost analysis (see the introductory commentary “Analyses of Benefit Versus Costs” this chapter).

When considering a horizontal alignment improvement, other factors (e.g. environmental impacts, right-of-way needs) can affect the decision and may result in delaying the project. The improvement may be removed from the project and programmed as a “Phased 3R Project”, according to DOT-OI 60-16, “Policy for Phase Constructed 3R Projects” (see Appendix B, “Selected NDOT Operating Instructions” of this manual).

If the decision is to improve the horizontal alignment, the roadway designer should begin with the desirable New and Reconstruction design criteria for the horizontal curve. However, the roadway designer could review the corridor and determine if less than desirable criteria would meet the need for improving the horizontal curve and typical cross-section. The 3R standards in the *MDS* (Ref. 17.1) should be met or exceeded when proposing horizontal curve improvements. Additional measures should be considered to mitigate an identified crash history, see section 3.B.3 of this chapter.

If the existing horizontal curve does not meet the requirements of the *MDS* (Ref 17.1), a design relaxation must be obtained (see Chapter One: Design Standards, Section 11.B, of this manual) unless a design relaxation was previously granted for the horizontal curve and if circumstances (such as functional classification and ADT) have not changed significantly.

If the decision is not to improve the horizontal alignment, other measures should be considered to mitigate an identified crash history, see section 3.B.3 of this chapter.

3.B.1 Superelevation

The superelevation shall be reviewed by the designer and improvements considered as recommended by the **Traffic Engineering** review. For 3R projects, the superelevations being improved will be designed in accordance with Chapter Three: Roadway Alignment, Section 2.C, of this manual except as follows:

- The roadway designer should check the existing superelevation using the as-built e_{max} . In the event no as-built information is available, the $e_{max} = 6\%$ table (**TABLE 3-9** of the *Green Book*, Ref. 17.5) can be used and, if practicable, the existing superelevation should be improved to match the table
- If the existing superelevation rate is over 6%, the existing superelevation should be checked using the $e_{max} = 8\%$ table (**TABLE 3-10** of the *Green Book*, Ref. 17.5). An 8% superelevation will not be exceeded without the approval of the **Roadway Design Engineer**
- For low-speed urban applications ($V \leq 45$ mph) the roadway designer should check the superelevation using the $e_{max} = 4\%$ table (**TABLE 3-8 & TABLE 3-13** of the *Green Book*, Ref. 17.5)
- The rate of superelevation (e) should be listed in the curve data on the plans for all curves; it is not acceptable to place the phrase "Use Existing Superelevation" on the plans
- Existing spiral transitions should be perpetuated on 3R projects
- Decreasing the superelevation may not be practicable and is usually unnecessary

When superelevation correction results in a wedge that is difficult to construct (six inches or more), reducing the superelevation correction should be considered.

3.B.2 Pavement Widening on Curves

For 3R projects, it is desirable that a two-foot widening be added on the inside lane of a horizontal curve if all the following conditions occur:

1. The curve radius is less than 1,910 feet.
2. The operating speed is 45 mph or greater.
3. The roadway does not have surfaced shoulders.
4. The projected average daily truck traffic is more than 50 per day.

Field observations or **District** recommendation may also justify the need for pavement widening on curves.

3.B.3 Traffic Control Devices for Horizontal Alignment

Traffic control devices such as signs, raised pavement markings and reflective guideposts may be installed to mitigate identified crash history. Regarding advisory curve and speed signs, both the **District Engineer (DE)** and the **Traffic Engineer** will be notified by the roadway designer for the appropriate action, as follows. If the final configuration of a curve has a calculated design speed:

- a. Greater than 5 mph and less than or equal to 10 mph less than the posted speed limit, the placement of advisory curve and speed signs is *desirable*.
- b. Greater than 10 mph and less than or equal to 15 mph less than the posted speed limit, the placement of advisory curve and speed signs is *required*.

4. INTERSECTIONS, DRIVEWAYS AND CHANNELIZATION

4.A Driveways and Intersections

For 3R projects, **Traffic Engineering** will review the crash history for the entire project including intersections and driveways and, if necessary, identify mitigation methods for reducing the potential for or severity of crashes. The existing skew of an intersection will not be changed unless justified by the crash history and a cost-effectiveness analysis or if realignment is made necessary by other design features of the project.

The adequacy of intersection/driveway geometry should be reviewed and discussed prior to the plan-in-hand. If adequate, the existing intersection/driveway geometry will be matched. Intersection sight distance is considered a desirable condition on 3R projects, mitigation is not required unless there is an identified problem.

If justified based on the crash history, intersections and driveways on 3R projects may be evaluated for intersection sight distance using departure sight triangles for Case B1 (left turn from a minor road) found in Chapter 9 of the *Green Book* (Ref. 17.5). If the existing conditions do not meet the required minimum sight distance, the roadway designer should either adjust the design or inform the **District** and **Traffic Engineering** so that the approach to the intersection or driveway may be signed accordingly.

When a roadway is resurfaced, the intersections and driveways will also be resurfaced unless the **DE** indicates otherwise. The intersection/driveway surfacing material should be decided on the plan-in-hand.

- On Asset Preservation projects produced in **M&R**, **M&R** will provide the quantities and locations of the driveways and intersections
- On Preventive Maintenance projects produced in **Roadway**, **Roadway** will provide the location and area of each driveway and intersection and **M&R** will provide the final asphalt quantities
- On 3R projects designed and managed by **Roadway**, **Roadway** will provide the location and area of each driveway and intersection and **M&R** will provide the final asphalt quantities
- If the resurfacing of an existing intersection/driveway which ties into rock or gravel surfacing results in a grade raise in excess of 0.5 inches, either crushed rock or gravel will be placed behind the intersection/driveway surfacing. Consult with the **DE** during the plan-in-hand to determine the type of aggregate to be used. An estimate of 10 tons for intersections and 5 tons for driveways may be used
- Driveways and intersections with slopes steeper than 1:6 perpendicular to the through roadway which are inside the 3R Project Clear Zone (see Section 6.D of this chapter) should be considered for 1:6 side slopes if there is sufficient existing right-of-way or as recommended by **Traffic Engineering** based on the crash history. See Chapter Four: Intersections, Driveways and Channelization, EXHIBITS 4.14 and 4.15, of this manual for grading examples
- Subgrade Preparation will be included for all new intersection and driveway pavement

4.B Raised Medians

In general, curb heights adjacent to high-speed roadways (posted speed limit ≥ 50 mph) should be no greater than four inches and should slope at no greater than 45° from the gutter to the top of curb. There are instances where a four-inch curb is insufficient to adequately address the existing hydraulic needs of the roadway; in these instances, permission to retain a curb height greater than four inches requires the approval of the **Roadway Design Engineer** (for pavement drainage considerations see the *Drainage Manual* (Ref. 17.8), Chapter One: Drainage, Sections 9 and 10). Six-inch high curbs are allowed for roundabout curb and splitter islands and to within 400 feet of the inscribed roundabout circle (see Chapter Four: Intersections, Driveways and Channelization, Section 1.A.3, of this manual).

Raised medians with six-inch curb on two-lane high-speed roadways ($V \geq 50$ mph) will be considered for modification or removal. If **Traffic Engineering** determines that the raised curb median should be retained, the median curb height will be reduced to four inches or less. The slope of the curb face will not be altered.

Before the plan-in-hand, the roadway designer should review raised medians on high-speed roadways ($V \geq 50$ mph) with **Traffic Engineering** to determine if they should remain in place, be modified, or be removed. Median modifications or removals should be noted on the plan-in-hand report.

