Chapter 2

CONTEXT SENSITIVE SOLUTIONS

SOUTH CAROLINA ROADWAY DESIGN MANUAL

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Chapter 2
CONTEXT SENSITIVE SOLUTIONS

The Context Sensitive Solutions (CSS) process is based on the concept that transportation projects should consider the context of their existence — not just the study area's physical boundaries. As defined on the Federal Highway Administration (FHWA) CSS website, CSS:

> *…is a collaborative, interdisciplinary approach that involves all stakeholders to develop a transportation facility that fits its physical setting and preserves scenic, aesthetic, historic and environmental resources, while maintaining safety and mobility. CSS is an approach that considers the total context within which a transportation improvement project will exist. CSS principles include the employment of early, continuous and meaningful involvement of the public and all stakeholders throughout the project development process.*

CSS recognizes how a highway or road is integrated within a community, can have far-reaching impacts (positive and negative) beyond its traffic or transportation function. This chapter provides guidance on the key principles and qualities of the CSS approach. It also includes references to additional information sources that provide further details and guidance on implementing the approach.

2.1 CSS RESOURCES

2.1.1 23 USC 109 "Standards"

Section 109(c)(1) of the *United States Code*, enacted by the 1995 *National Highway System Designation Act*, provides that a design for new construction, reconstruction, resurfacing (except for maintenance resurfacing), restoration or rehabilitation of highways on the National Highway System (other than highways also on the Interstate System) may take into account the constructed and natural environment of the area; the environmental, scenic, aesthetic, historic, community and preservation impacts of the activity; and access for other modes of transportation.

Section 109(c)(1), enacted by the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users* (SAFETEA-LU) and retained in the *Moving Ahead for Progress in the 21st Century Act* (MAP-21) authorizes the US Department of Transportation to consider the characteristics and qualities of CSS in establishing standards to be used on the National Highway System.

2.1.2 FHWA *Flexibility in Highway Design*

This 1997 FHWA publication provides guidance for highway engineers and project managers who want to learn more about the flexibility available when designing roads. The document was developed to provoke innovative thinking considering the scenic, historic, aesthetic and other cultural values, along with the safety and mobility needs of the highway transportation system.

2.1.3 NCHRP Report 480 *A Guide to Best Practices for Achieving Context Sensitive Solutions*

This 2003 publication provides detailed guidance for implementing the CSS approach. It includes sections on:

- effective decision making,
- reflecting community values,
- achieving environmental sensitivity,
- ensuring safe and feasible solutions,
- organizational needs, and
- case studies in Context Sensitive Design/Context Sensitive Solutions.

2.1.4 NCHRP Report 642 *Quantifying the Benefits of Context Sensitive Solutions*

This 2009 publication provides guidelines for determining the benefits of CSS. The key topics discussed include:

- introduction to the approach of benefit quantifications for projects;
- application requirements, standardize methods and data collection tools;
- project evaluation example illustrating a complete application;
- the action principles of CSS project development; and
- the principle-associated benefits of CSS.

2.1.5 AASHTO *Guide for Achieving Flexibility in Highway Design*

This 2004 AASHTO publication provides guidance for designers on how to think flexibly, recognize the many choices and options, and arrive at the best solution for a particular context.

2.1.6 FHWA CSS Website

This website includes links to information explaining CSS and its history, current CSS-related activities, guidance on CSS issues, and numerous other CSS resources.

2.1.7 Context Sensitive Solutions Website

The Context Sensitive Solutions website provides a Context Sensitive Solutions Resource Center that includes information and links for a broad range of CSS topics. It was created by Project for Public Spaces in collaboration with Scenic America to assist FHWA in integrating CSS into project planning, development and implementation.

2.1.8 Center for Environmental Excellence by AASHTO Website

This website addresses the following topics:

- Background (What is CSS? Where Did CSS Come From?)

