Chapter Six

DESIGN CONTROLS

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Chapter Six

DESIGN CONTROLS

6-1.0 HIGHWAY SYSTEMS

6-1.01 Functional Classification System

The Department's *Highway Design Manual* is based on the functional classification concept. Chapters Two through Five summarize the Department's design criteria for each functional class for rural and urban highways and streets and for the Project Scope of Work.

The Department has functionally classified all public highways and streets within Connecticut. To design a project, the designer should contact the appropriate Department office to determine the predicted functional class of the highway or street.

6-1.01.01 Arterials

Arterial highways are characterized by a capacity to quickly move relatively large volumes of traffic. They are sometimes deliberately restricted in their service to abutting properties. The arterial functional class is subdivided into principal and minor categories for rural and urban areas:

1. Principal Arterials. In both rural and urban areas, the principal arterials provide the highest traffic volumes and the greatest trip lengths. The designer should review the project scope of work and the environmental documents to determine which of the following principal arterials should be used in design and identify its corresponding criteria:

    a. Freeways. The freeway is the highest level of principal arterials. Full control of access, high design speeds and a high level of driver comfort and safety characterize these facilities. For these reasons, freeways are considered a special type of highway within the functional classification system, and separate design criteria have been developed for these facilities.

    b. Expressways. These are divided-highway facilities that are characterized by full or partial control of access. Expressways with full control of access are actually freeways. Partial control of access is characterized by a few at-grade intersections with other public roads, and there may be an occasional private access.

    c. Urban/Rural Arterials. These facilities are usually 2 or 4 lanes with or without a median. Partial control of access is desirable along these facilities. A high level of

geometric design is desirable to move the high traffic volumes quickly and efficiently through an area.

2. Minor Arterials. In rural areas, minor arterials will provide a mix of interstate and interregional travel service. In urban areas, minor arterials may carry local bus routes and provide intracommunity connections, but they will not, for example, penetrate neighborhoods. When compared to the principal arterial system, the minor arterials provide lower travel speeds, accommodate shorter trips and distances and lower traffic volumes but provide more access to property.

6-1.01.02 Collectors

Collector routes are characterized by a roughly even distribution of their access and mobility functions. Traffic volumes and speeds will typically be somewhat lower than those of arterials. In rural areas, collectors serve intraregional travel needs and provide connections to the arterial system. All cities and towns within a region will be connected. In urban areas, collectors act as intermediate links between the arterial system and points of origin and destination. Urban collectors typically penetrate residential neighborhoods and commercial and industrial areas. Local bus routes will often include collector streets.

6-1.01.03 Local Roads and Streets

All public roads and streets not classified as arterials or collectors will have a local classification. Local roads and streets are characterized by their many points of direct access to adjacent properties and their relatively minor value in accommodating mobility. Speeds and volumes are usually low and trip distances short. Through traffic is often deliberately discouraged.

6-1.02 Federal-Aid System

The following sections briefly describe the current Federal-aid system.

6-1.02.01 National Highway System

The National Highway System (NHS) is a system of those highways determined to have the greatest national importance to transportation, commerce and defense in the United States. It consists of the Interstate highway system, logical additions to the Interstate system, selected other principal arterials, and other facilities that meet the requirements of one of the subsystems within the NHS. The NHS represents approximately 4%-5% of the total public road miles in the United States. Specifically, the NHS includes the following subsystems (note that a specific highway route may be on more than one subsystem):

1. Interstate. The Interstate system of highways has a separate identity within the NHS. There are also provisions to add miles to the existing Interstate subsystem.

2. Other Principal Arterials. These are highways in rural and urban areas that provide access between an arterial and a major port, airport, public transportation facility or other intermodal transportation facility.

3. Strategic Highway Network. This is a network of highways that are important to the United States' strategic defense policy and that provide defense access, continuity and emergency capabilities for defense purposes.

4. Major Strategic Highway Network Connectors. These are highways that provide access between major military installations and highways that are part of the Strategic Highway Network.

6-1.02.02 Surface Transportation Program

The Surface Transportation Program (STP) is a block grant type program that may be used by the State and localities for any roads (including NHS facilities) that are not functionally classified as local routes. These roads are collectively referred to as Federal-aid roads. Bridge projects using STP funds are not restricted to Federal-aid roads, but may be used on any public road. Transit capital projects and public bus terminals are also eligible under the STP program.

6-1.02.03 Bridge Replacement and Rehabilitation Program

The Bridge Replacement and Rehabilitation Program (BRRP) has a separate identity within the Federal-aid program. BRRP funds are eligible for work on any bridge on any public road regardless of its functional classification.

6-1.03 Classification by Type of Area

The functional classification system is based on urban or rural designation. For a highly developed State like Connecticut, this is not sufficient to determine the appropriate project design. Therefore, the design criteria in Chapters Two, Four and Five are further divided by the type of area where the project is located. This refinement to the highway design process will allow the designer to better tailor the project to the constraints of the surrounding environment.