Where there are raised medians on cross-roads which are proposed to be modified, the medians should be reviewed by **Traffic Engineering**. Raised medians should generally be located outside of the mainline total shoulder width and the intersection should be checked with the appropriate design vehicle turning template (see Chapter Four: Intersections, Driveways and Channelization, EXHIBIT 4.13, of this manual).

5. INTERCHANGES AND GRADE SEPARATIONS

Interchange ramps will only be re-constructed to new geometrics if there is a safety issue or if the ramp pavement needs to be replaced as recommended by **M&R**.

The roadway designer should verify the need for bridge work for grade separation bridges. If the grade separation bridge needs are not the primary need for the project, these needs could be spilt out and repairs and rehabilitation completed as a separate project. Once the project process extends beyond the PCM 35 meeting (see the *DPO*, Ref. 17.7), grade separation bridge needs should be completed as part of a separate project.

When a grade separation bridge must be replaced, the approach profiles will not be improved unless crash performance data identifies a sight distance or other problem that needs to be mitigated as part of the improvement. The approach pavement may need to be replaced on the existing alignment on a profile that does not meet the new and reconstruction criteria. This can be performed as a short segment of new and reconstruction (see Chapter One: Roadway Design Standards, Section 11.B, of this manual).

New overhead structures should accommodate a grade raise on the undercrossing roadway (see Chapter Ten: Miscellaneous Design Issues, Section 2.E.1, of this manual).

6. THE TYPICAL ROADWAY CROSS-SECTION

6.A Initial Roadway Assumption for 3R Projects and Analysis of Alternatives

As a starting point for determining a typical cross-section for a 3R project, assume a desirable highway design typical cross-section. The desirable typical cross-section is the roadway top width as shown in the most recent as-built plan set OR the roadway top width from which the highway was most recently reconstructed. The roadway designer should compare the desirable highway design typical to the 3R minimum design standards lane and shoulder widths (see the *MDS*, Ref. 17.1) and use whichever is greater. This desirable top width can be compared to or tested against other narrower alternatives to decide on the project's typical cross-section. Analysis of cost effectiveness and safety performance is a means of comparing or testing various alternatives to achieve a practicable, cost-effective and timely project (see the introductory commentary "Analyses of Benefits Versus Costs" of this chapter). The shoulder width determined should be shown and labeled on the Typical Cross-Section Sheet(s) for the project (see Chapter Eleven: Highway Plans Assembly, EXHIBIT 11.3, of this manual).

For example, if building back the existing top width provides needed safety performance; it should be the selected alternative. However, a "built up" strategy instead of a "build out" strategy might be the selected alternative (see EXHIBIT 17.5). Applying a narrower shoulder over the existing foreslopes and avoiding "slivers" of embankment, new right of way and environmental permitting, while maintaining the overall safety performance, could be the appropriate alternative for the highway segment.

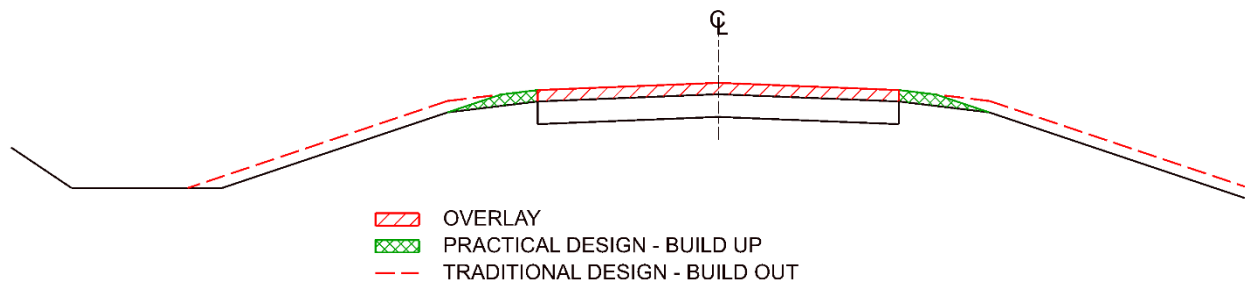


Exhibit 17.5 Build Up Strategy vs Build Out Strategy

6.B The Traveled Way

For 3R projects, there is potential for adjusting the cross-slope from the as-built plans on the existing roadway. The roadway designer should evaluate correcting the cross-slope of the roadway as part of the project to bring it into accordance with the Minimum Design Standard for that functional classification of roadway. Typically, this is a correction to 2% cross-slope. If cross-slope correction is needed, additional asphalt quantities may be required for the project.

12-foot lanes are desirable and the minimum width for most highway segments based on the *MDS* (Ref. 17.1). However, a lane width may be constructed (or striped) at less than 12 feet if a cost/benefit analysis shows more benefits than costs. Any reduction in lane width must first be approved by the **Roadway Design Engineer**. A reduction in lane width may result in a need for a design exception and/or a relaxation of the *MDS* (Ref. 17.1) (see Chapter One: Roadway Design Standards, Section 11, of this manual).

Application of a high friction surface course to the mainline roadway or bridge may provide a safety benefit to the project.

6.C Shoulders

The composition and dimensions of the shoulders will be part of a review of the as-built plans. Options may exist where the type and width of the shoulders could be modified to avoid additional work outside of the shoulder hinge point. The shoulder width chosen should be shown on the plans and labeled on the Typical Cross-Section Sheet(s) for the project (see Chapter Eleven: Highway Plans Assembly, EXHIBIT 11.3, of this manual).

For example, if there is a proposed four-inch grade raise on a roadway with two 12-foot lanes and eight-foot turf shoulders, the roadway could be designed to two 12-foot lanes, seven-foot shoulders, of which two feet is surfaced, with rumble strips and a beveled edge. Performing a benefit/cost analysis may conclude that this is more cost effective and provides an overall reduction in crashes. As part of this example, the shoulder width labeled on the plans should be shown as seven-foot. The width is less than what was previously constructed but wider than the 3R minimum width defined in the *MDS* (Ref. 17.1).

For shoulders that were previously designated (for example) as 10-foot with eight-foot paved, and where the surfaced width matches or exceeds the *MDS* (Ref. 17.1), the paved width will be identified as the shoulder width. The turf transition between the paved shoulder and the shoulder hinge point will not be labeled as part of the shoulder.

For 3R projects on the Priority Commercial System (see Chapter One: Roadway Design Standards, Section 4.F, of this manual), the minimum shoulder width shall follow the *MDS* (Ref. 17.1).

For guidance regarding the installation of two-foot surface shoulders on lower volume roadways, see Chapter Six: The Typical Roadway Cross-Section, Section 2.A.2, of this manual.

6.D The 3R Project Clear Zone

The Roadside Design Guide (Ref. 17.9) defines a Clear Zone as the total roadside border area, starting at the edge of the traveled way, available for safe use by errant vehicles. This area may consist of a shoulder, a recoverable slope (1:4 or flatter), a non-recoverable traversable slope (1:3 or flatter), and/or a clear run-out area.

Horizontal Clear Zone (HCZ) refers to the minimum clear zone requirements established for a segment of highway during a New and Reconstruction project (when the highway was originally built or most recently reconstructed). The HCZ may have also been referred to as the Lateral Obstacle Clearance in previous versions of the *MDS* (Ref. 17.1). One of the defining characteristics of the HCZ in the *MDS* is that side slopes must be 1:6 or flatter. For highway segments constructed or reconstructed prior to 1971 (when **NDOT** began establishing clear zones), there is no defined HCZ.

Fixed Obstacle Clearance (FOC) refers to the minimum clear zone requirements that must be met or maintained on a segment of highway for a 3R project. One of the differences between HCZ and FOC is the allowable side slope within the clear zone. FOC allows side slopes 1:3 or flatter.