- Why is CSS Important to Transportation Agencies?
- What Steps Can Help Institutionalize and Integrate CSS?
- Where Does CSS Apply in Program and Project Delivery?
- Links to CSS-Related Laws, Policies and Guidance.

2.1.9 SCDOT Traffic Calming Guidelines

This publication provides guidance to SCDOT personnel and local governments concerning traffic calming. The document details eligibility requirements, application forms, various traffic calming measures, construction specifications and web links to traffic calming resources.

This document is located on the Department's internet site.

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2.2 DESIGN TREATMENTS

This section highlights appropriate CSS treatments for both construction and maintenance elements of a road corridor and is intended to guide designers and planners working on a project. These suggested treatments do not include all potential solutions for the multitude of projects designed and constructed. They are presented as guidance that can be used for improvements or providing enhancement. The designer needs to use engineering judgement in determining the appropriate action for the design.

The suggested treatments provide guidance by exploring design solutions that are context-sensitive and consider stakeholder interest. Appropriate treatments for each project should result from a process where cost, regulatory considerations, design guidelines and safety are taken into account. Roadside elements can dramatically affect a roadway's character. When working within roadways, mobility and safety are the primary transportation concerns, while context, visual quality and traveler experience are equally important to stakeholders. Designers should become acquainted with best practices in transportation to help identify the right solutions and consider flexibility when developing an appropriate solution for the task. Review the resources listed in Section 2.1 for additional options.

2.2.1 Vision

A project vision, including purpose and need, should be developed and clearly documented early in the process. Developing the project vision should include input from project stakeholders and multi-modal transportation plans adopted by MPOs and COGs. This vision should then guide the project development decisions. Project team members, from project planning, design, rights of way, construction, maintenance and traffic should appreciate the importance of each function and agree to the project vision in order to successfully achieve that vision.

The project purpose can include other secondary, but important factors to the community that may influence the design, choice or success of the solutions. For example, the aesthetic appearance of safety improvements in the transportation system can affect the use, and hence, the intended benefit of such features as crosswalks or bridges.

2.2.2 Public Involvement

The cornerstone of successful CSS is public involvement. Effective public involvement encourages the exploration of issues from a variety of perspectives. Stakeholders need to be identified at the beginning and during the planning, programming and development processes, and be involved throughout these processes. Open collaboration and exchange of information and concerns between the transportation planners, designers and stakeholders promotes buy-in to project outcomes and trust among stakeholders.

This process includes talking, listening, teaching and learning. While projects are not expected to be unanimously endorsed by every citizen, the Department is committed to providing users with projects that meet their needs and fit into their communities. Good communication throughout the project and using appropriate tools to develop consensus among project stakeholders helps achieve support.

2.2.3 Design Exceptions

Designers are faced with many complex tradeoffs when designing highways and streets. A good design balances cost, safety, mobility, social and environmental impacts, and the needs of a wide variety of roadway users. Good design is also context-sensitive — resulting in streets and highways that are in harmony with the natural and social environments through which they pass.

It must be recognized, however, that to achieve the balance described above, it is not always possible to meet design criteria. Establishing design criteria that cover every possible situation, each with a unique set of constraints and objectives, is not possible. On occasion, designers encounter situations in which the appropriate solution may suggest that using a design value or dimension outside the normal range of practice is necessary. Arriving at this conclusion requires the designer to understand how design criteria affect safety and operations. For many situations, there is sufficient flexibility within the design criteria to achieve a balanced design and still meet minimum values. However, when this is not possible, a design exception may be the best option. See Section 3.2 for guidance on design exceptions.

2.2.4 Flexibility

The setting and character of the area, the values of the community, the needs of the highway users, and the challenges and opportunities are unique factors that designers must consider with each highway project. Whether the design to be developed is for a modest safety improvement or 10 miles of new-location highway, there are no patented solutions. For each potential project, designers are faced with the task of balancing the need for the highway improvement with the need to safely integrate the design into the surrounding natural and human environments. Design elements to consider include road alignment, roadside structures, sidewalks, shared-use paths, landscaped medians and street trees, traffic signs, utility facilities, site furniture and bridge design.

