Disclaimer – This document was developed to help support the use of the Design Criteria Form by providing examples of references within design guidelines. This is not intended to be an all-inclusive document, the development of design criteria requires engineering judgement and experience.

The Design Criteria Form is intended to capture design criteria, and should be used in conjunction with the existing and/or proposed information captured in the Design Report. If appropriate, add anticipated proposed actions or ranges within the notes section of the form (similar to the old Engineering Report, “proposed horizontal radius range from 300-500ft, all meet recommended design criteria, see Design Report”). Also consider adding links or file paths in the note section to the related documents, such as the Design Report or the Existing Alignment Package, to steer the designer and/or checker to other appropriate design information. This form is intended to collect the **TYPICAL** conditions. If it is considered that more than one typical condition exists, such as changes in posted/design speed or transition between rural and urban settings, consider developing separate Design Criteria Forms for each typical condition. However, this document is not intended to capture every variation along a project corridor.

It is likely that, based on the date of the Highway Design Manual (HDM) (1999) versus the AASHTO Policy on Geometric Design of Highways and Streets (aka the “Green Book”) (2018) (and other reference documents), conflicts exist between the various documents recommended design criteria. Careful consideration should be given if/when newer references supersede information contained in others based on the published/developed date and current Department practices. The selection of controlling criteria between various references should be noted in the Design Criteria Form and reviewed/approved by the Geometrics Subject Matter Expert (SME). It is imperative that the form has as much data as possible on the references used (title, date/version, page, table, section, etc) to make review and approval of the selected criteria as easy as possible. This also supports better documentation for future reference.

1. **FUNCTIONAL CLASSIFICATION:**
    - **a.** A central organizing criterion for the geometric design process. Functional classification is a system that characterizes roadways by their position in the transportation network and type of service they provide to motor vehicles, while a context classification is a system that characterizes roadways by their surrounding environment and how the roadway fits into the community (AASHTO 2018, pg 1-5 to 1-6).
    - b. Click on the roadway in NH Roads and Project Viewer to determine functional classification, density (urban/rural) - https://nhdotprojects.sr.unh.edu/
    - c. Functional Classification map - https://www.nh.gov/dot/org/projectdevelopment/planning/gis-data-catalog/documents/functional-system.pdf.
    - d. Urban population map - https://www.nh.gov/dot/org/projectdevelopment/planning/gis-data-catalog/documents/urban-population.pdf

e. AASHTO 2018, Sections 1.4 (Functional Classification for Motor Vehicles) and 1.5 (Context Classification for Geometric Design) offer useful descriptions of the different functional classification considerations.

f. Highway Function: HDM 1999, pg 3-5

2. NHS:

a. National Highway System (NHS) includes interstate Highway System as well as other roads important to the nation's economy, defense and mobility.

b. A higher standard of design is typically required on NHS facilities. Deficiencies may require formal design exceptions based on FHWA controlling criteria. Information regarding documentation of design exception can be found in the Highway Design Manual (HDM) Chapter 3.

c. NHS designation can be found in NH Roads and Project Viewer, as discussed under Functional Classification.

d. NHS Map - https://www.nh.gov/dot/org/projectdevelopment/planning/gis-data-catalog/documents/nhs-miles.pdf

3. DOS AUTHORIZED ROUTE:

a. Department of Safety (DOS) – Routes Authorized for Legal Use for Semi-Trailers 53 Feet in Length or Less (2014) identifies roadways that are required to facilitate movement of large WB-67 trailers (53'). Any roadway on the list, or within the designated areas described on the list, should consider turning movements associated with a WB-67. Confirmation that the referenced list is the most current should occur on a regular basis.

b. DOS 53' Trailer List - https://www.nh.gov/safety/divisions/nhsp/documents/trailerlist.pdf

4. AADT

a. Average Annual Daily Traffic (AADT) is the volume of traffic that is seen along a corridor, assumed to represent an average day and month condition. Current year data could be taken from the NH TDMS website, and may be considered satisfactory to use in specific instances (recommended to verify with Bureau of Traffic (BOT)), otherwise AADT for current, opening (the year the project construction will be complete) and design (20 years from the opening year) years should be collected by the BOT through submission of a Traffic Forecast Request form.

b. If traffic data is being collected by the Consultant, the proper adjustment factors should be used to determine an appropriate average day and month condition. Final traffic numbers should be vetted through BOT, and included on the Design Criteria Form.

c. If certain segments of the roadway within the project limits have **significantly** different AADTs, often due to turning at side roads, consider developing a second iteration of the DCF for each "AADT" segment of the road, which would help determine appropriate design controls for each condition. The limits of each segment should be clearly stated in the DCF.

d. Its recommended to include a reference to the data used in this section, including the source and date, in the comments section.