The 3R Project Clear Zone is a term used to describe the specific clear zone established as part of a 3R project. It is desirable that all 3R projects perpetuate the existing HCZ. Therefore, the desired 3R Project Clear Zone is the previously established HCZ for that highway segment.

It may not be practicable to perpetuate all elements of the HCZ previously established (or for the entire length of the 3R project) based on site conditions or other constraints. If this cannot be done, the roadway designer may adjust the 3R Project Clear Zone to no less than the applicable FOC from the *MDS* (Ref. 17.1) with **Unit Head** approval.

If there are roadside obstacles inside the HCZ area, but outside the FOC area, the obstacles may be shielded (protected) provided it is cost effective. A benefit/cost analysis (BCA) should be conducted to determine whether it is cost effective to protect the obstacles, remove them, or allow them to remain in place. A BCA ratio of 2:1 is desired when making this decision. In these instances, there is flexibility to allow obstacles to remain in place, down to the minimum applicable FOC width from the *MDS* (Ref. 17.1). A decision document describing the analysis should be completed and placed in the project file.

For Rural Interstate 3R projects, the 3R Project Clear Zone is 35 feet. The 3R Project Clear Zone is 30 feet for Municipal Interstate 3R projects.

If the FOC width from the *MDS* (Ref. 17.1) is not practicable to attain, the procedure for the relaxation of the 3R minimum design standards will be followed (see Chapter One: Design Standards, Section 11.B, of this manual).

In summary, the 3R Project Clear Zone should be noted in design plans as either HCZ or FOC as noted below:

1. The desirable condition is to set the 3R Project Clear Zone equal to the HCZ from the previous New and Reconstruction project, if 1:6 slope and clear of obstacles. It will be shown on the project's Typical Cross-Section Sheets and labeled "Horizontal Clear Zone" (see Chapter Eleven: Highway Plans Assembly, Section 4.B, of this manual); or
2. The FOC width from the *MDS* (Ref. 17.1) is applied to the 3R project if the previous project was constructed or reconstructed prior to 1971, or if applying the HCZ from a previous project is not practicable, as demonstrated by a BCA. This distance should be shown and labeled "Fixed Obstacle Clearance" on the project's Typical Cross-Section Sheets (see Chapter Eleven: Highway Plans Assembly, Section 4.B, of this manual).

Auxiliary Lanes should be evaluated using the selected 3R Project Clear Zone. See Chapter Six: The Typical Roadway Cross-Section, EXHIBIT 6.15, of this manual for additional information.

For more information on obstacles and shielding, see Section 9 of this chapter and Chapter Nine: Guardrail and Roadside Barriers of this manual.

6.E Foreslopes and Other Slopes, Earth Dikes, and Mailbox Turnouts

If the project includes foreslope grading, small slivers of fill should be avoided. It is desirable to construct slopes that are 1:3 or flatter. The minimum foreslope that should be used within the 3R Clear Zone is 1:3 (see Section 6.D of this chapter). Slopes beyond the 3R Clear Zone may be steeper than 1:3 but the roadway designer should evaluate the project as a whole and consider departure crashes, crash history and trends along the segment. Fill slope treatments beyond the 3R Clear Zone should be applied consistently along the length of the project. This evaluation should consist of a benefit/cost analysis to use the existing slopes in place.

The roadway designer should use a slope no steeper than 1:4 when blending shoulder construction to an existing 1:6 or flatter foreslope. A 1:3 slope should be used to blend the shoulder construction to an existing foreslope which is steeper than 1:6. Except where a slope is shielded, slopes steeper than 1:3 should be avoided unless there is a decision document approved by the **ADE**.

New earth dikes within the 3R Project Clear Zone (see Section 6.D of this chapter), which are perpendicular to the traffic, will have a 1:6 slope on both the onsite (upstream) and offside (downstream) face of the dike. Dikes and maintenance turnarounds in a median will have 1:10 slopes on both faces of the dike. When reconstructing a median dike, the roadway designer will verify that the median pipe and/or inlet still drains.

Driveways and Intersections within the 3R Project Clear Zone with slopes steeper than 1:6, which are perpendicular to the through roadway, may be used in place based on the crash history and recommendations by **Traffic Engineering**, otherwise consider building 1:6 side slopes.

Mailbox turnouts will be built as detailed in Standard Plan 307, "Mailbox Turnout" (see the Standard/Special Plans Book (*Standard Plans*), Ref. 17.10) ([Standard/Special Plans Manual - NDOT](#)).

6.F Turn Lanes and Auxiliary Lanes

An auxiliary lane may be added to a 3R project without grading to New and Reconstructed standards.

An existing sub-standard right-turn lane on a rural un-signalized high-speed ($V \geq 50$ mph) roadway (where a surfaced shoulder has been re-striped to provide a turn lane) will be reviewed by **Traffic Engineering** to determine if the turn lane is warranted.

If the right-turn lane is not warranted, removal of the right-turn lane may be considered. The decision to remove should be based on the cost to improve the turn lane to updated geometric standards. If the cost and impacts to right-of-way and the environment is significant, and removal seems like the best option, the roadway designer should consult with **Communications Division** about the appropriate public engagement to help determine the societal impacts of removing the turn lane. The turn lane may be removed only after the public comments have been considered.

If the right-turn lane is warranted, and if there is not a crash problem, geometrics may be improved, and the right-turn lane can remain in place. If warranted, and there is a history of crashes, consider either improving the right turn lane (i.e. increase storage or taper length) or building an offset right-turn lane (see Chapter Four: Intersections, Driveways and Channelization, Section 1.D.3, of this manual).

Traffic Engineering may recommend turn lanes and lane configuration changes by re-striping the roadway. The roadway designer should verify that the new configuration does not violate the 3R minimum design standards for shoulder or surfaced shoulder width.

For example, an existing 24-foot wide roadway may only require six-foot wide surfaced shoulders by standards, but the existing section has eight-foot wide surfaced shoulders. When the roadway is re-striped to a 36-foot wide three-lane section, two-foot wide surfaced shoulders result. This arrangement would require either expanding the existing shoulders to obtain the six-foot wide surfaced shoulder or a design exception and/or a relaxation of the *MDS* (Ref. 17.1) could be considered if added shoulders are not needed based on engineering analysis (see Chapter One: Design Standards, Section 11, of this manual).

7. EARTHWORK

If the volume of the shoulder construction plus the embankment is less than 500 cu. yds. per mile, pay for “Earth Shoulder Construction” only (see Chapter Eight: Surfacing, Section 4.C, of this manual). If the total exceeds 500 cu. yds. per mile, the pay items would be “Earthwork Measured as Embankment” and “Earthwork Shoulder Construction”.

Any grading under new pavement (e.g. at guardrail, mailbox turnouts, culvert locations) will be paid for as “Earthwork Measured as Embankment”, or “Roadway Grading”, where necessary. See Chapter Seven: Earthwork, Sections 4.B.1 and 4.C of this manual).

The required roadway grading details will be shown on the Typical Cross-Sections or on the General Information (G) Sheets (see Chapter Eleven: Highway Plans Assembly, Sections 4.B and 4.G, of this manual).

If paying for embankment as an established quantity (EQ), a balance factor of 1.0 shall be used and the pay item will be “Earthwork Measured in Embankment (EQ)” (see Chapter Seven: Earthwork, Section 4.B.1, of this manual).

When using “Earthwork Measured in Embankment (EQ)” as the pay item: the embankment quantity will be multiplied by an assumed balance factor of 1.5 when calculating the pay item “Water Applied”.

