The information contained in Chapter One: Design Standards, dated July 2006, has been updated to reflect the February 2018 Errata. The errata addresses errors, changes in procedure, changes in NDOT department titles, changes in other Roadway Design Manual chapters and other reference material citations which have occurred since the latest publication of this chapter.

Chapter One
Design Standards

1. DESIGN STANDARDS

Design standards have been developed to provide a systematic means of achieving quality roadway design in a uniform manner. They incorporate basic design considerations and design controls, described in later sections, for the various functional classes of roadway and types of improvements to be made.

This manual and the Nebraska Minimum Design Standards, (Reference 1.1), are the primary sources of roadway design standards for NDOT. These state standards are based on guidelines from AASHTO, the Federal Highway Administration (FHWA), the Occupational Safety and Health Administration (OSHA), the Access Board, and others. On projects in municipal areas, designers may also need to comply with local codes and street standards. For additional information, the following sources may be consulted:

**NDOT Publications**

The following is a partial listing of pertinent NDOT publications:

- Access Control Policy to the State Highway System ([http://www.roads.nebraska.gov/media/3460/access-control-policy.pdf](http://www.roads.nebraska.gov/media/3460/access-control-policy.pdf))
AASHTO Publications

The following is a partial listing of applicable AASHTO publications:

- A Policy on Geometric Design of Highways and Streets (latest edition)
- Roadside Design Guide
- A Policy on the Accommodation of Utilities Within Highway Right-of-Way
- A Policy on the Accommodation of Utilities Within Freeway Right-of-Way
- Guide for the Development of Bicycle Facilities
- Guide for Erecting Mailboxes on Highway

Federal Highway Administration (FHWA) Publications

The Federal Highway Administration (FHWA) sets forth specific policies and procedures for projects on the National Highway System (NHS), (See Section 5.A). FHWA manuals, bulletins, notices and technical advisories are available for guidance. Examples of some of their publications are:

- A User's Guide to Positive Guidance, FHWA-TO-81-1
- Federal Aid Policy Guide
  (http://www.fhwa.dot.gov/legsregs/directives/fapg/cfr0470a.htm)
- New Methods for Determining Requirements for Truck Climbing Lanes, FHWA-IP-89-022
- Manual on Uniform Traffic Control Devices
  (http://mutcd.fhwa.dot.gov/kno_2009r1r2.htm)
- Traffic Control Devices Handbook

The Access Board

The Access Board is an independent Federal agency devoted to accessibility for people with disabilities. Guidelines developed under the Americans with Disabilities Act (ADA), which covers access to a wide range of facilities in the public and private sectors and under the Architectural Barriers Act (ABA), which requires access to certain federally funded facilities may be found at:

(http://www.access-board.gov/guidelines-and-standards)
2. **NEBRASKA MINIMUM DESIGN STANDARDS**

   The Nebraska Minimum Design Standards, (Reference 1.1) are developed by the Board of Public Roads Classifications and Standards. Included are design standards for rural and municipal state highways, municipal streets and rural roads. These standards generally represent minimum values; higher values should be used within reasonable economic and environmental limits. To ensure uniform practice on a statewide basis, designs not meeting the minimum design standards may not be used without a design relaxation (See Appendix H, “Application of Standards”). Deviations from minimum design standards to save established slopes, trees, wetlands or right-of-way items (e.g., wells, windmills, towers, cemeteries, etc.) will require design relaxation approval.

   The designer should follow these steps to use the Nebraska Minimum Design Standards (Reference 1.1):

   1. Review the engineering review statement and recommendations from the Project Development Division.
   2. Request projected traffic data from the Traffic Analysis Section in the intermodal Planning Division.
   3. Determine the roadway segment’s national functional classification, (See Section 5.B).
   4. Determine if the project roadway is on the priority commercial system, (See Section 5.B).
   5. Determine whether the terrain is level or rolling, (See Section 6.D).
   6. Enter the Nebraska Minimum Design Standards (Reference 1.1) to determine the design number and other design information.
   7. Compare the minimum design standards requirements with the recommendations from the engineering review statement. If there is a discrepancy, the designer should discuss it with his/her Roadway Design Unit Head to determine if changes can be made. If changes cannot be made, follow the design relaxation procedures (See Appendix H, “Application of Design Standards”).

