City of Round Rock, Texas

# Transportation Criteria Manual
# Design and Construction Standards
# (DACS)

May 2018

# Transportation Criteria Manual

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City of Round Rock, Texas

# General Guidelines
# Design and Construction Standards
# (DACS)

**May 2018**

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## INTRODUCTION

The purpose of this section of the Design and Construction Standards (DACS) is to serve as an introductory section to describe some general concepts that are important when developing projects in the City of Round Rock and its Extraterritorial Jurisdiction (ETJ).

The City's Strategic Plan outlines the goals, vision, and action agenda for its future. The DACS, which include Design Criteria Manuals, Specifications, and Construction Details, can accomplish this as follows:

- Standardize design and construction practices for projects in the City;
- Improve the quality and durability, while reducing maintenance costs for city utilities and roadways;
- Facilitate project delivery by outlining specific criteria and objectives for the various types of projects in the City; and,
- Improve coordination between the various departments and stakeholders engaged in development of City infrastructure projects.

Figure 1 represents the organization of the DACS including design criteria manuals, specifications, and reference documents.

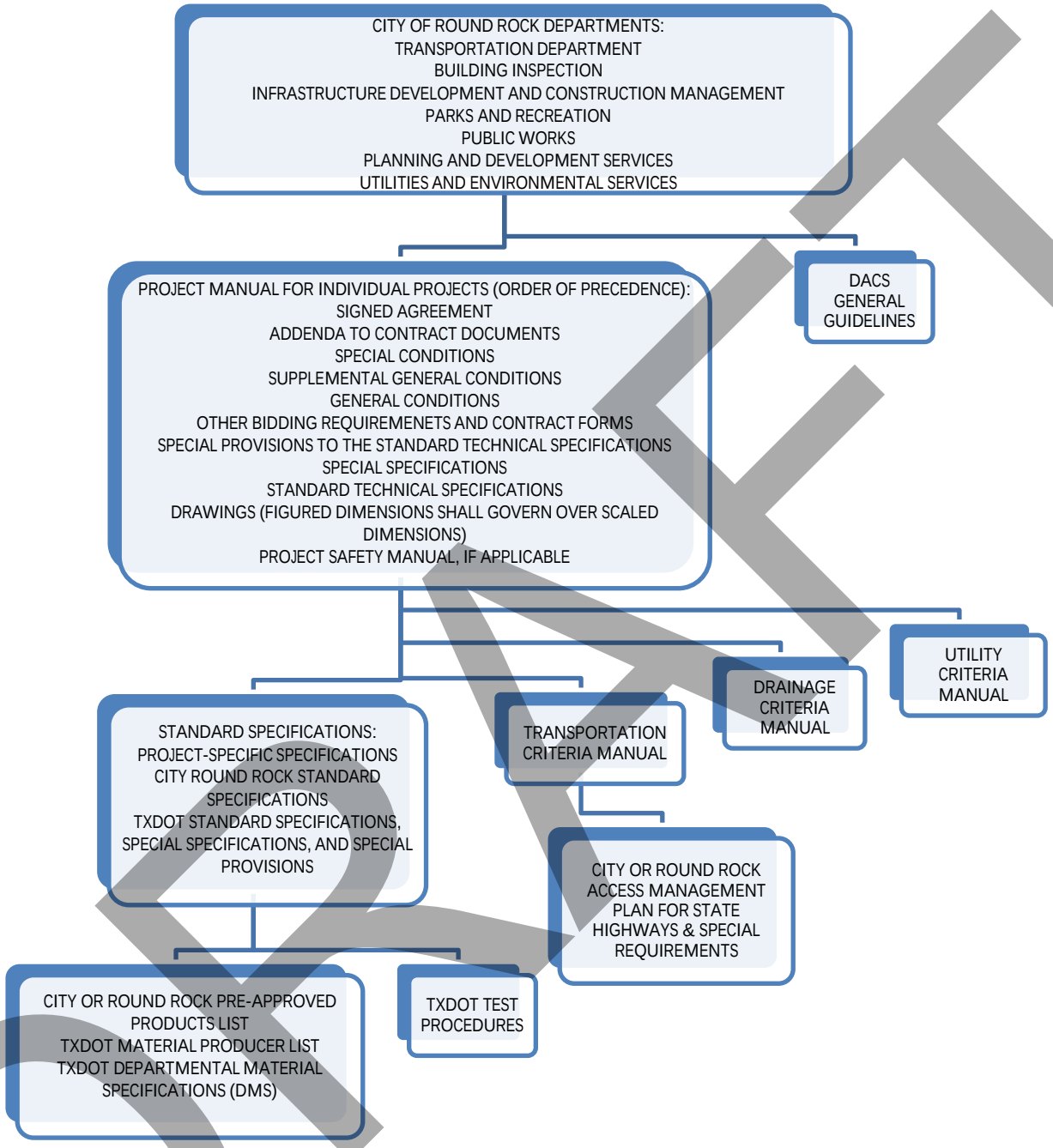


**Figure 1: DACS ORGANIZATION AND REFERENCES**

## SECTION 0.1 – DESIGN CRITERIA – GENERAL GUIDELINES

### 0.101 REFERENCE STANDARDS

The most current version of the references in APPENDIX I may be used along with engineering judgment to justify waivers from the criteria outlined below in support of the Vision and Goals of the Transportation Criteria Manual. Inconsistencies between references shall be resolved by the Transportation Director.

### 0.102 SPECIFIC DESIGN CRITERIA

Transportation projects shall be developed in accordance with the design criteria in the Transportation Criteria Manual, the references listed in APPENDIX I, City Ordinances, and accepted industry practice. Future maintenance and operational concerns shall also be considered.

The following Manuals are to be included and referenced during project development within the City of Round Rock and Extraterritorial Jurisdiction. The Design Criteria, Specifications, and Construction Details shall govern the design and construction of all projects within the City. Where there is any conflict between any of the criteria in the Manuals listed below and other criteria contained herein, whichever imposes the more stringent shall control.

- Transportation Criteria Manual;
- Drainage Specifications (Drainage Criteria Manual);
- Utility Specifications (Utilities Criteria Manual); and,
- City of Round Rock and TxDOT Specifications.

The following planning documents shall be used in conjunction with the reference documents to develop projects in the City:

- Transportation Master Plan;
- Access Management Plan for State Highways and Special Requirements;
- Transit Plan;
- Development Code; and,
- Downtown Master Plan.

Refer to the City's website or appropriate City Department for the current version of these plans. Also, refer to the Bibliography of the Transportation Criteria Manual for further information.

### 0.103 DESIGN EXCEPTIONS AND DESIGN WAIVERS

Once the appropriate functional classification and design criteria have been established for a transportation project, it is important to maintain consistent criteria throughout the project limits. When certain design criteria cannot be achieved, a design exception or waiver request is used to evaluate, document, and approve the request.

The design of transportation projects shall conform to the approved design criteria for the appropriate roadway classification, whenever possible; however, in some situations, achieving conformance with all design criteria is not practical or reasonable.

A design exception request and approval is required whenever the criteria for certain controlling criteria specified for a project are not met. The following controlling criteria will require a design exception:

- Design Speed;
- Lane Width;
- Shoulder Width;
- Horizontal Curve Radius;
- Superelevation rate;
- Stopping Sight Distance (SSD);
- Maximum Grade;
- Cross Slope;
- Vertical Clearance; and,
- Design Loading Structural Capacity.

The SSD applies to horizontal alignments and vertical alignments except for sag vertical curves for roadway facilities with continuous street lighting.

A design waiver request and approval is required when criteria in a non-controlling category is not met.

- Curb Parking Lane Width;
- Speed Change (refuge) Lane Width;
- Length of Speed Change Lanes;
- Curb Offset;
- Median Opening Width;
- Horizontal Clearance (clear zone);
- Railroad Overpass Geometrics; and,
- Guardrail Length (Length of Need).

## 0.104 DESIGN VARIANCES (ADAAG/TAS)

A design variance is required whenever the design guidelines specified in the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and the Texas Accessibility Standards are not met. Design variances should be sent to the Texas Department of Licensing and Regulation (TDLR) for approval prior to incorporating into the project design. The Project Engineer is responsible for obtaining the approval; however, granting of design variances is rare, and every effort should be made to comply with the requirements.

## 0.105 DESIGN DOCUMENTATION FOR DESIGN EXCEPTIONS AND WAIVERS

Design exception and design waiver requests shall be submitted for review and approval by the Transportation Director prior to incorporating into the final design of a transportation project.

The request and supporting documentation shall be submitted prior to, or concurrently with the 30% design submittal; or, as soon as the need for one is identified.

The following is the minimum information necessary to justify the need for a design exception or waiver:

- Specific design criteria that will not be met;
- Existing roadway characteristics;
- Alternatives considered;
- Comparison of the safety and operational performance of the roadway and other impacts such as right-of-way, community, environmental, cost, and usability by all modes of transportation;
- Proposed mitigation measures; and,
- Compatibility with adjacent sections of roadway.

## 0.106 PROJECT ENGINEER RESPONSIBILITIES

The Project Engineer, also referred to as the Engineer of Record, the Engineer/Architect, or the Project Manager shall have the following responsibilities:

- Serve as the primary point of contact between the City and the Engineering/Architectural Consultant firm;
- Prepare and distribute all project correspondence including letters, submittal packages, and meeting minutes;
- Review Contractor Submittals and Working Drawings;
- Attend the pre-construction meeting and distribute meeting minutes;
- Ensure all required permits and necessary third party agency reviews have been completed prior to releasing the project manual and drawings for bidding; and,
- Present a written notice to the City that the project is substantially complete and ready for final project walk through.

# SECTION 0.2 – CONSTRUCTION – GENERAL GUIDELINES

## 0.201 PRE-APPROVED PRODUCTS LIST

The City maintains a Pre-Approved Products List (www.roundrocktexas.gov) for use in developing plans and specifications for private development and Capital Improvement Projects (CIPs). The current version shall be used, as the City anticipates adding or removing items as necessary.

TxDOT maintains a Material Producer List with products, materials, producers, manufacturers, and producer codes for pre-approved items meeting TxDOT Specifications.

Where conflicts or discrepancies exist between the City's Pre-Approved Products List and TxDOT's Material Producer list, priority shall be given to the City's List.

The Project Engineer shall obtain approval from the Transportation Director prior to incorporating non-approved items into a project.

1.

## 0.202 AUTHORITY AND DEFINITIONS – TRANSPORTATION PROJECTS

The City of Round Rock Transportation Director or their designee shall have the authority to review and approve design exceptions or design variances to the transportation design criteria in the Transportation Criteria Manual.

Specifications shall mean the following:

- Any project-specific specifications listed or referenced in the bid documents;
- City of Round Rock Standard Specifications listed in the bid documents; and,
- Texas Department of Transportation "Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges" latest edition, with current Special Provisions and Special Specifications, incorporated by reference.

Refer to TxDOT Standard Specifications, Item 1 for additional Abbreviations and Definitions.

"Engineer" where used in the contract documents and specifications shall mean the City of Round Rock Transportation Director or their designee. The Engineer has the authority to observe, test, inspect, approve, and accept the work. The Engineer decides all questions about the quality and acceptability of materials, work performed, work progress, Contract interpretations, and acceptable Contract fulfillment. The Engineer has the authority to enforce and make effective these decisions.

"Design Engineer" where used in the contract documents shall mean the Professional Engineer licensed in the State of Texas who signed and sealed the contract documents.

## 0.203 PRE-CONSTRUCTION MEETING

Prior to the start of any construction project, the City and the Contractor shall hold a pre-construction meeting. Attendance at the pre-construction meeting is required for the following:

- City Project Manager;
- City Construction Inspector(s);
- Project Engineer or Architect, or Consultant's Project Manager;
- Contractor and major subcontractors; and,
- TxDOT, Williamson County, or MUD representative, if applicable.

## 0.204 CONTRACTOR SUBMITTALS AND WORKING DRAWINGS

This section addresses Contractor Submittals and Working Drawings (also called "shop drawings") to be submitted and reviewed by the City or the Project Engineer during the construction phase of a project. The Contractor shall submit the Contractor Submittals and Working Drawings to supplement the plans with all necessary details not included on the Contract plans. The Contractor will prepare and furnish working drawings in a timely manner and obtain approval, if required, before the beginning of the associated work. The Contractor shall have a licensed professional engineer sign, seal, and date the working drawings as indicated in Table 1.

The routing of submittals for review and approval will be established at the preconstruction conference. The Contractor is responsible for the accuracy, coordination, and conformity of the various components and details of the working drawings, including subcontractors. City approval of the Contractor's working drawings will not relieve the Contractor of any responsibility under the Contract. The work performed will not be measured or paid for directly but will be subsidiary to pertinent Items.

The Contractor and the City shall agree on the appropriate number of copies to be submitted during the preconstruction conference.

Submittals shall be consecutively numbered by the Contractor. A resubmittal, if required, shall retain the original submittal number and shall be appended with an "R".

Table 1
Signature and Approval Requirements for Working Drawings

| Working Drawings For | | Requires Licensed Professional Engineer's Signature, Seal, and Date | Requires City Approval |
|---|---|---|---|
| 1. Alternate or optional designs submitted by Contractor | | Yes | Yes |
| 2. Supplementary shop and fabrication drawings for structural Items | | No unless required on the plans | See applicable Item |
| 3. Contractor-proposed temporary facilities that affect the public safety, not included on the plans | | Yes | Yes |
| 4. Form and falsework details | Bridges, retaining walls, and other major structures | Yes unless otherwise shown on the plans | No[1,2] |
| | Minor structures | No unless otherwise shown on the plans | No |
| 5. Erection drawings | | Yes | No[1,2] |
| 6. Contractor-proposed major modifications to traffic control plan | | Yes | Yes |

1. The Engineer may require that the Contractor have a licensed professional engineer certify that the temporary works are constructed according to the sealed drawings.
2. Approval is required for items spanning over live traffic or where safety of the traveling public is affected, in the opinion of the Engineer.

The Contractor shall provide all submittals required by the Contract Documents and Specifications. The following shall be provided before or at the pre-construction conference:

- Engineered Trench Safety Plan;
- Engineered Traffic Control Plan;
- Storm Water Pollution Prevention Plan (SWPPP), required if project area is more than one (1) acre;
- Notice of Intent (NOI), required if project area is more than five (5) acres; and,
- Utility Locates: provide evidence of contact with Texas One Call Center

The following requirements pertain to Contractor submittals:

- Use 8-1/2”x11” or 11”x17” size paper;
- Maintain a submittal log and make available to the City;
- Consecutively number and include the Contractor’s stamp;
- Be signed and sealed by a Professional Engineer where required by the Specifications;
- Allow sufficient time for review by the City.

## 0.205 CONSTRUCTION PLAN PREPARATION AND CHECKLISTS

The Project Engineer shall prepare the project General Notes using the current City of Round Rock Template. The General Notes shall be included in the Project Manual in Section 00900 “Special Conditions” and in the plan set.

Transportation plan sets shall be prepared in accordance with the guidance and appropriate checklists included in the Transportation Criteria Manual Section 13 – “Plan Set Preparation and Project Authorization”.

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## SECTION 1 – STREET DESIGN CRITERIA

### 1.1 GENERAL

This section provides design criteria for the various functional classifications of streets and roadways within the City. The criteria described in this section are the minimum values. The design engineer shall provide higher values where feasible. Exceptions to these criteria shall be as specifically approved by the Transportation Director.

One of the primary design criteria for a new facility is the design speed. The proper design speed selection is influenced by the character of terrain, the density and type of adjacent land use, the classification and function of the roadway, the traffic volumes expected to use the roadway and by economic and environmental considerations. It is important to recognize and treat individual roadways based on their specific characteristics. The design speed should be determined based on the design engineer's judgments on what design criteria are the most feasible for that particular roadway. The design speeds specified in Tables 1-1a, 1-1b, and 1-1c shall be used for each of the street classifications, unless otherwise directed by the Transportation Director.

When designing a new facility, or modifications to an existing facility, the operating speed of vehicles is assumed to be, in order of desirability, a) the 85$^{th}$ percentile speed, b) the posted speed limit, or c) in the case of a new facility, the design speed.

In order to provide a facility that is as safe and predictable as possible, it is desirable to have a uniform design speed. Therefore, the design speed shall remain constant throughout the facility.

This manual is intended to provide design criteria for urban streets with a design speed of 45 mph or less. The designer shall refer to the design resources listed in the Bibliography for highways with a design speed of 50 mph or greater.

All streets shall be planned to properly integrate with the existing and proposed system of local, collector and arterial streets. The following plans available from the City (latest version, as adopted) shall be referred to:

- Comprehensive Transportation Master Plan;
- Comprehensive Parks, Recreation and Open Space Master Plan;
- Southwest Downtown Plan; and,
- Downtown Master Plan.

Refer to the Transportation Master Plan for designation of Arterials and Collectors within the City limits and extraterritorial jurisdiction. Other street classifications shall be as designated through the planning process in consultation with the Transportation Department.

Street classifications shall be as designated by the Transportation Director.

**The City of Round Rock Transportation Director, or their designated representative shall have the authority to apply these standards to proposed street and infrastructure design and construction within the City of Round Rock. Authorized Transportation Department staff may allow or require different values for design parameters than those given in this**

**manual to resolve unusual field conditions, to increase the safety of the travelling public, and/or to better meet other needs of the public infrastructure.**

The design criteria for the various street classifications are summarized in Tables 1-1a, 1-1b, and 1-1c on the following page. Figures 1-1 through 1-12 depict the typical section for each street classification. Figures 1-13 through 1-18 provide geometric criteria for elbow-type and cul-de-sac streets. Figures 1-19 through 1-21 provide graphical information regarding medians, tapers and intersection sight triangles.

### 1.1.1 Reference Standards

The most current version of the reference documents shall be used for project development of transportation facilities. Engineering judgment shall be used to justify waivers from the design criteria; however, Design Exceptions or Waivers shall only be granted at the sole discretion of the City's Transportation Department. Inconsistencies between references shall be resolved in consultation with the City's Transportation Department.

## 1.2 STREET CLASSIFICATIONS

Street classifications are used to categorize streets according to their functions. There are four street classifications for urban roadways: Local Street, Collector Street, Arterial Street and Alley. Freeway design criteria are not included in this Manual, and therefore the designer should reference the appropriate design criteria in the Texas Department of Transportation (TxDOT) Roadway Design Manual.

The functional classification for each street shall be identified upon the time of the submittal of preliminary plans and shall be as approved by the City.

- **Local Streets.** The primary function of a local street is to serve abutting land use and traffic within a neighborhood or limited residential district. A local street is not generally continuous through several districts. Designations include the following:
  - Two Lane Local Queuing Street (L [Local] 52-30 [52' ROW, 30' Road Width). See Figure 1-1.
  - Two Lane Local Street with Parking (L 61-39). See Figure 1-2.

- **Collector Streets.** The primary function of a collector street is to collect traffic from intersecting local streets and expedite the movement of this traffic to an arterial street or other collector street. Designations include the following:
  - Two Lane Commercial Collector with On-Street Parallel Parking (C 70-41). See Figure 1-3.
  - Three Lane Collector with Off-Street Shared Path (C 70-39). See Figure 1-4.
  - Two Lane Collector with Diagonal and Parallel Parking (C 80-52). See Figure 1-5.
  - Three Lane Collector with Off-Street Shared Path and Parallel Parking (C 80-53, C 90-53). See Figure 1-6 and Figure 1-7.

- **Arterial Streets.** Arterial streets are designed to carry high volumes of through traffic. Access is usually limited to intersections and major driveways. Arterial streets serve as a link between major activity centers within the urban area. Designations include the following:
  - Four Lane Arterial with Off-Street Shared Path (A 110-54, A 120-54). See Figure 1-8 and Figure 1-9.
  - Six Lane Arterial with Off-Street Shared Path (A 135-76, A 150-76). See Figure 1-10 and Figure 1-11.

- **Alley**. An alley is a passageway designed primarily to provide access to or from the rear or side of property otherwise abutting on a public street. See Figure 1-12.

| Table 1-1a: Geometric Criteria - Local Streets | | |
|---|---|---|
| | **Local Residential Street (L 52-30)** | **Two Lane Local Street with Parking (L 61-39)** |
| **Cross Section Elements** | | |
| Transportation Criteria Manual Figure: Typical Section | 1-1 | 1-2 |
| Average Daily Traffic (ADT) (vehicles per day) | < 2,000 | < 2,000 |
| Design Speed (mph) | 30 | 30 |
| ROW Width (ft) | 52 | 60 |
| Pavement Width Curb-Curb (ft) | 30 | 39 |
| Median Width Curb-Curb (ft) | n/a | n/a |
| Sidewalk Width (ft) | 4 (both sides) | 4 (both sides) |
| Typical Spacing of Cross Street (ft) | 300 | 300 |
| Clear Zone (ft) | 3 (from face of curb) | 3 (from face of curb) |
| **Horizontal Alignment** | | |
| Minimum Centerline Radius (ft) (Note 4) | 300 | 300 |
| Stopping Sight Distance (ft) | 200 | 200 |
| Superelevation rate “e” maximum | None | None |
| Minimum tangent between curves (ft) | 50 | 50 |
| Minimum Horizontal Tangent Length approaching an Intersection (ft) | 50 | 50 |
| **Vertical Alignment** | | |
| Maximum Grade (%) | 8 | 8 |
| Minimum Grade (%) | 0.5 | 0.5 |
| Minimum Crest K-value | 19 | 19 |
| Minimum Sag K-value | 37 | 37 |
| Vertical Clearance: | | |
| Over/Under Roadway (ft) | 16.5 | 16.5 |
| Over Railroad (ft) | 23 | 23 |
| **Intersections** | | |
| Intersection Sight Distance | See Section 1.8.3 | |
| Curb Return Radius | See Section 1.6.3 | |
| Design Vehicle Type | Passenger Vehicle (P) and Single Unit Truck (SU) | |

Notes:

1. This table lists the minimum design criteria. Deviations from listed criteria shall be as approved by the Transportation Director.
2. Design speed shall be used for design purposes; however the posted speed may be different.
3. See bibliography for reference standards.
4. Minimum centerline radius may be reduced to 180 feet if the design speed is 25 mph.
5. Refer to typical sections for further information.

| Table 1-1b: Geometric Criteria – Collector Streets | | | | |
|---|---|---|---|---|
| | Two Lane Collector with Diagonal & Parallel Parking (C 80-52) | Two Lane Commercial Collector with On-Street Parallel Parking (C 70-41) | Three Lane Collector with Off-Street Shared Path and Parallel Parking (C 80-53 & C 90-53) | Three Lane Collector with Off-Street Shared Path (C 70-39) |
| **Cross Section Elements** | | | | |
| Transportation Criteria Manual Figure: Typical Section | 1-5 | 1-3 | 1-6, 1-7 | 1-4 |
| Average Daily Traffic (ADT) (vehicles per day) | 2,000-6,000 | 2,000-6,000 | 2,000-6,000 | 2,000-6,000 |
| Design Speed (mph) | 35 | 35 | 35 | 35 |
| ROW Width (ft) | 80 | 70 | 80 or 90 | 70 |
| Pavement Width Curb-Curb (ft) | 52 | 41 | 53 | 39 |
| Median Width Curb-Curb (ft) | n/a | n/a | n/a | n/a |
| Sidewalk / Shared Use Path Width (ft) | 7 (both sides) | 7.5 (both sides) | 5 & 8 (C 80-52) 7 (both sides) (C 90-52) | 5 & 10 |
| Typical Spacing of Cross Street (ft) | 300 | 500 | 300 | 300 |
| Clear Zone (ft) | 3 (from face of curb) | 3 (from face of curb) | 3 (from face of curb) | 3 (from face of curb) |
| **Horizontal Alignment** | | | | |
| Minimum Centerline Radius (ft) | 300 (Note 4) | 470 | 470 | 470 |
| Stopping Sight Distance (ft) | 200 | 250 | 250 | 250 |
| Superelevation rate "e" maximum | None | None | None | None |
| Minimum tangent between curves (ft) | 100 | 100 | 100 | 100 |
| Minimum Horizontal Tangent Length approaching an Intersection (ft) | 50 | 50 | 75 | 75 |
| **Vertical Alignment** | | | | |
| Maximum Grade (%) | 6 | 6 | 6 | 6 |
| Minimum Grade (%) | 0.5 | 0.5 | 0.5 | 0.5 |
| Minimum Crest K-value | 19 | 29 | 29 | 29 |
| Minimum Sag K-value | 37 | 49 | 49 | 49 |
| Vertical Clearance: | | | | |
| Over/Under Roadway (ft) | 16.5 | 16.5 | 16.5 | 16.5 |
| Over Railroad (ft) | 23 | 23 | 23 | 23 |
| **Intersections** | | | | |
| Intersection Sight Distance | See Section 1.8.3 | | | |
| Curb Return Radius | See Section 1.6.3 | | | |
| Design Vehicle for Intersection & Driveway Design | Single-Unit Truck (SU) and Intermediate Semitrailer (WB-40) | | | |