The roadway designer should provide design data and Earthwork Data (Q) Sheets for projects with adequate surveys (see Chapter Eleven: Highway Plans Assembly, Section 4.Q, of this manual).

Cross-sections, when included, should show grading (e.g. for culverts, guardrail grading).

See Chapter Seven: Earthwork, of this manual, for additional information.

8. SURFACING

8.A Mainline Surfacing Taper Rate

For an overlay on a high-speed ($V \geq 50$ mph) roadway, the minimum taper rate at the end of the project is 33 feet to each inch of change in grade (e.g. for a two-inch mill with a four-inch overlay: $2 \times 33 = 66$ feet). The preferred taper rate is 50 feet to each inch of change in grade (e.g. for a two-inch mill with a four-inch overlay: $2 \times 50 = 100$ feet).

The taper rate at the end of an overlay on a low-speed ($V \leq 45$ mph) roadway is 25 feet to each inch change in grade or ending at an intersection if it is within the taper length.

8.B Rumble Strips, Edgeline Rumble Stripes, and Centerline Rumble Stripes

Rumble strips, edgeline rumble stripes, and centerline rumble stripes should be perpetuated on projects, considered for inclusion in the scope of work as recommended or advised by the **Traffic Engineering** and/or the **District**, or constructed as needed to meet the requirements of the NDOT Policy on The Predicted Safety Performance of 3R Projects (refer to this chapter's Introduction). Construction of rumble strips on the project may be coordinated with another project in the area to reduce mobilization costs.

For additional requirements, guidance and information on rumble strips, edgeline rumble stripes, and centerline rumble Stripes, see Chapter Eight: Surfacing, Section 7, of this manual.

8.C Beveled Edge

See Chapter Six: The Typical Roadway Cross-Section, Section 2.C, of this manual.

8.D Surfacing Quantities

Additional quantities for asphalt are required if cross-slope correction is utilized as part of the project. Also, correcting the superelevation requires additional quantities be provided. Additional quantities for superelevation and cross-slope correction are shown separately on the Design Plans.

For additional information see Chapter Eight: Surfacing, Section 5, of this manual.

9. GUARDRAIL AND ROADSIDE BARRIERS

Obstacles within the 3R Project Clear Zone should be evaluated to see if they should be removed, shielded, or may be left in place. The 3R Project Clear Zone is defined in Section 6.D of this chapter. Any guardrail or barrier design will be in accordance with Chapter Nine: Guardrail and Roadside Barriers of this manual.

Existing roadside barriers must be reviewed for compliance with the National Cooperative Highway Research Program (NCHRP) Report 350 or the Manual for Assessing Safety Hardware (MASH). If guardrail or hardware work is necessary, the guardrail will be upgraded to the MASH criteria.

The minimum allowable height for W-Beam guardrail on a 3R project is 26½ inches above the surfacing, in accordance with the Roadside Design Guide (Ref. 17.9). If the guardrail is in compliance except for the height, the guardrail should be raised to a minimum height of 28 inches and used in place. If guardrail is to be used in place a decision document, requiring **Unit Head** approval, will be placed in the document file.

The Bridge Buttress will be assessed based on the existing guardrail height connection, a minimum height of 28 inches above the surfacing is required for the Bridge Approach Section (BAS). If the guardrail is to be upgraded, the roadway designer will identify the need for upgrading buttress remodel. The roadway designer will notify the **Bridge Designer** of the buttress remodel request.

9.A Within the 3R Project Clear Zone

Existing guardrail shielding an obstacle within the 3R Project Clear Zone **will not** be removed without mitigating the obstacle it is intended to shield. If the obstacle was previously mitigated, the guardrail may be removed. Any guardrail that is to be removed as part of the project should be discussed at the plan-in-hand and included in the Plan-In-Hand Report. Mitigating the obstacle may include extending a culvert, adding a flared end section, removing a tree, flattening a foreslope, etc.

9.B Cost-Effectiveness Analysis

If a cost-effectiveness analysis indicates that an obstacle within the 3R project clear zone may be used in place without shielding, the roadway designer shall include the analysis and backup data in the project file. It is desirable to flatten existing fill slopes steeper than 1:3, however, existing fill slopes that are not shielded, may be used in place per the *MDS* (Ref. 17.1) within the applicable 3R fixed obstacle clearance.

The **Unit Head** or designee should perform a cost effective analysis such as “Roadside Safety Analysis Program” (RSAP) or similar to determine the desirability of the following:

- Removing existing guardrail if the obstacle is removed or modified
- Installing a barrier to shield obstacles within the 3R Project Clear Zone.
- Installing a barrier to shield concrete box culverts and for culvert pipes with a diameter greater than 36 inches which are located within the 3R Project Clear Zone
- Delineating an obstacle which is not practicable to remove or shield

Existing guardrail, which a cost-effectiveness analysis indicates is not required, **may not** be removed without the written approval of the **Roadway Design Engineer** as evidenced by a Design Decision Document filed in the project folder.

9.C Roadside Barriers and End Treatments

When it is not possible to install sufficient roadside barrier length to shield the 3R Project Clear Zone as appropriate (e.g. a railroad access drive which cannot be relocated and is within the design length of the guardrail), the roadway designer will obtain the concurrence of the **Unit Head** and document the reason in the project file.

For guardrail design, the roadway designer should use the tables and typical layout guidance found in Chapter Nine: Guardrail and Roadside Barriers, EXHIBIT 9.3, of this manual for runout length (L_r) values. The roadway designer may interpolate L_r values for speeds not listed in the tables. There are several common guardrail design scenarios on 3R projects that may occur.

- A Guardrail End Treatment Type I (see Chapter Nine: Guardrail and Roadside Barriers, Section 4.A, of this manual) may be installed to minimize earthwork and to avoid buying right-of-way on projects where right-of-way is not being purchased for other features of the project
- The area behind the roadside barrier (either new installation or existing) will be evaluated for the required barrier deflection (see **Table 5-6** of the Roadside Design Guide, Ref. 17.9) and cleared or re-designed as necessary
- A short radius guardrail may be used in select situations with **Unit Head** approval (see Chapter Nine: Guardrail and Roadside Barriers, Section 7.A, of this manual)
- Cable guardrail may be installed at the locations that warrant a roadside barrier when the additional barrier deflection is allowed, including culvert locations when there are concerns with snow and drifting