2.A **New and Reconstructed Projects**

   New and reconstructed projects generally consist of: construction of a new road, relocating an existing route on new alignment, major widening (adding lanes) on an existing road, or reconstruction of an existing route on old alignment. New and reconstructed projects also include projects in which the principal activity is building a new bridge or rehabilitation consisting of bridge widening. New and reconstructed projects shall be considered when:

   - Significant existing geometric deficiencies are to be corrected.
   - Significant grading is to be done that requires major right-of-way to be acquired and/or major utility relocations.
3. MAINTENANCE PROJECTS

The Board of Public Roads Classifications and Standards has also established minimum maintenance standards for each functional classification roadway ("Procedures for Classifications and Standards", Reference 1.4). Maintenance projects are programmed for bringing the roadway surfacing back to its' original condition.

3.A Maintenance Project Policy Guidelines

Design guidelines for projects to be designed under “Maintenance Projects” are as follows:

1. “Maintenance Projects” shall consist of resurfacing work and shoulder work only. If there are deficiencies, other than surfacing, a future project should be programmed to correct them.
2. Maintenance projects are for 24 ft. (7.3 m) or less in width only, except:
   A. For roadways with existing surfaced shoulders, resurfacing of the existing surfaced shoulders will be allowed if the Materials and Research Division determines that a grade raise of more than ½ in. (13 mm) at the edge of the pavement is needed.
   B. 28 ft. (8.5 m) widths will be allowed on roadways with an existing 28 ft. (8.5 m) top.
3. No surface widening work will be allowed, except:
   When the Materials and Research Division has determined that the surfacing strategy will be an in-place recycle of the existing asphalt surface to a certain depth, then a lowering of the grade to a lesser depth will be accomplished by trench widening up to 2 ft. (0.6 m) in width on each side. A resurfacing of the entire surfaced roadway width will then be made with up to a 2 ½ in. (63 mm) overlay. The total existing roadway width, outside edge of shoulder to outside edge of shoulder, does not change. This surface widening is a direct result of this type of maintenance strategy rather than the result of a planned surface widening to meet 3R Minimum Design Standards, thus the NDOT, in its sole discretion, has determined that any maintenance project with this type of strategy may remain classified as a maintenance project.
4. A grade raise of up to 2 ½ in. (63 mm) is acceptable; a grade raise of more than 2 ½ in. (63 mm) at the edge of the pavement will be the exception and will require justification by the Materials and Research Division documented to the project file. Up to a ½ in. (13 mm) grade raise at the edge of the pavement will require NO shoulder or guardrail work. A grade raise of more than ½ in. (13 mm) at the edge of the pavement will require an investigation for the need of guardrail work.
5. Surfacing will be feathered out at intersections and driveways.
6. Surfacing will be milled out at bridge approaches so that there is no grade raise at bridges.
7. If more than a 2 in. (50 mm) depth is placed at the centerline a city agreement may be required.
8. If the grade is raised and the contractor does the shoulder work, the District Engineer will determine if suitable earthwork material is available within the right-of-way.
9. The “10 ft. straightedge, 1/8 in. variation limit, in the longitudinal direction, and at the discretion of the Engineer” version of a smoothness specification will be used on all maintenance projects.
10. No guardrail, new mailbox turnout, or superelevation correction work will be allowed.
    A. If guardrail work is required the project will be reclassified to a 3R project.
11. Curb ramps will be built where needed when surfacing overlays of 2 in. (50 mm) or more are placed (2 in. (50 mm) total lift even if the surface is milled first). A city agreement may be required.
4. OTHER TYPES OF PROJECTS

4.A Safety Improvement Projects

Safety improvement projects are projects that are usually located at specific high accident sites. The **Highway Safety Division** identifies the high accident locations and the **Safety Committee** then evaluates individual projects on a case-by-case basis. **District Engineers** may also request study of individual locations. Usually safety improvement projects are designed with 10-year traffic forecasts. These projects may include intersection projects, adding left turn lanes, minor radii improvements, sight distance improvements, etc.