5. **<u>SPEED</u>**
   a. Useful discussion on facility speeds, including operating, running and design speeds, can be found in AASHTO 2018, Section 2.3.6 (Speeds), and within the chapters discussing each specific functional classification. For instance, additional discussion for rural arterials can be found in AASHTO Green Book 2018, Section 7.2.2.1 (Design Speed). The HDM 1999, pg. 3-12 has additional limited discussion on selecting a design speed.
   b. There are many studies and alternative resources that provide design speed selection guidance. Any reference manual or speed study used to determine the final selected design speed should be documented.
   c. If certain segments of the roadway within the project limits have distinctly different speeds, often as a result of changing roadway context, consider developing a second iteration of the DCF for each "speed" segment of the road, which would help determine appropriate design controls for each condition. The limits of each segment should be clearly stated in the DCF.
   d. NH DOT Bureau of Traffic (BOT) maintains a google earth file of existing posted speed limit signs, available internally only at the following link - \\dot\Data\Global\B34-HighwayDesign\#KML for Google Earth\2018 Speed Signs.kmz

6. **<u>TYPICAL SECTION</u>**:
   a. **<u>Widths (travelway, shoulder, sidewalk)</u>** - The logical approach to determining appropriate lane and shoulder width is to provide a width related to the traffic demands while also considering the types of vehicles being served (such as freight or bicycles).
      i. AASHTO Green Book 2018, Section 4.2 (Travel Way), Section 4.3 (Lane Width), Section 4.4 (Shoulders), and Section 4.17 (Pedestrian Facilities); Additional information can be found in AASHTO Green Book 2018 under the respective roadway functional classification, such as AASHTO Green Book 2018, Table 7-3 for a rural arterial.
      ii. HDM 1999, pg 3-9 (Travel Lanes, Shoulders, and Medians), offers useful background info on this design element and NHDOT typical widths.
      iii. HDM Volume 2 Draft Typical Sections (Rev 08/22/2019) (https://www.nh.gov/dot/org/projectdevelopment/highwaydesign/designmanual/volume2-chapter1.htm)
      iv. HDM Volume 2 Draft Sample Layouts (Rev 08/22/2019) https://www.nh.gov/dot/org/projectdevelopment/highwaydesign/designmanual/volume2-chapter2.htm
      v. NH DOT Highway Design Special Details – Sidewalk Curb Ramp Details https://www.nh.gov/dot/org/projectdevelopment/highwaydesign/detailsheets/documents/crb_ramp_1_9.pdf
   b. **<u>Cross Slope (travelway, shoulder, sidewalk)</u>** – Sufficient cross slopes should be proposed to ensure proper drainage while avoiding adverse effects to vehicle (or other facility user) operations.
      i. HDM 1999, pg 3-12 (Pavement and Shoulder Slopes)
      ii. See same references as listed under "Widths", above.

c. **Barrier Offset** – This refers to the distance between the edge of pavement/face of curb and the face of barrier. Offsets should be set to reduce the potential for adverse effects associated with barrier installation (ie vaulting, roll-overs, etc). See later discussion on Clear Zone for when barrier may be warranted.

   iii. AASHTO Green Book 2018, Section 4.6.2 (Lateral Offset, Roadside Design)

   iv. AASHTO RDG 2011, Section 5.6.1 (Barrier Offset)

   v. AASHTO RDB 2011, Section 5.6.2.1.1 (Curb/Guardrail Combinations for Strong-Post W-Beam Guardrail)

   vi. HDM 1999, pg 11-1 (Barriers)

d. **General Note** - Other conditions may exist that warrant design by “Other” references, such as the AASHTO Geometric Design for Low Volume Roads or NCHRP study recommendations.