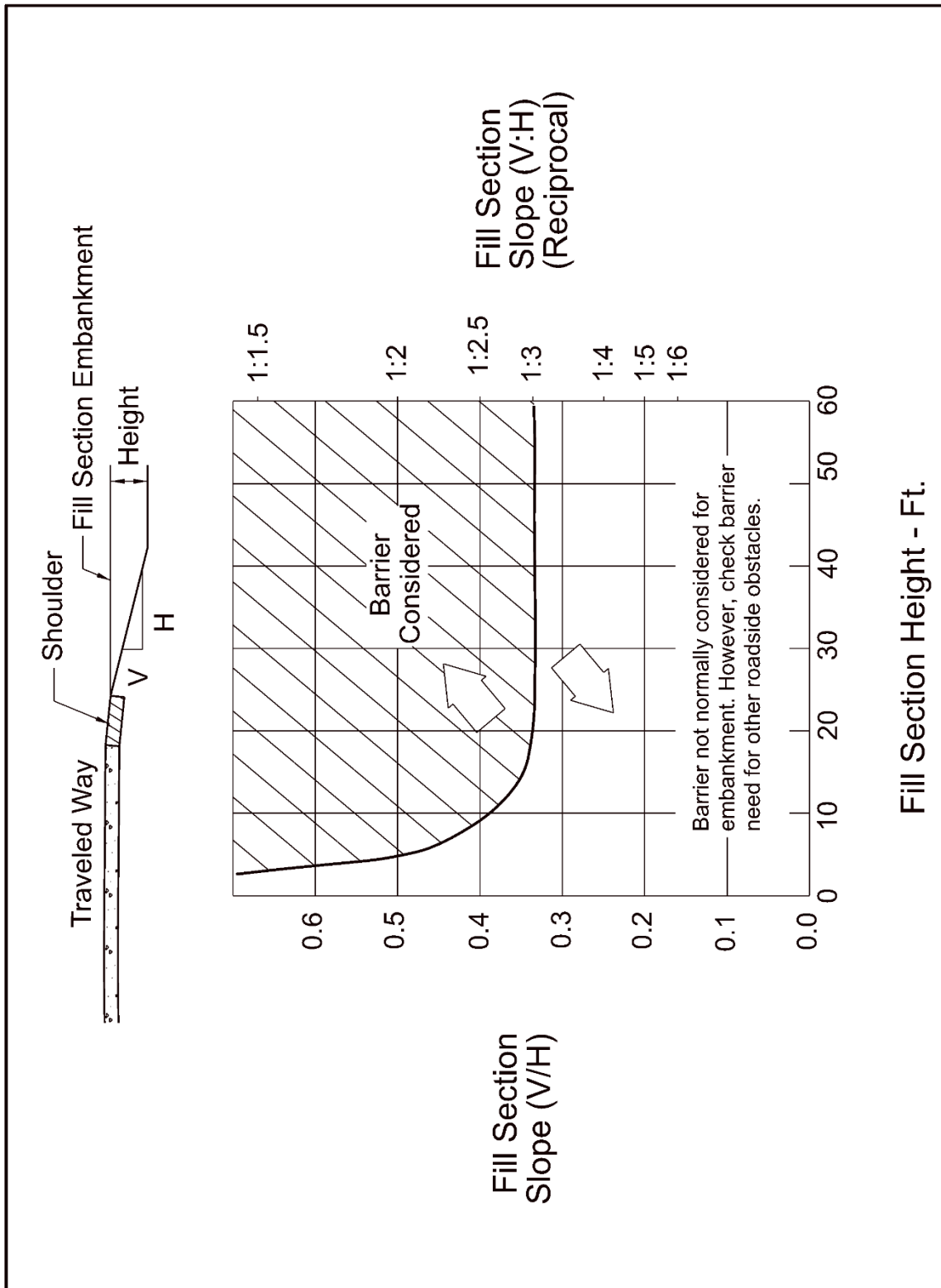


Exhibit 17.6 Comparative Barrier Consideration for Embankments
 Source: Roadside Design Guide (Ref. 17.9)

10. MISCELLANEOUS DESIGN ISSUES

10.A Railroads

Work on railroad right-of-way must conform to Title 415, Nebraska Administrative Code, Chapter 6 (Highway-Rail Crossings – Construction, Repair and Maintenance) and requires a special provision prepared by the **Rail Unit** in the **Local Assistance Division**. Chapter 6 may be found at ([rr415, chap4 /NEW](#)).

The roadway designer should e-mail the **Highway Liaison Manager** in the **Rail Unit** in the **Local Assistance Division** with the Project C.N., Project No., Designer, and Designer's Phone Number for the initiation of the "Railroad Project Information Sheet" (NDOT-95) after the plan-in-hand.

For the **Plans, Specifications and Estimates (PS&E)** turn-in, the roadway designer should compute separate quantities for the work which is on railroad right-of-way (see Chapter Twelve: Cost Estimating & Funding, Section 1.E, of this manual).

The condition of a railroad crossing, the width of the crossing, and the distance to the center and nearest point of the signals should be noted on the plan-in-hand.

10.B Bridges

Bridges on 3R projects will generally be used in place with some measure of preservation applied to the structure. Generally, these activities will consist of needed repairs to the structure and surrounding area to preserve the asset (see Chapter One: Roadway Design Standards, Sections 6.B.1 and 6.C.2.a, of this manual).

The roadway designer should review the bridge determination during Roadway Design (Clarity Task 5350) and determine if additional roadway work is required to accommodate the bridge determination. For example, if there are erosion issues at the abutment, flumes or inlets may be needed at the end of the bridge deck to mitigate this erosion. Additional inlets or flumes may be needed at the bridge corners if the bridge determination includes three-inch or four-inch "Curb Angles".

There may be a need for bridge repairs that necessitate traffic maintenance and phasing of construction activities. This may require the use of temporary signals, barriers, or stream access crossings to accommodate construction.

Guardrail connections and bridge rail on the project will be evaluated and, if necessary, upgraded to current criteria (e.g. guardrail meeting NCHRP 350 is in place). The roadway designer should request a determination of the acceptability of the bridge rail by **Bridge** prior to the plan-in-hand field inspection (see Section 9.C of this chapter for additional information).

The roadway designer will make adjustments to the approach roadway cross-section as needed to match the bridge cross-slope. Tapering of the roadway cross-slope may be needed to match the bridge floor elevation.

See Sections 1.G & 17.B of this chapter and Chapter Ten: Miscellaneous Design Issues: Section 2, of this manual for additional information.

10.C Temporary Roads

Either phased construction, detour, shoofly or temporary roads may be used to accommodate traffic during construction. See Chapter Fourteen: Traffic, Section 6, of this manual for details.

10.D Lighting

Before the plan-in-hand, the roadway designer should request a review of state highway junctions for lighting warrants from the **Roadway Design ITS/Lighting Unit (ITS/Lighting)**. See Chapter Ten: Miscellaneous Design Issues, Section 13, of this manual for additional information.

10.E Agreements/Cost Sharing

10.E.1 Agreements

Projects located within the corporate limits of a municipality, **Sanitary Improvement District (SID)**, or in rural areas that demonstrate urban traffic characteristics should be reviewed before the plan-in-hand for ADA work, lighting, and applicable cost sharing. **City/Village/SID** representatives should be invited to the plan-in-hand and be informed of the estimated cost (see DOT-OI 60-11, "Municipal Cost Sharing", Appendix B, "Selected NDOT Operating Instructions", of this manual).

An agreement is required at the request of the **DE** or if any of the following items are associated with the project. Those may include:

1. Financial participation, including city betterments (see DOT-OI 60-11, "Municipal Cost Sharing", Appendix B, "Selected NDOT Operating Instructions") of this manual).
2. Rehabilitation of **Municipality**-owned utilities.
3. **City** work off the highway system that may require coordination.
4. Elimination of encroachments on **State** right-of-way.
5. Assignment of duties/responsibilities for maintenance or operation of facilities
 - a. Storm sewer and culverts
 - b. MS4 Stormwater Treatment Facilities (STFs)
 - c. Traffic signals
 - d. Lighting structures and power
 - e. No parking zone ordinances
6. Relocation or change in function of municipal or county roadways.
7. Detour utilizing local street or county roads.

10.E.2 Letter of Notification

If the conditions above that require an agreement are not met, then a Letter of Notification may be used to provide the **Municipality** an opportunity to comment on the project. A Letter of Notification may also be used when constructing ADA ramps and transitions. The letter should include a statement commenting that the **City** or **County** is responsible for the maintenance of the ADA ramps, transitions, and sidewalk that are constructed as part of the project. As part of the letter, the location of the ramps that are part of the project should be included.

The Letter of Notification should include an option for the **City** or **County** to respond with comments or concerns. If they have concerns, then **NDOT** should consider entering into an agreement with the **City** or **County** establishing responsibility of local for operations, maintenance and repairs for the sidewalk or ADA Ramps.