Notes:

1. This table lists the minimum design criteria. Deviations from listed criteria shall be as approved by the Transportation Director.
2. Design speed shall be used for design purposes; however the posted speed may be different.
3. See bibliography for reference standards.
4. Minimum centerline radius shall be increased to 470 feet if the design speed is 35 mph.
5. Refer to typical sections for further information.

| Table 1-1c: Geometric Criteria – Arterial Streets | | | | | | |
|---|---|---|---|---|---|---|
| | Four Lane Arterial with Off-Street Shared Path (A 110-54, A 120-54) | | | Six Lane Arterial with Off-Street Shared Path (A 135-76, A 150-76) | | |
| **Cross Section Elements** | | | | | | |
| Transportation Criteria Manual Figure: Typical Section | 1-8, 1-9 | | | 1-10, 1-11 | | |
| Average Daily Traffic (ADT) (vehicles per day) | 8,000 – 12,000 | | | > 12,000 | | |
| ROW Width (ft) | 100, 110 or120 | | | 125, 135, 140 or150 | | |
| Pavement Width Curb-Curb (ft) | 2@27 | | | 2@38 | | |
| Median Width Curb-Curb (ft) (Varies with Turn Lanes) | 17 to 28 | | | 18 to 28 | | |
| Shared Path Width (ft) | 10 & 5 (110-54)<br>10 & 10 (120-54) | | | 10<br>(both sides) | | |
| Typical Spacing of Cross Street (ft) | 1,000 | | | 1,000 | | |
| Clear Zone (ft) | 3<br>(from face of curb) | | | 3<br>(from face of curb) | | |
| Design Speed (mph) (Note 7) | 45 | 50 | 55 | 45 | 50 | 55 |
| **Horizontal Alignment** | | | | | | |
| Minimum Centerline Radius (ft) Low speed Urban Street Criteria (with no superelevation) | 1,000 | N/A | N/A | 1,000 | N/A | N/A |
| Stopping Sight Distance (ft) | 360 | 425 | 495 | 360 | 425 | 495 |
| Superelevation rate “e” maximum | 4% | 6% | 6% | 4% | 6% | 6% |
| Minimum tangent between curves (ft) (Note 5) | 150 | | | 200 | | |
| Minimum Horizontal Tangent Length Approaching an Intersection (ft) | 75 | | | 75 | | |
| **Vertical Alignment** | | | | | | |
| Maximum Grade (%) | 4 | | | 4 | | |
| Minimum Grade (%) | 0.5 | | | 0.5 | | |
| Minimum Crest K-value | 61 | 84 | 115 | 61 | 84 | 115 |
| Minimum Sag K-value | 79 | 96 | 115 | 79 | 96 | 115 |
| Vertical Clearance: | | | | | | |
| Over/Under Roadway (ft) | 16.5 | | | 16.5 | | |
| Over Railroad (ft) | 23.5 | | | 23.5 | | |
| **Intersections** | | | | | | |
| Intersection Sight Distance | See Section 1.8.3 | | | | | |
| Curb Return Radius | See Section 1.6.3 | | | | | |
| Design Vehicle for Intersection & Driveway Design | Intermediate Semi-Trailer (WB-50) Note: WB-67 may be required based on the typical delivery vehicle for the site. | | | | | |

Notes:

1. This table lists the minimum design criteria. Deviations from listed criteria shall be as approved by the Transportation Director.
2. Design speed shall be used for design purposes; however the posted speed may be different.
3. See bibliography for reference standards.
4. Increase minimum centerline radius to 1,400 feet for a design speed of 50 mph.
5. If superelevation is provided, the tangent length between curves shall be increased to include both transition lengths.
6. Refer to typical sections for further information.
7. Design speed as approved by the Transportation Director.

## 1.3 RIGHT OF WAY, STREET AND LANE WIDTHS

The minimum right of way (ROW) for each street classification is shown in Tables 1-1 a-c. The City may require wider widths depending on the need for additional turning lanes or variable terrain.

The minimum lane width shall be 12 feet.

## 1.4 SINGLE OUTLET STREETS

Traffic issues pertaining to single outlet streets are partially mitigated by: (1) providing mid-block turnarounds (or cross-streets/loop streets), (2) increased pavement widths and (3) utilization of divided roadways, as noted in Table 1-2.

**Table 1-2: Single Outlet Streets**

| ADT (vehicles per day) | Street Width (Lip of Gutter to Lip of Gutter) (ft) |
|---|---|
| Less than 300 | 27’ |
| 300 – 2,500 | 37’ |
| Greater than 2,500 | 2 @ 24’ w/20’ min. median width |
| Note: If the length of the street exceeds 750 feet, the single outlet street must be designed with 2 at 24’ with 20 foot median width. | |

The criteria pertaining to single outlet streets are applicable to new developments whether the single outlet is temporary or permanent. When future extensions to the street system are anticipated, which will provide additional outlets, a temporary restriction may be placed on the amount of development allowed, until an additional outlet becomes available.

## 1.5 HORIZONTAL AND VERTICAL ALIGNMENT

### 1.5.1 Horizontal Alignment

Horizontal alignment shall conform to the currently adopted City of Round Rock Transportation Master Plan, approved ROW plans, and approved subdivision plats. Street alignment shall provide continuous alignment with existing, planned, or platted streets with which they will connect.

All streets shall be extended to the property lines across the property to be developed, unless the street to be constructed has been approved by the City as a cul-de-sac or other no-outlet street.

The minimum horizontal radii for the various functional classifications are shown in Tables 1-1 a-c. Refer to the TxDOT Roadway Design Manual for further discussion of low-speed and high speed highways with or without superelevation.

The minimum radius is calculated from the following formula:

$$R = V^2 / [15 \times (e+f)]$$

Where: R = curve radius, feet
V = design speed, mph
e = superelevation rate per foot
f = side friction factor: see Table 1-3

**Table 1-3: Side Friction Factors**

| Design Speed (mph) | Side Friction Factor (f) |
|---|---|
| 30 | 0.22 |
| 35 | 0.20 |
| 40 | 0.18 |
| 45 | 0.16 |

If the roadway design is to include superelevation, a maximum rate of 4% is recommended for urban conditions, primarily due to narrow ROW widths, driveway grades, and ADA/TAS criteria for an accessible route within crosswalks and driveways. All roadway designs utilizing superelevation are subject to review and approval by the Transportation Director.

### 1.5.2 Vertical Alignment

The maximum grade for the various street classifications is shown in Tables 1-1 a-c. Short grades less than 500 feet in length may be up to 2% steeper if necessary.

The minimum grade specified in Tables 1-1 a-c shall be maintained for curb and gutter streets in order to provide adequate drainage of the pavement surface.

The vertical grade line shall be designed such that proposed or future cross walks meet the requirements of an accessible route in accordance with the ADA. The vertical grade shall consider the interface between back of sidewalk/shared path and the ultimate surface elevation just outside the ROW in order to accommodate drainage needs.

Designing a sag or crest vertical point of intersection without a vertical curve is generally acceptable where the grade difference is:

1.0% or less for design speeds equal to or less than 45 mph; or,
0.5% or less for design speeds greater than 45 mph

The minimum “K” value for vertical sag and crest curves is shown in Tables 1-1 a-c. The “K” value is used in the formula:

$$L = K \times A$$

Where: L = vertical curve length, feet
K = length of vertical curve per percent change in A (see Tables 1-1a-c)
A = algebraic difference in tangent grades, percent

The minimum vertical curve length should be at least three times the design speed.

## 1.6 INTERSECTIONS

### 1.6.1 Angles

Proposed public street must intersect one another at 90-degree angles or as close as possible within a range of 80 to 100 degrees.

### 1.6.2 Spacing and Offsets

Several studies of intersection design types have shown T-type intersections to be far safer than cross-type. Extensive use of "T" intersections in residential subdivisions is strongly recommended. One disadvantage, however, is "corner cutting" when inadequate offset exists between adjacent intersections. To reduce "corner cutting" due to inadequate offset distance, intersecting streets shall be offset at least 300 feet between the edge of pavement of the two streets.

Offset intersections have disadvantages when one (1) or both such streets is a collector intersecting an arterial street, if volumes will be such to warrant traffic signals. Operations at such locations are more complicated than those for normal cross-type intersections. Therefore, other design solutions should be sought if signalization might otherwise be required. When offset intersections are used at an arterial street, they should be located to avoid conflicting left turns (this is especially important where two (2) way, left-turn lanes are to be provided or where left-turn slots are used in a fairly narrow median). Such left-turn conflicts exist when an intersection offsets to the right rather than to the left.

Multi-leg intersections with more than four approaches shall not be allowed.

Signalized intersections shall be spaced at minimum one-half mile intervals, unless otherwise approved by the Transportation Director.

### 1.6.3 Corner Radii

Intersection corner radii shall be checked for the appropriate design vehicle using turning template software or the templates in AASHTO A Policy on Geometric Design of Highways and Streets.

The corner curb return radii for intersecting streets shall be in accordance with the following minimum values:

| Street Classifications | Minimum Curb Return Radius |
|---|---|
| Local-Local Intersection | 20 feet |
| Local-Collector Intersection | 25 feet |
| Collector-Collector Intersection | 25 feet |
| Collector-Arterial Intersection | 30 feet |
| Arterial-Arterial Intersections | 40 feet |

The design of the intersection shall consider the requirements of an accessible route in accordance with the ADA, placement of signal poles, location of curb ramps, and drainage patterns.

### 1.6.4 Vertical Alignment within the Intersection Area

Intersection areas should be designed with as flat a grade as practicable. In some cases, this may not be feasible due to terrain constraints and may be economically impractical.

The design speed for the major street at any intersection shall be maintained through the intersection approaches. The minor street may be designed with a change in grade based on reduced design speeds between the maximum grade in the approach and the cross-slope of the intersected street not to exceed eight (8) percent for local streets and six (6) percent for collector streets. The change in grade shall be accomplished by means of a vertical curve of length equal to the minimum length for the design speed of that approach (minimum K value).

### 1.6.5 Horizontal Alignment within the Intersection Area

The horizontal approach to an intersection should be tangent for a length of one hundred (100) feet (see Tables 1-1 a-c). Note that this tangent length is considered a minimum. Longer tangents are highly desirable. The tangent distance is measured from the curb line of one street to the first point of curvature on the intersecting street. In this regard, centerline radii greater or equal to one thousand (1,000) feet may be considered a tangent.

## 1.7 CUL-DE-SAC

Cul-de-sac streets are open at one end, with the closed end constructed to allow traffic to turn around within the cul-de-sac. Single outlet streets serve a network of streets with one (1) point of access. The maximum length shall be 750 feet, measured from the centerline of the nearest intersecting street to the center point of the cul-de-sac. Lengths exceeding seven hundred and fifty (750) feet, however, will require a recommendation from the City's Fire Department and approval by the Planning and Zoning Commission.

Collector and arterial streets shall not terminate in a cul-de-sac.

The use of landscape islands within the cul-de-sac is not recommended..

Care shall be taken to design cul-de-sac drainage, utilities and incidentals to avoid perimeter conflicts such as curb inlets, utilities and proposed driveways.

Dead-end streets that are stubbed out for future extension to the adjacent property must terminate in an open-ended cul-de-sac as illustrated in Figure 1-17, unless the dead-end street is less than 150 feet long, in which case the cul-de-sac may be omitted. If the stubbed-out street is not extended when the adjacent property is developed, a cul-de-sac is required on the adjacent property, or access to the dead-end street from the adjacent property must be provided

## 1.8 SIGHT DISTANCE CRITERIA

### 1.8.1 Horizontal Stopping Sight Distance

Roadway and intersection design must provide the minimum horizontal stopping sight distance so that drivers can see objects in the road or the control device (i.e. signs or signal heads) in advance of providing the required action. Stopping sight distance is the

sum of two distances: (1) the distance traversed by the vehicle from the instant the driver sights an object or traffic control device necessitating a stop to the instant the brakes are applied; and (2) the distance needed to stop the vehicle from the instant brake application begins. Table 1-4 lists the design values for stopping sight distance to be used for level terrain without excessive grades:

**Table 1-4: Minimum Stopping Sight Distance Including Brake Reaction Distance and Braking Distance (ft)**

| Design Speed (mph) | Street Grade In Percent | | | | |
|---|---|---|---|---|---|
| | Upgrades | | Flat | Down Grades | |
| | 6% | 3% | 0% | -3% | -6% |
| 30 | 184 | 200 | 200 | 205 | 215 |
| 35 | 229 | 237 | 250 | 257 | 271 |
| 40 | 278 | 289 | 305 | 315 | 333 |
| 45 | 331 | 344 | 360 | 378 | 400 |

Refer to the latest edition of AASHTO's A Policy on Geometric Design of Highways and Streets to calculate stopping sight distance for steeper grades.

### 1.8.2 Minimum Sight Distance for Signal Visibility

The geometry of each intersection to be signalized, including vertical grades, horizontal curves, and obstructions as well as the lateral and vertical angles of sight toward a signal face, as determined by the typical driver-eye position, shall be considered in determining the vertical, longitudinal, and lateral position of the signal face. Refer to the TMUTCD for determination of the minimum sight distance for signal visibility.

### 1.8.3 Intersection Sight Distance

Intersection sight distance shall be provided at intersections to allow the drivers of stopped vehicles a sufficient view of the intersecting highway to decide when to enter the intersecting highway or to cross it. Specified areas along intersection approach legs and across their included corners should be clear of obstructions that might block a driver's view of potentially conflicting vehicles. These specified areas are known as clear sight triangles and are illustrated in Figure 1-21. Refer to the latest edition of AASHTO's A Policy on Geometric Design of Highways and Streets to determine the intersection sight distance and clear sight triangle requirements, for design of new intersections or evaluation of sight distance for existing intersections.

It should be noted that the current zoning ordinance states "At an intersection of two streets or at the intersection of a driveway and a street nothing shall be erected, placed, allowed to grow, or planted so that it impedes vision between the height of three feet and ten feet above the curb within a triangle formed by the intersecting streets or street and driveway, and measuring 40 feet along the sides of the triangle that face the intersection.

Triangle sides shall be measured from the face of the curb to the face of the curb at intersections and driveways." See Figure 1-21 for illustration. This requirement may provide adequate sight triangle clearances to meet the intersection sight distance criteria and should be provided as a minimum. In situations where greater sight triangle lengths need to be provided for adequate intersection sight distance, the higher value will govern.

## 1.9 CLEAR ZONES AND PROTECTION

The term "clear zone" is used to describe the generally flat and unobstructed area that is provided beyond the travel lanes. The clear zone may include shoulders. The clear zone is measured from the edge of travel way for uncurbed streets, and from the face of curb for curbed streets.

### 1.9.1 Clear Zone Criteria

The minimum clear zone, measured from the face of curb, shall be 3.0 feet; however the clear zone may be reduced to 1.5 feet where it is not feasible to provide 3.0 feet.

Curbs are not regarded as an adequate barrier for redirecting vehicles. The provision of guardrails to redirect errant vehicles may only be necessary on high-speed facilities with design speed greater than or equal to 45 mph. The need for guardrails on low-speed facilities with design speed less than 45 mph should be based on engineering judgment, local conditions, and type of roadside hazard.

Because most curbs do not have a capability to redirect vehicles, especially at higher design speeds, obstructions should be located as far away as practical.

The minimum clear zone for rural, uncurbed roadways within the City and a design speed of 45 mph or less shall be 10 feet, however 20 feet should be provided where feasible.

If a roadside obstacle exists, treatment should be considered in the following priority:

1. Eliminate the obstacle;
2. Redesign the obstacle so it can be safely traversed;
3. Relocate the obstacle outside the clear zone to reduce the likelihood that it will be struck;
4. Treat the obstacle to reduce accident severity, i.e. use flush or yielding designs
5. Shield the obstacle with a barrier (metal beam guard fence, concrete barrier, or crash attenuator); and,
6. Delineate the obstacle if the above alternatives are not appropriate.

The types of obstacles that are commonly shielded using roadside barriers are as follows:

- Slopes greater than 3:1 or vertical drop-offs;
- Bridge ends and areas alongside bridges;
- Signs, traffic signal, and luminaire supports without breakaway design;
- A concrete base extending 6 inches or more above the ground;
- Retaining walls;
- Culverts;

- Street furniture;
- Rock or other natural formations;
- Trees with diameter greater than 6 inches (see discussion below); and,
- Utilities such as cabinets, fire hydrants, or poles.

### 1.9.2 Types of Barriers

Metal beam guard fence (MBGF) may be used to protect most roadside obstacles, if the hazard cannot be eliminated. MBGF, end treatment, and downstream anchor terminal shall be in accordance with the appropriate TxDOT Standards.

Refer to Section 6 of Appendix A in the TxDOT Roadway Design Manual, for the procedure to calculate the Length of Need for MBGF.

MBGF shall be placed at the edge of pavement for roadways with shoulders, and at the face of curb for curbed roadways. The installation shall allow for 2'-6" (minimum) or 5'-0" (desirable) deflection behind the guardrail posts. The MBGF installation shall include a concrete mow strip.

Pedestrian rails shall be in accordance with TxDOT Standard "Pedestrian Handrail Details".

Bridge railings shall be in accordance with TxDOT Standards and the "Bridge Railing Manual".

The ends of bridge railings shall be protected with metal beam guard fence/end treatment or a crash attenuator.

Concrete safety barrier is not typically used for urban street construction but may be used, if necessary, for example, at the top of an MSE retaining wall.

### 1.9.3 Transportation Guidelines for Landscaping

Safety shall be the foremost consideration in the placement and selection of plant material in the City's right-of-way. The main focus of these guidelines is the prevention of traffic hazards that can be created by the placement of landscaping which restricts the sight distance or creates roadside obstacles. The following addresses acceptable criteria for landscaping and planting on roadsides, within the median, and at intersections. All dimensions specified for trunk diameter and height will include plants at maturity unless it is stated otherwise on the Drawings.

Table 1-5 lists the criteria for placement of trees within the ROW.

| Table 1-5: Minimum Setback Requirements For Existing And Newly Planted Trees | | | | | |
|---|---|---|---|---|---|
| Design Speed (mph) | Tree Diameter At Maturity (inches) | Roadways with Barrier Curb | | Roadways with Shoulders[1] | |
| | | Existing (feet) | New (feet) | Existing (feet) | New (feet) |
| ≤45 | =6 | 1.5 (minimum) 3 (desirable) | 3 | 10 | 10 (minimum) 20 (desirable) |
| | >6 | 4 (minimum) 6 (desirable) | 6 | 18 | 25 |
| 50 | =6 | 2 (minimum) 3 (desirable) | 4 | 10 | 20 (minimum) 30 (desirable) |
| | >6 | 4 (minimum) 6 (desirable) | 6 | 30 | 30 |
| [1] Includes roadways with side slope of 6H:1V or flatter within the clear zone | | | | | |

Trees shall be set back 2 feet from the edge of sidewalk, measured from the edge of sidewalk to edge of mature trunk. Trees shall not be allowed in sidewalks less than 12 feet in width.

On roadways with shoulders having side slopes steeper than 6H:1V, no tree shall be planted or allowed to remain within the recommended clear zone as shown Table 1-6.

| Table 1-6: Lateral Clearance On Cut And Fill Sections Roadways With Shoulders (Feet) | | | | | | |
|---|---|---|---|---|---|---|
| Design Speed (mph) | Fill Section Side Slope | | | Cut Section Side Slope | | |
| | 5H:1V | 4H:1V | 3H:1V & Steeper | 5H:1V | 4H:1V | 3H:1V & Steeper |
| ≤45 | 18 | 19 | 20 | 16 | 16 | 16 |
| 50 | 24 | 30 | 56 | 19 | 18 | 17 |

A minimum clearance height of 8 feet above the street level must be provided and maintained for all existing and newly planted trees if adjacent to a sidewalk. However, if the limbs of trees overhang the curb line or edge of travel lane of any street, a minimum clearance height of 14 feet is required.

All plantings, except ground covers with no more than 12 inches in height, shall be located greater than seventy-five (75) feet from the end of the median nose.

Ground covers with no more than 12 inches in height and trees with a mature trunk diameter of 6 inches or less is recommended in the area from a point 75 feet to 150 feet from the nose of the median. All trees shall be maintained to provide an 8 foot minimum foliage clearance height. A minimum 15 feet spacing (center-to-center) shall be provided for all trees.

Only small trees and low growing shrubs no greater than 2 feet in height are recommended within 150 feet of a school crossing to assure pedestrian safety by not restricting the sight visibility of motorists.

Only low growing shrubs no greater than a height of 2 feet and small trees are recommended within 250 feet of a railroad crossing to assure adequate sight visibility.

Landscaping shall not restrict visibility to traffic control devices such as signs and traffic signals.

No landscaping of any type shall obstruct vision within the intersection sight triangle as defined in this section of the manual. These requirements will apply to any material from a height of two feet to a clearance height of eight feet above the top of curb including, but not limited to, full grown trees, full-grown shrubs, fences, structures, any signs except traffic control signs, etc.

The designer shall adhere to the City of Round Rock Code of Ordinances Chapter 43: Tree Protection and Preservation as amended and adopted, if existing trees are within the public ROW, or may otherwise be impacted by construction. If existing trees are closer than the minimum distances stated above, an exception may be granted if the City determines it is preferable to preserve the tree.

Any new trees to be planted shall be as listed on the City of Round Rock approved tree list, which is available from the Planning and Development Services Department.

## 1.10 TAPER TERMINOLOGY

The following terminology is used when describing the criteria for the various tapers in roadway design:

1) ROAD WIDTH TRANSITION TAPER is a taper necessary to transition between different roadway widths.
2) APPROACH TAPER is a taper from the point where all approaching traffic must shift laterally, to the point where the bay taper begins.
3) BAY TAPER is a taper from the edge of the adjacent through traffic lane to the beginning of the full width of the turn storage lane.
4) DEPARTURE TAPER of a left-turn bay is a taper from the point where through traffic beyond the intersection begins a lateral shift to the left to the point where the through lane is adjacent and parallel to the centerline.

Refer to Figure 1-20 for the illustration of the various taper lengths for a typical left turn bay configuration.

## 1.11 STREET WIDTH TRANSITION TAPERS

Where two street sections of different widths are to be connected, a transition taper is required between the outside traveled edges of the two sections. The length of the transition taper shall be calculated using the following equation:

$$L = W \times S \qquad \text{For Design Speed of 45 mph or higher}$$

$$L = (W \times S^2) / 60 \qquad \text{For Design Speed less than 45 mph}$$

Where: L = Taper length, feet
W = Width of offset, feet
S = Design Speed, mph

This transition length calculation is not to be used in the design of left-turn storage lanes or speed change lanes.

When tapers are located on a curve, the separate halves of the roadway should be designed with different curve radii to create a smooth taper without any angle points in the curvature.

## 1.12 LEFT TURN LANES

Refer to Figures 1-19 and 1-20 for typical configuration and taper lengths of left-turn lanes. The following sections describe the criteria for each taper.

### 1.12.1 Approach Tapers

Approach tapers shall be calculated using the following formulas:

$$L = W \times S \qquad \text{For Design Speed of 45 mph or higher}$$

$$L = (W \times S^2) / 60 \qquad \text{For Design Speed less than 45 mph}$$

Where: L = Taper length, feet
W = Width of offset, feet
S = Design Speed, mph

### 1.12.2 Bay Tapers

Bay tapers for left turn bays on City streets shall be designed using two reverse curves with radii equal to 300 feet each. The length of the bay taper using the symmetrical reverse curve will be approximately 118 feet for a twelve foot-wide turn lane. Alternatively, the bay taper may be calculated using the following formula:

$$L = (W \times S) / 3$$

Where: L = Taper length, feet
W = Width of offset, feet
S = Design Speed, mph

### 1.12.3 Deceleration Length

Deceleration length assumes that moderate deceleration will occur in the through traffic lane and the vehicle entering the left-turn lane will clear the through traffic lane at a speed of 10 mph slower than through traffic. Table 1-7 lists the deceleration lengths for various design speeds.