4.B Off-System Urban Projects

The federal STP provides funds on an annual basis for all cities of the first class in Nebraska. The funding split is 80% federal and 20% city. Eligible projects under this program include:

- Construction, reconstruction, resurfacing, restoration and rehabilitation and operational improvements for highways and bridges on any public road rated higher than a minor collector, including work to accommodate other transportation modes.
- Capital costs for transit projects and publicly owned bus terminals and facilities.
- Carpool projects, parking facilities and non-recreational bicycle and pedestrian facilities.
- Highway and transit safety improvement programs, rail-highway grade crossings and projects to mitigate hazards due to wildlife.
- Capital and operating costs for traffic monitoring, management and control facilities.
- Transportation control measures listed in Section 108 of the Clean Air Act, (Reference 1.5) ([http://www.ehso.com/ehshome/CAA2.php](http://www.ehso.com/ehshome/CAA2.php))
- Wetlands mitigation efforts.

4.C Secondary Roads - Off-System Rural Projects

The **Local Projects Section** of the **Materials & Research Division** deals with all off-system rural roads for which local road standards have been developed. For further information see Part Two of the Nebraska Minimum Design Standards, (Reference 1.1).
5. HIGHWAY SYSTEM CLASSIFICATION

The roadway system has been classified for identification, prioritization and funding purposes for planning, design, traffic operations, and administration of the highway program. Classification relates to network, function, roadway location, access, traffic volume, trip purposes and length. In turn, classification designation dictates the standards that should be used for roadway design.

5.A Federal Classification

The National Highway System (NHS) is an interconnected system of principal arterial routes that serves major population centers, international border crossings, ports, airports, public transportation facilities, other intermodal transportation facilities and other major travel destinations. NHS highways also meet national defense requirements and serve interstate and interregional travel (Reference 1.7).

The Surface Transportation Program (STP) is a funding program that includes public roads not functionally classified as minor rural collectors, local roads, or streets. It includes some collector routes that were not previously on the federal-aid system. In addition to being a funding source for these routes, the STP specifies some set aside funds for obstacle elimination projects and for transportation enhancement activities (See Section 4.B).
5.B **Nebraska National Functional Classification**

Functional classification is the grouping of highways by the character of service they provide. It basically considers the level of access and mobility the roadway is to provide. The Nebraska National Highway Functional Classification (NNFC) Map identifies four roadway classes:

1. Interstates and freeways.
2. Principal arterials.
3. Minor arterials.
4. Major collectors.

These classes are based on **American Association of State Highway and Transportation Officials’ (AASHTO)** functional classes found in **A Policy on Geometric Design of Highways and Streets** (Reference 1.9).

The intended purpose of a roadway determines its design. Functional classification is a means of identifying the travel purposes to be served. The Nebraska National Highway Functional Roadway Classes on the map are:

- **Interstate**: a national defense highway system established to connect most cities of 50,000 or more population in the U.S., with complete access control and a minimum of two 12 ft. (3.6 m) lanes in each direction, divided in most instances by wide medians.
- **Principal Arterials**: corridor movement with trip length and density compatible with significant statewide or interstate travel. There is usually a high operating speed and level of service with some degree of access control through limiting intersection spacing and direct property access.
- **Minor Arterials**: routes to provide linkage of cities, towns and other traffic generators, integrating interstate and intercounty service, usually at relatively high speed and minimum interference to through movement.
- **Major Collectors**: serve a dual function of property access and feeding arterials, generally for shorter trip lengths. They will have lower speeds and levels of service than arterials. In urban areas, collectors are usually designed to discourage through traffic in residential areas by following indirect and discontinuous alignment.