The following sections briefly discuss the classifications by type of area for urban and rural locations. The designer is responsible for determining which type of area is most appropriate for the project under design.

6-1.03.01 Rural Highways and Roads

Chapter Four presents the Department's design criteria for new construction or major reconstruction of rural highways and roads; Chapter Two presents the criteria for 3R non-freeway projects. Many highways in Connecticut are classified as rural but frequently pass

through relatively built-up areas. Therefore, Chapters Two and Four present design criteria based on the extent of roadside development. The tables in the chapters provide criteria for the average number of access points per mile per side. These criteria provide some guidance for the designer, but they should not be considered rigid. In addition, the designer should consider the following narrative descriptions:

1. Open. This fits the traditional concept of a rural area. The driver has almost total freedom of movement and is generally not affected by occasional access points along the highway or road. For the purpose of determining the classification, access points will average less than 15 per mile per side. Right-of-way is usually not a problem.

2. Low/Moderate Density. The roadside development has increased to a level where the prudent driver will instinctively reduce his/her speed as compared to an open highway. The driver must be more alert to the possibility of entering and exiting vehicles, but he/she is still able to maintain a relatively high travel speed. The estimated number of access points will average between 15 and 30 per mile per side. Right-of-way may be difficult to attain.

3. Moderate/High Density. The roadside development has increased to a level that is comparable to a suburban area within an urbanized boundary. The extent of the development will have a significant impact on the selected travel speed of a prudent driver. Exiting and entering vehicles are frequent, and traffic signals are typical at major intersections. The estimated number of access points will average greater than 30 per mile per side. Right-of-way is usually quite difficult to attain.

6-1.03.02 Urban Highways and Streets

Chapter Five presents the Department's design criteria for new construction or major reconstruction of urban highways and streets; Chapter Two presents the criteria for 3R non-freeway projects. The type of area where the project is located subdivides each functional classification table. The designer should consider the following descriptions when selecting the applicable type of area:

1. Suburban. These areas are usually located at the fringes of urbanized and small urban areas. The predominant character of the surrounding environment is usually residential, but it will also include a considerable number of commercial establishments. There may also be a few industrial parks in suburban areas. On suburban roads and streets, drivers usually have a significant degree of freedom but, nonetheless, they must also devote some of their attention to entering and exiting vehicles. Roadside development is characterized by low to moderate density. Pedestrian activity may or may not be a significant design factor. Right-of-way is often available for roadway improvements.

   Local and collector streets in suburban areas are typically located in residential areas, but may also serve a commercial area. Posted speed limits typically range between 25 and 40 mph. The majority of intersections will have stop or yield control, but there will be an occasional traffic signal. A typical suburban arterial will have strip commercial

development and perhaps a few residential properties. Posted speed limits usually range between 35 mph and 50 mph, and there will usually be a few signalized intersections along the arterial.

2. Intermediate. As its name implies, intermediate areas fall between suburban and built-up areas. The surrounding environment may be either residential, commercial or industrial or some combination of these. On roads and streets in intermediate areas, the extent of roadside development will have a significant impact on the selected speeds of drivers. The increasing frequency of intersections is also a major control on average travel speeds. Pedestrian activity has now become a significant design consideration, and sidewalks and crosswalks at intersections are common. The available right-of-way will often restrict the practical extent of roadway improvements.

   Local and collector streets in intermediate areas typically have posted speed limits between 25 and 35 mph. The frequency of signalized intersections has increased substantially when compared to suburban areas. An arterial in an intermediate area will often have intensive commercial development along its roadside. Posted speed limits range between 30 and 40 mph. These arterials typically have several signalized intersections per mile.

3. Built-up. These areas normally refer to the central business district within an urbanized or small urban area. The roadside development has a high density and is often commercial. However, a substantial number of roads and streets in built-up areas pass through a high-density, residential environment (e.g., apartment complexes, row houses). Access to property is the primary function of the road network in built-up areas; the average driver rarely passes through a built-up area for mobility purposes. Pedestrian considerations may be as important as vehicular considerations, especially at intersections. Right-of-way for roadway improvements is usually not available.

   Because of the high density of development in built-up areas, the distinction between the functional classes (local, collector or arterial) becomes less important when considering signalization and speeds. The primary distinction among the three functional classes is often the relative traffic volumes and, therefore, the number of lanes. As many as half the intersections may be signalized; posted speed limits typically range between 25 and 35 mph.

6-2.0 SPEED

6-2.01 Definitions

1. Design Speed. Design speed is a selected speed used to determine the various geometric design features of the roadway. A design speed is selected for each project, which will establish criteria for several design elements including horizontal and vertical curvature, superelevation and sight distance.