7. SUPERELEVATION: Adjustment of the roadway cross slope to counterbalance the outward radial (centrifugal) force experienced while traveling in a circular path (i.e. through a horizontal curve), often referred to as roadway “bank”.

a. **E_{max}** – Maximum full bank superelevation typically based on the facility type

   i. AASHTO Green Book 2018, Section 3.3.3 (General Considerations) for horizontal alignments, specifically Section 3.3.3.2 (Maximum Superelevation Rates for Streets and Highways)

   ii. AASHTO Green Book 2018, under the respective roadway functional classification (ex. AASHTO Green Book 2018, Section 7.2.2.8 (Superelevation) for rural arterials).

   iii. HDM 1999, pg 3-13 (Horizontal Curvature and Superelevation)

b. **Superelevation Runoff** – The proportion of the superelevation transition that occurs within a tangent versus within the curve.

   i. AASHTO Green Book 2018, Section 3.3.8 (Transition Design Controls)

   ii. HDM 1999, pg 4-15 through 4-24 (Superelevation). The typical runoff used in Highway Design is a 70/30 split. In cases of constrained condition, the runoff may be shifted to 60/40, however, anything below that should be discussed with the Geometrics Subject Matter Expert.

c. AASHTO 2018 Section 3.3 (Horizontal Alignment) for spiral design criteria (note that historically, the use of spiral curves has been discouraged, and as such, is not thoroughly covered in this document)

8. MAXIMUM RELATIVE GRADIENT (MRG): Superelevation transition rates, often used when the ideal superelevation runoff proportions cannot be met.

a. AASHTO Green Book 2018, Section 3.3.8.2.1 (Minimum Length of Superelevation Runoff)

b. HDM 1999, Table 4-4 (Relationship of Design Speed to Maximum Relative Profile Gradients)

c. If necessary, interpolate the MRG between the closest two speeds to determine the appropriate MRG.

9. **<u>CLEAR ZONE:</u>** Unobstructed, traversable area provided beyond the edge of the through traveled way for the recovery of errant vehicles.

a. Since the clear zone is not necessarily considered a primary design control (meaning its selection does not inform other design criteria within the form itself, the DCF allows two "typical" foreslope/backslope condition combinations. If a condition does not exist (ie there is no backslope within the clear zone, but a continued foreslope), indicate such with an N/A in the particular typical condition.

b. AASHTO RDG, Chapter 3 (Roadside Topography and Drainage Features), specifically Tables 3.1 – Suggested Clear Zone Distances from Edge of Through Traveled Lane

c. AASHTO Green Book 2018 under the respective functional classification, such as AAHSTO Green Book 2018, Section 7.2.4 (Roadside Design) for rural arterials.

d. HDM 1999, 3-11 (Lateral Clearances)

e. NH DOT Utility Accommodations Manual (UAM) 2017

10. **<u>HORIZONTAL ALIGNMENT:</u>** Curvature based on the required alignment of the roadway, should be based on an appropriate relationship between design speed, curvature, and their joint relationships with superelevation (roadway banking) and side friction.

a. **<u>Minimum Radius, Minimum Radius with Reverse Crown (RC), Minimum Radius with Normal Crown (NC)</u>**

i. AASHTO Green Book, Section 3.3.5 (Design Superelevation Tables). Table should correspond with the appropriate E_{max}.

ii. AASHTO Green Book, Section 3.3.13 (General Controls for Horizontal Alignment) for relationship between adjacent compound curve radii.

iii. HDM 1999, pg 4-3 thru 4-4 (Horizontal Alignment General Controls), 4-11 thru 4-24 (Horizontal Curves, overlapping with previous references in the Superelevation section above). This segment includes superelevation tables that have been superseded by updated guidance in the AASHTO Green Book.

b. **<u>Minimum Curve Length</u>**

i. AASHTO Green Book 2018, Section 3.3.13 (General Controls for Horizontal Alignment)

ii. HDM 1999, pg 4-3 (Horizontal Alignment General Controls)

c. AASHTO 2018 Section 3.3 (Horizontal Alignment) for spiral design criteria (note that historically, the use of spiral curves has been discouraged, and as such, is not thoroughly covered in this document)

11. **<u>VERTICAL ALIGNMENT:</u>** Profile of the road to align with the natural topography while also promoting uniform operation of the roadway.