**Table 1-7: Deceleration Length**

| Design Speed (mph) | Deceleration Length (ft) |
|---|---|
| 30 | 160 |
| 35 | 215 |
| 40 | 275 |
| 45 | 345 |

On City streets, due to driveways and median openings, the required length of the speed change lanes may not be feasible to design. Therefore, in most cases the deceleration length can be omitted from the design.

### 1.12.4 Storage Length

At a minimum, storage lengths shall be 150 feet when turning from an Arterial into a Collector or an Arterial, and 100 feet when turning from an Arterial into a Local street.

At a minimum, storage lengths shall be 100 feet when turning from a Collector into an Arterial. Minimum storage length for a left turn bay into a driveway shall be 100 feet.

If a TIA or similar traffic study is required, it shall be used to document the minimum storage lengths to be provided for left turns. The minimum storage lengths stated in this section may be used if; in the City's opinion a TIA or traffic study is not needed for a particular development.

The calculated queue storage at unsignalized locations shall be based on a traffic model or simulation model, or by the following:

$$L = (V/30)(S)$$

Where: L = storage length, feet
V = left-turn vehicles per hour
S = queue storage length, feet, per vehicle (see Table 1-8)

At signalized intersections, the turn lane should be of sufficient length to store the turning vehicles and clear the equivalent lane volume of all other traffic on the approach, whichever is the longest. This length is necessary to ensure that full use of the separate turn lane will be achieved and that the queue in the adjacent lane on the approach will not block vehicles from the turn lane. The required storage may be obtained using an acceptable traffic model such as the latest version of the Highway Capacity Manual (HCM) software (HCS), SYNCHRO, VISSIM or other approved model. Where such model results have not been applied, the following may be used:

$$L = (V/N)(2)(S)$$

Where:
L = storage length, feet
V = left-turn volume per hour, vph
N = number of cycles
2 = a factor that provides for storage of all left-turning vehicles on most cycles; a value of 1.8 may be acceptable on collector streets
S = queue storage length, feet, per vehicle (see Table 1-8)

**Table 1-8: Queue Storage Length**

| % of trucks | S (ft) |
|---|---|
| <5 | 25 |
| 5-9 | 30 |
| 10-14 | 35 |
| 15-19 | 40 |

### 1.12.5 Departure Taper Length

The desired length for a departure taper on City streets shall begin at the end of the storage lane and end at the beginning of the approach taper.

## 1.13 RIGHT-TURN/DECELERATION LANES

Site driveways and roadways shall include a right turn deceleration lane if the projected right turn peak hour volume is 50 or more vehicles per hour.

The length of a right-turn storage lane shall be a minimum of 100 feet. The storage length for a right-turn bay into a driveway shall be a minimum of 100 feet. Where a TIA has been completed, the right-turn storage length should be based on the analysis results.

Right-turn acceleration lanes typically are not used on urban streets.

## 1.14 TURN LANE WARRANTS

Left-turn and right-turn deceleration lanes shall be provided when required by the findings of a city-approved Traffic Impact Analysis (TIA).

Refer to the latest edition of AASHTO's A Policy on Geometric Design of Highways and Streets to evaluate left-turn lane requirements at unsignalized intersections on two-lane roadways.

## 1.15 MEDIANS

The median width for divided arterials shall be a minimum of 27 feet measured from face of curb to face of curb as shown in the typical section figures 1-8 through 1-11.

Medians as measured from nose to nose on divided arterials shall have a minimum opening distance equal to the width of the intersecting street. The minimum width of a mid-block median opening shall be not less than 60 feet, or greater than 70 feet. The median opening shall be checked using the turning radius template for the appropriate design vehicle.

Full-function median openings on arterials should be allowed only where the minimum spacing for signalized intersections are practicable. At intermediate locations along major arterials, limited-function openings may be provided at the spacing listed in Table 1-9.

High volume driveways on arterials should only be located opposite streets or other driveways when the minimum spacing requirements for signalized locations are met. Otherwise, T-intersection configurations should be designed. When driveways are located opposite street intersections the two shall have compatible design elements.

On streets other than arterials, full-function median openings are acceptable at the spacing listed in Table 1-9. Access to public streets will have priority over access to private property on arterial streets.

The primary purpose of left-turn lanes at intersections is to provide storage space. A secondary purpose of turn lanes is to provide a location for deceleration removed from the through traffic lanes, thereby maintaining the capacity of the through roadway. Studies have demonstrated that accident experience is significantly reduced when left-turn lanes are provided at intersections of two (2) major streets, i.e., collectors and arterials.

**Table 1-9: Median Opening Criteria**
**(Refer to Figure 1-19)**

| Design Speed (mph) | Minimum Spacing Distance "B" + "C" (Figure 1-19) |
|---|---|
| | 150' Minimum Storage Requirement* |
| 30 | 500' |
| 35 | 575' |
| 40 | 650' |
| 45 | 750' |
| 50 | 900' |

* Minimum storage when turning into a collector or arterial street

At a minimum, storage lengths should be one hundred and fifty (150) feet when turning into a collector or an arterial and one hundred (100) feet when turning into a local street. At any unsignalized intersections, the storage length, exclusive of taper may be based on the number of turning vehicles likely to arrive in an average two (2) minute period within the peak hour with each vehicle accounting for approximately twenty (20) feet of storage. At signalized intersections, the storage length depends on the signal cycle length, the signal phasing arrangement and the rate of arrivals and departures of left-turning vehicles (see Table 1-8).

Median breaks on Arterial roadways for residential driveways shall not be provided unless otherwise approved by the Transportation Director. Median breaks for non-residential driveways shall only be provided if sufficient spacing between other median breaks is maintained, and there is adequate room to accommodate deceleration and storage length.

End treatment of medians at intersections should be designed to accommodate the appropriate design vehicle. Semicircular radii may be used on the noses of medians up to six feet wide. Bullet-nosed medians should be used for medians of greater width. Table 1-10 lists the required control radii for the intersection of the various street classifications and shall be used to define turning radii through intersections when designing the median opening and nose.

**Table 1-10: Required Control Radii**

| Street Classification | Intersecting Street | Control Radius (Turning Radius through Intersection) (ft) |
|---|---|---|
| Arterial | Arterial | 75 |
| | Major collector (Divided) | |
| | Major collector (Undivided) | 50 |
| | Local Collector | |
| Major Collector (Divided) | Major Collector (Divided) | |
| | Major Collector (Undivided) | |
| Major Collector (Divided or Undivided) | Local Residential Collector | |
| | Local Street | |
| Local Residential Collector | Local Residential Collector | |
| | Local Street | |
| Local Street | Local Street | 35 |

Medians and islands shall be landscaped with grass turf or constructed of stamped pattern concrete, brick, stone or concrete pavers, or other engraved concrete surfaces as approved by the City. Grass turf areas shall be not less than 6 feet in width. All medians and islands shall be bordered by standard curb and gutter, unless otherwise approved by the City.

Landscaping, signs, and other objects placed in the median shall comply with the minimum sight triangles described in section 1.8.3.

Isolated, small channelization islands should be avoided. Islands with at least 50 square feet are desirable but, under very restricted conditions, islands with at least 35 square feet may be used. Islands used for pedestrian refuge should be 6 feet wide, and must be in accordance with ADA/TAS requirements for an accessible route.

## 1.16 DRAINAGE STRUCTURES

The location of drainage structures, inlets, catch basins, etc., shall be consistent with the intended use of the roadway and in accordance with the City's Design and Construction Standards (DACS) - Drainage Criteria Manual.

Inlets or catch basins shall not be located within the corner curb return. Clearance is needed to allow space for street lights, street name signs, utility poles, pedestrians, sidewalk ramps, etc.

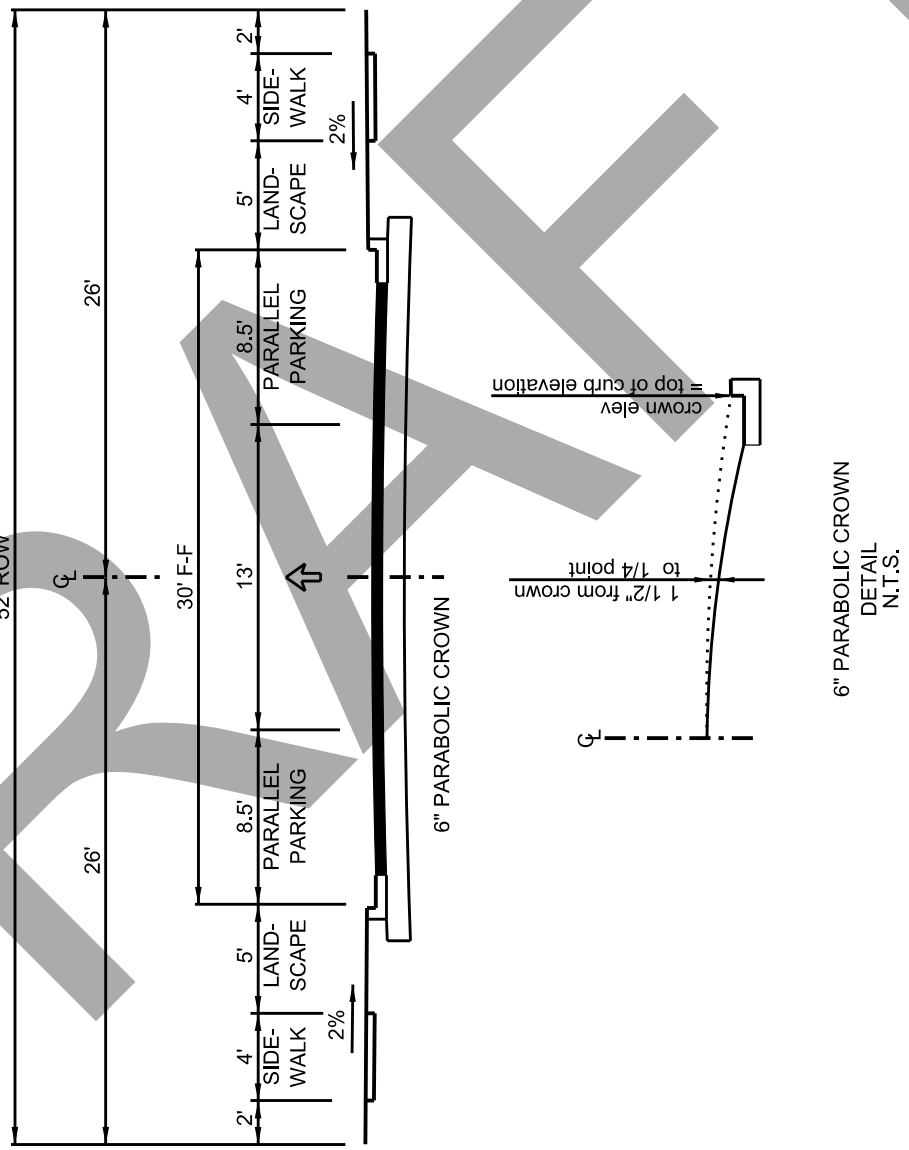
At intersections which have valley drainage, the crowns of the intersecting streets will culminate in a distance of forty (40) feet from the intersecting curb lines unless otherwise noted on the construction plans. Inlets on intersecting streets shall not be constructed within fifty (50) feet of the valley drainage.

Valley gutters shall not be constructed across streets with collector or higher classification.

## 1.17 PAVEMENT CROSS SLOPE

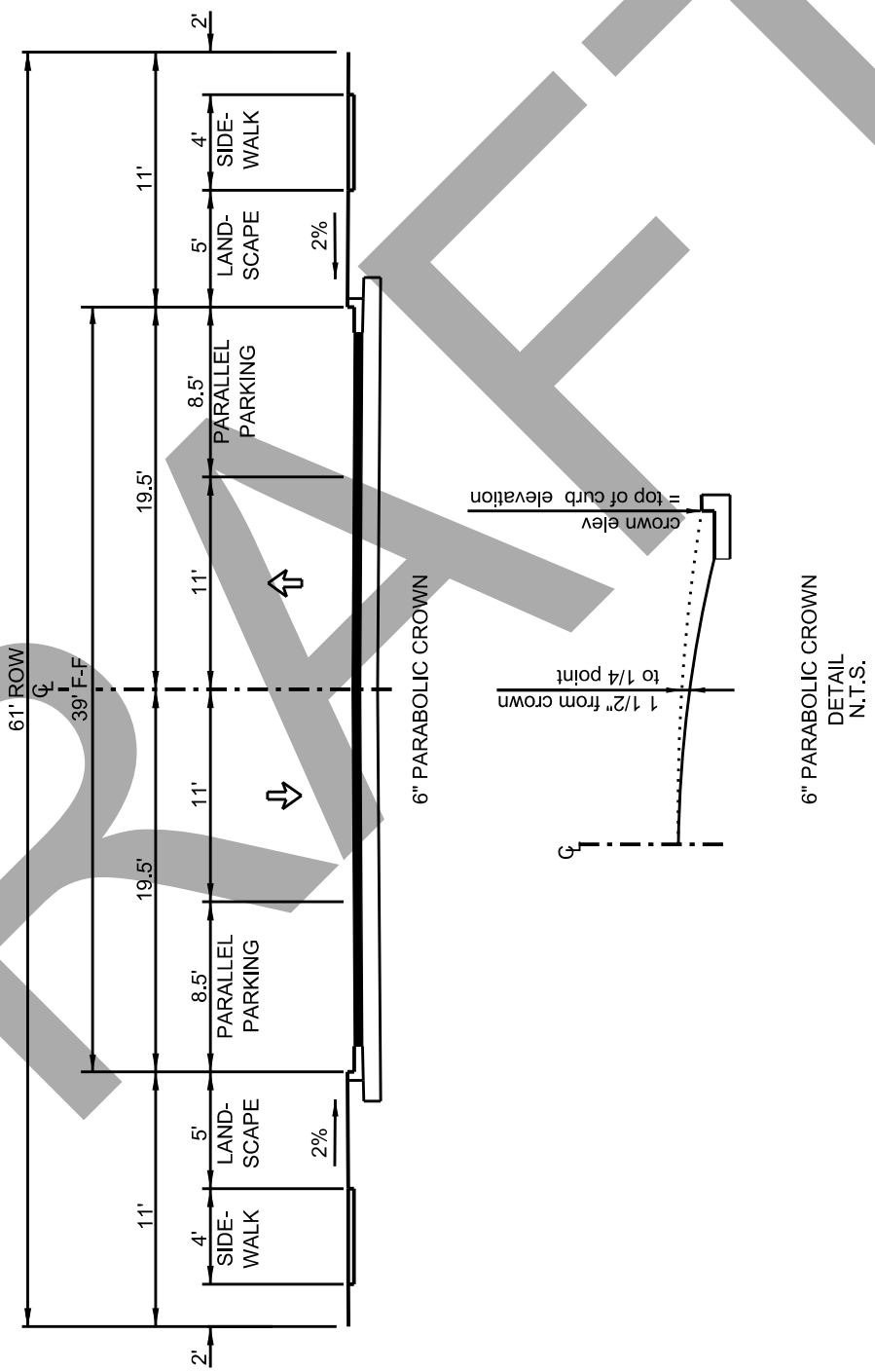
The typical cross slope for roadways with less than three lanes in one direction shall be 2.00%. The cross slope shall be increased to 2.50% for roadways with three lanes in each direction. Local streets shall have a parabolic crown as shown in the Typical Sections.

# Figure 1-1 Typical Section
# Local Residential Street (L 52-30)



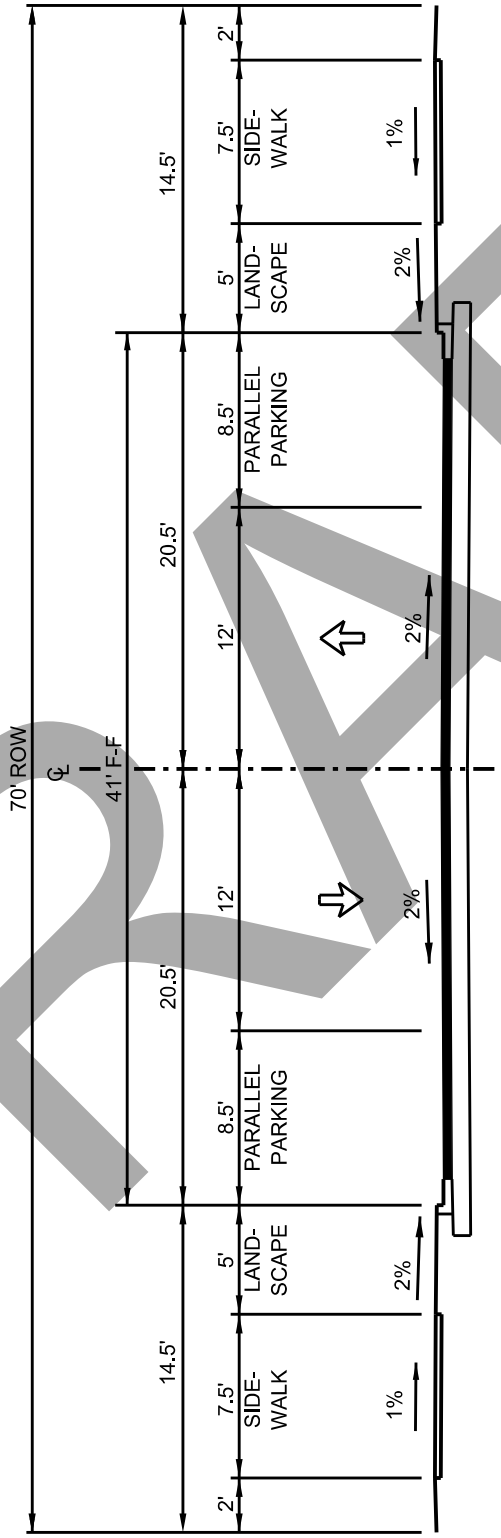

NOTE: PER ADA RULES A 5'X5' PASSING SPACE
IS REQUIRED EVERY 200' FOR SIDEWALKS < 5' WIDE

# Figure 1-2 Typical Section Two Lane Local Street With Parking (L 61-39)

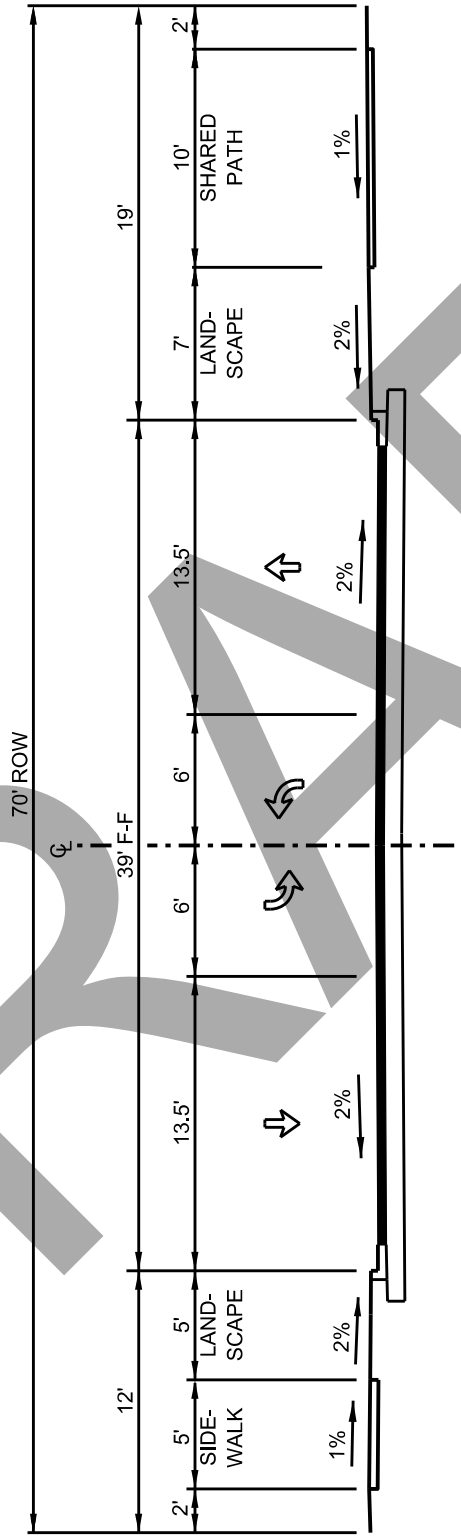



NOTE: PER ADA RULES A 5'X5' PASSING SPACE
IS REQUIRED EVERY 200' FOR SIDEWALKS < 5' WIDE

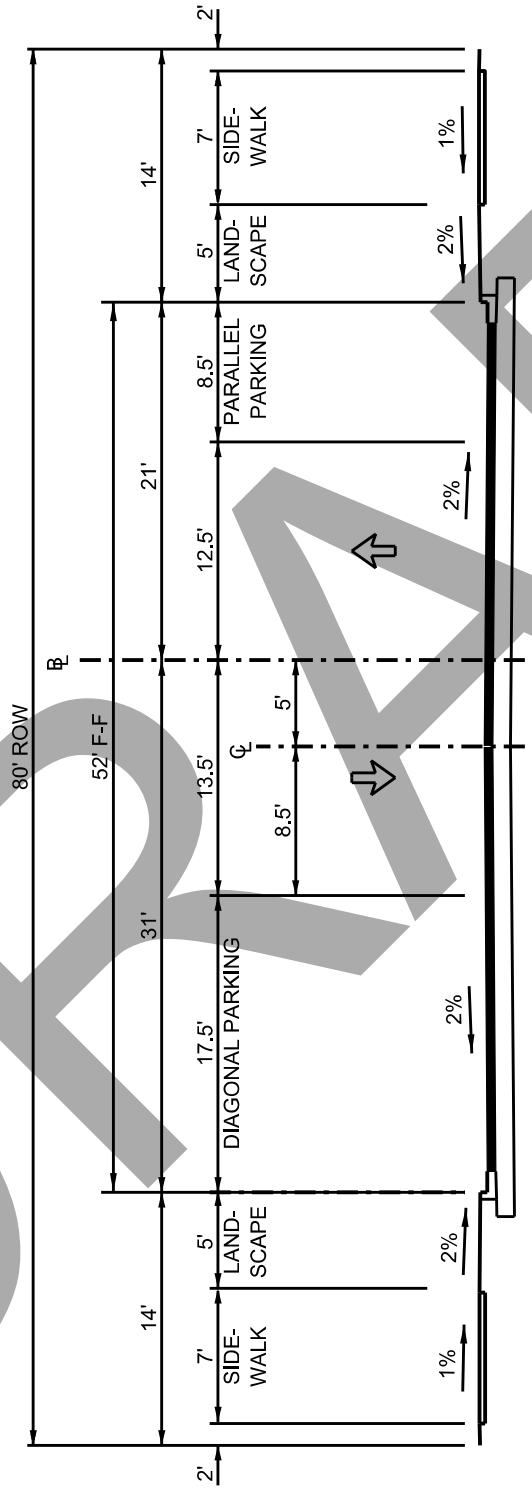
# Figure 1-3 Typical Section Two Lane Commercial Collector with on Street Parallel Parking (C 70-41)



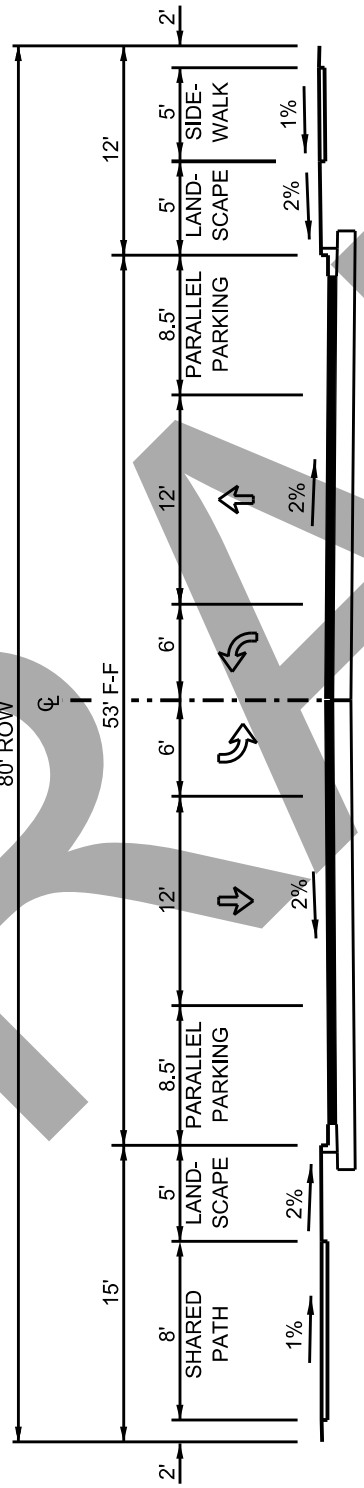
# Figure 1-4 Typical Section Three Lane Collector with Off-Street Shared Path (C 70-39)