2. Low Speed. For geometric design applications, low speed is defined as less than 45 mph.

3. High Speed. For geometric design applications, high speed is defined as greater than or equal to 45 mph.

4. Average Running Speed. Running speed is the average speed of a vehicle over a specified section of highway. It is equal to the length of the highway section divided by the running time required for the vehicle to travel through the section. The average running speed is the distance summation for all vehicles divided by the running time summation for all vehicles.

5. Average Travel Speed. Average travel speed is the distance summation for all vehicles divided by the total time summation for all vehicles. (Note: Average running speed only includes the time the vehicle is in motion. Therefore, on uninterrupted flow facilities that are not congested, average running speed and average travel speed is equal).

6. Operating Speed. Operating speed, as defined by AASHTO, is the speed at which drivers are observed operating their vehicles during free-flow conditions. The 85th percentile of the distribution of observed speeds is the most frequently used measure of the operating speed associated with a particular location or geometric feature.

7. 85th-Percentile Speed. The 85th-percentile speed is the speed below which 85 percent of vehicles travel on a given highway. The most common application of the value is its use as one of the factors, and usually the most important factor, for determining the posted, regulatory speed limit of a highway section. In most cases, field measurements for the 85th-percentile speed will be conducted during off-peak hours when drivers are free to select their desired speed.

6-2.02 Design Speed

Design speed, perhaps more so than any other design control, will have a major impact on all facets of geometric design. Many design elements, such as horizontal and vertical curvature, superelevation and sight distances, are directly dependent on the design speed; i.e., the selected design speed is used directly in the equations for these geometric design elements. Other features, such as lane and shoulder width and clear zones, logically vary with design speed but are not a direct function of the design speed.

Chapters Four and Five present the minimum design speeds for new construction and major reconstruction. The design speed will vary according to functional classification, urban/rural location and type of area. Chapter Two presents the Department's policy for determining the design speed on 3R non-freeway projects. Design speeds are selected at 5-mph increments.

The following should be evaluated when determining the project design speed:

1. Balance. The selected design speed should be a reasonable balance between topography, urban or rural character, and the functional use of the highway. The designer must weigh the benefits of a desired degree of safety, mobility and efficiency against the environmental, right-of-way and cost impacts.

2. Driver Expectancy. The element of driver expectancy should be considered when selecting the design speed. The driver expects to be able to drive at certain maximum speeds based on the functional and rural or urban character of the highway. Therefore, the design speed should fit the travel desires and habits of the great majority of drivers. Driver expectancy should also be considered where design speed transitions are introduced. If a difficult condition is obvious, drivers are more likely to accept a lower speed than if there is no apparent reason for it.

3. Traffic Volumes. This may also impact the selection of design speed. With all other factors equal, a higher volume highway may justify a higher design speed because of the increased capacity and savings in vehicular operating costs. However, the designer should consider that at low volumes drivers are likely to travel at higher speeds. Therefore, the values in Chapters Four and Five are applicable to a wide range of traffic volumes.

4. Consistency. When a substantial length of highway is under design, the designer should assume a constant design speed. Where restrictive conditions dictate a lower design speed, it should be introduced gradually over a sufficient distance to transition drivers down to the lower speed.

5. Design Speed as Minimum Control. Although the selected design speed establishes the minimum criteria for highway alignment, the designer should consider providing flatter horizontal curves and longer sight distances if compatible with community objectives. Even in difficult terrain, an occasional tangent or flat curve may be appropriate. The designer should also be especially careful when providing a long tangent on any highway and then minimum radii at the end of the tangent. A lengthy tangent section may encourage a driver to exceed the design speed of the horizontal curve.

6. Posted Speed Limit. For all new construction/major reconstruction projects, the selected design speed should equal or exceed the anticipated posted or regulatory speed limit of the completed facility. This requirement recognizes the important relationship between likely travel speeds and the highway design. It also recognizes that a posted speed limit creates a definite driver expectation of safe operating speed. The design speeds in Chapters Four and Five and the procedure in Chapter Two for 3R non-freeway projects

are intended to achieve this objective. Section 6-2.03 discusses the Department's policy on determining the posted speed limit.

6-2.03 Posted Speed Limit

The Traffic Engineering Division is responsible for recommending to the State Traffic Commission the posted speed limit on all State highways. It also typically assists or advises municipalities in determining the posted speed on other public roads and streets. The Traffic Engineering Division conducts an engineering evaluation of each site. The following factors are evaluated:

1. the 85th percentile speed,
2. roadway geometrics,
3. functional classification and type of area,
4. type and density of roadside development,
5. crash experience, and
6. pedestrian activity.

6-3.0 HIGHWAY CAPACITY

6-3.01 Definitions

1. AM/PM Peak Volumes. The one-hour volumes for each movement at an intersection or interchange in the morning and evening. Both AM/PM Peak Volumes should be used for intersection and interchange analyses in suburban and urban areas where traffic volumes are high.