This *Manual* recognizes the need for flexibility and provides that flexibility (e.g., low-volume rural roads or residential areas versus higher volume rural or urban facilities). The formulation of these values demonstrates considerable flexibility.

2.2.5 Central Business District

A central business district (CBD) is the commercial, business and transportation network center of a city or town. In larger cities, it is often synonymous with the city's "financial district." Geographically, it often coincides with the "city center" or "downtown," but the two concepts are separate. Many cities have a central business district that is located away from its commercial or cultural city center or downtown. CBDs typically have development immediately adjacent to the right-of-way line with sidewalks from the curb to the business fronts.

2.2.6 Expanded Context Classification

In A Policy on Geometric Design of Highways and Streets 2018 (2018 Green Book), AASHTO introduced an expanded context classification system. In addition to the traditional rural and urban classifications AASHTO included definitions for rural towns, suburban and urban core. The expanded system was originally introduced in NCHRP Report 855: An Expanded Functional Classification System for Highways and Streets. Reviewing the expanded classification systems

will give designers additional insights into appropriate design elements for their project. The 2018 Green Book provides guidance on how the CBD concept relates to the context classification.

2.2.7 Driver Expectancy

Driver expectancy relates to the readiness of the driver to respond to events or the presentation of information. It can be defined as an inclination, based on previous experience, to respond in a set manner to a roadway or traffic situation. It should be stressed that the initial response is to the expected situation rather than the actual one.

There are certain elements in the design of various components of the roadway that particularly affect design consistency, driver expectancy and vehicular operation. These components include horizontal and vertical alignment, embankments and cut slopes, shoulders, crown and cross slopes, superelevation, bridge widths, signing, delineation and guardrail.

2.2.8 Design Consistency

Design consistency is achieved when the geometric features of the roadway are consistent with the operational characteristics expected by the driver. Inconsistencies normally relate to:

- changes in design speed,
- changes in cross section, and/or
- incompatibility in geometry and operational requirements.

Variations in design speed may occur on a given stretch of roadway where portions of the highway have been constructed as separate projects over an extended time period. Inconsistencies may include changes in criteria or SCDOT policy, reclassification of the facility or financial feasibility.

Driver expectancies are formed through experience and training. The successful response to situations that generally occur in the same way is an important part of the driver's store of knowledge. The following are two major types of design inconsistencies relative to cross sections:

1. Service Inconsistencies. Service inconsistencies may include:

    - cross-sectional differences within a given section of highway that are untypical of the area (e.g., one bridge, among many, that does not have full shoulder widths);
    - a short two-lane section on a multilane segment of a highway;
    - a single lane drop on a section of highway that does not have any other lane drops; or
    - a left exit on a freeway where all other exits are from the right.

2. Alignment Inconsistency. Cross-sectional inconsistencies are usually the result of upgrading a highway cross section without upgrading the alignment. Pavements may be widened and shoulders added on an existing two-lane highway. The wider cross section might convey a conflicting message to the driver and lead to an inappropriate expectancy based on the visual aspects of the cross section. However, widening alone can

measurably improve the safety characteristics of a road, particularly on very narrow, low-volume roads. Designers should be aware of potential inconsistencies that frequently can be overcome with relatively low-cost treatments. Pavement markings, warning signs and delineation devices can be very helpful to the driver when roads are widened on existing alignments.

Incompatibility in geometric and operational requirements may result even when geometric components are appropriately selected. For example, a direct entry ramp is designed to permit vehicular entry into the stream of traffic without coming to a complete stop; however, the vehicle is forced to stop when a gap in the through traffic stream is not immediately available.

2.2.9 Lane Width

Lane width has an influence on the safety and comfort of the driver. The physical dimensions of cars and trucks, speeds, highway type and vehicle type influence the width of the travel lanes. The normal through lane width is 10 feet to 14 feet, and for auxiliary lanes 9 feet to 12 feet, depending on percent of truck usage. Lane width ranges are provided in Chapters 14, 15, 16, 17 and 18.