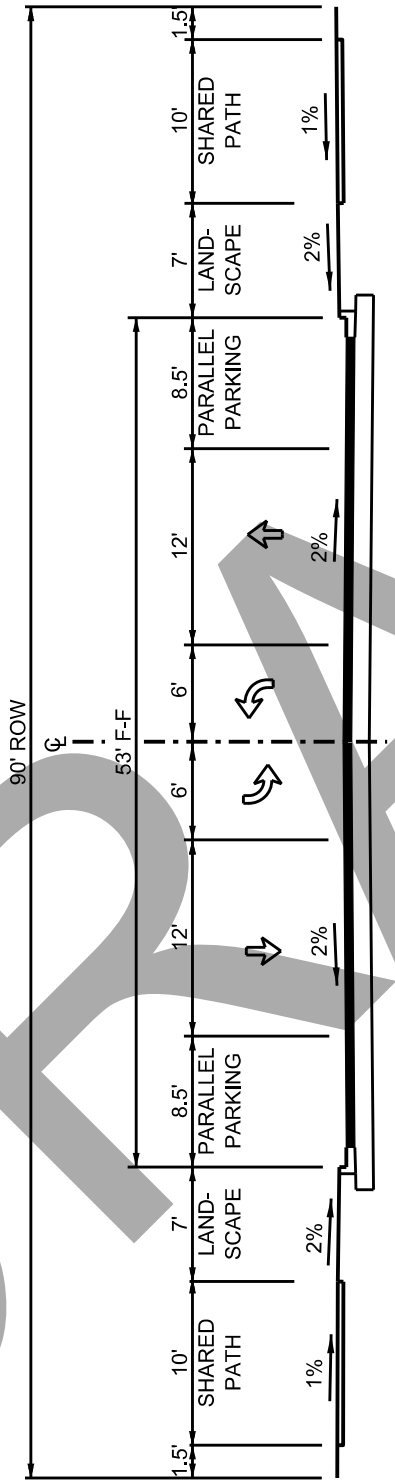
# Figure 1-5 Typical Section Two Lane Collector with Diagonal and Parallel Parking (C 80-52)



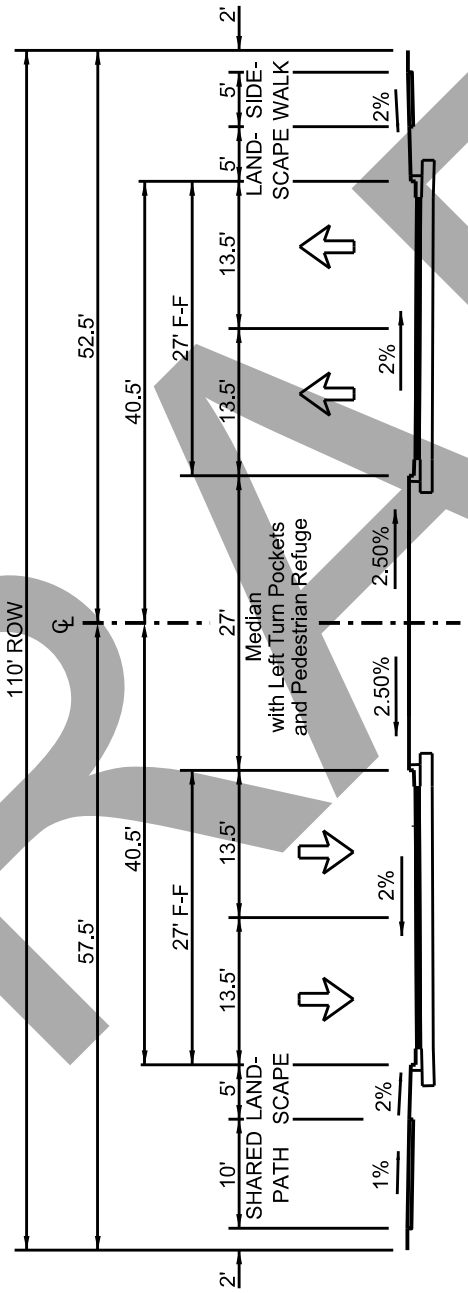
# Figure 1-6 Typical Section Three Lane Collector with Off-Street Shared Path and Parallel Parking (C 80-53)



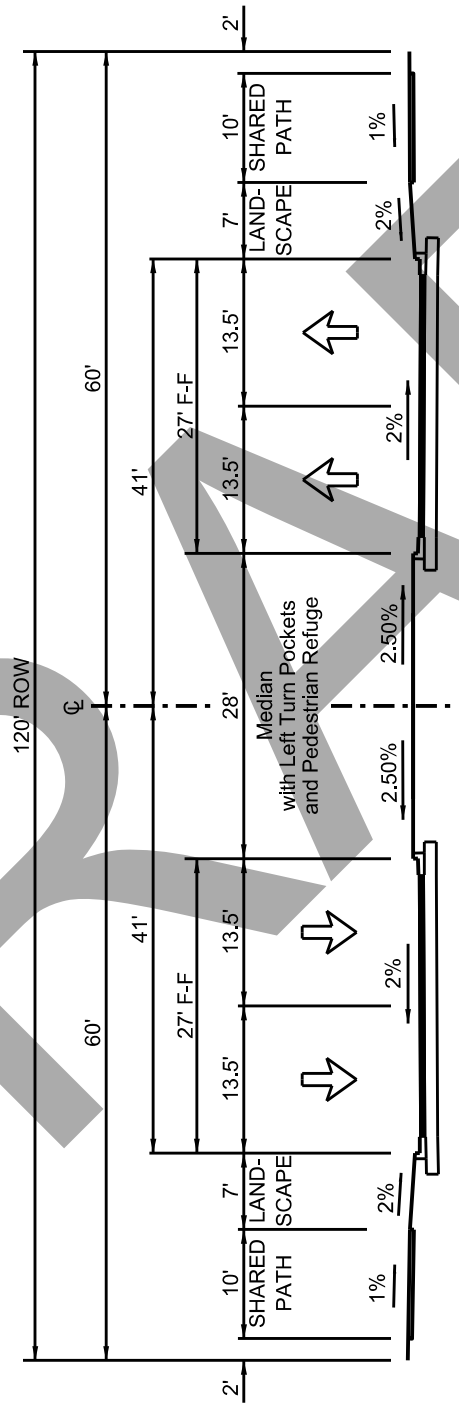
# Figure 1-7 Typical Section Three Lane Collector with Off-Street Shared Paths and Parallel Parking (C 90-53)



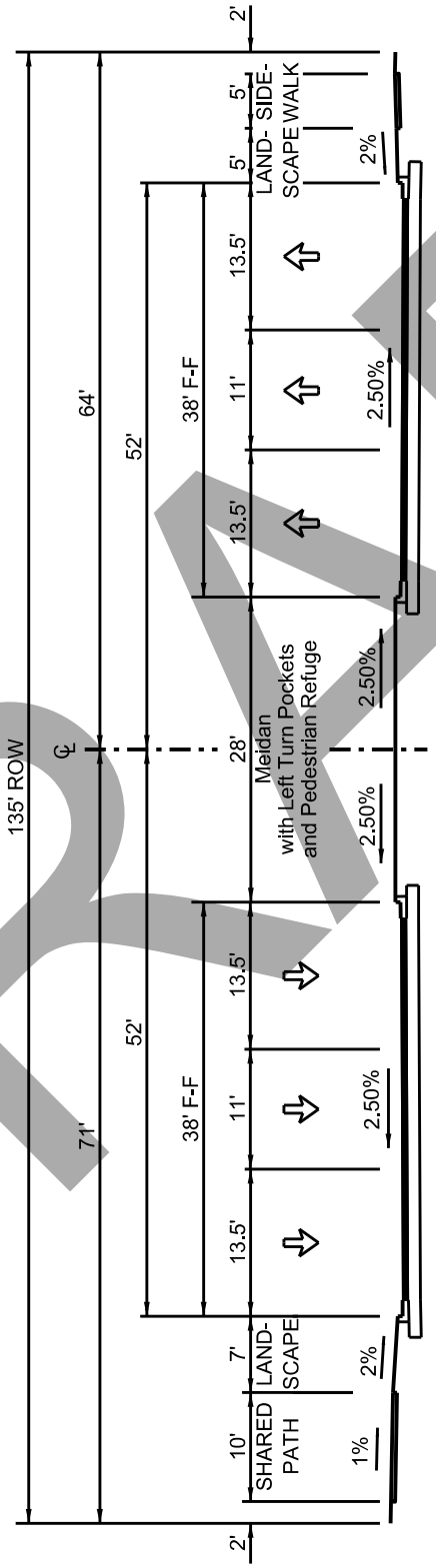
# Figure 1-8 Typical Section Four Lane Arterial with Off-Street Shared Path (A 110-54)



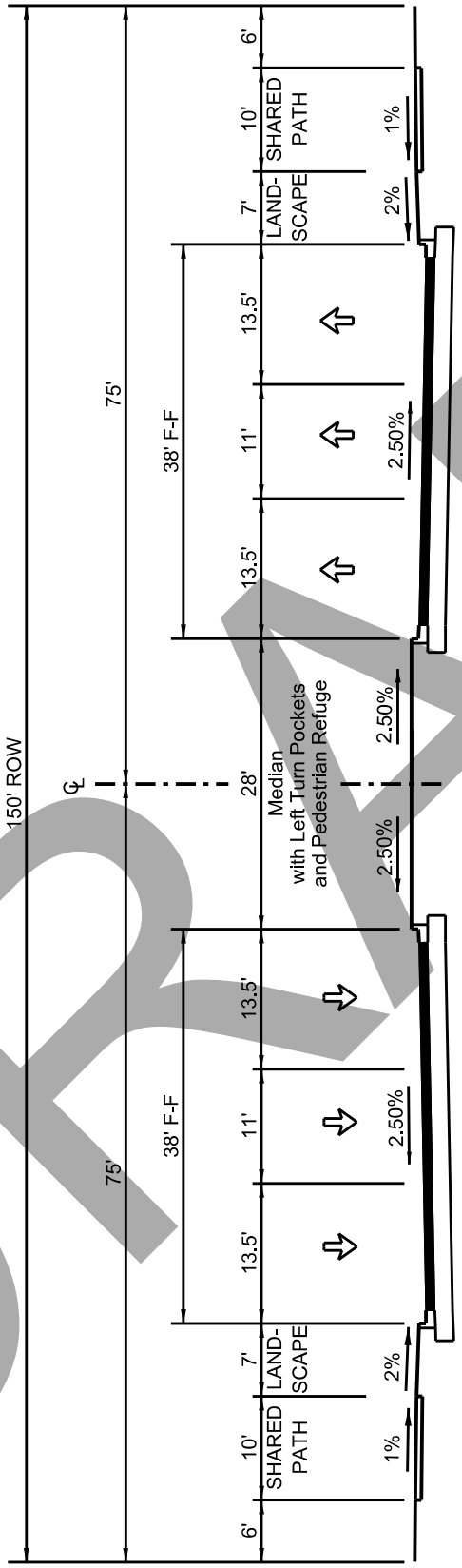
# Figure 1-9 Typical Section Four Lane Arterial with Off-Street Shared Paths (A 120-54)



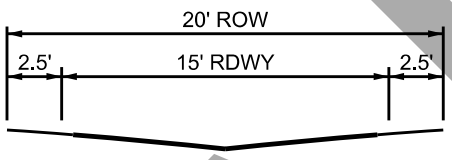
# Figure 1-10 Typical Section Six Lane Arterial with Off-Street Shared Path (A 135-76)



# Figure 1-11 Typical Section Six Lane Arterial with Off-Street Shared Path (A 150-76)

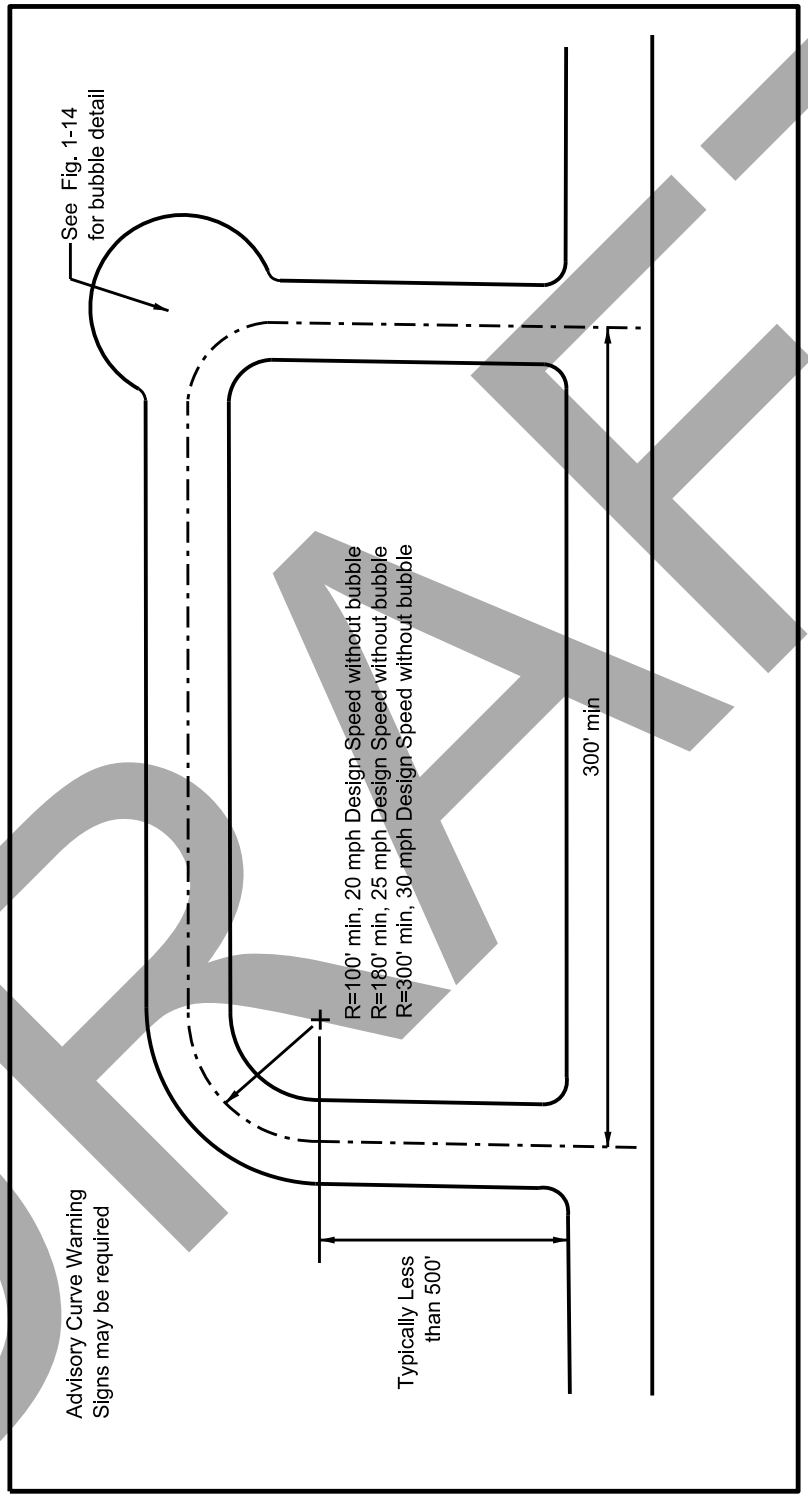


# Figure 1-12 Typical Section
# Residential Rear Alley (RA 20-15)

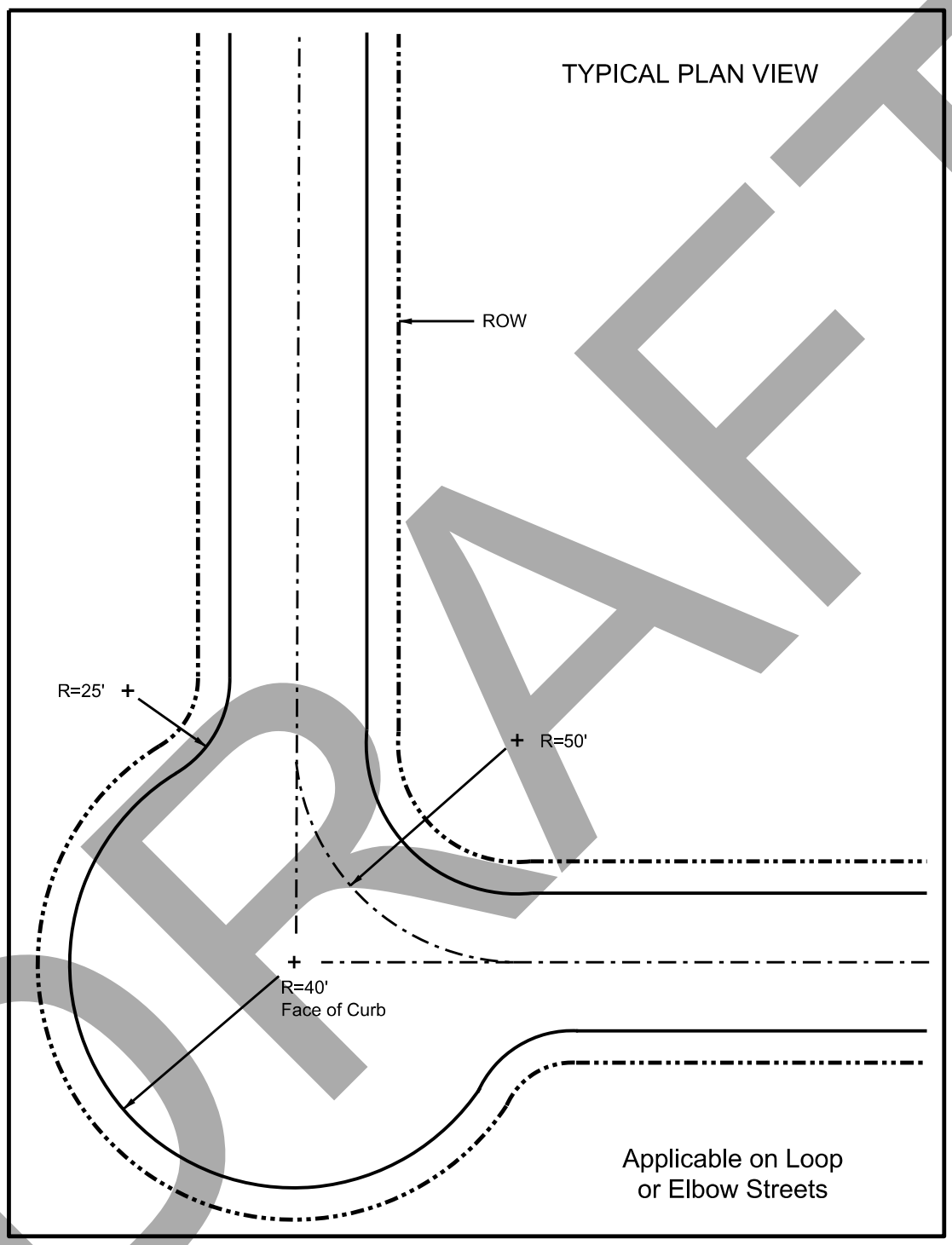



NOTE: Utility obstructions not permitted in roadway.

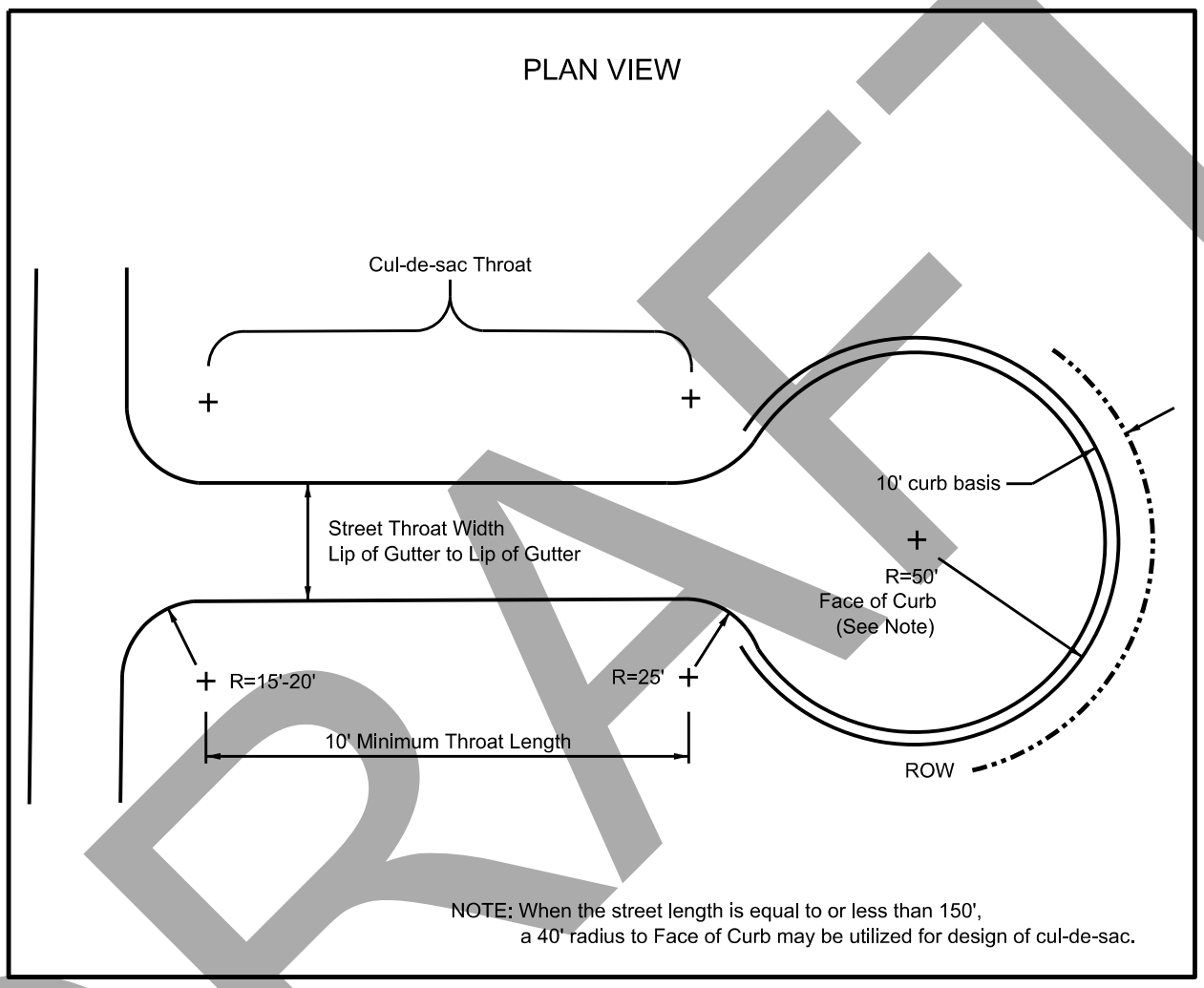
# Figure 1-13 Design Criteria for Elbow Streets