2. Average Annual Daily Traffic (AADT). The total yearly volume in both directions of travel divided by the number of days in the year.

3. Average Daily Traffic (ADT). The calculation of average traffic volumes in both directions of travel in a time period greater than one day and less than one year and divided by the number of days in that time period. Although not precisely correct, ADT is often used interchangeably with AADT. The use of ADT could produce a bias because of seasonal peaks.

4. Capacity. The maximum sustainable flow rate at which vehicles can reasonably be expected to traverse a point or uniform section of a road during a given time period under prevailing roadway, traffic and control conditions. The time period most often used for analysis is 15 minutes.

5. Delay. A critical performance measure on interrupted flow facilities, especially at signalized intersections. For this element, average stopped-time delay is measured, which is expressed in seconds per vehicle.

6. Density. The number of vehicles occupying a given length of lane, averaged over space. It is usually expressed as vehicles per mile (vpm) per lane.

7. Design Hourly Volume (DHV). The 1-hr volume in both directions of travel in the design year selected for determining the highway design. Section 6-3.02 discusses the Department's policy for selecting the DHV for highway design. The 30th highest hourly volume is normally used for design.

8. Directional Design Hourly Volume (DDHV). The 1-hr volume in one direction of travel in the selected design year.

9. Directional Distribution (D). The division, by percent, of the traffic in each direction of travel during the design hour.

10. K. The ratio of DHV to AADT. K will vary based on the hour selected for design and the characteristics of the specific highway facility.

11. Level of Service (LOS). A qualitative concept that has been developed to characterize acceptable degrees of congestion. LOS is used to describe operational conditions within a traffic stream based on service measures such as speed, travel time and delay. In the *Highway Capacity Manual*, the qualitative descriptions of each level of service (A to F) have been converted into quantitative measures for the capacity analysis for each

highway element (e.g., freeway, signalized intersection). Chapters Four and Five present guidelines for selecting the level of service for highway design. These apply to all highway elements (mainline, intersections, weaving areas, etc.)

12. Peak-Hour Factor (PHF). A ratio of the total hourly volume to the maximum 15-min rate of flow within the peak hour.

13. Rate of Flow. The equivalent hourly rate at which vehicles pass over a given point or section of a lane or roadway during a given time interval less than one hour, usually 15 min.

14. Service Flow Rate. The maximum hourly vehicular volume that can reasonably pass through a highway element under prevailing roadway traffic and control conditions while maintaining a designated level of service.

15. Truck Factor (T). A factor that reflects the percentage of heavy vehicles (trucks, buses and recreational vehicles) in the traffic stream during the DHV, ADT and/or AADT. The poorer operating capabilities and larger size of heavy vehicles must be reflected in the capacity analysis.

6-3.02 Selection of Design Hourly Volume

For most geometric design elements that are impacted by traffic volumes, the peaking characteristics are most significant. The highway facility should be able to accommodate the predicted traffic volumes for the great majority of time at the selected level of service. An analysis of peaking trends has led to the conclusion that the 30th highest hourly volume (30 HV) in the selected design year is a reasonable design control. This design hourly volume (DHV) will affect many design elements including the number of travel lanes, lane and shoulder width, and intersection geometrics.

A highway should be designed to accommodate the traffic that might occur within the life of the facility under reasonable maintenance. This involves projecting the traffic conditions for a selected future year. For new construction and major reconstruction, traffic volume projections are usually based on 20 years from the expected construction completion date. This is a reasonable compromise between a facility's useful life, the uncertainties of long-range projections and the consequences of inaccurate projections.

For 3R non-freeway projects, the designer should provide a highway facility that, desirably, will accommodate the DHV for ten years in the future at the selected level of service. At a minimum, the highway facility should accommodate current traffic volumes at the selected level of service. Chapter Two discusses the geometric design of 3R non-freeway projects in detail.

Bridge design life is considered to be approximately 50 years. This should be considered in the geometric design of bridges and in the design of roadways that pass beneath a bridge.

The designer should analyze the proposed design using the a.m. and p.m. DHVs separately. This could have an impact on the geometric design of the highway.

The Office of Inventory and Forecasting in the Bureau of Policy and Planning prepares traffic forecasts for DHV, AADT, directional distribution and percentage of heavy vehicles. A simple traffic analysis would be predicting the 30th highest hourly volume in 20 years by applying the traffic growth factors to present volumes. The forecaster must also incorporate the impact of any anticipated land development or traffic diversions onto or away from the facility. In addition, the forecaster must determine the traffic characteristics of directional distribution and composition specifically during the DHV. For intersections and interchanges, DHV forecasts must be made for every possible through and turning movement.