Wider lane widths are typically associated with higher speed roadways (e.g., freeways, arterials). As speed and traffic volumes increase, additional lane width is desirable to accommodate the variations in lateral placement of the vehicle within the lane. Greater lane widths better accommodate wider vehicles in the traffic stream (e.g., trucks, buses, recreational vehicles). Wider lane widths also marginally increase the capacity of the roadway.

For lower speeds, lower volume roads and streets with little or no truck traffic, through lane widths as narrow as 10 feet may be acceptable; lane widths less than 12 feet are considered adequate for a wide range of volume, speed and other conditions. Design for lane width should include consideration of the horizontal alignment. Adequate lane width is very important along horizontal curves because vehicles off-track, which means that their paths exceed the width of the vehicle. See Section 5.2.6. They require additional room to avoid encroaching into the opposing traffic, adjacent travel lanes and/or the shoulder, which may also be used by pedestrians and/or bicyclists. Increased lane width reduces the demands placed on the motorists by reducing the amount of concentration needed to stay within the travel lane.

In urban areas and along rural routes that pass through urban settings, narrower lane widths may be appropriate. For these locations, space is limited and lower speeds are desired. Narrower lane widths for urban streets lessen pedestrian crossing distances, enable the provision for on-street parking and transit stops, and enable the development of left-turn lanes for safety. Lesser widths also tend to encourage lower speeds, an outcome that may be desirable in urban areas. In considering the use of narrower lanes, designers should recognize that narrow travel lanes reduce vehicle separation from other vehicles and bicyclists.

2.2.10 Shoulder Width

Shoulders, whether paved or unpaved, serve a variety of functions. Shoulders:

- provide structural support for the traveled way;

- provide space for emergency storage of disabled vehicles, enforcement and maintenance activities;
- provide an area for drivers to maneuver to avoid crashes;
- improve bicycle accommodation;
- increase safety by providing a stable, clear recovery area for drivers who have left the travel lane;
- improve stopping sight distance;
- store and carry water; and
- improve capacity by increasing driver comfort.

Shoulder widths typically vary from 2 feet to 12 feet. Regardless of width and surfacing, shoulders should be flush with the roadway surface and sufficiently stable to support vehicular use in all kinds of weather without rutting. Criteria for shoulder widths are provided in Chapters 14, 15, 16, 17 and 18. Wider shoulder widths should be provided to accommodate bicyclists on SC Touring Routes and routes designated by a bicycling plan adopted by an MPO or COG.

Where a full-width shoulder cannot be achieved, the designer should strive to provide as wide a shoulder as practical that meets its functional requirements. Major functions of the shoulder are to provide sight distance and serve as part of the clear zone. Mitigating a narrow shoulder can include the provision of a wider clear zone or flatter side slope to partially counteract the loss of the shoulder. The use of traversable ditch designs may also be appropriate where narrow shoulders are used. Sight distance can be mitigated by revising cut slopes, shifting horizontal alignment, revising vertical alignment or geometric improvements.

Another important function is the storage of disabled or stopped vehicles. If a full, continuous shoulder is not possible, designers should at least seek to provide intermittent full-width turnouts, especially on higher-volume, high-speed roads. The provision for full or at least operationally functional shoulder widths associated with vehicle refuge and law enforcement supports incident management.

2.2.11 Road Alignment and Design Speed

The horizontal and vertical alignment of a roadway greatly affects the driver's experience and contributes to the scenic features of the corridor. Many South Carolina roadways are characterized by the road's curving nature as it follows the topography of the natural landscape. In some circumstances, where vehicles move faster than the roadway's ability to safely accommodate them, these undulating roadways may have a higher number of crashes.