10.F Utilities

Utility coordination for 3R projects is handled similarly to utility coordination on New and Reconstruction projects. The roadway designer should reference Chapter Ten: Miscellaneous Design Issues, Section 12, of this manual for detailed information regarding utility coordination on both project types. This section will highlight areas key to the delivery of 3R projects.

The roadway designer should review the project with the **Utility Coordinator** in **Roadway** before the plan-in-hand to discuss the project scope in order to determine any possible utility impacts, as well as after the plan-in-hand to determine if additional survey for utilities is required.

The **Utility Coordinator** and **Utility Engineer** should be invited to Project Coordination Meetings 30, 35, and 50 for identifying and determining impacts to utilities within the project limits.

10.F.1 Preliminary Utility Inspection Report

To verify the location and type of existing utilities on the project site, the **Utility Coordinator** conducts a review of the project utilizing the Nebraska One-Call website, NDOT ARMS permit database, and may conduct a field visit to verify the information. An additional utility survey may need to be ordered to address additional utilities identified by the **Utility Coordinator** which are not in the **NDOT** survey.

A review of existing **NDOT** owned utilities also needs to be conducted on every project. The roadway designer will need to coordinate with the **Utility Coordinator** on this review. **NDOT** owned utilities are managed by **Traffic Engineering**, **ITS**, **Lighting**, and **Strategic Planning**. Below is a non-exclusive list of **NDOT** owned utilities for each division.

Traffic Engineering: traffic control devices, traffic signals and signs, etc.

Roadway Design ITS: Intelligent Transportation Systems (ITS): cameras, towers, Dynamic Message Signs (DMS) boards, pavement sensors, etc.

Roadway Design Lighting: light poles, pull boxes, lighting control centers, etc.

Strategic Planning: automated traffic counters, weigh in motion sensors, etc.

Each device is likely to have the associated underground fiber optic and electrical lines that may be in conflict and need to be mitigated.

The **Utility Coordinator** will incorporate any existing **NDOT** owned utilities into the Preliminary Utility Inspection Report. The report will also address where the existing facility is located, if it will conflict with the project, how that conflict is anticipated to be resolved, and who is responsible for resolving the conflict. Construction plans and Special Provisions may be required if a **NDOT** owned utility is in conflict. A summary of existing and proposed **NDOT** owned utilities shall be captured in the PIH report.

The **Utility** Coordinator will complete the Preliminary Utility Inspection Report on OnBase and provide a copy to the roadway designer. The Preliminary Utility Inspection Report identifies the type of and owner of each facility on the project, where the existing location is expected to be, if the facility is anticipated to be in conflict, and if the required utility relocation work will be conducted by the utility company or **NDOT's** contractor. A preliminary utility cost estimate is also provided on the Preliminary Utility Inspection Report.

10.F.2 Utility Potholing

The roadway designer may encounter underground utilities that are impacted by the design and should review the project with the **Utility Coordinator** to determine if potholing is necessary. Potholing is a localized excavation method for obtaining visual confirmation of the location of existing utilities. The roadway designer can develop a design to avoid some utility impacts once the location of existing utility facilities is confirmed. It is more likely that potholing will be required in Urban areas as underground utilities are more prevalent and a greater disruption if impacted.

10.F.3 Plan-in-Hand Report

A Utility Summary shall be included in the plan-in-hand report. The Utility Summary shall be comprised of a list of the utility companies in the project area, any anticipated conflicts affecting those utilities, and any utility facility that should be avoided, if possible. Existing and proposed **NDOT** owned utilities shall also be addressed in the plan-in-hand report.

The information to be included in the plan-in-hand shall consist of who has facilities within the project area, where those facilities are located, if any existing facilities are in conflict with the project, how the utility conflict will be mitigated, and who is responsible for relocating the utility in conflict, whether it is the utility company or the **NDOT** Contractor.

The Preliminary Utility Inspection Report can be used to assist the roadway designer in developing this summary. However, additional coordination may be required with the **Utility Coordinator** if a significant amount of time has passed since the Preliminary Utility Inspection Report was created.

10.F.4 Utility Status 45 Estimate

The initial utility estimate is developed by **PDD** at 2.9% of the construction cost. The utility cost estimate needs to be updated at the time of the Status 45 estimate due to the varied nature of utility impacts on each project. The roadway designer needs to coordinate with the **Utility Coordinator** to develop an updated cost estimate that pertains to the actual utility relocation work on the project. For additional information, see Chapter Twelve: Cost Estimating & Funding of this manual.

10.F.5 Status of Utilities

This is required for the **PS&E** submittal. It will be requested by the **Contracts Unit** in **Construction** and provided by the **Utility Coordinator**. The roadway designer is not responsible for submitting Status of Utilities to **PS&E**.

11. HIGHWAY PLANS ASSEMBLY

3R projects are most often shown as plan view over plan view (piggyback) sheets. A resurfacing project may be drawn on Plan and Profile (L) Sheets (see Chapter Eleven: Highway Plans Assembly, Section 4.L, of this manual). If there are special ditches on the project; the use of plan and profile sheets for resurfacing projects can be avoided by placing a special ditch chart on the General Information (G) Sheet (see Chapter Eleven: Highway Plans Assembly, Section 4.G, of this manual). Functional Design Plans (Phase 4) are generally not produced for 3R Projects.

12. COST ESTIMATING & FUNDING

Each 3R project should have an accurate itemized estimate developed in **Roadway**. 3R project development is typically shorter than for New and Reconstruction projects, therefore, cost estimates need to be updated frequently. This keeps the unit prices current and the project budget accurate for planning. Specifically, status 30 and 45 estimates are key in project programming and planning. Status 40 estimates are not typically produced for 3R Projects. See Chapter 12: Cost Estimating & Funding, of this manual for a detailed description of estimate preparation. When other governmental agencies are sharing the cost of the improvements, these costs should be split out in the estimate (see chapter 12, Chapter Twelve: Cost Estimating & Funding, Section 2.F, of this manual).

13. PROJECT DEVELOPMENT

Environmental impacts should be weighed as part of the evaluation of the project scope, schedule and cost. Impacts to resources could have a detrimental impact to the timely delivery of the improvement.

13.A Wetland Impacts and Environmental Permits

The Planning Document will provide sufficient information to the **Wetlands Biologist** of the **Technical Resources Unit (TRU)** in **PDD** to determine if wetland delineation is required, if additional delineations are required the roadway designer will coordinate with the **Wetlands Biologist**. Mitigation strategy should be discussed prior to the plan in hand inspection with the **Wetlands Biologist**. If the **Wetlands Biologist** has determined that no acceptable mitigation bank site is located in proximity to the project, on-site mitigation may be required. See Chapter Thirteen: Planning and Project Development, Section 5.B, of this manual for further information.

13.B Environmental Classification

Federally funded 3R projects generally fall into a Class II for Environmental Classification. Class II is a Categorical Exclusion (CE). The CE will have varying degrees of documentation required based on the impacts associated with the scope of work. Evaluation will occur for sensitive areas (Section 4(f), Section 6(f), Hazardous Materials, etc.) that are located within the project's environmental study area. If impacted by the project, such as acquiring temporary easements or modified access to a 4(f) property, additional coordination or mitigation may be required from the regulatory agencies. For additional information see Chapter Thirteen: Planning and Project Development, Section 5.A.1, of this manual.

13.C Floodplains

Projects with floodplain encroachments are certified by **Roadway** and **Bridge Hydraulics Sections** (see Section 17.D of this chapter) and are submitted to the **Highway Environmental Biologist** for submittal of the floodplain permit to the community. Certifications are uploaded to OnBase by **Roadway** and **Bridge Hydraulics**.