6-3.03 Capacity Analyses

The highway mainline, intersection or interchange should be designed to accommodate the selected design hourly volume (DHV) at the selected level of service. This may involve adjusting the various highway factors that affect capacity until a design is developed that will accommodate the DHV. The detailed calculation factors and methodologies are in the *Highway Capacity Manual* (HCM). In reality the design service volume of the facility should be calculated. Capacity assumes a level of service E; design service volume is the maximum volume of traffic that a projected highway of designed dimensions is able to serve without the degree of congestion falling below a preselected level.

6-4.0 ACCESS CONTROL

Access control is defined as the condition where the public authority fully or partially controls the right of abutting owners to have access to and from the public highway. The functional classification of a highway (Section 6-1.0) is partially determined by the degree of access it allows. Access control may be exercised by statute, zoning, right-of-way purchases, driveway controls, turning and parking regulations, or geometric design (e.g., grade separations and frontage roads).

Chapters Two, Three and Four provide the typical degree of access control for the various functional classes and for the type of area. The following provides definitions for the three basic type

1. Full Control. Full control of access is achieved by giving priority to through traffic by providing access only at grade separation interchanges with selected public roads. No at-grade crossings or private driveway connections are allowed. The freeway is the common term used for this type of highway. Full control of access maximizes the capacity, safety and vehicular speeds on the freeway.

2. Partial Control. Partial control of access is an intermediate level between full control and regulatory restriction. Priority is given to through traffic, but a few at-grade intersections and private driveway connections may be allowed. The proper selection and spacing of at-grade intersections and service connections will provide a balance between the mobility and access service of the highway.

3. Control by Regulation. All highways warrant some degree of access control. If access points are properly spaced and designed, the adverse effects on highway capacity and safety will be minimized. These points should be located where they can best suit the traffic and land-use characteristics of the highway under design. Their design should enable vehicles to enter and exit safely with a minimum of interference to through traffic.

The Department and all Connecticut municipalities exercises control by regulation to determine where private interests may have access to and from the public road system. Occasionally, statutory control is used on arterials to restrict access to only public roads and major traffic generators. Zoning may be used to effectively control the adjacent property development so that major generators of traffic will not develop. However, zoning restrictions are at the discretion of the local government. Driveway regulations and permits are used to control the geometric design of an entrance, driveway spacing and driveway proximity to public road intersections. Section 11-8.0 discusses the applicable criteria for driveway design. The Department's *Highway Encroachment Permit Regulations* discusses the procedures and design criteria for obtaining driveway permits onto State highways.

6-5.0 PROJECT SCOPE OF WORK

6-5.01 Description

The scope of work for the proposed highway project is a major control in highway design. The project scope of work will reflect the basic intent of the highway project and will determine the overall level of highway improvement. New construction and reconstruction projects will often have significant impacts (e.g., considerable right-of-way involvement). In contrast, 3R non-freeway projects typically restrict improvements to the existing right-of-way. The decision on the project scope of work will determine the use of the Department's *Highway Design Manual*.

The following descriptions are intended to provide guidance for the determination of the project scope of work.

6-5.01.01 New Construction

New construction is defined as the following for the various highway elements:

1. Highway Mainline. New horizontal and vertical alignment on new location is considered new construction of a highway mainline. Chapters Four and Five present the Department's criteria for new construction.

2. Intersections At-Grade. Any intersection that falls within the project limits of a new highway mainline is considered new construction. Likewise, any existing intersection that is relocated to a new point of intersection is considered new construction. Chapter Eleven presents the Department's criteria for the new construction of intersections; Chapters Four and Five present the Department's criteria for the width of cross-section elements within the intersection (e.g., auxiliary lane width).

3. Interchanges. Any construction of an interchange on a new highway mainline is considered new construction. In addition, the construction of a new interchange on an existing highway is considered new construction. Chapter Twelve presents the Department's criteria for the new construction of interchanges. Chapters Four and Five present the Department's criteria for the width of cross-section elements for the highway mainline within the interchange.

4. Bridges. Bridges on a new highway mainline are considered new construction for bridges. Chapters Four and Five present the Department's criteria for the width of bridges that are new construction.

6-5.01.02 4R (Freeways)

4R (resurfacing, restoration, rehabilitation and reconstruction) is used to describe any project on an existing freeway. These may or may not involve significant right-of-way acquisitions. 4R freeway projects are defined as the following for the various highway elements:

1. Highway Mainline. 4R work on an existing freeway mainline may include:

   a. lane and shoulder pavement resurfacing;

   b. lane and shoulder pavement reconstruction;

   c. lane and shoulder widening;

   d. addition of through and/or auxiliary lanes;

   e. flattening a selected horizontal or vertical curve;

   f. major reconstruction of the existing alignment;

   g. widening the roadside clear zone;

   h. upgrading the safety appurtenances to meet current criteria;

   i. flattening side slopes;

   j. structural, geometric and/or safety improvements to existing bridges within the project limits;

   k. upgrading the existing drainage system; and/or

   l. traffic management, TSM and upgrading of signing.