In addition to safety concerns, roads historically evolve in response to an increase of use. Alignments are straightened for improved visibility, shoulders are paved and roadways are widened to accommodate turning or passing lanes. While these changes are made to improve mobility and safety, they can affect the original visual appeal of the roadway and detract from the driver's experience.

While evaluating the safety and mobility considerations associated with road realignment is vital, maintaining character defined features is equally important.

Because many current South Carolina roadways are in rural areas where traffic volumes do not approach the capacity of the roadway, safety is the driving force behind most alignment decisions

along those roadways. When safety is an issue, there are two basic ways for designers to consider the relationship between operating speed and road design:

1. Traditional Engineering Approach. The road's existing horizontal alignment, vertical alignment and/or typical section are inadequate to safely convey traffic at anticipated volumes and speeds. For this reason, the road should be straightened and/ or widened to enhance safety, which may affect the valued character-defining features of the roadway.

2. Alternative Approach. Traffic is traveling too fast to negotiate safely the roadway's alignment and width. For this reason, the designer should consider reducing operating speeds to enhance safety as well as preserve roadway character-defining features.

The key to both approaches is the selection of an appropriate design speed. Design speed is arguably the most important design control used in selecting standards for the design of a roadway segment. The appropriate target speed should be based on land use conditions, building densities, environmental context and the needs of users. See Section 3.5.2 for guidance on selecting design speeds. Designers should seek consistency among all aspects of the roadway, its context and the chosen design speed.

The core principle is that the design speed should not be lower than the anticipated operating speed. However, selection of the anticipated operating speed is critical. It need not (and, in fact, should not) be based solely on the current speed limit or existing measured speed. Future operating speed, for example, can be safely influenced by the design of the roadway.

Selection of a lower design speed within the parameters of terrain, land use and functional classification may reduce the need for adjustments to horizontal alignment, vertical alignment and typical section. This can reduce impacts and project costs while still ensuring appropriate roadway safety and capacity while preserving the character-defining features of the roadway.

Along local streets, the designer may also include traffic calming measures. Traffic calming measures tend to be more appropriate along urban or small-town portions of roadways, and their aesthetic effects on the surrounding landscape should be considered. In contrast with passive techniques (e.g., lane widths) traffic calming measures actively reduce the speed of vehicles through horizontal and vertical geometry. For additional guidance, see the *SCDOT Traffic Calming Guidelines*.

2.2.12 Roadside Barriers

Wide varieties of traffic barriers are available for installation along highways and streets, including both longitudinal barriers and crash cushions. Design of traffic barriers is an important detail that contributes to the overall look of the roadway; therefore, in addition to safety, the selection of an appropriate barrier design should include aesthetic considerations. Because aesthetic considerations are usually a factor, many barriers are designed to add to the visual quality while meeting crash test criteria for facilities with truck traffic. Given these options, designers must balance decisions based on safety, cost and aesthetics. For additional guidance on roadside barriers, see the AASHTO *Roadside Design Guide* and *SCDOT Standard Drawings.*

2.2.13 Bridges, Walls and Other Structures

Bridges and small structures can contribute to or detract from a roadway's character and quality. If an existing bridge or small structure is considered a character-defining feature of the roadway, it should be preserved through maintenance, rehabilitation and repair, if possible. When a bridge must be replaced, compatibility can be achieved by replacing the structure in-kind or by reconstructing a bridge with similar detail. If, however, the bridge detracts from the roadway's character, a replacement bridge can enhance the road if a design more compatible with the character of the roadway and its users is selected.

All structural design should take into account the context of the landscape and reflect its historic, rural or urban character. As viewed in its context, form is most affected by the geometry and the type of bridge structure chosen. The designer should choose materials and colors that are complementary to the landscape while maintaining compliance with applicable design criteria. Color and texture can be used to reduce or enhance the visual contrast depending upon design goals and can be applied to multiple stages of design.