Floodplain permit applications are uploaded by the **Highway Environmental Biologist** to OnBase, as well as the approved floodplain permit.

14. TRAFFIC

Traffic Engineering will conduct a safety review for each 3R project and recommend mitigation measures based on the crash history. The roadway designer will review the mitigation measures for consistency with the scope of the project and for possible inclusion in the project. Recommendations that exceed the scope of the proposed project may be forwarded to the **NDOT Safety Committee** for a recommendation to program a safety project.

For example, the roadway designer shall request a crash data analysis from the **Highway Safety Manager** in **Traffic Engineering** for a curve identified as having crash issues. If the crash analysis indicates that the traveling public may benefit from improving the curve, the dollar amount of the benefit (the value of the expected change in the number and type of crashes) will be requested from the **Traffic Engineering Highway Safety, Evaluation, and Analysis Unit**.

If indicated by the crash history and if recommended by **Traffic Engineering**, the roadway designer shall evaluate the acceleration and deceleration lengths of interchange, rest area, and weigh station ramps to see if they are compatible with the design speed (see Chapter 10 of the *Green Book*, Ref. 17.5), and will coordinate with **Traffic Engineering** as required.

Changes to the existing roadway configuration may require a level of public input commensurate with the significance of the change. For example, the removal of striped right turn lanes, would require public input. The roadway designer shall coordinate with the **Communication Division** when the scope of the project is known, to determine the necessary level of public involvement including Public Information Meetings, flyers, or press releases. Other significant roadway changes that may necessitate public involvement include adding right turn lanes, adding two-way left turn lanes, road diets, complete streets, or other geometric changes that may impact the public.

15. RIGHT-OF-WAY

It is preferable to avoid right-of-way acquisition on 3R projects; however, additional right-of-way may be needed for the completion of the project. Acquisition of additional property rights may result in controversy and delay to the project due the acquisition process or the public involvement process.

Appropriate details and reasons for acquiring right-of-way should be communicated to the **ROW Design Engineer** during Roadway Design (Clarity Task 5350). The need for additional right-of-way may stem from intersection improvements, culvert extensions, guardrail grading, or any other design feature.

When projects, which do not have right-of-way acquisition scheduled, may require additional property rights, this should be communicated to the **ROW Design Engineer** and the **Project Scheduling and Program Management Division** as soon as these areas are known so that **ROW** may begin right-of-way survey. See Chapter Fifteen: Right-of-Way, of this manual for additional information.

16. PEDESTRIAN AND BICYCLE FACILITIES

NDOT has adopted the guidance in the [Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way \(2023\)](#) (*Accessibility Guidelines*) (Ref. 17.11) ([§ 1190.1 Accessibility Guidelines](#)), issued by the **Architectural and Transportation Barriers Compliance Board**. Facilities for those with disabilities may meet local requirements if those requirements meet or exceed **NDOT** policy.

For 3R projects in **Omaha, Lincoln** and other first-class cities, the roadway designer should meet with the **City** and discuss pedestrian and bicycle facilities. This meeting could occur prior to or as part of the PIH inspection. The 3R project scope should support the communities plans for multimodal facilities. The 3R project should build pedestrian and bicycle facilities if there is sufficient right of way to accommodate the facilities, Sidewalks should be connected to the sidewalks that are discontinuous and adjacent to the highway right-of-way. The cost of the pedestrian and bicycle facilities should be paid for as part of the municipal cost share for the project (see the Nebraska Dept. of Transportation Operating Instruction 60-11, “Municipal Cost Sharing” in Appendix B, “Selected NDOT Operating Instructions”, in this manual). The municipal cost share should begin just beyond the curb ramps and pedestrian facilities adjacent to the highway intersections. Pedestrian and bicycle facilities over bridges may not be practicable and should be discussed with the **ADE** for recommendations on how to proceed.

For 3R projects in all other **Cities**, the designer should consider the need for pedestrian and bicycle facilities. The designer should consider the types of business, parks or schools, worn paths, and existing facilities that are not continuous or not connected and discuss the need for facilities along the highway with the **DE**. If it is determined that there is a need for improved pedestrian and bicycle facilities, they will be constructed as part of the project scope. These facilities will desirably be constructed on the highway right of way. For cities with a population less than 5,000, pedestrian and bicycle facilities will be constructed as a project cost.

For additional information, see Chapter Sixteen: [Pedestrian and Bicycle Facilities](#), Chapter Ten: [Miscellaneous Design Issues](#), Section 14.A, “Accessible Parking”, and DOT-OI 60-10, “ADA Accessibility Requirements in Transportation Projects” (Appendix B, “Selected NDOT Operating Instructions), in this manual.

17. DRAINAGE DESIGN AND EROSION CONTROL

17.A Culverts and Hydraulic Considerations

3R projects generally do not require a hydraulic analysis of culverts unless there is a known drainage or hydraulic problem, or culvert replacement. Known drainage or hydraulic problems can include highway overtopping, channel degradation, scour, deteriorating culverts, embankment settlement, etc. Culvert survey and survey sheets should be checked for culvert conditions. Show all culverts on all 3R projects where we have a culvert survey (Use in Place) where needed. Culverts in poor condition should be considered for replacement. When a culvert is to be replaced, a hydrologic and hydraulic analysis is completed to determine the size of the replacement structure. Drainage and culvert replacements should be discussed with **District** personnel.

The roadway designer should be consistent with culvert extensions, looking at the project as a whole. In general, culverts that are extended will be extended to the 3R FOC. Culverts may be extended to the New and Reconstructed HCZ distance with the written approval of the **Roadway Design Engineer**. Culvert extensions should be reviewed when culvert extensions require extensive grading or special ditches. Drainage of culverts and ditches should be perpetuated to maintain existing flow patterns.

Pipe replacements should consider the risk of corrosion in the selection of pipe material. The roadway designer should refer to the pipe material policy for the selection of pipe material. In addition, the NRCS Web Soil Survey ([Web Soil Survey - Home](#)) can be used to assist in the determination of the "risk of corrosion" of the pipe replacement. The risk of corrosion is expressed as "low", "moderate", or "high".

When extending a culvert in a location where additional property rights are being acquired, the roadway designer should review the right-of-way design and try to provide at least 10 feet of cleanout space beyond the ends of the culvert.

For additional information, see Section 1.H of this chapter.

17.B Concrete Box Culverts

There are instances where limitations to impacts in channels/wetlands or absence of time in the schedule to acquire property rights prohibits extending concrete box culverts. In these instances, it may be possible to extend the parapet and wings vertically to account for a raise in grade. The ability to increase the height of the parapet and wings is structure dependent and requires the approval of the **Bridge Special Projects Unit** prior to the plan-in-hand visit. Contact the **Bridge Special Projects Engineer** prior to the plan-in-hand visit to discuss the needs of the project. Written concurrence from the **Bridge Special Projects Engineer** is necessary to raise the parapets and walls on each culvert or bridge sized box culvert. In the event none of these options are feasible, an acceptable solution may be to remove the wings and a portion of the box and extend back the same distance with a taller parapet and wings designed to handle the increased soil pressures.

Concrete box culverts with a span of three feet or less may be extended with culvert pipes (the roadway designer will request special plans from the **Special Projects Unit in Bridge**). When box culverts are extended, the preferred method is to remove the wings and two feet of the culvert

barrel before extending the culvert. As an option (e.g. for phasing), the wings of the box culverts may be removed to the parapet line and the extension doweled into the existing box (a special plan will be required from the **Special Projects Unit in Bridge**). Discuss the preferred method with **District** on the Plan-in-Hand.