   Section 3-1.0 presents the Department's criteria for the design of 4R freeway projects on highway mainline.

2. Interchanges. An existing interchange may be within the project limits of a 4R project, or a 4R project may be initiated solely to improve an existing interchange. The scope of work may range from a total reconstruction of the existing interchange to selected design improvements. Most often, the level of improvement to an existing interchange within larger project limits will be commensurate with the level of improvement to the highway mainline. Therefore, 4R work on an existing interchange might include:

   a. upgrading the interchange type (e.g., converting a cloverleaf to a directional interchange);

   b. adding new connections for movements;

   c. adding collector-distributor roads;

   d. lengthening an existing acceleration or deceleration lane;

   e. improving roadside safety within the interchange limits;

   f. realigning an existing ramp; and/or

g. widening an existing ramp.

Chapter Twelve discusses the Department's criteria for the design of the interchange elements.

3. Bridges. Any work on an existing freeway bridge is considered a 4R project. In addition, a bridge may be within the limits of a 4R project, but no improvement may be proposed. Therefore, the scope of work for a freeway bridge may be one of the following:

   a. bridge replacement, either as an independent project or within the limits of a mainline/interchange 4R project;

   b. bridge rehabilitation/reconstruction, either as an independent project or within the limits of a mainline/interchange 4R project; or

   c. bridge will remain in place within the limits of a mainline/interchange 4R project.

   Section 3-1.0 presents the Department's criteria for 4R freeway bridge projects.

6-5.01.03 Major Reconstruction (Non-Freeway)

Major reconstruction on a non-freeway will usually require significant right-of-way purchases and will often have a major impact on the surrounding area. Major reconstruction is defined as the following for the various highway elements:

1. Highway Mainline. Major reconstruction of an existing highway mainline will typically include reconstruction of the existing horizontal and vertical alignment but will be essentially within the existing highway corridor. The primary reason to perform major reconstruction is because the existing facility cannot accommodate its current or future demands and requires an extensive improvement to provide an acceptable level of service. Any project that increases the basic number of through traffic lanes on an existing road is considered Major Reconstruction. Because of the significant level of work, the geometric design of the project should be determined by the criteria for new construction. Therefore, the values in Chapters Four and Five will be used to design major reconstruction projects.

2. Intersections At-Grade. Any intersection that falls within the limits of a major reconstruction project will also be evaluated for major reconstruction. The scope of work for a project strictly to improve an existing intersection may also be considered major reconstruction if the proposed work is extensive. This could include the:

   a. addition of through and/or auxiliary lanes for all approaches;
   b. relocation and flattening of turning radii;
   c. addition of turning roadways;
   d. flattening the approach and intersection gradients;
   e. realigning the angle of intersection; and/or
   f. rechannelizing the intersection.

Because of the extensive level of work for major reconstruction, the criteria in Chapter Eleven will apply to the design of the intersection. The criteria in Chapters Four and Five apply for the width of the cross-section elements.

3. Interchanges. An existing interchange may be within the project limits of a non-freeway facility that is being redesigned as a major reconstruction project. The interchange should also be evaluated for major reconstruction. This may only apply to those interchange elements that directly impact the safety and operations of the non-freeway facility not the entire interchange. In addition, the scope of work for a project strictly to improve an existing interchange may be considered major reconstruction if the proposed work is extensive. This would apply to an interchange between two non-freeway facilities; if a freeway is one of the intersecting facilities, this will be a 4R project. The major reconstruction of an existing interchange may be characterized by:

   a. upgrading the interchange type (e.g., converting a cloverleaf to a directional interchange);

   b. adding new connections for movements that are currently not provided; and/or

   c. adding collector-distributor roads.

   When major reconstruction is being performed on an existing interchange, the entire interchange should be evaluated according to the criteria in Chapters Four, Five and Twelve.

4. Bridges. "Major reconstruction" on a non-freeway bridge refers to a bridge within the limits of a major reconstruction project. An independent project to perform work solely on a bridge and its approaches is a spot improvement (Section 6-5.01.05). Therefore, the scope of work as it applies to non-freeway bridges and major reconstruction projects may be one of the following:

   a. bridge replacement, either as a spot improvement (Section 3-2.0) or as part of the major reconstruction of a highway mainline (Section 10-4.0);

   b. bridge rehabilitation/reconstruction, either as a spot improvement (Section 3-2.0) or as part of the major reconstruction of a highway mainline (Section 10-4.0); or

   c. bridge will remain in place within the limits of the major reconstruction of a highway mainline (Section 10-4.0).