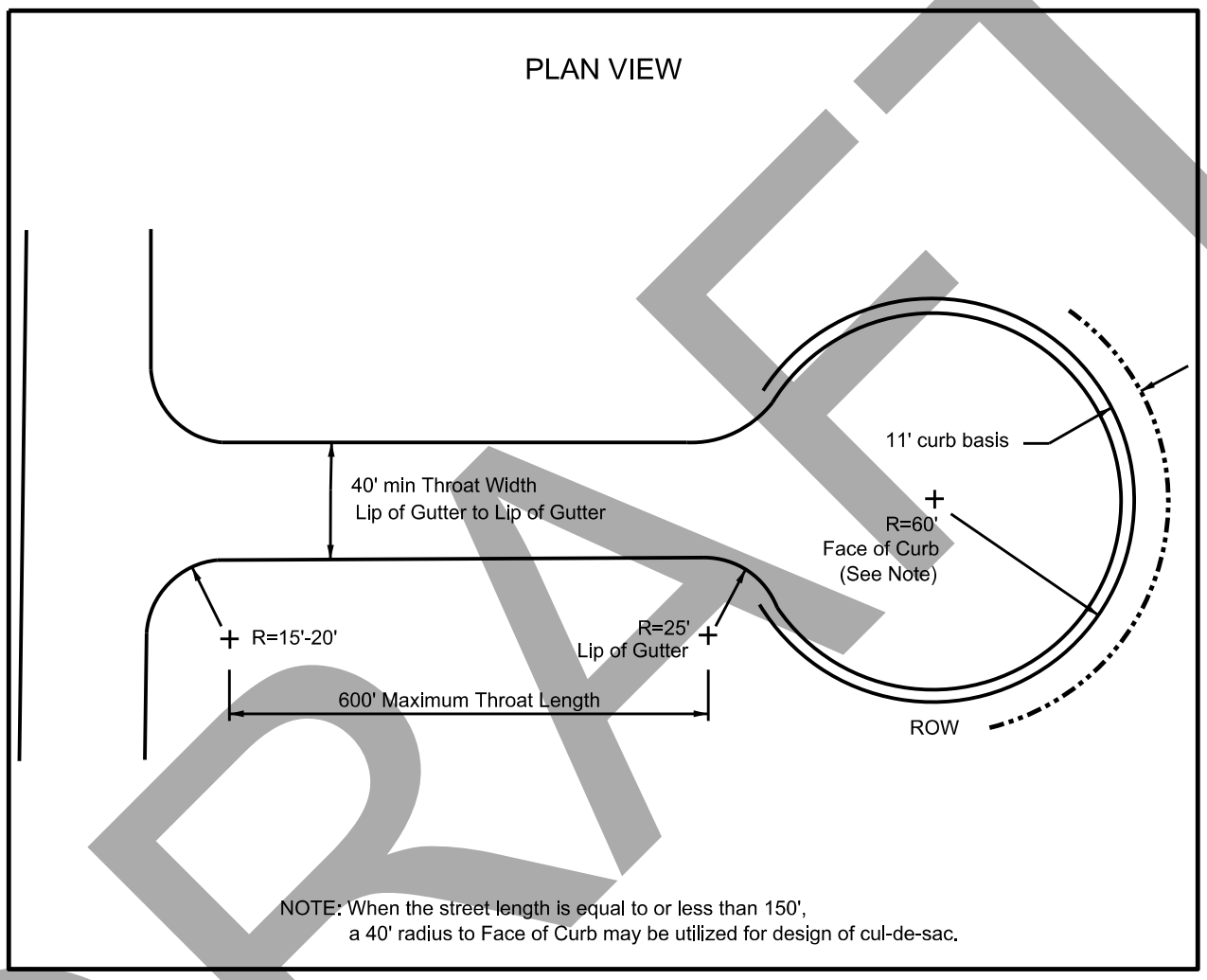
# Figure 1-14 Design Criteria for Corner Bubble



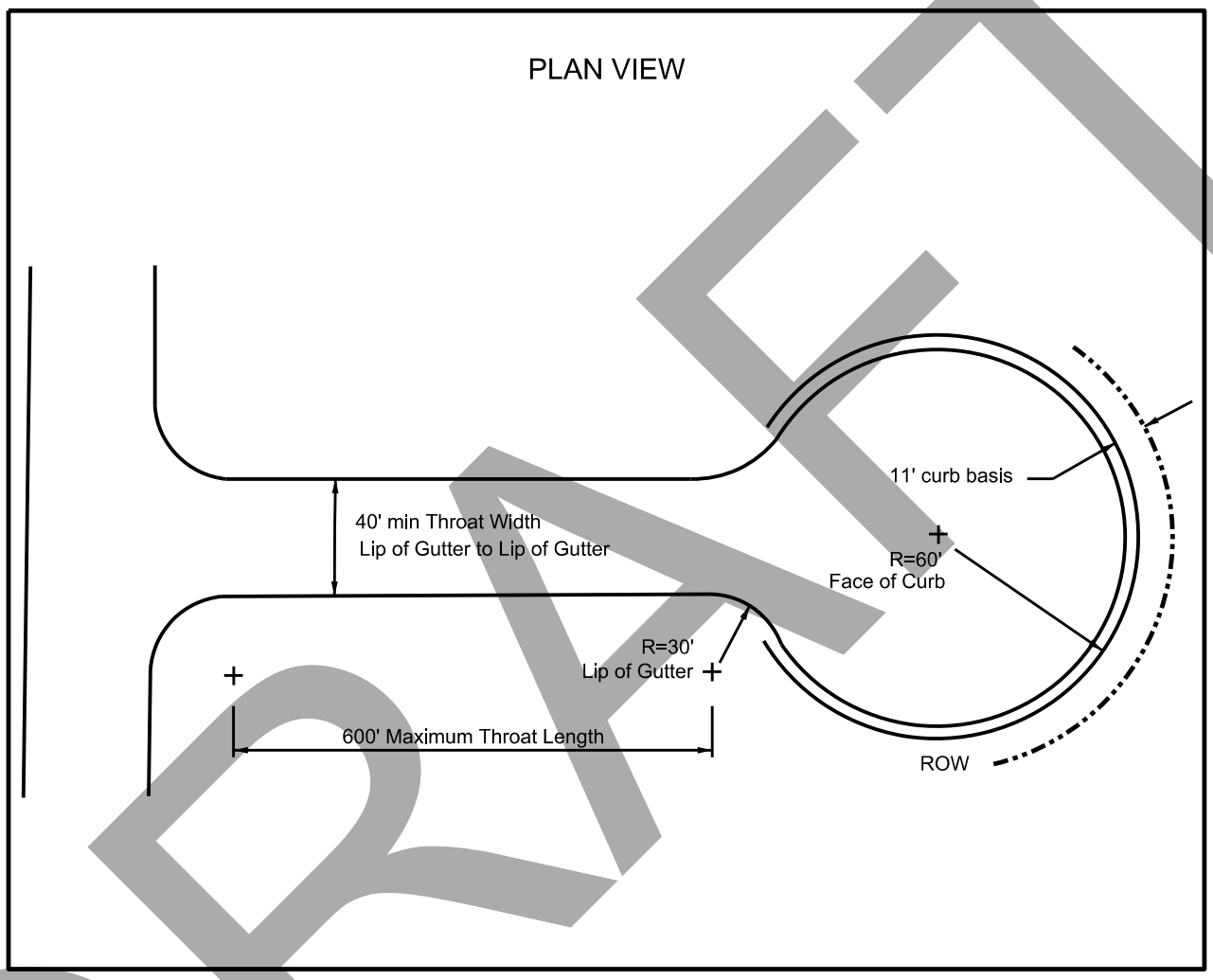
# Figure 1-15 Design Criteria for Local Cul-de-Sac



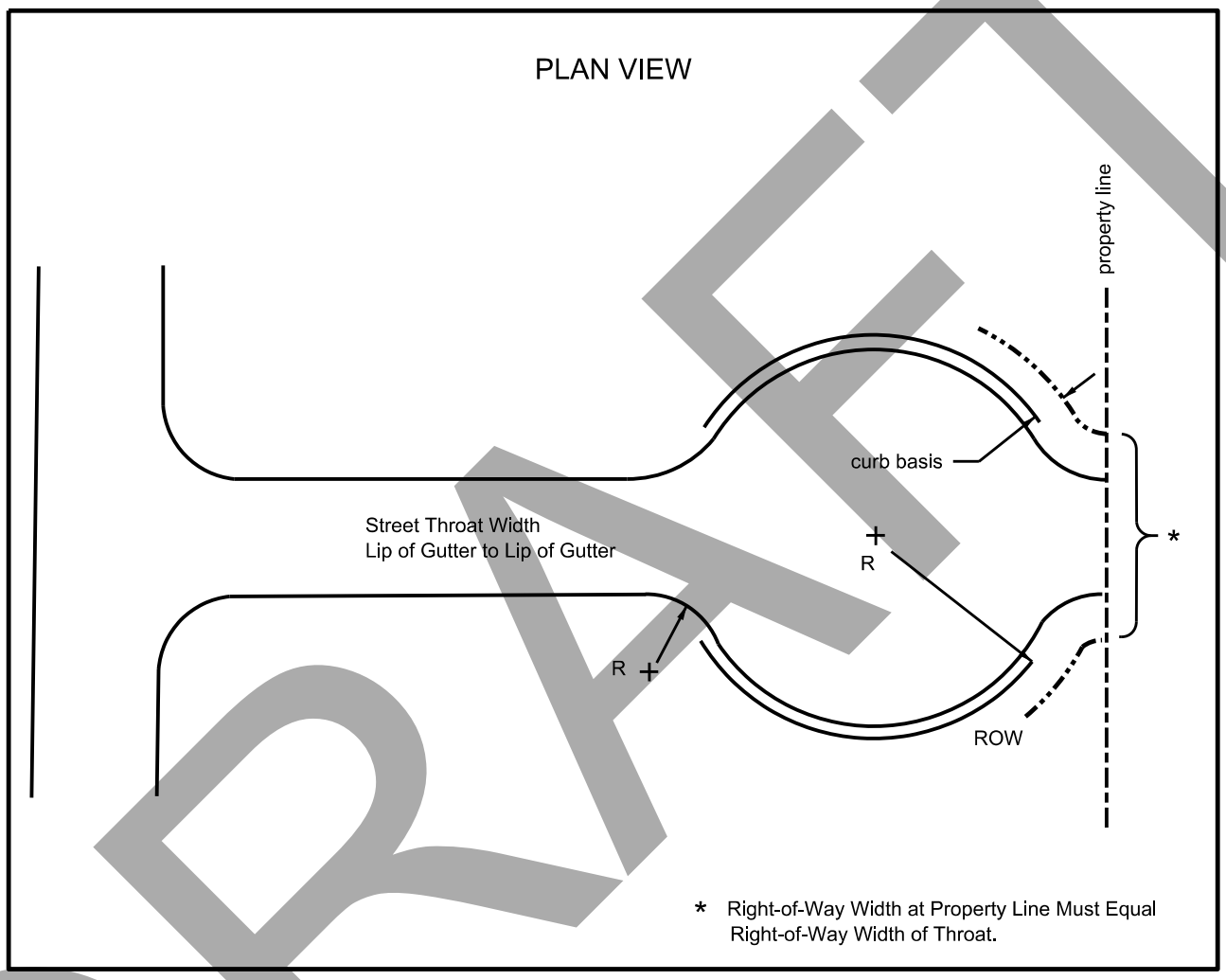
# Figure 1-16 Design Criteria for Commercial Cul-de-Sac



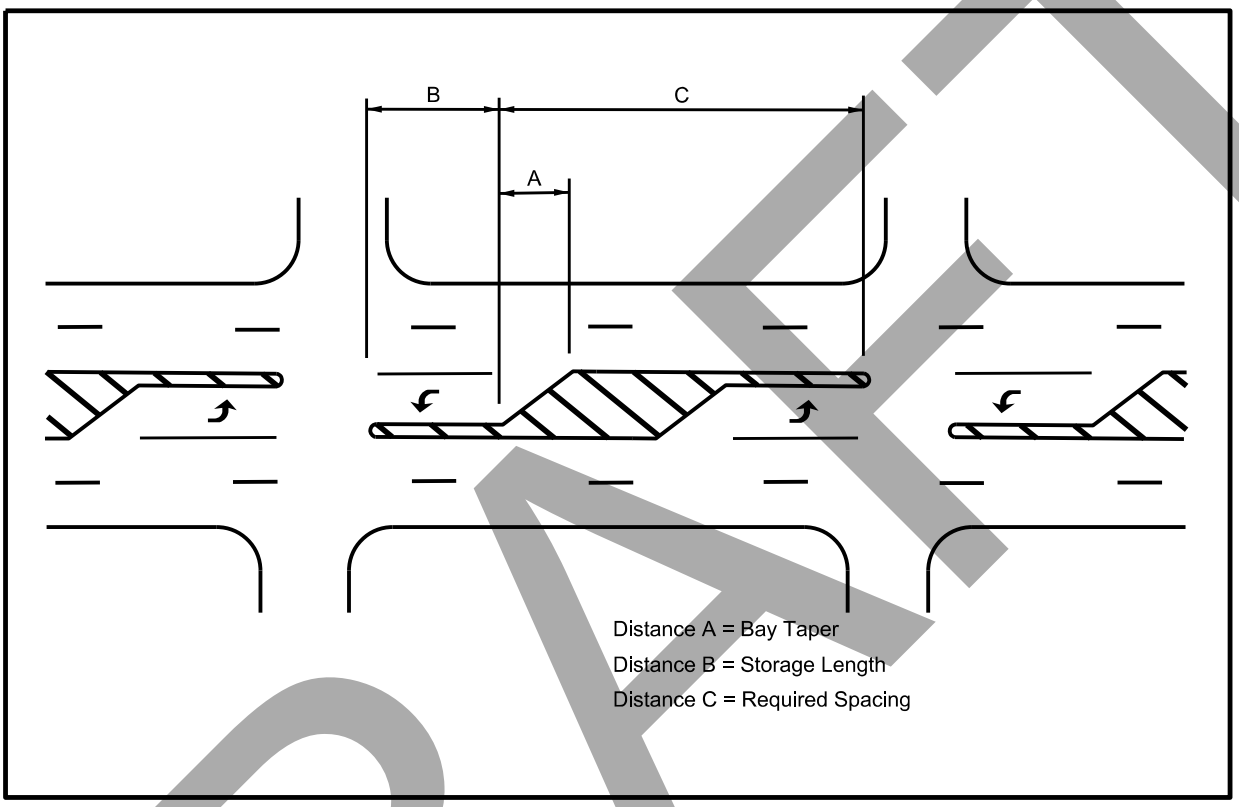
# Figure 1-17 Design Criteria for Industrial Cul-de-Sac



# Figure 1-18 Design Criteria for Open-Ended Cul-de-Sac



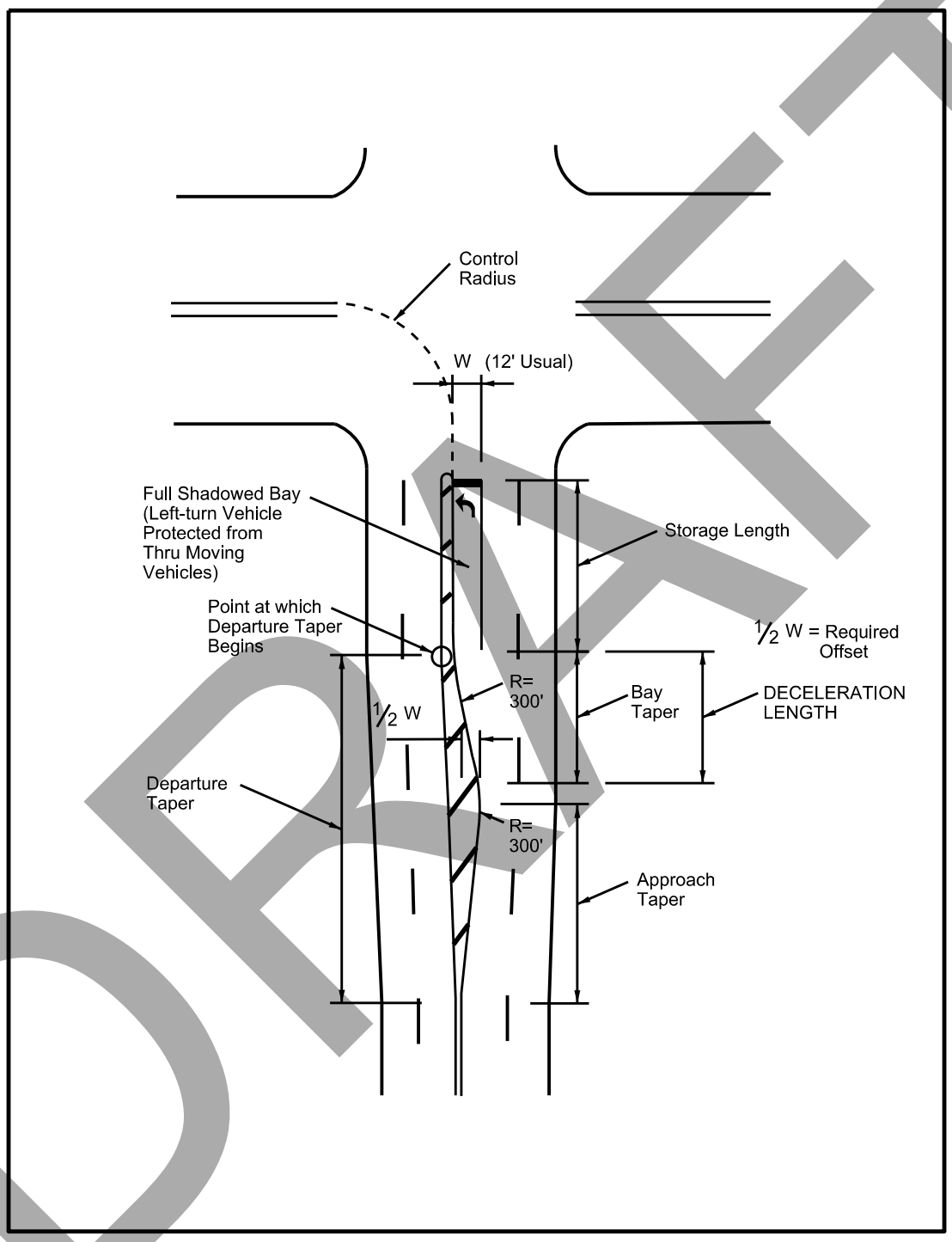
# Figure 1-19 Median Breaks



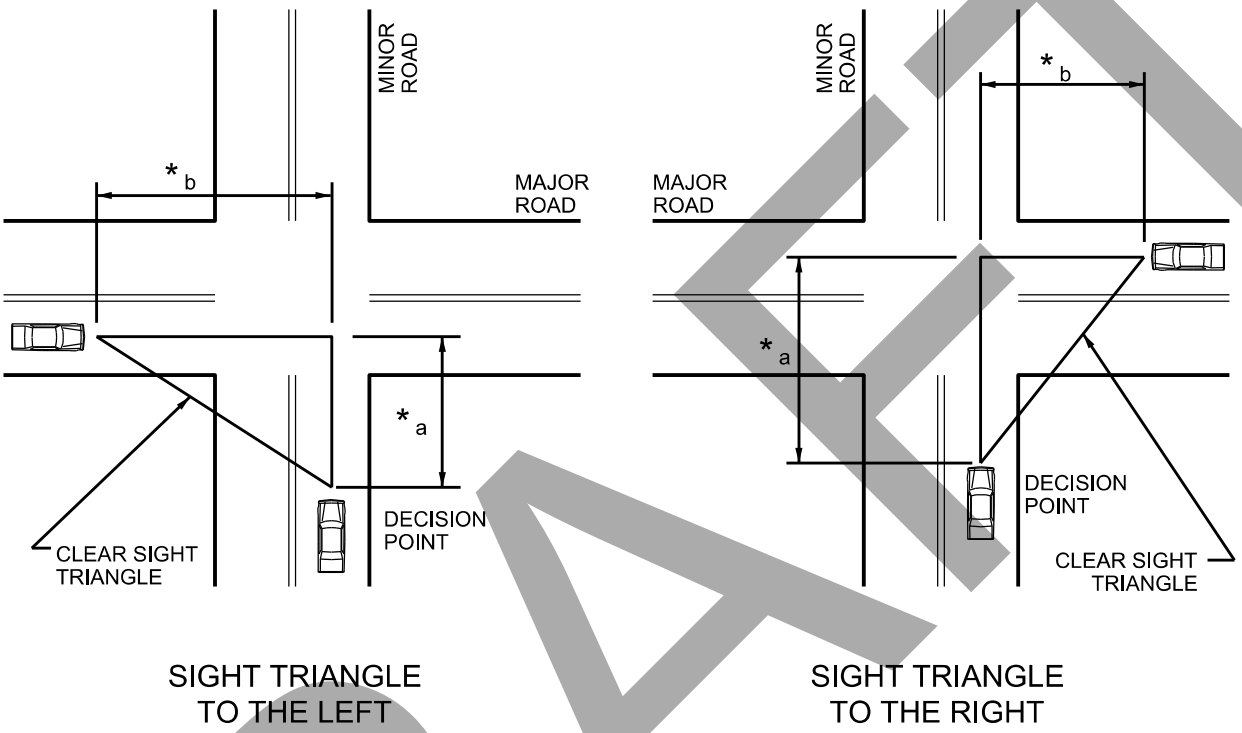

| Median Opening Criteria | | |
|---|---|---|
| Design Speed (mph) | Minimum Spacing* Distance "C" | Minimum Spacing Distance "B" + "C" |
| | 100' Minimum Storage Requirement** | 150' Minimum Storage Requirement*** |
| 30 | 350' | 500' |
| 35 | 425' | 575' |
| 40 | 500' | 650' |
| 45 | 600' | 750' |
| 50 | 750' | 900' |

* Plus storage lengths based on peak hour volumes
** Minimum storage when turning into a local street
*** Minimum storage when turning into a collector or arterial street

# Figure 1-20 Left Turn Channelization



# Figure 1-21 Intersection Sight Triangles




* Refer to latest edition of AASHTO'S A POLICY ON GEOMETRIC DESIGN OF HIGHWAYS AND STREETS to evaluate sight triangles

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## SECTION 2 – TRAFFIC IMPACT ANALYSIS

### 2.1 GENERAL

The following guidelines for a Traffic Impact Analysis (TIA) are intended to supplement the requirements of Chapter 46, Zoning, City of Round Rock Code of Ordinances.

### 2.2 ADMINISTRATIVE REQUIREMENTS

A traffic impact analysis report will be required for all proposed developments that add site traffic on to the roadway network within the City's jurisdiction. **A traffic impact analysis report shall be required for developments that are projected to generate 100 or more peak hour vehicle trips in the opening year.**

The applicant is responsible for contacting the Transportation Director before a development application is submitted to determine the proposed trip generation for the site and confirm whether a TIA will be required. Trip generation shall be calculated based on the criteria in Section 2.3.2A. If a TIA is required, the draft scope of the TIA and the requirements for TIA content and format must be submitted for review and approval.

The applicant is responsible for submitting one (1) original and an electronic copy of the TIA report at the time that a development application is submitted. If the applicant fails to comply with the technical requirements and the scope of study outlined in the preliminary meeting, the applicant will be advised in writing that an addendum is needed. An addendum must be submitted eighteen (18) working days or twenty-six (26) calendar days prior to the date on which the project is scheduled for consideration by the City of Round Rock Planning and Zoning Commission. If the TIA addendum is not submitted within this time frame and the staff does not have adequate time to review the report and submit comments to be included in the Commission agenda packet, the development request may be postponed to the next scheduled Commission meeting.

After the TIA and any addenda have been approved by the staff, one (1) original copy and an electronic copy of the final version of the TIA incorporating all corrections and additions must be submitted as a permanent file record. A final TIA for a zoning case must be submitted before the first reading of the rezoning by the City Council. A final TIA for a site plan must be submitted before release of the site plan.

### 2.3 TECHNICAL CRITERIA AND REQUIREMENTS

Technical requirements have been established to standardize the format by which a TIA is prepared and to ensure that the content and quality of the TIA will result in an accurate and useful analysis. The Transportation Department will review a TIA based on these criteria and may require a revised report or an addendum for those reports which are incomplete or inaccurate.

There are five (5) major elements or activities in preparing a TIA.

A. Determine the scope of the TIA.

B. Estimate and distribute site-generated traffic, based on proposed phasing

C. Forecast future non-site related traffic.

D. Analyze the capacity and projected operation of roadways and intersections, based on each proposed phase

E. Recommend land use and/or appropriate traffic engineering modifications to mitigate traffic impacts and maintain an acceptable level of service.

### 2.3.1 Scope of the TIA

The study area or scope of a TIA shall be determined by the Transportation Director. Applicants are responsible for scheduling a meeting to determine the scope of the TIA and to discuss all requirements before any studies are conducted. The elements to be determined during the meeting shall include the following:

(1) Type of study - The possible types of reports include: a letter report, full traffic impact analysis report or special report (e.g., sight distance survey).

(2) Impact area – Impact area will include identifying the study intersections and roadways to be analyzed in the study.

(3) Period of analysis - Periods of analysis generally includes AM peak and PM peak during a typical work day. Depending on the nature of the land use and vicinity to other uses, other periods such as mid-day peak, school peak, weekend peak or event peak hour may also be required to be analyzed.

(4) Analysis scenarios - Scenarios for analysis include existing conditions, opening year conditions without development, opening year conditions with development, and any phased considerations if the project will be developed in phases. Ten years after opening analysis may be required under special cases and will be determined by the Transportation Director. TIA update is required if phasing is modified.

(5) Type of Analysis – As a minimum intersection capacity analysis will be required. Depending upon the nature of the project, roadway capacity analysis, weaving analysis, etc. may also be required as determined by the Transportation Director.