All other roadways are local roads and streets.

5.C **Nebraska State Functional Classification**

By act of the **Nebraska Legislature**, the **Board of Public Roads Classifications and Standards** has established a state functional classification. The state functional classification is defined for rural and municipal areas. **EXHIBITS 1.1 AND 1.2** identify characteristics of roadway types in rural and municipal settings, respectively. Rural highways consist of all public highways and roads outside the limits of any incorporated municipality. Municipal streets are all public streets within the limits of any incorporated municipality. Municipal areas are further subdivided by population size: over 50,000 (urban areas), 5,001-49,999 (small urban areas), and 1-5,000 (villages and cities of the second class) (See “Procedures for Classifications and Standards”, Reference 1.4). Municipalities of 5,001 and over population are cities of the first class.
# Nebraska Department of Transportation - Roadway Design Manual
## Chapter One: Design Standards

### Functional Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>General Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate</td>
<td>The Federally designated National System of Interstate and Defense Highways.</td>
</tr>
<tr>
<td>Expressway</td>
<td>A group of highways following major traffic desires in Nebraska which rank next in importance to the National System of Interstate and Defense Highways. The expressway system is one that ultimately should be developed to multilane divided highway standards.</td>
</tr>
<tr>
<td>Major Arterial</td>
<td>The balance of routes that serve major statewide interests for highway transportation. This system is characterized by high-speed, relatively long-distance travel patterns.</td>
</tr>
<tr>
<td>Scenic-Recreation</td>
<td>Highways or roads located within or which provide access to or through state parks, recreation or wilderness areas, other areas of geographical, historical, geological, recreational, biological, or archaeological significance, or areas of scenic beauty.</td>
</tr>
<tr>
<td>Other Arterial</td>
<td>Highways of less importance as through-travel routes that serve places of smaller population and smaller recreation areas not served by higher systems.</td>
</tr>
<tr>
<td>Collector</td>
<td>Highways that pick up traffic from many local or land-service roads and carry it to community centers or to the arterial systems. They are the main school bus routes, mail routes, and farm-to-market routes.</td>
</tr>
<tr>
<td>Local</td>
<td>All remaining rural roads except minimum maintenance roads.</td>
</tr>
<tr>
<td>Minimum Maintenance</td>
<td>(a) Roads used occasionally by a limited number of people as alternative access roads for areas served primarily by local, collector, or arterial roads, or (b) roads which are the principal access roads to agricultural lands for farm machinery and which are not primarily used by passenger or commercial vehicles.</td>
</tr>
</tbody>
</table>

**Exhibit 1.1 Nebraska State Rural Highway Functional Classifications** *(Source: Reference 1.8)*

<table>
<thead>
<tr>
<th>Classification</th>
<th>General Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interstate</td>
<td>The Federally designated National System of Interstate and Defense Highways.</td>
</tr>
<tr>
<td>Expressway</td>
<td>(a) Extensions of rural expressways within some urban areas and (b) some additional routes serving very high volumes of local traffic within urban areas.</td>
</tr>
<tr>
<td>Major Arterial</td>
<td>Extensions of rural major arterials that provide continuous service through municipalities for long-distance rural travel. They are the arterial streets used to transport products into and out of municipalities.</td>
</tr>
<tr>
<td>Other Arterial</td>
<td>(a) Municipal extensions of rural other arterials and (b) arterial movements peculiar to a municipality's own complex, that is streets which interconnect major areas of activity within a municipality, such as shopping centers, the central business district, manufacturing centers, and industrial parks.</td>
</tr>
<tr>
<td>Collector</td>
<td>A group of streets which collect traffic from residential streets and move it to smaller commercial centers or to higher arterial systems.</td>
</tr>
<tr>
<td>Local</td>
<td>The balance of streets in each municipality, principally residential access service streets and local business streets. They are characterized by very short trip lengths, almost exclusively limited to vehicles desiring to go to or from adjacent property.</td>
</tr>
</tbody>
</table>