6-5.01.04 3R (Non-Freeways)

3R (resurfacing, restoration and/or rehabilitation) on non-freeways will typically involve either no or minor right-of-way acquisition (e.g., slivers, an occasional building). A 3R non-freeway project is defined as the following for the various highway elements:

1. Highway Mainline. 3R work on an existing highway mainline is work essentially on the existing highway alignment, but which frequently includes selected improvements to the

highway geometrics. The basic number of through traffic lanes must be the same before and after the project. Typical improvements for 3R projects include:

a. lane and shoulder pavement resurfacing;

b. full-depth reconstruction of the travel lanes up to one third of the project length (total project length may be full-depth reconstruction with approval from the appropriate Division Manager);

c. shoulder pavement reconstruction (for all or part of the project length);

d. lane and shoulder widening;

e. addition of auxiliary lanes;

f. flattening a selected horizontal or vertical curve;

g. widening the roadside clear zone;

h. converting an existing median to include left-turn lanes;

i. revising the location, spacing or design of existing driveways along the mainline;

j. adding or removing parking lanes;

k. adding curbs or sidewalks;

l. structural, geometric or safety improvements to existing bridges within the project limits;

m. relocating utility poles;

n. upgrading safety appurtenances to meet current criteria;

o. upgrading of the existing drainage system; and/or

p. upgrading of signing, pavement markings, traffic signals, etc.

Chapter Two presents the Department's criteria for the design of 3R non-freeway projects.

2. Intersections At-Grade. Any intersection within the limits of a 3R project will be evaluated for 3R-type improvements. In addition, an existing intersection may also be improved as an independent project. This may be considered as either a 3R project or a spot improvement (Section 6-5.01.05).

A 3R project at an existing intersection may include improvements such as:

a. widening the approach roadway width,
b. adding an auxiliary lane,

c. lengthening an existing auxiliary lane,
d. improving the intersection sight distance,
e. flattening the existing turning radii,
f. minor realignment of the intersection angle,
g. adding a turning roadway,
h. widening an existing turning roadway,
i. minor rechannelization,
j. upgrading the existing signal system, and/or
k. upgrading the existing drainage system.

Chapter Two discusses the Department's design criteria for 3R work to an existing intersection. This is primarily a reference to the criteria in Chapter Eleven.

3. Interchanges. An interchange may be within the project limits of a 3R project on a non-freeway facility. The project should also include an evaluation of those interchange elements which directly impact the safety and operations of the non-freeway. 3R-type work to an existing interchange within a 3R project might include:

a. lengthening an existing acceleration or deceleration lane,
b. improving roadside safety within the interchange limits,
c. realigning an existing ramp,
d. widening an existing ramp, and/or
e. improvements to the ramp/non-freeway intersection.

Chapter Twelve discusses the Department's design criteria for interchanges.

4. Bridges. "3R" work on a non-freeway bridge refers to a bridge within the limits of a 3R project. An independent project to perform work solely on a bridge and its approaches is a spot improvement (Section 6-5.01.05). Therefore, the scope of work as it applies to non-freeway bridges and 3R projects may be one of the following:

a. bridge replacement, either as a spot improvement (Section 3-2.0) or as part of a 3R project (Section 2-7.0);

b. bridge rehabilitation/reconstruction, either as a spot improvement (Section 3-2.0) or as part of a 3R project (Section 2-7.0); or

c. bridge will remain in place within the limits of a 3R project (Section 2-7.0).

6-5.01.05 Spot Improvements

These projects are intended to correct a deficiency at an isolated location. This may be an intersection, a horizontal curve, a bridge or a limited roadside section. Many spot improvement projects are safety projects and projects identified by the Highway Bridge Replacement and Rehabilitation Program. Section 3-2.0 discusses the Department's criteria for the design of spot improvement projects.

6-5.01.06 Pavement Resurfacing and Reclamation (Non-Freeways and Non-NHS)

Section 3-3.0 discusses the scope and design criteria for resurfacing and reclamation projects.

6-5.02 Procedures

The procedures for selecting and revising the project scope of work are integrated into the Department's Project Initiation and Project Modification process. These overall procedures are outlined in the *Pre-Construction Management System's (PCMS) User Manual* and Appendix. The following provides additional details specifically for the project scope of work:

1. Planning, Project Concept, Traffic, Maintenance, Design or other groups may initiate projects. When the RPM is prepared, the initiating unit will select the project scope of work.

2. The Project Initiation is prepared based on the approved project scope of work.

3. When the project is initiated, the designer will begin work on the project. At any time during design, the designer may recommend to revise the project scope of work based on an evaluation of actual field conditions. The Scoping Committee must then approve the revised scope. Once approved, the designer must prepare a Recommended Project Modification to document and justify the revised project scope of work. The modification is then submitted to the appropriate office director for approval. From this point, the processing of the modification is similar to that of the RPM.