(6) Assumptions – Assumptions include land use categories, trip generation, pass-by reductions, internal capture reductions, transit reductions, and growth rate assumptions.

(7) Roadway Improvements – Proposed roadway improvements that will be completed prior to the opening year of the development will need to be included in the analysis.

(8) Other projects – Other projects in the vicinity of the study area that will be completed prior to the opening year of the development will need to be included in the analysis.

### 2.3.2 Site Generated Traffic

The following procedures are accepted practice in the City's Transportation Master Planning and should be addressed in each report: trip generation, trip distribution and traffic assignment.

A. **Trip Generation.**

Trip generation shall be based upon the proposed land use and density. A.M. peak, P.M. peak and total daily site-generated traffic must be calculated using an independent variable or determinant which has been confirmed by the City during the pre-application meeting. The applicant must identify and justify the applicability of the trip rates used. Gross square footage is the usually accepted determinant for office and gross leasable square footage is the usually accepted determinant for retail projects. The number of dwelling units is the most often accepted determinant for residential uses. A table of proposed land uses must also be included in each TIA report for review.

Trip generation rates shall be adopted from the latest edition of "TRIP GENERATION, An ITE Informational Report, Institute of Transportation Engineers, Washington DC, 2012" (or latest edition). If the above source does not contain the appropriate trip rates for the proposed land use, other sources may be used at the discretion of the Transportation Director. The other sources may include collection of local traffic data for similar land uses, research papers, etc.

Average weekday trip rates shall be used in estimating total daily trips generated unless otherwise indicated by staff in defining the scope of study. Weekend or other trip rates shall also be required if the peak hour does not occur on an average weekday. The trip rate for peak hour of adjacent street traffic shall be used to estimate A.M./P.M. peak hour traffic entering and exiting the site. Guidelines in the Trip Generation manual shall be used for determining whether to use average trip rates or equations.

If the TIA is filed in conjunction with a site plan review, trip generation shall be based upon the uses and intensities identified on the site plan. If a site plan is not available, trip generation shall be based upon the maximum allowable density for the most intensive use. Reductions for internal capture, pass-by traffic, and transit usage should be discussed during the pre-application meeting and must be supported by adequate documentation. No reductions in trip rates may be made for driveway turning movements unless it can be documented that certain trips will not use the driveway. Guidelines contained in ITE's Trip Generation Handbook (2004 or latest edition) shall be used to document internal capture and pass-by trips.

B. **Trip Distribution.**

Percentages for directional distribution of the site generated traffic must be well referenced. The basis for directional attraction shall largely rely on the following information:

1. Marketing Study
2. Subarea Transportation Study

3. City or Regional Travel Demand Model Estimation
4. Local Traffic Data Collected as part of the TIA

The site traffic distribution on the impacted roadway network shall be documented in the TIA report.

C. **Traffic Assignment.**

This is the assignment of site generated traffic according to the percentages of distribution determined in the previous step. Traffic assignments shall be clearly illustrated with roadway and intersection geometry. The proposed roadway network shall include all the study intersections and roadways identified during the pre-application meeting.

### 2.3.3 Forecasting Future Non-site Traffic

Non-site related traffic must be estimated for the proposed build-out year of the project. In forecasting future traffic, the following factors must be considered:

A. Existing traffic.

B. Existing and proposed street network.

C. Traffic growth rates, using historic trends.

D. Traffic from any site plan within or adjacent to the study area of the TIA.

E. A reasonable portion of traffic from any project with a preliminary plat or recorded subdivision plat within or adjacent to the study area of the TIA.

F. A reasonable portion of traffic from any project with approved zoning within or adjacent to the study area of the TIA, unless there is reason to believe that the project is unlikely to be built within the time frame covered in the TIA.

Traffic growth rates and projects to be considered in background traffic should be determined during the pre-application meeting. Existing 24-hour traffic counts and A.M./P.M. peak hour intersection turning movement counts are needed as input. A copy of the traffic counts with the date and time they were conducted must be provided. Annual traffic growth rates must be well documented. A comparison should be made with other recent forecasts where available.

### 2.3.4 Capacity Analysis and Traffic Impact Assessment

Levels of service for roadways and intersections must be calculated before and after the proposed development. The acceptable software models for calculating levels of service are:

A. HCS (Highway Capacity Software), latest edition by McTrans

B. PASSER V, latest edition by Texas Transportation Institute

C. Synchro plus SimTraffic, latest edition by Trafficware Ltd.

D. Other methodologies as approved by the Transportation Director.

In a multi-phased development, levels of service must be evaluated before and after each new phase. Unless otherwise indicated during the pre-application meeting, Level of Service D shall be the minimum acceptable standard. In

addition, the following characteristics shall be addressed when evaluating capacity and level of service:

A. Physical Configuration - intersection and roadway geometry.

B. Traffic Characteristics - volume, peak hour factor, heavy vehicle factor.

C. Traffic Control - signalized or unsignalized control.

D. Environmental Condition - topography, sight distance and other safety hazards.

E. Capacity - as determined in the latest edition of the Highway Capacity Manual, Transportation Research Board.

The applicant must indicate all assumptions used in the analysis, including cycle length, phasing, G/C ratios, etc. Default values must be used for percent of heavy vehicles, peak hour factor, arrival type, etc. (as per the criteria established in the Highway Capacity Manual) unless the applicant can document other values through field data.

A capacity analysis must be performed for study intersections within and adjacent to the site, as determined in the scope of the TIA. Volume/capacity ratios for the critical movements ($X_C$) must be provided for each intersection analyzed. If the overall level of service is D or worse, volume/capacity ratios must also be provided for each movement within the intersection.

The TIA must present conclusions regarding the impacts of the proposed development on the roadway system. These conclusions should be expressed in quantitative terms whenever possible. The report must specifically address any adverse traffic impacts (worse than level of service D) which cannot be avoided if the development occurs and recommend improvements to mitigate the traffic impacts. Transit-related or pedestrian/bicycle-related issues should also be discussed if applicable.

### 2.3.5 Recommendations on Roadway Improvements and Traffic Control Modifications

The TIA must include specific recommendations to mitigate the transportation impacts of site-generated traffic on roadways and intersections to an acceptable level of service. Various traffic control improvements or land use decisions can be used to mitigate traffic impacts on adjacent roadways and intersections. These include, but are not limited to, the following:

A. **Roadway Improvements.**

1. Lane addition and reconfiguration
   a. through traffic lane
   b. right turn lane
   c. left turn lane
2. Sight distance improvement
3. Grade separation
4. Geometric or alignment improvements

B. **Traffic Control Modifications.**

1. Stop sign control
2. Signal controls
   a. new installation
   b. upgrade existing traffic signal
3. Other improvements
   a. restricted turns
   b. channelized islands

C. **Land Use Controls.**

1. Reduce density
2. Alter proposed land use

D. **Alternative Modes and Demand Management Options.**

1. Transit Incentives
2. Ridesharing Incentives
3. Flexible Work Hours
4. Other Options

In some cases, a combination of the above strategies may be necessary.

Site driveways and roadways shall include a right turn deceleration lane if the projected right turn peak hour volume is 50 or more vehicles per hour.

The TIA must clearly identify in the recommendations any roadway improvements (including geometric changes), traffic control modifications (including signal retiming), or other measures necessary to mitigate site-generated traffic impacts.

### 2.3.6 Certification Statement

The TIA must be completed by a professional engineer who is competent in traffic engineering and registered in Texas. The TIA report shall include the following statement, signed and sealed by the professional engineer responsible for the contents of the document:

*"I hereby certify that this report complies with Ordinance requirements and applicable technical requirements of the City of Round Rock and is complete and accurate to the best of my knowledge."*

## 2.4 SUBMITTAL REQUIREMENTS

Below is a checklist of TIA submittal requirements for Zoning Cases, Site Plans, Subdivision Platting, and General Plan Amendments.

A. **Scope of TIA.**
   1. Study area (as defined in consultation with staff).
   2. Target year for project build-out and each phase.

B. **Trip Generation.**
   1. Proposed land use or zoning district for each tract.
   2. Generation rates based on proposed land use intensity
      a. Daily (24 hour)
      b. Peak hour (A.M., P.M., other)

C. **Trip Distribution.**
   1. Percentages for directional distribution.
   2. Sources of information.

D. **Traffic Assignment**.
   1. Roadway network in study area (existing and proposed).
   2. Access points (Driveways) .

E. **Traffic Forecast.**
   1. Existing 24-hour A.M./P.M. peak traffic, including copies of field data.
   2. Assumptions on annual growth rate or other source of future background traffic at time of build-out.
   3. Projected site, background and total traffic for 24-hour, A.M./P.M. peak at time of build-out.

F. **Capacity Analysis for Street Intersections and Driveways.**
   1. Intersection/roadway geometry (existing and proposed).
   2. Traffic control (signalized or unsignalized).
   3. Traffic characteristics (turn movements, percent trucks and buses).

G. **Traffic Impact Assessment.**
   1. Impacts expressed in quantitative terms.
   2. Adverse impacts which cannot be avoided.
   3. Transit issues (if applicable).
   4. Pedestrian issues (if applicable).

H. **Recommendations.**
   1. Roadway improvements.
   2. Traffic operation modifications.
   3. Limitation of land use intensity.

I. **Certification Statements (as provided in Section 2.3.6 above)**

If a TIA has been reviewed and approved for a zoning case on a project and if a

site plan, subdivision platting, and general plan amendment are submitted for the same project, a TIA addendum and/or update will be required if there are significant changes to the land uses, anticipated target year (build-out year), trip generation, trip distribution, background traffic or funded improvements. The level of detail needed for the revised analysis should be discussed with the Transportation Director during the scoping meeting.

## 2.5 FISCAL POSTING

The developer shall be responsible for posting the pro-rata share of the fiscal for any traffic signal(s) identified in the TIA that are not constructed at the time of development.. The TIA shall contain a table clearly identifying the recommended improvements, entity responsible for the improvements, the cost of construction, site traffic as a percentage of total traffic, and the developer's pro-rata cost. For a multi phased development, the above information shall be provided for each phase of development. The fiscal shall be posted prior to final plat recordation, site development permitting, and/or building permit issuance, whichever is first.

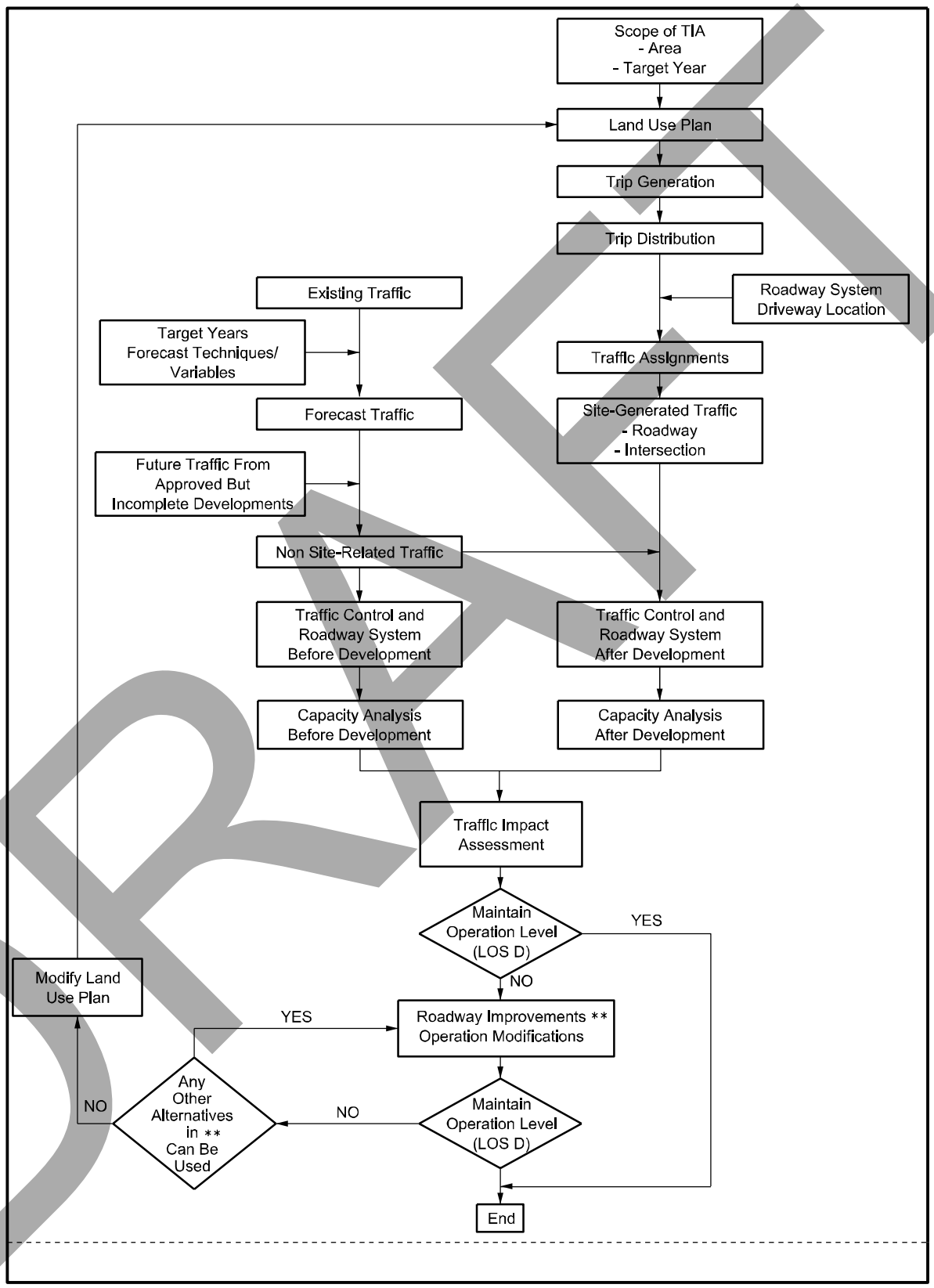
## 2.6 TIA VALIDITY PERIOD

The TIA will be valid for a 12 month period beyond the ultimate build-out year of the development. If the certificate of occupancy is not obtained by the developer within this time frame and the build out is delayed, a TIA update may be required at the discretion of the Transportation Director.

## 2.7 PHASED DEVELOPMENTS

For phased developments, the TIA shall be completed to include analysis for all phases and recommend improvements for each phase. The mitigation can also be phased based on the horizon year of each phase. However, if the future phases generate more traffic than what was assumed in the TIA, an addendum will be required. If the developer proposes to build in phases and submits only one phase of development for approval, the developer should be aware that traffic conditions may change when other phases are added, requiring additional on-site and off-site improvements as determined by a TIA addendum.

# Figure 2-1 Flow Chart for Traffic Impact Analysis



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# SECTION 3 – PAVEMENT DESIGN

## 3.1 INTRODUCTION

### 3.1.1 Objective

The objective of this section is to provide the City of Round Rock's (the City) Roadway Designers and Geotechnical Engineers with a pavement design overview covering the design inputs, design methodology, and representative pavement sections for the various roadway classifications within the City and its jurisdiction.

This section is intended to address most pavement design considerations within the City. Deviations from the pavement design methodology or minimum design criteria set forth in this section shall be documented in the Pavement Design Report and approved by the Transportation Director.

### 3.1.2 Scope

The scope of this document includes design criteria and design guidance for flexible and rigid pavements constructed on city streets under the authority of the City of Round Rock, within city limits and within its Extraterritorial Jurisdiction (ETJ).

This document is not intended to cover design of pavement for highways under the authority of the Texas Department of Transportation (TxDOT) or Williamson County. For these roadways, the reader is referred to design manuals such as TxDOT's “Pavement Design Guide” or Williamson County's Criteria Manual.

### 3.1.3 Standard of Care

The services described in this section shall be completed under the direction of an appropriately experienced Professional Engineer registered in the State of Texas. Geotechnical engineers shall be retained to address the geotechnical-related aspects of pavement designs described in this section. Roles and responsibilities adopted for the purpose of this manual are provided below:

- Roadway Designer: Professional Civil Engineer with responsible charge for completion of the design project. The Roadway Designer is responsible for coordinating all elements of the project (civil, roadway, geotechnical, pavement, etc.), and preparing final plans and specifications required for contractors to bid on construction of the project. The Roadway Designer is also responsible for developing design traffic parameters and roadway design layouts for use by the Geotechnical Engineer and/or Pavement Engineer;
- Geotechnical Engineer: Professional Civil Engineer responsible for the geotechnical engineering-related aspects of pavement design, including subsurface investigation and subgrade treatment/ stabilization recommendations. Depending on the project, the

Geotechnical Engineer may also assume the responsibilities of the Pavement Engineer; and

- Pavement Engineer: Professional Civil Engineer responsible for the pavement design, including pavement materials selection and layer thicknesses required to support design traffic loading and life cycle cost analyses. Depending on the project, these responsibilities may be transferred to the Geotechnical Engineer.

### 3.1.4 References

This section has been updated significantly from the previous version of the City's Transportation Criteria Manual adopted in 2005. The bases of these updates are recent research findings presented by the Capital Area Pavement Engineering Council Initiative (CAPEC), and the more recent version of the TxDOT Pavement Design Guide (2011) and its 2016 draft revisions. Refer to the bibliography for these specific references.

### 3.1.5 List of Acronyms

Commonly used acronyms in this section are listed below.

| | |
|---|---|
| ACPA | American Concrete Pavement Association |
| CAMPO | Capital Area Metropolitan Planning Organization |
| CAPEC | Capital Area Pavement Engineers Council |
| MSL | Mean Sea Level |
| NRCS | Natural Resource Conservation Service |
| OSHA | Occupational Safety and Health Administration |
| PCA | Portland Cement Association |
| PDR | Pavement Design Report |
| ROW | Right-of-Way |
| TxDOT | Texas Department of Transportation |
| USGS | United States Geological Survey |

## 3.2 PAVEMENT DESIGN CRITERIA

### 3.2.1 General Criteria

All streets shall be constructed on an engineered subgrade, above which shall be placed a base layer and the pavement. Pavements shall be either Hot Mix Asphaltic Concrete (HMAC) or Concrete Pavement. For the purpose of this guide, HMAC pavements are considered "flexible pavements," and concrete pavements are considered "rigid pavements".

### 3.2.2 Design Life

Specific to flexible pavements, the following design periods apply:

- Pavement Design Life: 20 years;
- Time to First Overlay: 20 years; and
- Time Between Overlays: 10 years.

Rigid pavements to be constructed in public right-of-way (ROW) shall be designed for a minimum 30-year design life.

### 3.2.3 Design Methodology

The recommended pavement design methodology is a balanced approach that requires the Pavement Engineer to address the following:

- Design for Crack Resistance:
  - Consider environmental stresses (shrink/swell) in all soils regardless of high plasticity ('high 'PI') soils;
  - Include Potential Vertical Rise (PVR) assessment calculations;
  - Consider fatigue cracking criteria in surface layers; and
  - Consider thinner base layers to offset cost (e.g., compensate with subgrade treatment or thicker HMAC/Concrete Pavement).
- Develop Subgrade Improvement Strategies (as needed):
  - Consider subbase layers; and
  - Recommend combination strategies.

### 3.2.4 Design Process Overview

Pavement design shall be based on the analytical process described in this section. This process will yield the required thickness of the pavement structure based on environmental and traffic conditions expected over the design life of the pavement. The Pavement Engineer should strive to produce the most cost-effective structural pavement design for the City using Life-Cycle Cost Analysis (LCCA) methodology developed by the Federal Highway Administration (FHWA).

The required pavement design software programs will provide the engineer with multiple pavement thickness options. The choice of materials to be used, the staging of construction, and design considerations all have an impact on the final pavement design selected. Prior to finalizing the pavement design, the Pavement Engineer shall coordinate with the City of Round Rock to account for such items as construction impacts (i.e., staged, urgency of completion, detours, and future widening), recycling efforts, drainage characteristics, traffic safety, and noise mitigation.

A Pavement Design Report (PDR) shall be prepared for each project. The PDR shall recommend a pavement section or sections based on analyses using traffic inputs, service factors, and subgrade conditions at the project site. The PDR shall be prepared by an appropriately experienced Professional Engineer licensed in the State of Texas.

The Design Engineer or Geotechnical Engineer shall submit a preliminary pavement design to the City for review and approval by the Transportation Director prior to finalizing the PDR and Contract Bidding Documents. The City has final approval authority for all pavement designs for streets in the public ROW.

In general, the steps for pavement design include those listed below:

1. Estimate design traffic loading and assign street classification;
2. Perform a geotechnical investigation to characterize subsurface soils: assign subgrade strength, evaluate risk of expansive soils, and identify any other geologic hazards or constraints;
3. Determine whether subgrade treatment/stabilization is required, and identify suitable alternatives;
4. Identify suitable pavement types (rigid or flexible), and develop preliminary pavement cross-section alternatives;
5. Evaluate long-term performance (fatigue, cracking, rutting, etc.) using the following software programs, and develop final pavement cross-section alternatives. The CORR's currently required software programs include:
    a. Flexible Pavement : FPS-21 by TxDOT; and
    b. Rigid Pavement: StreetPave12 by ACPA.
6. Perform Life Cycle Cost Analysis (LCCA), and develop recommended pavement cross-sections. Based on proposed street classification and requirements, the CORR may waive this requirement on a conditional basis; and
7. Prepare pavement design drawings, details, and specifications for inclusion in contract documents.

The version numbers listed above are currently available. The Pavement Engineer shall obtain and use the latest published version of the software programs for use in design. Detailed description and instructions for obtaining these software programs are provided later in this section.

## 3.3 TRAFFIC PARAMETERS FOR DESIGN

### 3.3.1 Traffic Data Collection

Traffic data must be developed for new roadways or existing roadways being widened for added capacity. Traffic data must address the variety of factors usually depicted with Traffic Impact Analyses (TIA) that predict the type and volume of future traffic. TIA should be adapted to address:

- Rather than peak hourly volumes, it is necessary to determine the full spectrum 24-hour traffic volumes and percent trucks required/ reported; and

- Rehabilitation or reconstruction of existing roadways should utilize traffic counts obtained from current traffic data and adapted to predict future volumes.

It is important that the traffic projections consider complete build-out of subdivisions and any future development that will be served by a specific street. Should the roadway's geometry require change (e.g., widening to add capacity or narrowing to add bicycle lanes or parking), these counts will need to be adjusted to a projected traffic level and number of lanes appropriate for the geometry changes. Additionally, if the proposed roadway is along a new alignment, the anticipated traffic must be estimated for pavement design.

Resources to be consulted for obtaining existing traffic data are described below in order of precedence.

- City of Round Rock. The Roadway Designer should first contact the City's Transportation Department to verify what traffic data are available and to determine the need for collecting new traffic data. The methodology for obtaining existing and future traffic counts shall be approved by the Transportation Director prior to initiating a project. Traffic data may also be provided in the Transportation Master Plan (TMP) developed by the City.
- TxDOT. For roadways in TxDOT jurisdiction, a request for 20-year traffic projection for flexible pavements and 30-year traffic projection for rigid pavements may be made from the Traffic Section of the Transportation Planning and Programming Division (TPP) using Form 2124, Request for Traffic Data.
- CAMPO. The Capital Area Metropolitan Planning Organization (CAMPO, http://www.campotexas.org/) has links to count data provided by the City of Austin, TxDOT, and other local agencies, if site-specific current or forecasted traffic count data are not available for the specific street under design.
- Software. Software such as StreetPave12 (software for rigid pavement design discussed subsequently herein) has predetermined traffic spectra and counts. These predetermined spectra are designated for "residential", "collector", "minor arterial," and "major arterial" general designated street classifications.

### 3.3.2 Design Basis and Required Traffic Parameters

Flexible and rigid pavement designs are developed around different traffic parameters, as described below.

- Flexible pavement design is developed around the 18 kip Equivalent Single Axle Wheel Loads (ESALs) in one direction. This parameter is the key input for FPS-21 flexible pavement design (discussed later).
- Rigid pavement design, using software such as StreetPave12, focuses on a traffic "spectrum" based on street classification rather than direct input of ESALs. In turn, Streetpave12 calculates the

design 18-kip ESALs of the specified pavement section for the given spectrum.

If both flexible and rigid pavement design alternatives are being considered, the design traffic needs to be reviewed to confirm the traffic ESALs considered for designs are equivalent. Since calculated ESALs are one of the outputs in StreetPave12, it becomes an iterative process whereby the AADT and percent trucks inputs are changed to obtain the predicted ESALs.