a. **<u>Assumed Terrain</u>**

i. AAHSTO Green Book 2018, Section 3.4.1 (Terrain). It should be noted that very few roadways in NH are considered Mountainous.

ii. HDM 1999, pg 4-26 (Maximum Grades) refers to the AASHTO Green Book for terrain.

iii. If certain segments of the roadway within the project limits have distinctly different terrains, often corresponding to a change in roadway context, consider developing a second iteration of the DCF for each “terrain” segment of the road, which would help determine appropriate design controls for each condition. The limits of each segment should be clearly stated in the DCF.

b. **Minimum Grade**

i. AASHTO Green Book 2018, Section 3.4.2.2 (Control Grades for Design); The AASHTO Green Book 2018 also has information under the respective function classification, such as AASHTO Green Book 2018, Section 7.2.2.6 (Grades) for rural arterials.

ii. AASHTO Green Book 2018 under the respective functional classification, such as AAHSTO Green Book 2018, Section 7.2.2.6 (Grades) for rural arterials.

iii. HDM 1999, pg 4-26 (Minimum Grades)

c. **Maximum Grade**

i. AASHTO Green Book 2018, Section 3.4.2.2 (Control Grades for Design)

ii. AASHTO Green Book 2018 under the respective functional classification, such as AASHTO Green Book 2018, Section 7.2.2.6 (Grades) for rural arterials, specifically Table 7-2 (Maximum Grades for Arterials Rural Areas)

iii. AASHTO Green Book 2018, Section 3.4.2 (Grades) and Section 3.4.3 (Climbing Lanes) for vertical alignment considerations for heavy vehicles.

iv. HDM 1999, pg 4-26 (Maximum Grades) refers to the AASHTO Green Book for maximum grades.

d. **Minimum K Crest (SSD)**

i. AASHTO Green Book 2018, Table 3-35 (Design Controls for Crest Vertical Curves Based on Stopping Sight Distance)

ii. AASHTO Green Book 2018, Section 3.4.6.2.1 (Design Controls: Stopping Sight Distance) for discussion on headlight height SSD evaluation (pg 3-170)

iii. See HDM 1999, pg 4-29 thru 4-39 for general information on vertical curves

e. **Minimum K Sag (SSD)**

i. AASHTO Green Book 2018, Table 3-37 (Design Controls for Sag Vertical Curves)

ii. AASHTO Green Book 2018, Section 3.4.6.3 (Sag Vertical Curves) for discussion on headlight height SSD evaluation (pg 3-172)

iii. See HDM 1999, pg 4-29 thru 4-39 for general information on vertical curves

f. **Minimum Length Vertical Curve**

i. Crest – AASHTO Green Book 2018, pg 3-168, pg 3-171

ii. Sag – AASHTO Green Book 2018, pg 3-175 - 3-176

iii. HDM 1981 (English Units), Table 4-6 (Minimum Vertical Curve Lengths, NH Policy), or use converted HDM Table 4-7 (Minimum Vertical Curve Lengths)

iv. HDM 1999, pg 4-29 thru 4-39 for general information on vertical curves

12. **MINIMUM VERTICAL CLEARANCE:** Measured from an overhead structure to the finished roadway surface or highest rail of the railroad, and must be provided over the entire useable roadway width, including shoulders.
    a. HDM 1999, Figure 3-2 (Minimum Vertical Clearances)
    b. In a railroad overpass condition, specific minimum vertical clearance may differ depending on the owner of the railroad

13. **STOPPING SIGHT DISTANCE (SSD):** Length of the roadway ahead that is visible to a driver, and should be sufficient to enable a moving vehicle (traveling at or near the design speed) to stop before reaching a stationary object in its path.
    a. AASHTO Green Book 2018, Section 3.2.2 (Stopping Sight Distance), specifically Table 3-1 (Stopping Sight Distance on Level Roadways) and Table 3-2 (Stopping Sight Distance on Grades)
    b. AASHTO Green Book 2018, Section 9.6.5 (Stopping Sight Distance at Intersections for Turning Roadways)
    c. HDM 1999, pg 3-14 for general information on stopping sight distance