**Exhibit 1.2 Nebraska State Municipal Streets Functional Classification** *(Source: Reference 1.8)*
5.D  Priority Commercial and Expressway Systems

5.D.1  Priority Commercial System

The Priority Commercial System, initiated in 1988, provides a continuous network of routes that are designed to carry higher traffic volumes, especially larger volumes of commercial vehicles.

This system, which includes the rural expressway system, was established at 3,303 miles. As with all state systems, there may be variances in exact mileage from year-to-year as highway alignments change and as municipal boundaries are altered. It directly serves all of the first class (5,001 – 100,000 population) and larger cities, directly serves 80 of the 115 second class cities (800 – 5,000 population), and comes within 10 miles of another 18 second class cities.

The non-expressway portion of this system is being constructed with two 12 ft. (3.6 m) driving lanes and 10 ft. (3 m) shoulders, 8 ft. (2.4 m) of which is to be paved. In addition to the system as established, any route which has a design year traffic volume (the volume at the initial year of construction plus 20 years) of 3,000 ADT or greater will be developed with 8 ft. (2.4 m) paved shoulders. Bridges are to be widened to shoulder width.

5.D.2  Expressway System

As part of the 1988 Needs Study, Department engineers reviewed Nebraska socioeconomic data. This data included population and demographic trends, general economic activity as reflected in sales tax revenue, agricultural production, employment data, and other information relative to economic trends. The initial review precipitated the development of an expanded Expressway System of approximately 600 miles.

Factors included in the development of the system were: 1) to connect urban centers of 15,000 population or greater to the Interstate System, 2) to add those routes which have an average daily traffic of 500 or more heavy commercial vehicles, and 3) to add additional segments for continuity.

The Expressway System is being constructed as multi-lane divided highways. Interchanges may be built where an Expressway intersects with high volume highways. Access other than at public roads will be limited. Whether the system will directly serve developed areas, or whether bypass routes will be constructed, will be decided on a case-by-case basis. The Expressway System currently consists of some two-lane highways that will ultimately be constructed to multilane divided highway standards.
6. **DESIGN CONTROLS**

Once the type of roadway improvement is determined and the functional classification of the roadway known, several basic factors serve as design controls. They are determinants for other geometric design standards. See the *Nebraska Minimum Design Standards*, (Reference 1.1) and *A Policy on Geometric Design of Highways and Streets*, (Reference 1.9).

6.A **Design Year Forecast Traffic**

The ADT for the design year, the year twenty years after the initial construction of the project, is used as a target in design for New and Reconstructed projects. See Chapter Seventeen for the design year for 3R projects. For additional information, see the *Nebraska Minimum Design Standards*, Reference 1.1.

Traffic projections on individual project segments must be compared to the priority commercial system map for design standard compliance.

6.B **Design Speed**

The desirable design speed for a roadway project is 5 mph greater than the anticipated posted speed limit for the roadway. The minimum design speed is the design speed from the *Nebraska Minimum Design Standards*, (Reference 1.1). An exception to the above would be in the instance where the design speed from the *Nebraska Minimum Design Standards* is greater than the anticipated posted speed; in this case the minimum design speed from the standards will be used. For example, if the design speed from the *Nebraska Minimum Design Standards* is 60 mph and the anticipated posted speed of the roadway is 50 mph, a design speed of 60 mph will be used.

Rural roadway projects should be designed to **one** design speed. If a rural project has a posted speed of 65 mph, the desirable design speed is 70 mph; but if one section of the roadway can only be designed to 65 mph, the **entire** project should be designed to 65 mph in order to meet driver expectations.