If there is a drop in the stream bed elevation, concrete box culverts can be modified to a larger rise to accommodate the drop in elevation before extending.

17.C Pipe Culverts

Culverts may remain within the 3R Project Clear Zone if they are:

- 36 inches or less in diameter or round-equivalent culverts 36 inches or less in width which have flared end sections,
- are within 45° of perpendicular to the direction of travel, and
- meet 1:3 or flatter side slopes

For Interstate Projects, culverts large enough to be considered an obstacle and either within the 3R Project Clear Zone, or currently protected with guardrail, should be analyzed for extension to the 3R Project Clear Zone.

For replacement of median drains on the Interstate, the designer should select a type of pipe (pipe material) that is consistent for the Interstate segment.

17.C.1 Headwall Removal

Headwalls on pipes 36 inches or less, and multi-pipe installations 30 inches or less within the 3R Project Clear Zone (see Section 6.E of this chapter) should be removed and replaced with flared end sections (refer to Chapter Nine: Guardrail and Roadside Barriers, EXHIBIT 9.1, of this manual).

Where an existing concrete headwall is in place, the concrete will be completely removed.

17.C.2 Pipe Extension

If pipe extensions are needed, culvert pipes should be extended in kind. A pipe culvert extension may be skewed up to 3° without an elbow.

Corrugated metal pipes should be extended in two-foot increments. When a metal culvert pipe is extended that does not have an existing end treatment or which is on a skew, a minimum of two feet should be removed from the end of the culvert before extending. If a corrugated metal pipe is extended, the pipes will be connected with an approved water-tight connecting band. If a corrugated metal pipe is shortened and then extended, a concrete collar will be used. When metal arch pipes are extended, concrete collars will be used instead of a connecting band.

Concrete pipes should be extended in four-foot increments utilizing a concrete collar to connect to the existing pipe.

17.D Floodplains

An **NDOT** review is required on projects to determine whether a project encroaches upon a Base Floodplain. Projects that encroach upon a Base Floodplain or Regulatory Floodway must meet the following:

1. Base Floodplains – No increase greater than one foot of rise in the Base Flood Elevation, based on the 1% annual chance event (100-year event); and,
2. No increase in potential for property loss or hazard to life; and
3. Regulatory Floodways – No rise in the Base Flood Elevation within a Regulatory Floodway, based on the 1% annual chance event (100-year event).

If the above criteria cannot be met, a project may require an adjustment to the plans to meet the requirements or undergo a Conditional Letter of Map Revision (CLOMR)/Letter of Map Revision (LOMR) process. The **Roadway Hydraulics** and/or **Bridge Hydraulics Section(s)** will provide more guidance if/when this occurs.

The roadway designer's responsibilities for floodplain reviews is to upload and maintain the appropriate project information to OnBase, including the Project Description, Location Map, and Design plans showing the limits of construction. The responsibility for completing the floodplain certification, including the certification of compliance with floodplain regulations, rests with:

- a. The **Bridge Hydraulics Section** for bridge-sized structures, which are structures having an opening measured along the center of the roadway of more than 20 feet (multiple culverts, bridge or box culvert), or
- b. The **Roadway Hydraulics Section** for other structures (bridge, box culvert or multiple pipe culverts with less than a 20-foot span, encroachments into a floodplain by the highway embankment, and other obstructions).

The designer will also add the appropriate floodplain wording to the PIH Report if/as required (see Appendix L "PIH Report & PQS Memo Floodplain Wording", of this manual).

Floodplain terminology which may be encountered by the roadway designer include:

- Participating Community – a **County, City, or Village** in the **State of Nebraska** which participates in the National Flood Insurance Program (NFIP). Project work that will encroach upon a Base Floodplain within the jurisdiction of a participating community requires a permit from that community before it can start. A list of participating communities can be found in the Community Status Book on the **Federal Emergency Management Agency (FEMA)** website ([Community Status Book | FEMA.gov](https://www.fema.gov/community-status-book))
- Non-Participating Community - a **County, City, or Village** in the **State of Nebraska** which does not participate in the NFIP. Project work that will encroach upon a Base Floodplain within the jurisdiction of a non-participating community does not require a permit from the community
- Mapped Community – A **County, City, or Village** which has **FEMA** approved and published floodplain mapping that covers the community's jurisdiction. Some maps have been approved and published but not printed due to a lack of any Base Floodplains within the extents of the map. Communities located within these areas will usually be identified as a NSFHA (No Special Flood Hazard Area) community. Base Floodplains and

Regulatory Floodways encroached upon by a project within a Mapped Community require a certification showing compliance with floodplain regulations

- Unmapped Community - A **County, City, or Village** which does not have **FEMA** approved and published floodplain mapping. In such communities, **NDOT** policy is to define drainage's having a watershed in excess of 640 acres (one square mile) upstream of where project work occurs as potential Base Floodplains. **NDOT** policy is also to define potential Base Floodplains as areas that the **Nebraska Department of Natural Resources (NeDNR)** has identified on its website as Flood Awareness Areas or as a Preliminary Flood Hazard Layer. Potential Base Floodplains encroached upon by a project within an Unmapped Community require a certification showing compliance with floodplain regulations

For more information regarding floodplain encroachments, see Chapter 1 in the *Drainage Manual* (Ref. 17.8).

17.E Seeding & Erosion Control

Type B seeding for an overlay project should be based on the width of the estimated disturbance. Generally, seeding equipment works in eight-foot increments so an overlay project may only require an eight-foot width of Type B seeding (see Chapter Two: Erosion and Sediment Control, Section 6.A.1 of the *Drainage Manual*, Ref. 17.8, for further information). Type A seeding may be used in areas as coordinated with the **Roadside Development and Compliance Unit** in **PDD**.

18. REFERENCES

- 17.1 Board of Public Roads Classifications and Standards, Nebraska Minimum Design Standards (MDS), Current Edition. ([nac-428-rules-reqs-nbcs.pdf](#))
- 17.2 Transportation Research Board, National Cooperative Highway Research Program, Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation (3R) Projects, (*NCHRP Report 876*) ISBN 978-0-309-48225-7, Washington D.C., 2018 ([Guidelines for Integrating Safety and Cost-Effectiveness into Resurfacing, Restoration, and Rehabilitation \(3R\) Projects | The National Academies Press](#))
- 17.3 Federal Highway Administration, Bridge Preservation Guide, U.S. Department of Transportation, FHWA, Washington, D.C., 2018. ([FHWA Bridge Preservation Guide](#))
- 17.4 American Association of State Highway and Transportation Officials, A Policy on Design Standards - Interstate System, (*I-State GB*) Washington, D.C., 2016.
- 17.5 American Association of State Highway and Transportation Officials, A Policy on Geometric Design of Highways and Streets (the *Green Book*), Washington, D.C., 2018.
- 17.6 Transportation Research Board, National Research Council, Highway Capacity Manual, Sixth Edition, Washington, D.C., 2017.
- 17.7 Nebraska Department of Transportation, Design Process Outline (DPO), Current Edition ([Design Process Outline](#))
- 17.8 Nebraska Department of Transportation, Drainage Design and Erosion Control Manual (Drainage Manual), Current Edition ([Roadway Design Manuals - NDOT](#))
- 17.9 American Association of State Highway and Transportation Officials, Roadside Design Guide, Washington, D.C., 2011.
- 17.10 Nebraska Department of Transportation, Standard/Special Plans Book, (*Standard Plans*) Current Edition. ([Standard/Special Plans Manual - NDOT](#))
- 17.11 Architectural and Transportation Compliance Board, Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (Accessibility Guidelines), Washington, D.C., August 8, 2023. ([§ 1190.1 Accessibility Guidelines](#))