14. **DECISION SIGHT DISTANCE (DSD):** Length of a driver's sight line required to perceive, react and perform a maneuver to adjust speed.
    a. Because this criterion is seldom used as critical, a range of values covering all maneuvers is adequate. However, if the Designer determines this may be a critical aspect of a given project, more precise description of the criteria may be required. Consult with the Geometrics SME if necessary.
    b. AASHTO Green Book 2018, Table 3-3 (Decision Sight Distance)
    c. HDM 1999, pg 3-15 for general information on decision sight distance

15. **PASSING SIGHT DISTANCE (PSD):** Length of a driver's sight line needed to safely complete a normal passing maneuver.
    a. AASHTO Green Book 2018, Table 3-4 (Passing Sight Distance of Two-Lane Highways)
        i. AASHTO Green Book 2018, Table 3-36 (Design Controls for Crest Vertical Curves Based on Passing Sight Distance)
    b. HDM 1999, pg 3-15 for general information on passing sight distance

16. **FULL DECELERATION LENGTH:** Length of auxiliary lane needed to recognize the upcoming turn lane and prepare for the turn maneuver (ie perception reaction), and also to complete the lane change and decelerate prior to storage within the lane.
    a. AASHTO Green Book 2018, Table 9-20 (Desirable Lane Change and Deceleration Distance)

b. HDM 1999, pg 5-11 for very limited discussion on deceleration lanes, and intersection geometry in general.

c. While deceleration lengths are a particular element of an auxiliary lane length, the overall length of an auxiliary lane is also a function of the storage length (vehicle queue). For additional discussion regarding storage length, see:

   i. AASHTO Green Book 2018, Table 9-21 (Calculated Storage Lengths to Accommodate the 50th Percentile Critical Gap), Table 9-22 (Calculated Storage Lengths to Accommodate the 85th Percentile Critical Gap) and Table 9-23 (Queue Storage Length Adjustments for Trucks), if documentation of storage configuration is appropriate.

   ii. HDM 1999, pg 5-10 thru 5-11 for general intersection layout guidance.

d. NH DOT Standard Plan PM – 7 for additional intersection layout guidance. Confer with BOT for additional clarification if necessary.

17. <u>DESIGN VEHICLE:</u> A vehicle that is likely to use a facility with considerable frequency or a particular vehicle with special characteristics appropriate to a particular location which will determine critical features such as radii at intersections and turning roadways. Selection of the design vehicle is strongly based on **engineering judgment**.

a. Although there is very general guidance in both the AASHTO Green Book 2018 (Section 2.8 – Design Vehicles) and the HDM, this is a very site specific decision.

b. The design vehicle should represent the vehicle that frequently uses the facility. Consideration should be given to vehicles that may require access to certain parcels within a project, such as a gas station and the need to perpetuate access for delivery of gas via a gas tanker truck.

c. Selection of design vehicles may vary between mainline and side road criteria, and is most clearly captured with separate DCFs for each roadway.

d. A check vehicle is a vehicle that may need to have access through a corridor given certain circumstances, movements must not be prohibited, but may not be used to actually design the roadway.

e. Review the DOS Route Authorized for Legal use for Semi-Trailers 53 Feet in Length or Less to see if the WB-67 (53' trailer) should be considered as a design vehicle.

18. <u>INTERSECTION SIGHT DISTANCE (ISD):</u> Sight distance provided at intersections to allow drivers to perceive the presence of potentially conflicting vehicles.

a. See AASHTO 2018, Section 9.5 (Intersection Sight Distance).

b. This does not replace the need to account for stopping sight distance, as discussed elsewhere in this form. Stopping sight distance should be provided continuously along each roadway so that drivers have a view of the roadway ahead that is sufficient to allow drivers to stop.

c. Dimension of the legs of the sight triangles depend on the design speeds of the intersecting roadway and the type of traffic control used at the intersection.

d. For a two way stop controlled intersection, the DESIRABLE decision point (vertex) of the departure sight triangle on the minor road is 18’ from the edge of the major-road traveled way. However, if that condition cannot be met, alternative offsets should be evaluated, however, the minimum recommended offset from the edge of the major-road traveled way is 14.5’ – AASHTO 2018, Section 9.5.3.2 (Case B – Intersections with Stop Control on the Minor Road).

e. Consideration should be given to the location of the decision point (vertex) versus the decision point based on existing pavement markings, such as stop bars. While the location of the decision point does not change the calculated ISD, it will change the layout of the sight triangle, and therefore, may change what is considered an “obstruction” and what is not.