Deviation from the established design speed will require **Assistant Design Engineer** approval while **Board of Public Roads and Classifications** approval will be required to design to less than the statutory design speed from the *Nebraska Minimum Design Standards*, (Reference 1.1).

6.C **Sight Distance**

Sight distance is the length of roadway that is visible to the driver in various situations including stopping sight distance, passing sight distance, and intersection sight distance. For further discussion of sight distance see Chapter Three: *Roadway Alignment*, Section 1.
6.D  **Terrain**

Terrain is a design control affecting alignment. Two basic types of terrain are found in Nebraska:

- **Level**: the condition where highway sight distances, as governed by both horizontal and vertical restrictions, are generally long or could be made to be so without construction difficulty or major expense.
- **Rolling**: the condition where the natural slopes rise above and fall below the road or street grade and where occasional steep slopes offer some restriction to normal horizontal and vertical roadway alignment.

6.E  **Access Control**

Access control effectively increases roadway capacity by restricting the number and location of access points along the highway. This provides a safer environment for the roadway user, increases the efficient movement of through traffic, and reduces roadway accidents by minimizing the number of conflict points located along the highway (See Chapter Fifteen: Right-of-Way, Section 3).

6.F  **Lateral Obstacle Clearance**

Lateral obstacle clearance is the roadside area starting at the edge of the travel lane available for the safe use of errant vehicles. It may consist of the shoulder, a recoverable slope, a non-recoverable slope and/or a clear runout area. The required lateral obstacle clearance will vary depending upon the design roadway standard (DR) (See Nebraska Minimum Design Standards, Reference 1.1). Chapter Six: The Typical Roadway Cross-Section, Section 9, discusses this further.

6.G  **Urban/Rural**

Separate design standards have been developed for rural areas and urban (municipal) areas. In addition, typical cross-sections differ depending upon rural/urban location. In general, urban design standards reflect lower design speeds and restricted rights-of-way for the higher traffic volumes more common in urban areas while rural design standards reflect higher design speeds and the more flexible right-of-way opportunities possible in rural areas.
7. DESIGN ANALYSIS AND EVALUATION

7.A Capacity Analysis

NDOT's goal is to provide a transportation system to meet the needs of the forecast design year traffic. Providing unlimited capacity to handle any amount of traffic is not fiscally responsible. Good design must provide sufficient roadway capacity, providing acceptable levels of service to motorists without undue burden on the resources of the state. The principal objective of capacity analysis is to estimate the maximum amount of traffic that can be accommodated by a given facility while maintaining predetermined operational quality, or level of service.

Capacity analysis provides the necessary information to evaluate improvement alternatives. The designer should work with the Traffic Engineering Division to ensure that the design typical section and alignment contained in the project file would provide the intended capacity and level of service for the project roadway.

7.B Economic Analysis

In general, the designer should follow the design standards unless the estimated cost of doing so is exorbitant. When a design relaxation is to be requested, the designer needs to substantiate the specific estimated costs associated with following versus deviating from the minimum design standards. The Construction Division Cost Estimating Unit provides assistance as requested by the designer for determining cost estimates of different design alternatives (See Chapter Twelve: Cost Estimating & Funding, Section 1.B).

7.C Accident Analysis

Project improvements typically are evaluated on the basis of accident analyses. High accident location analyses are performed to prioritize projects and also to evaluate project alternatives. The Traffic Engineering Division performs accident analyses.
8. REFERENCES


1.2 Nebraska Department of Transportation, State Highway Inventory Report.


1.6 23 Congressional Federal Register 625 (http://www.access.gpo.gov/nara/cfr/waisidx_02/23cfrv1_02.html)


1.8 Nebraska. Laws, Statutes, Etc., Nebraska Highway and Bridge Law; Consisting Of Chapter 39, Highways and Bridges; Sections 49-801 And 49-802, Definitions And Rules Of Construction; Article 6 Of Chapter 60, Nebraska Rules Of The Road. Revised Reissued Statutes Of Nebraska, Current Edition