The flexible and rigid pavement design methodologies vary somewhat regarding what is required to calculate design traffic, but in general, the following information is needed to forecast the cumulative ESAL input value needed for pavement design:

- Two-Way Average Annual Daily Traffic (ADT or AADT). ADT is a two-direction volume parameter required to generate the distribution of axle loading over time and represents vehicles per day. The beginning ADT should be determined for the year the street is opened to traffic. If a project includes reconstruction of a city street in the same configuration, current year traffic data should be obtained by performing traffic counts. For new-alignment or widening projects, opening year traffic data may be determined based on the results of a Traffic Impact Analysis (TIA), Traffic Assessment, or similar traffic study. The typical ADT ranges for each street classification are included for reference purposes and serve as a guide for ADT ranges appropriate for each classification. These minimum ADT values for each classification shall be used if traffic data is unavailable, or the results of the traffic study yield lower values. ADT is assumed to increase over time compounded according to a forecasted growth rate.
- Percentage of Trucks in ADT. This parameter represents the percentage of trucks in ADT counts, including dual-rear-tire pickups and buses with a single axle wheel load of approximately18-Kips or greater, for each street classification category.
- Traffic Growth Rate for the Design Period. This factor represents the annual traffic growth rate for a designated street classification (presented in Section 3.3.7). The representative growth rates should be used to calculate ending ADT, unless the results of a TIA or traffic study indicate a higher value.
- ESAL Factors for Each Vehicle Type. Discussed in subsequent sections.
- Traffic Distribution. Includes Directional and Design Lane Distribution Factors (discussed later).

In addition to the truck loads based on traffic counts, other heavy loads such as fire trucks (most likely not included in count data, ),especially if there is a fire station located along the street being designed) and as construction traffic (for either nearby construction projects or for a new phased subdivision) must

be considered. Depending on the repetition of these heavy loaded vehicles, they may significantly increase the overall ESALs being considered for design.

### 3.3.3 Traffic Distribution

There are two traffic distribution factors included in traffic calculations, as is described below.

- Directional distribution: Typically considered 50% in each direction, unless the street is a one-way street for which the directional distribution factor is 100%. If the traffic data projections conclude a different split, the higher of the two estimates shall be used in the traffic calculations.
- Lane distribution: The lane distribution factor depends on the number of travel lanes included on the road in each direction. Recommended lane distribution factors are presented below in Table 3-1.

**Table 3-1. Recommend Lane Distribution Factors**

| Number of Lanes in Each Direction | Percent Traffic in Design Lane |
|---|---|
| 1 | 100 |
| 2 | 80 – 100 (80) |
| 3 | 60 – 80 (70) |
| 4 | 50 – 75 (70) |

Note:
Values in parentheses represent recommended preliminary design values when site-specific traffic data is not available.

### 3.3.4 Flexible Pavement Traffic Inputs

In addition to the general traffic criteria listed previously, specific traffic criteria required for the design of flexible pavements includes these described below:

- Beginning ADT: This input is for the Average Daily Traffic at the beginning of the analysis period. It is expressed as vehicles per day. This parameter is used to estimate the user delay cost during overlay at the end of each performance period (see Section 6. Life Cycle Cost Analysis),
- End ADT: This input is for the Average Daily Traffic at the end of the analysis period which is generally for 20-year period. It is expressed as Vehicle per day; and
- 18 Kip ESAL (1 direction): The 18 Kips Equivalent Single Axle Load is the damage caused by one pass of the vehicle to the pavement structure equivalent to one pass of a standard 18 Kips load. It is expressed in Millions and is calculated by using the following equations:

$$ESALs = \sum AADT * GF * 365 \frac{days}{year} * \%truck * TF * DDF * LDF$$

Where,

AADT = Annual Average Daily Traffic

TF = Truck Factor

DDF = Directional Distribution Factor

LDF = Lane Distributional Factor

GF = $\frac{((1+GR)^{DL})-1)}{GR}$

GR = Annual growth rate, %

### 3.3.5 Rigid Pavement Traffic Inputs

In addition to the general traffic criteria listed previously, specific traffic criteria required for the design of rigid pavements includes the following:

- Trucks per Day: This input is a two-way daily estimate of trucks at the beginning of the analysis period. The number of trucks per day may be measured in a traffic count collected for a street, or calculated based on the percent trucks of the expected initial daily traffic.
- Street Classification-based Traffic Spectrum: Recommended software (i.e., StreetPave12) calculates 18 Kip ESALs based on either predetermined traffic spectrums or counts or user input traffic distributions for the specific functional class of pavement for which a design is being calculated. The truck factors used in StreetPave12's calculation of 18 Kip ESALs are internal to the program and are not a user input.

### 3.3.6 Consideration of Construction Loading and other Heavy Loads

Occasional heavy traffic loads should be considered in the design of pavements. Occasional heavy loads can be broadly categorized as one of the following:

- Long-term periodic loading (fire trucks, transit or school buses, solid waste trucks, etc.); and
- Construction loading (initial pavement construction, pavement maintenance/rehabilitation, adjacent construction).

Estimates of long-term periodic loads can be developed by detailed traffic studies and/or by examining the proximity of existing / planned facilities and regular routes related to this type of traffic.

Estimates of construction traffic loading can be developed based on knowledge of ongoing and/or planned construction in the vicinity of the project. An example calculation of estimated additional daily ESALs due to construction traffic is provided below in Table 3-2. Examples of instances where construction loading can play a significant role in pavement design life include phased subdivisions with particular focus on streets near the start of such subdivisions (i.e., streets are constructed prior to final build-out of the

subdivision and are used for subsequent construction access), and adjacent heavy construction projects (e.g., commercial and/or high-rise construction).

To the extent practicable, the Roadway Designer should develop site-specific estimates of occasional heavy loads. Occasional heavy loads should be incorporated into the pavement traffic design parameters presented in Table 3-3 by one of the following methods, selected at the discretion of the Roadway Designer:

- Increased Daily Trucks;
- Increased Percentage of Trucks; and
- Additional ESALs (similar to example in Table 3-2).

**Table 3-2. Example Calculation of Construction Equipment Traffic Loading (from CAPEC 2016)**

| Construction Activity | Example Equipment | Assumed Weight (lbs) | Calculated Load Equivalency Factor | Assumed Number of Operations per Day | Additional ESALs per Day of Construction |
|---|---|---|---|---|---|
| Excavating Existing Asphalt Pavement | Asphalt Milling Machine | 40,550 | 3.44 | 10 | 35 |
| | Road Reclaimer | 53,900 | 10.89 | 10 | 109 |
| Rough Grading | Motor Grader | 58,250 | 0.95 | 20 | 20 |
| | Excavator | 22,050 | 2.23 | 20 | 45 |
| | Backhoe | 27,110 | 0.50 | 20 | 10 |
| Compacting | Vibratory Steel Drum | 15,950 | 0.12 | 20 | 3 |
| | Pneumatic Tired Roller | 30,600 | 0.05 | 20 | 2 |
| Paving | Paving Machine | 43,000 | 2.20 | 20 | 44 |
| | Dump Truck (hot asphalt) | 80,000 | 4.02 | 20 | 81 |
| | Concrete Redi-Mix Truck | 61,000 | 6.28 | 20 | 126 |
| Miscellaneous | Bulldozer (non-track) | 58,250 | 0.95 | 10 | 10 |
| | Rear end/Belly Dump | 80,000 | 4.02 | 30 | 121 |
| | Water Trucks | 56,000 | 5.99 | 20 | 120 |
| Total Potential Additional ESALs per Day of Construction: | | | | | 726 |

### 3.3.7 Representative Traffic Design Parameters by Street Classification

Because traffic data is not always available, there is a need to define either ranges or minimum/maximum traffic parameters which can be developed for general categories of roadways. This is logical since the level of traffic loading typically defines various street classifications, which are used to categorize streets according to their functions.

Table 3-3 lists the representative traffic input values to be used for each street classification. These values are to be used unless otherwise directed or approved by the Transportation Director. Note that the street classifications defined here do not directly reflect the traffic categories in StreetPave12. These values may be used for general review of pavement designs or to develop general construction cost estimates for funding considerations. The projected traffic for pavement design must be estimated based on specific site conditions for the roadway(s) being designed.

Street classifications presented in CAPEC 2016 have been adopted for the purposes of this manual based on recent research, and are updated from the CORR street designations. Representative traffic design parameters for different street classifications are provided in Table 3-3.

**Table 3-3. Representative Traffic Design Parameters by Street Classification[1]**

| Street Classification | Representative ESALs | General Range in ADT | General Range in Trucks (%) | General Number of Trucks/Day | Growth Rate (%) | Initial Serviceability Index, $PSI_i$[2] | Terminal Serviceability Index, $PSI_t$[2] | Design Confidence Level or Reliability (%) | Flexible Pavement Design: FPS-21 Design Confidence Code |
|---|---|---|---|---|---|---|---|---|---|
| Urban Arterial (High Traffic) | 9,000,000 | 4,000 - 25,000 (14,000) | 4 - 15 (10) | 160 – 3,750 (1,400) | 4.0 | 4.5 (initial) 4.2 (overlay) | 3.0 | 95 | C |
| Urban Arterial (Low Traffic) | 3,100,000 | 6,000 - 9,000 (6,000) | 4 - 15 (7) | 240 – 1,350 (420) | 4.0 | 4.5 (initial) 4.2 (overlay) | 3.0 | 95 | C |
| Urban Collector (High Traffic) | 2,600,000 | 2,000 - 8,000 (5,000) | 3 - 10 (7) | 60 – 800 (350) | 4.0 | 4.5 (initial) 4.2 (overlay) | 3.0 | 95 | C |
| Urban Collector (Low Traffic) | 1,000,000 | 2,000 - 4,000 (2,000) | 3 - 10 (7) | 60 – 400 (140) | 3.5 | 4.2 (initial) 4.0 (overlay) | 2.5 | 90 | B |
| Urban Local | 250,000 | 200 - 3,000 (500) | 6 - 10 (6) | 12 – 300 (30) | 3.0 | 4.2 (initial) 4.0 (overlay) | 2.0 | 90 | B |

Note:

1. Single values and values in parentheses represent recommended design values when site-specific traffic data is not available. However, the Pavement Engineer is strongly encouraged to examine pavement design sensitivity to traffic design parameters at the upper end of the listed range. Prior to completion of final pavement design, actual traffic values (determined by a TIA, traffic study, or other available data) should be compared to initial assumed values to verify pavement design is adequate for expected traffic, and any necessary modifications shall be incorporated into the pavement design plans and specifications.
2. PSI – Pavement Serviceability Index.

## 3.4 GEOTECHNICAL DESIGN CRITERIA FOR PAVEMENT SUBGRADE

### 3.4.1 Overview

Subgrade preparation (native soil) is a critical component of a well-designed roadway, since most construction and performance is dependent upon project subgrade properties and characteristics. The characterization and evaluation of subgrade is thus critical to the performance of pavement structures. This consideration is particularly important in the complex soil and geologic conditions of the Round Rock area. The subsurface geology of the City of Round Rock and its Extraterritorial Jurisdiction (ETJ) typically comprises of expansive soils with low to very high swell potential. The diverse subsurface conditions of Round Rock warrant particular care with regard to appropriate geotechnical investigation and proper characterization of subgrade conditions for the design of pavements.

This subsection provides review of the development of geotechnical design criteria for roadways, with focus on the expansive soil and other subsurface conditions common to Round Rock.

The Geotechnical Engineer who develops the pavement design shall refer to the specific criteria in this chapter, the additional resources listed in the Bibliography, and good industry practice when preparing pavement designs for City projects. All design criteria, design inputs, and recommendations shall be approved by the Transportation Director prior to incorporating in the project.

### 3.4.2 Effective Plasticity Index ($PI_{eff}$)

Provide modifications to subgrade layers to limit the effective Plasticity Index ($PI_{eff}$) to the following criteria:

- Arterial/Collector: $PI_{eff} \leq 30$; and
- Local/Residential: $PI_{eff} \leq 40$.

This method calculates the Effective PI as a weighted average of the PI of the different soil strata within the upper 15 feet of the subgrade, based on PI tests according to TxDOT Tex-106E. In certain circumstances the City may permit a 10 feet depth to be considered for the effective PI calculation. Weight Factors of 3, 2, and 1 are typically used for the top 5 feet, the middle 5 feet, and the bottom 5 feet, respectively. $PI_{eff}$ is determined by the following equation:

$$PI_{eff} = \Sigma (F_i \times D_i \times PI_i) / \Sigma (F_i \times D_i)$$

$F_i$ = Weight Factor;

$D_i$ = Depth of Soil Stratum within Particular Weight Factor Region; and

$PI_i$ = Plasticity Index of Soil Stratum within Particular Weight Factor Region.

An example calculation of $PI_{eff}$ is provided in Figure 3-1.

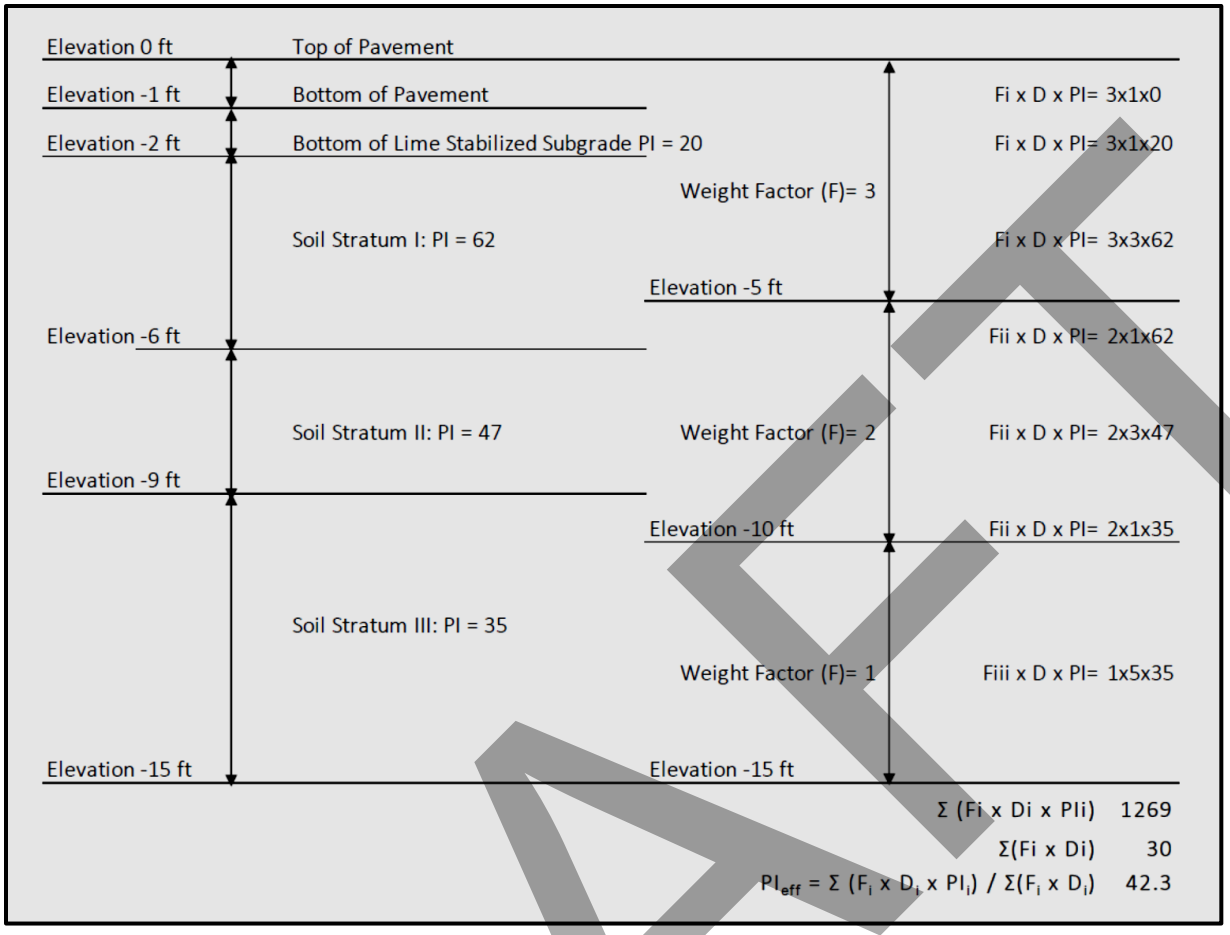


**Figure 3-1. Example Calculation of Effective PI (CAPEC 2016).**

### 3.4.3 Potential Vertical Rise (PVR)

Provide modifications to subgrade layers to limit the Potential Vertical Rise (PVR), considering a 15-foot depth below the proposed pavement surface elevation, to the following performance criteria:

- Arterial/Collector: PVR ≤ 2.0; and
- Local/Residential: PVR ≤ 3.0.

This traditional method to estimate the swell potential of fine grained clay soils is based on the historical work of TxDOT and uses correlations of Plasticity Index (PI) to develop an estimate of swelling. It is based on McDowell's 1959 method and is based on a "free swell" conversion ratio. The required data inputs from laboratory soils testing are:

- ω = Moisture content;
- γ = Unit Weight;
- LL = Liquid Limit;
- PI = Plasticity Index; and
- % Passing the No. 40 Sieve = Fine Grained Material.

This model estimates the cumulative potential vertical rise (PVR) of the pavement section based on 15 feet of material. A sample output for the Tex-124-E is included in Figure 3-2. The spreadsheet can be downloaded from the TxDOT website. When using the spreadsheet, the pavement design thicknesses resulting from FPS21 or StreetPave12 shall be included as the top layer with an assumption of no swell (i.e., inputs for liquid limit, moisture content, percent passing the No. 40, and PI are all set to zero).

**PVR Data BH**

| Depth to Bottom of Layer [ft] | Average Load [psi] | Liquid Limit (LL) | Dry 0.2LL+9 | Wet 0.47LL+2 | Percent Moisture | Dry Avg Wet | Percent -No.40 | Plasticity Index (PI) | Percent Volume Swell | Percent Free Swell | PVR [in] Top of Layer | PVR [in] Bottom of Layer | Differential Swell [in] | Modified -No.40 Factor | Modified Density Factor | PVR in Layers [in] | Total PVR [in] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.0 | 0.0 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | **3.70** |
| 1.0 | 0.5 | | 9.0 | 2.0 | | Dry | | | 0.0 | 0.0 | **0.00** | **0.00** | 0.00 | 0.00 | 1.00 | 0.00 | **3.70** |
| 2.0 | 1.5 | 40 | 17.0 | 20.8 | 26.1 | Wet | 50.0 | 20 | 1.4 | 4.1 | **0.00** | **0.12** | 0.12 | 0.50 | 1.00 | 0.06 | **3.64** |
| 3.0 | 2.5 | 74 | 23.8 | 36.8 | 26.1 | Dry | 100.0 | 62 | 15.6 | 19.3 | **0.74** | **1.42** | 0.68 | 1.00 | 1.00 | 0.68 | **2.96** |
| 4.0 | 3.5 | 74 | 23.8 | 36.8 | 26.1 | Dry | 100.0 | 62 | 15.6 | 19.3 | **1.42** | **2.04** | 0.62 | 1.00 | 1.00 | 0.62 | **2.35** |
| 5.0 | 4.5 | 74 | 23.8 | 36.8 | 26.1 | Dry | 100.0 | 62 | 15.6 | 19.3 | **2.04** | **2.60** | 0.56 | 1.00 | 1.00 | 0.56 | **1.79** |
| 6.0 | 5.5 | 74 | 23.8 | 36.8 | 26.1 | Dry | 90.0 | 62 | 15.6 | 19.3 | **2.60** | **3.10** | 0.51 | 0.90 | 1.00 | 0.46 | **1.33** |
| 7.0 | 6.5 | 62 | 21.4 | 31.1 | 18.7 | Dry | 90.0 | 47 | 13.5 | 17.1 | **2.70** | **3.07** | 0.38 | 0.90 | 1.00 | 0.34 | **0.99** |
| 9.0 | 8.0 | 47 | 18.4 | 24.1 | 18.7 | Dry | 85.0 | 47 | 13.5 | 17.1 | **3.07** | **3.71** | 0.63 | 0.85 | 1.00 | 0.54 | **0.45** |
| 12.0 | 10.5 | 47 | 18.4 | 24.1 | 19.3 | Dry | 85.0 | 35 | 9.6 | 12.9 | **2.55** | **2.81** | 0.26 | 0.85 | 1.00 | 0.22 | **0.23** |
| 15.0 | 13.5 | 47 | 18.4 | 24.1 | 19.3 | Dry | 85.0 | 35 | 9.6 | 12.9 | **2.81** | **3.08** | 0.28 | 0.85 | 1.00 | 0.23 | **0.00** |

Fields are chart inputs | Fields are final answers per layer | Final Total PVR for the borehole

Note: PVR calculations are based on future pavement grade being the same as present grade. Bold numbers are interpolated and extrapolated values.

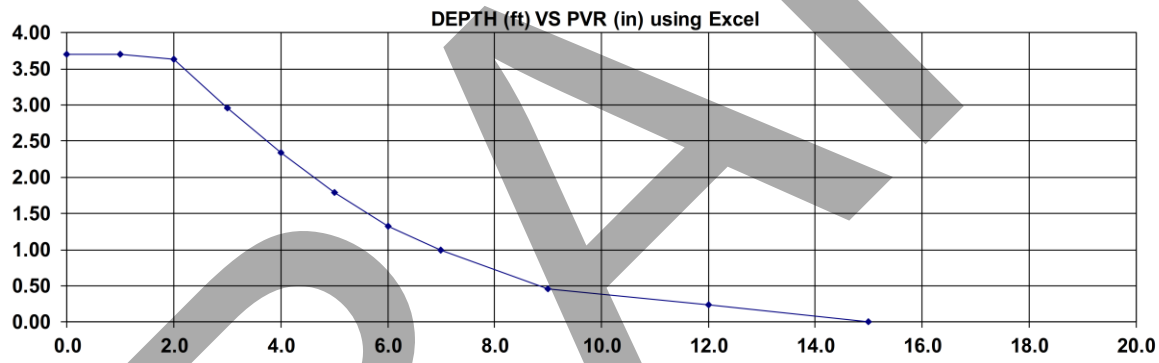


**Figure 3-2. Example Calculation of PVR using TxDOT's Tex-124-E Calculation Spreadsheet (CAPEC 2016).**

### 3.4.4 Design Subgrade Support

The subgrade design strength parameter of relevance to both flexible and rigid pavement design is 'modulus.' Resilient Modulus ($M_R$) is used in flexible pavement design, while Modulus of Subgrade Reaction (K) is used in rigid pavement design. The relevant subgrade modulus should be obtained by direct laboratory testing, field testing and analysis/correlations, and/or correlations with other laboratory test values.

#### 3.4.4.1 Test Methods

The following is a list of common procedures used for developing design modulus. However, it is the responsibility of the Pavement Engineer to select the appropriate method(s) for determining design modulus.

- Field Testing:
  - Non-Destructive Testing (NDT):
    - Falling Weight Deflectometer (FWD): ASTM D4602–93 (2015);
    - Heavy Weight Deflectometer (HWD): ASTM D4602–93 (2015);
  - Dynamic Cone Penetrometer: ASTM D6951/D6951M – 09 (2015);
  - Plate Load Test for K-Value: AASHTO T 222-78; and
  - Plate Load Test for CBR: ASTM D4429-09;
- Direct Laboratory Testing:
  - Resilient Modulus: AASHTO T 307-99;
- Indirect Laboratory Testing:
  - California Bearing Ratio (CBR): ASTM D1883-16 or AASHTO T193;
  - TxDOT K-value: Tex-125-E;
  - Texas Triaxial Classification: Tex-117-E; and
  - Unconfined Compressive Strength: ASTM D2166/D2166M-16 or AASHTO T208.

#### 3.4.4.2 Correlation Methods

Estimates of design modulus can be developed from correlations with various other types of field and laboratory tests. Although there are numerous correlations for various soil test parameters, Table 3-4 summarizes suggested correlations to be used in establishing the subgrade soil strength modulus. The Geotechnical Engineer is responsible for applying judgment in the use of such equations and assessing the validity of estimated modulus values.