2.2.14 Bicycle Facilities

Bicycles are a viable mode of transportation in South Carolina, both for commuting and recreation. SCDOT practice is to consider bicycles and pedestrians on all South Carolina roadways, in part by referencing multi-modal transportation plans adopted by MPOs and COGs. This ensures that system modifications are routinely planned, designed, constructed, operated and maintained in a way that enables safe and efficient access for all users. The result should be a system for all users that is comprehensive, integrated, connected, safe and efficient allowing users to choose among different transportation modes, both motorized and non-motorized.

Accommodating bicycles on roadways often presents challenges that can result in widening of roadways, potentially altering character-defining features. For example, an important feature of many roadways is the narrow two-lane cross section through rural areas. Projects along roadways that have scenic intrinsic qualities should strive to preserve this narrow pavement and more intimate and pastoral scale while still accommodating bicyclists.

Designers should be familiar with current standards and guidance for bicycles and incorporate them into their projects. This can be particularly important in roadway projects, where creative design is necessary to allocate limited roadway and/or right of way for all modes of travel. Section 13.2 and AASHTO *Guide to the Development of Bicycle Facilities* provide guidelines for bicycle facilities. In addition, the ITE document *Designing Walkable Urban Thoroughfares: A Context Sensitive Approach* provides guidance on the tradeoffs among all modes of travel. This document is especially valuable in understanding what options exist in terms of widths for motor vehicle lanes, bike lanes, shared lanes, shared-use paths and sidewalks.

2.2.15 Pedestrian Environment

In keeping with South Carolina's practice, the designer must consider the needs of pedestrians along all State roadways. Sidewalks, where provided, are not just pedestrian thoroughfares; they are social places in communities serving adjacent land uses. The surrounding context, particularly important in urban roadway projects is the sidewalk's physical condition (e.g., existing

grade, access points, cross slope, width, materials) and location (e.g., historic town, urban downtown, residential area, nature preserve).

Sidewalks should accommodate pedestrians of all ages and abilities, with attention given to locating pedestrian amenities that logically direct people to desired destinations in a safe and attractive environment. Sidewalk design and maintenance should respond to the context and address the full variety of functions the sidewalk will serve. Generally, sidewalks in urban areas should provide opportunities for planting buffers, bus stops, signs and street trees. These users will require access to adjacent shops and services as well as on-street parking and public transit. In rural/suburban areas, sidewalks usually serve children traveling to school and recreational activities (e.g., walking, jogging, biking).

In suburban and rural areas where land uses are not located near the back of the sidewalk, it is more common to find a pedestrian zone separated from the roadway by the shoulder or a grass strip. Designers should consider the types of pedestrians who use the sidewalk (e.g., ranges of age, mobility, ability) and how long pedestrians use the sidewalk — long-term (gathering spaces), short-term (mass transit stops) or transition (walking through).

Section 13.3 provides further guidance on sidewalks.

2.2.16 Landscape

Trees and other vegetation play a vital role in defining the spatial relationship of a corridor. They often represent an indigenous or designed landscape and enhance the aesthetic quality of the roadway. A rolling open field or a canopy-covered street can contribute to a memorable travel experience while the aesthetics of changing seasons often attract visitors year round. However, the treatment of trees along a roadway may pose safety and aesthetic conflict between designers and stakeholders, especially for trees identified as vital character-defining features requiring protection and preservation. *Note: mature trees greater than four inches in diameter inside the clear zone are considered fixed objects that may require removal.*

CSS encourage designers to explore flexible alternatives that augment the roadway's intrinsic qualities, reflect community values and meet engineering requirements for safety and mobility. Along roadways where trees are identified as important features, the designer should consider traffic characteristics and safety concerns by using design minimums, lower design speeds and/or minimum clear zone widths. Application of alternative techniques (e.g., modified road alignment, adding curb, protective barriers, roadway lighting, pavement striping, warning signs, shoulder rumble strips) is also encouraged. The desire for plantings is common on urban, context sensitive projects. See the Department's website for landscaping guidance.

2.3 REFERENCES

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