6-6.0 EXCEPTIONS TO GEOMETRIC DESIGN CRITERIA

This Section discusses the Department's procedures for identifying, justifying and processing exceptions to the geometric design criteria in the *Highway Design Manual*.

6-6.01 Department Intent

The general intent of the Connecticut Department of Transportation is that all design criteria in this *Manual* should be met. Where a range of values is presented, the designer should use the upper values within the range where the cost, social, economic, community and environmental impacts are not critical. This is intended to ensure that the Department will provide a highway system that meets the transportation needs of the State and provides a reasonable level of safety, comfort and convenience for the traveling public. However, recognizing that this will not always be practical, the Department has established a process to evaluate and approve exceptions to geometric design criteria.

6-6.02 Controlling Design Criteria

Controlling design criteria are those highway design elements that are judged to be the most critical indicators of a highway's safety and its overall serviceability. Obviously, not all design criteria in the Department's *Highway Design Manual* are equally important. Therefore, the Department and FHWA have identified those design elements that qualify as controlling criteria and, therefore, must complete the formal documentation and approval process when not met.

The designer is also responsible for meeting the other design criteria in the *Manual*, if practical. These criteria represent good engineering practice, and the designer should make every reasonable effort to meet these criteria on all projects.

The following establishes the controlling criteria for the design exception process:

1. design speed;
2. travel lane and shoulder widths;
3. auxiliary lane and shoulder widths;
4. bridge widths;
5. structural capacity;
6. horizontal alignment:
    a. minimum radii, and
    b. compound curves which do not meet the 1.5:1 ratio;
7. vertical curvature based on:

a. level SSD at crests, and

b. level SSD at sags;

8. maximum grades;

9. stopping sight distance (based on level grades);

10. cross slopes;

11. superelevation:

a. rate based on emax = 6.0%, and

b. transition lengths;

12. vertical clearances;

13. accessibility requirements for disabled individuals;*

14. roadside clear zones; and**

15. intersection sight distance, see Section 11-2.02.**

The designer is encouraged to use the Department's recommended design speed and then seek design exceptions for individual elements that do not meet the applicable criteria for that design speed (e.g., minimum radius, SSD at crest vertical curve).

6-6.03 Application

6-6.03.01 Project Scope of Work

This design exception process will apply to:

1. all new construction projects,

2. all major reconstruction projects,

3. all 3R projects, and

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* *No design exceptions are permitted which do not meet CGS Sections 7-118a and 14-253a or which do not meet the Americans with Disabilities Act (Public Law 101-336*).

** *Not FHWA controlling design criteria. Not controlling design criteria for projects designed by municipalities (or their consultants) on facilities owned and maintained by the municipality except where they intersect with State highways.*

4. bridge widths, underpass widths and vertical clearances on spot improvement projects which involve work on a bridge. For other design elements, the design exception process will apply to spot improvements as discussed in Section 3-2.02.

6-6.03.02 Highway System/Funding Source

The design exception process will apply as follows:

1. NHS. The process will apply to all projects on the National Highway System regardless of the source of funding.

2. Non-NHS/State Highway System. The process will apply to all projects on State highways not on the NHS regardless of the source of funding.

3. Off State Highway System. The process will apply to all projects off the State highway system that include Federal and/or State funds. It will not apply to projects off the State highway system with 100% local funds.

6-6.04 Procedures for Exceptions

The designer will not request an exception to controlling design criteria until he/she has evaluated the impacts of providing the minimum or better design values. If these impacts are judged to be unacceptable, then the designer can initiate the exception process. The designer's goal will be to identify and seek approval of design exceptions as early in the final design phase as practical.

The following establishes the procedures the highway designer should follow for all proposed exceptions to design criteria:

1. The designer should present information to demonstrate the impacts of meeting the minimum or lower design criteria. This can include but is not limited to:

   a. construction costs,
   b. environmental consequences,
   c. right-of-way impacts, and
   d. community involvement/concerns.

2. The designer should provide sufficient information to demonstrate the consequences of using a design value that does not meet the minimum criteria. Where appropriate, this may include but is not limited to:

   a. impacts on traffic serviceability (i.e., level of service);
   b. impacts on safety (i.e., crash history);
   c. impacts on traffic operations; and
   d. impacts on future maintenance.

3. The designer should prepare a written summary of the information and submit it to the appropriate Division Manager for review.

4. The designer will then arrange a meeting through the office of the Engineering Administrator to discuss all proposed design exceptions. The Engineering Administrator, Division Manager and the Project Manager and/or Engineer will usually attend the meeting. The FHWA will also be represented for projects that require full FHWA oversight.

6-7.0 REFERENCES

1. *A Policy on Geometric Design of Highway and Streets*, AASHTO, 2001.

2. *Highway Capacity Manual*, TRB, 2000.

3. *Code of Federal Regulations 23*, Office of the Federal Register, published April 1 of every year.