**Table 3-4. Summary of Subgrade Strength Correlations (adapted from CAPEC 2016)**

| Basis of Correlation | Equation | Origin | Comment |
|---|---|---|---|
| California Bearing Ratio (CBR) to $M_R$ | MR = (1500)(CBR) | Heukelom & Klomp (1962) | For fine-grained non-expansive soils with soaked CBR ≤10 |
| | MR = 2555 x $CBR^{0.64}$ | NCHRP 137A | --- |
| Dynamic Cone Penetrometer Resistance (DCP) to CBR | CBR = 292/PR1.12 | ASTM D6951 | --- |
| | CBR = 1/(0.002871)(PR) | Webster, Brown and Porter, 1994 | For high plasticity clay (CH) |
| | CBR = $1/[(0.017019)(PR)]^2$ | Webster, Brown and Porter, 1994 | For low plastic clay (CL) |
| Unconfined Compressive Strength (UCS) to $M_R$ | MR = 143.33(UCS) + 4283.5 | Hossain & Kim (2014) | --- |
| Texas Triaxial Classification (TTC) | MR = $2161.2(TTC)^2$ - 26263(TTC) + 81981 | 1993 AASHTO Guide | --- |

Notes:
1. PR = Penetration Rate from DCP test (mm/blow)
2. UCS = Unconfined Compressive Strength
3. TTC = Texas Triaxial Classification

Typical ranges of strength and modulus values for various subgrade soil materials are presented in Table 3-5. These values are for preliminary design purposes and to assess reasonability of test results; actual field data should be developed for final design purposes. Note that the modulus values used in in FPS-21 for flexible pavement design (back-calculated modulus) are not equivalent to the Resilient Modulus or Elastic Modulus values obtained from correlations shown in Table 3-4.

**Table 3-5. Typical Strength-Related Parameters for Various Subgrade Soils (adapted from CAPEC 2016)**

| Material (USC given where appropriate) | CBR | K-Value (pci) | UCS (psi) | Elastic or Resilient Modulus (psi) | Back-calculated Modulus use in FPS-21 (psi) |
|---|---|---|---|---|---|
| Gravel or Gravelly Soils (GW, GP, GM, GC) | 20 - 100 | 200 – 300+ | --- | 20,000 – 40, 000 | Typically, 3 times the laboratory Resilient Modulus value; field FWD testing can determine directly. |
| Sandy Soils (SW, SP, SM, SC) | 10 – 40 | 200 – 300 | --- | 7,000 – 30,000 | |
| Silty Soils (ML, MH) | 8 – 15 | 200 – 300 | --- | 5,000 – 20,000 | |
| Clay Soils, Low Compressibility, LL<50 (CL) | 5 – 15 | 100 – 200 | 5 – 40 | 5,000 – 10,000 | |
| Clay Soils, High Compressibility, LL>50 (CH) | 1 - 5 | 50 - 100 | 1 - 5 | 2,000 – 5,000 | |

## 3.5 CRITERIA FOR GEOTECHNICAL INVESTIGATIONS

### 3.5.1 Commentary on the Geology and Soils of the City of Round Rock

The City of Round Rock and its Extraterritorial Jurisdiction is bisected by the Balcones Fault Zone (BFZ), a series of normal faults trending northeast-southwest and generally downthrown to the east. West of the BFZ lies the Grand Prairie Physiographic Region of Texas (an extension of the Edwards Plateau), which is typically characterized by thin, rocky soils overlying Lower Cretaceous-aged limestone, dolomitic limestone, marl, and chert units. East of the BFZ lies the Black Prairie Physiographic Region of Texas, typically characterized by thick, black, calcareous clay soils overlying Late Cretaceous-aged shales, marls, and chalk units (Housh, 2007). Abrupt variations in soil type can occur in the vicinity of BFZ and nearby areas as a result of secondary faulting. More recent Quaternary-age alluvium and terrace deposits are encountered in the vicinity of creeks and streams.

High-plasticity, expansive clay soils are prominent in the Round Rock area, and are a notorious source of distress in pavements and other structures due to their shrink/swell behavior. The distribution of potentially-expansive soils in the Round Rock area is illustrated in Figure 3-3.

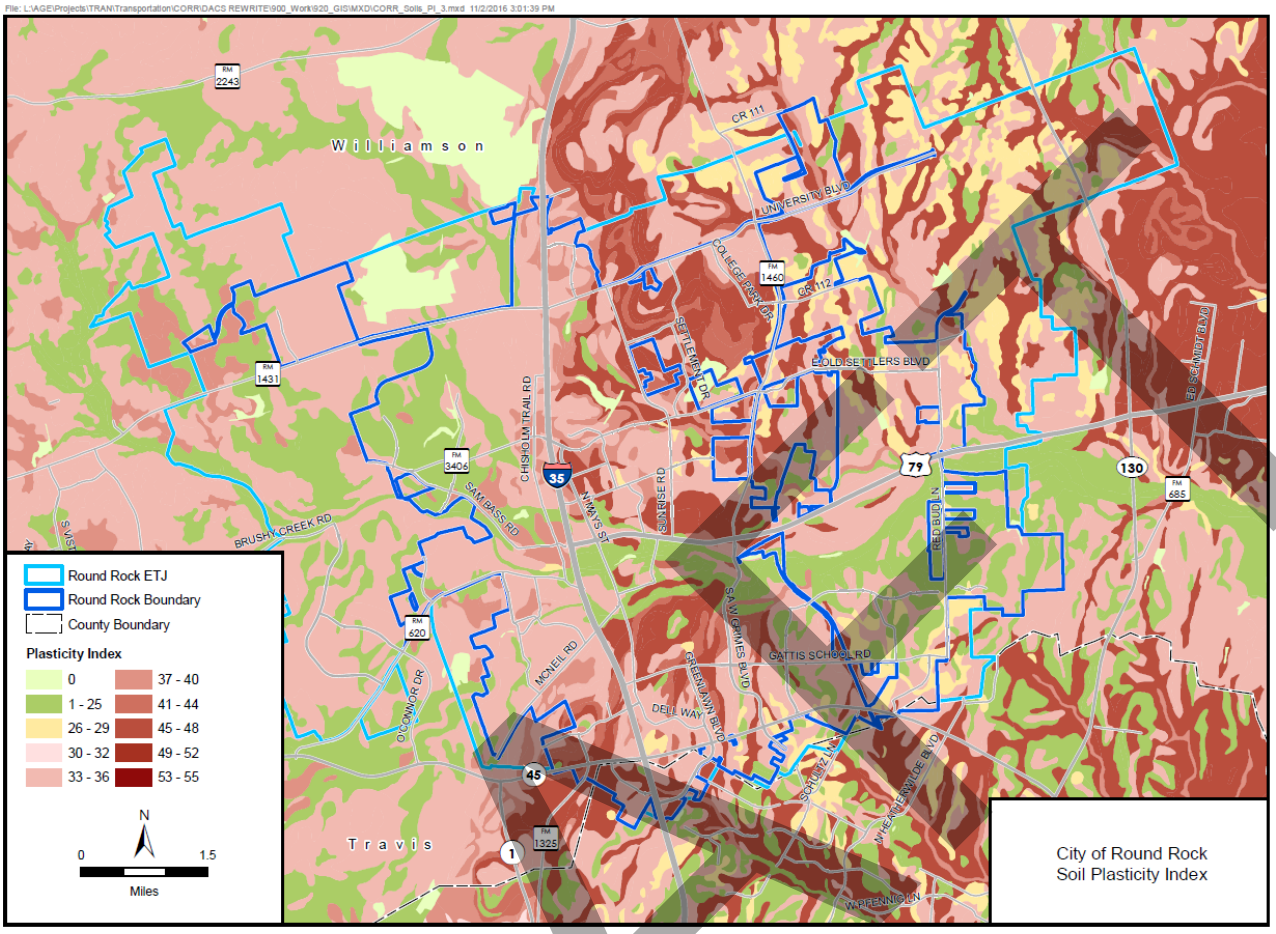


**Figure 3-3. Distribution of Potentially Expansive Soils on the Basis of Plasticity Index (source: NRCS).**

### 3.5.2 General Requirements

A geotechnical investigation is required for all projects to gain an understanding on the nature and variability of pavement supporting subgrade soils. The investigation shall be performed by a Professional Engineer, licensed in Texas, with advanced knowledge/experience in geotechnical engineering. At the completion of the field and laboratory investigations, described below, the engineer will provide subsurface information and site-specific technical recommendations for the design of the pavement foundation layers.

### 3.5.3 Field Investigation

The investigation shall include soil borings and laboratory testing, and other investigative measures, if applicable. Soil borings shall be drilled to minimum depth of (i) 15 feet (below the proposed finished grade), or (ii) to intact/competent rock, whichever is less. Note that Edwards Limestone is not considered intact/competent rock due to known karst features within this unit. Similarly, high-plasticity clay shale formations (Del Rio, Eagle Ford, and Taylor) are not considered competent/intact rock due to shrink/swell potential as these units weather.

The spacing of borings along proposed alignments shall be equal to or less than 500 feet and completed on alternating sides of the roadway, if practical. A minimum of 3 borings should be performed on each project regardless of alignment length. All borings should be performed within the limits of proposed pavement, unless otherwise approved by the City.

Continuous sampling shall be conducted to the boring termination depth, including split-spoon sampling of granular soils and thin wall tube sampling of cohesive soils. Coring intact rock shall not be required for pavement design unless the Roadway Designer or the City specifies, or the Geotechnical Engineer believes coring is warranted (e.g., sites underlain by Edwards Limestone with karst potential). An example of when rock coring may be beneficial are instances in which proposed grade requires cuts into the subsurface rock, and there is interest in evaluating the rock quality to assess its potential for re-use as on-site processed aggregate for pavement sections or other structures.

### 3.5.4 Laboratory Investigation

Select samples shall be tested in a laboratory to determine grain size characteristics, Atterberg limits, in-situ moisture, and other engineering properties, as deemed appropriate. Bulk samples of each subgrade soil type shall be obtained from the field and tested to determine the Texas Triaxial Classification (TTC) or California Bearing Ratio (CBR). Both test methods provide results that can be correlated to the elastic modulus of the subgrade, a required input parameter for pavement design analyses. The TTC shall be the preferred method to estimate the elastic modulus of the subgrade material. The TTC (or CBR) testing may be waived if in-field pavement deflection testing is obtained or otherwise available. In this case, the deflection data is used to back calculate the subgrade elastic modulus.

Plasticity testing shall be conducted on each unique cohesive subgrade soil to determine the liquid limit (LL) and plastic limit (PL). Those soils with a LL greater than 50 and plasticity index (PI = LL-PL) greater than 20 shall be considered expansive for purposes of this manual, and candidates for subgrade treatment. Each candidate soil shall be tested for total soluble sulfate, pH, and organic content. A lime series test shall be conducted on those soils with soluble sulfate content less than 8,000 ppm and an organic content less than 2%.

The geotechnical investigation and pavement design shall use the following Test Procedures developed by the Texas Department of Transportation. Refer to the TxDOT web site for a full list of applicable test procedures related to geotechnical investigation and testing of materials related to pavement design.

| Table 3-6. Geotechnical Test Procedures | |
|---|---|
| **TxDOT Test Method** | **Description** |
| Tex-100-E | Surveying and Sampling Soils for Highways |
| Tex-103-E or ASTM D2216 | Determining Moisture Content in Soil Materials |
| Tex-104-E or ASTM D4318 | Determining Liquid Limits of Soils |
| Tex-105-E or ASTM D4318 | Determining Plastic Limit of Soils |
| Tex-106-E or ASTM D4318 | Calculating the Plasticity Index of Soils |
| Tex-107-E | Determining the Bar Linear Shrinkage of Soils |
| Tex-110-E or ASTM D6913 | Determining Particle Size Analysis of Soils |
| Tex-112-E | Admixing Lime to Reduce Plasticity Index of Soils |
| Tex-117-E | Triaxial Compression for Disturbed Soils and Base Materials |
| Tex-121-E | Soil-Lime Testing |
| Tex-124-E | Determining Potential Vertical Rise |
| Tex-128-E | Determining Soil pH |
| Tex-145-E | Determining Sulfate Content in Soils – Colorimetric Method |
| Tex-146-E | Conductivity Test for Field Detection of Sulfates in Soil |
| ASTM D4546 | Standard Test Methods for 1-D Swell or Collapse of Soils |
| ASTM D1883 | Standard Test Method for CBR of Laboratory Compacted Soils |

### 3.5.5 Geotechnical Report Requirements

The geotechnical investigation data shall be compiled and summarized in a Geotechnical Data Report, which may also be incorporated into the Pavement Design Report. Whether a standalone document or included in the design report, the geotechnical content shall include the following:

1. Site Information:
   a. Description of the project and location with site location map;
   b. Topographic and drainage features;
   c. Discussion of geologic setting of the project area;
   d. Geologic map (USGS and/or Texas Bureau of Economic Geology); and
   e. Mapped surface soils within the project area (NRCS Web Soil Survey);
2. Field Investigation:
   a. Boring logs with results of laboratory index testing (moisture, gradation, Atterberg limits) at appropriate depths;
   b. Boring location plan; and
   c. Summary of encountered soils and groundwater conditions.
3. Laboratory Test Results:
   a. Laboratory test summary table and individual test reports for the following:
      i. Index Tests (Atterberg Limits including P.I., Gradation, Moisture, Natural Density);
      ii. Strength Tests (Unconfined Compression, CBR, Texas Triaxial, etc.);
      iii. Moisture-density relationship tests;

iv. Volume change (Swell); and,
v. Chemical analysis (pH, sulfate content, etc.).

4. Engineering Recommendations:

   a. Expansive characteristics of subgrade soils and estimated PVRs (TxDOT Test Method Tex-124-E);

   b. Recommendations for reducing the $PI_{eff}$ and PVR to acceptable values per Section 3.4;

   c. Compatibility of subgrade soils to lime treatment and recommended lime content;

   d. Compatibility of subgrade soils to cement treatment and recommended cement content;

   e. Recommendations for alternate subgrade stabilization/treatment (e.g., geosynthetics, moisture treatment, etc.);

   f. Characterization and mitigation of groundwater, if encountered or anticipated; and,

   g. Requirements for cut and fill slopes to be incorporated in the design.

## 3.6 GUIDELINES FOR FLEXIBLE AND RIGID PAVEMENT DESIGN

### 3.6.1 General Pavement System Components

Various material layers are incorporated into properly designed flexible and rigid pavement sections. Flexible and rigid pavement systems generally consist of the sequence of material layers (top to bottom) listed in Table 3-7.

Note that “bond breakers” are always required for rigid pavements when the concrete slab directly overlies cement-treated subgrade or Lime-treated subgrade in the design pavement section. A bond breaker layer consisting of a minimum of 2 inches of HMAC is intended to prevent direct bonding between concrete slabs and cement-treated base, as bonding increases risk of pavement cracking due to the following mechanisms: (1) cracks in base reflect through slab; and/or (2) climate-induced tensile stresses in slab. Bond breaker layer is not required when asphalt-treated base is used directly under concrete slab.

| Table 3-7. Typical Pavement System Components | | | |
|---|---|---|---|
| **Material Layer** | **Specification** | **Flexible Pavement** | **Rigid Pavement** |
| Hot Mix Asphaltic Concrete (HMAC) | TxDOT Item 340/341 | X | N/A |
| Concrete Pavement | TxDOT Item 360 | N/A | X |
| Bond Breaker | TxDOT Item 340/341 | N/A | O |
| Flexible Base | TxDOT Item 247 | X | N/A |
| Treated Base | TxDOT Item 276 (cement) /<br>TxDOT Item 292 (asphalt) | N/A | X |
| Treated Subgrade:<br>-Lime<br>-Cement<br>-Lime-Cement | TxDOT Item 260<br>TxDOT Item 275 | O | O |
| Geosynthetics (Geogrid) | TxDOT Item 5001<br>TxDOT Item DMS 6240 | O | O |
| Native Subgrade:<br>-Proof Rolling<br>-Recompaction (Rolling) | TxDOT Item 216<br>TxDOT Item 210 | X | X |
| Notes:<br>1. X = Included<br>2. O = May be included based on design analysis results and at Engineer's Discretion | | | |

### 3.6.2 Factors Affecting the Selection of Flexible or Rigid Pavement

Selection of either flexible or rigid pavement is at the discretion of the Pavement Engineer, with approval by the Transportation Director. However, flexible existing pavements predominate in the City of Round Rock. The relative advantages of each pavement type are discussed below.

Flexible Pavements. The typical advantages of flexible pavements relative to rigid pavements include, but may not be limited to:

1. Lower initial construction cost;
2. Lower repair costs (per event basis);
3. Ability to increase service life with periodic maintenance (e.g., overlays); and
4. Ability to improve in stages with traffic growth.

Rigid Pavements. The typical advantages of rigid pavements relative to flexible pavements include, but may not be limited to:

1. Improved durability;
2. Longer service life;
3. Less maintenance over design life; and
4. Minimal deformation over time (i.e., no rutting).

### 3.6.3 Representative Pavement Material Properties

Elastic modulus parameters are used to model the various pavement layer strengths. Representative values of these parameters for use in pavement design software are provided in the following table.

| Table 3-8. Representative Pavement System Components | | |
|---|---|---|
| **Material Layer** | **Poisson's Ratio** | **FPS-21 Design Modulus (ksi)** |
| Thin Overlay Mixtures (TOM) | 0.35 | 500 |
| Dense-graded Hot Mix Asphaltic Concrete (HMAC) | 0.35 | 500 (<4" HMAC)(1)<br>650 (>4" HMAC) |
| Seal Coat | 0.35 | 200 |
| Flexible Base | 0.35 | 40 |
| Lime Treated Subgrade | 0.3 | (3x Subgrade Modulus)<br>≥ 20(2) |
| Cement Treated Subgrade | 0.3 | 40 |
| Cement Treated Base | 0.25 | 150 |
| Native Subgrade | 0.4 | Use back-calculated Moduli, typically 8-20 ksi. |

Notes:
1. The representative pavement thickness presented in Tables 3-9 assumes a HMAC design modulus of 500 ksi.
2. The representative pavement thickness presented in Tables 3-9 assumes incorporating a lime-treated subgrade in the pavement section.

### 3.6.4 Representative Pavement Section by Street Category

Depending on site conditions and expected traffic volumes, thicker pavement sections may be required by the design procedures detailed in subsequent paragraphs of this section. Any representative pavement sections included herein do not relieve the Pavement Engineer from the responsibility of designing a cross section that is appropriate for the site specific soil conditions to meet the required design life of 20 years for flexible pavement or 30 years for rigid pavement.

Representative pavement sections were developed based on criteria presented in Sections 3-8 (Flexible Pavement) and 3-9 (Rigid Pavement).

**Table 3-9. Representative Flexible Pavement Sections by Subgrade Type and Street Category**

| Street Classification | Existing Subgrade Conditions | Flexible Pavement Layer Thickness | | |
|---|---|---|---|---|
| | | HMAC (in.) | Flexible Base (in.) | Treated Subgrade (in.) |
| ARTERIALS | | | | |
| Urban Arterial (High Traffic) | Very High Swell | RAR | RAR | RAR |
| | High Swell | 8.5 (12.0) | 24.0 (20.0) | 12.0 |
| | Moderate Swell | 8.5 (12.0) | 23.0 (16.0) | 10.0 |
| | Low Swell | 8.5 (11.5) | 22.0 (16.0) | 10.0 |
| Urban Arterial (Low Traffic) | Very High Swell | n/a | n/a | n/a |
| | High Swell | 6.0 (12.0) | 20.0 (20.0) | 12.0 |
| | Moderate Swell | 6.0 (12.0) | 19.0 (16.0) | 10.0 |
| | Low Swell | 6.0 (11.5) | 18.0 (16.0) | 10.0 |
| COLLECTORS | | | | |
| Urban Collector (High Traffic) | Very High Swell | RAR | RAR | RAR |
| | High Swell | 6.5 | 18.0 | 12.0 |
| | Moderate Swell | 6.0 | 18.0 | 10.0 |
| | Low Swell | 6.0 | 16.0 | 8.0 |
| Urban Collector (Low Traffic) | Very High Swell | n/a | n/a | n/a |
| | High Swell | 5.0 | 15.0 | 12.0 |
| | Moderate Swell | 5.0 | 14.0 | 10.0 |
| | Low Swell | 5.0 | 12.0 | 8.0 |
| LOCALS | | | | |
| Urban Local | Very High Swell | RAR | RAR | RAR |
| | High Swell | 3.0 | 14.0 | 10.0 |
| | Moderate Swell | 3.0 | 10.0 | 10.0 |
| | Low Swell | 3.0 | 8.0 | 8.0 |

Notes:

1. Values in parenthesis represent Perpetual Flexible Pavement Layer Thicknesses. All Arterials are recommended to follow Perpetual Design for increased performance. The City may approve Non-Perpetual Arterials on a case-by-case basis.
2. RAR – Remove And Replace existing subgrade material with suitable non-expansive fill material per the recommendations of the geotechnical engineer.
3. Very High Swell: Subgrade with very high swelling potential, represented by PI > 50. Such cases will likely require deep treatment to reduce PVR to acceptable values.
4. High Swell: Subgrade with high swelling potential, represented by PI = 36 to 49.
5. Moderate Swell: Subgrade with moderate swelling potential, represented by PI = 20 to 35.
6. Low Swell: Subgrade with low swelling potential, represented by PI < 20.
7. The pavement sections in this table should be considered representative for each street classification. Different pavement sections may be required based on the results of a project-specific Pavement Design Report or as directed by the City.
8. All materials shall be in accordance with TxDOT Specifications.
9. Minimum HMAC pavement thickness is 3 inches.

**Table 3-10. Representative Rigid Pavement Sections by Subgrade Type and Street Category**

| Street Classification | Existing Subgrade Conditions | Rigid Pavement Layer Thickness | | |
|---|---|---|---|---|
| | | Conc. (in.) | HMAC Bond Breaker (in.) | Treated Subgrade (in.) |
| ARTERIALS | | | | |
| Urban Arterial (High Traffic) | Very High Swell | RAR | RAR | RAR |
| | High Swell | 10.0 | 2.0 | 8.0 |
| | Moderate Swell | 9.5 | 2.0 | 8.0 |
| | Low Swell | 9.0 | 2.0 | 8.0 |
| Urban Arterial (Low Traffic) | Very High Swell | n/a | n/a | n/a |
| | High Swell | 9.0 | 2.0 | 8.0 |
| | Moderate Swell | 8.5 | 2.0 | 8.0 |
| | Low Swell | 8.0 | 2.0 | 8.0 |
| COLLECTORS | | | | |
| Urban Collector (High Traffic) | Very High Swell | RAR | RAR | RAR |
| | High Swell | 7.5 | 2.0 | 8.0 |
| | Moderate Swell | 7.0 | 2.0 | 8.0 |
| | Low Swell | 6.5 | 2.0 | 8.0 |
| Urban Collector (Low Traffic) | Very High Swell | n/a | n/a | n/a |
| | High Swell | 7.0 | 2.0 | 8.0 |
| | Moderate Swell | 6.5 | 2.0 | 8.0 |
| | Low Swell | 6.0 | 2.0 | 8.0 |
| LOCALS | | | | |
| Urban Local | Very High Swell | RAR | RAR | RAR |
| | High Swell | 6.0 | 2.0 | 8.0 |
| | Moderate Swell | 6.0 | 2.0 | 8.0 |
| | Low Swell | 6.0 | 2.0 | 8.0 |

Notes:

1. RAR – Remove And Replace existing subgrade material with suitable non-expansive fill material per the recommendations of the geotechnical engineer.
2. Very High Swell: Subgrade with very high swelling potential, represented by PI > 50. Such cases will likely require deep treatment to reduce PVR to acceptable values.
3. High Swell: Subgrade with high swelling potential, represented by PI = 36 to 49.
4. Moderate Swell: Subgrade with moderate swelling potential, represented by PI = 20 to 35.
5. Low Swell: Subgrade with low swelling potential, represented by PI < 20.
6. The pavement sections in this table should be considered representative for each street classification. Different pavement sections may be required based on the results of a project-specific Pavement Design Report or as directed by the City.
7. All materials shall be in accordance with TxDOT Specifications.
8. Minimum Rigid pavement thickness is 6 inches.

### 3.6.5 Pavement Design Report Criteria

The pavement design analyses, findings, and recommendations shall be compiled in a Pavement Design Report (PDR). At a minimum, the Geotechnical Report shall include the following:

- Cover sheet showing project information and signatures;
- Project Information:
  - Narrative discussing the overall project, scope of work, site particulars, drainage, and topographic features;
  - Project location map and description of proposed improvements;
  - Existing pavement section (if applicable);
  - Existing subgrade conditions (referenced from Geotechnical Report);
  - Traffic data and any adjustments;
  - Project specific factors used for selecting the pavement type; and
  - Summary of discussions with City officials and waivers received (if any);
- Pavement Design Summary:
  - Summary of all pavement design input values;
  - Design output values for typical pavement sections;
  - Recommended subgrade stabilization measures (if applicable);
  - Recommended pavement section or sections;
  - Recommended pavement related specifications (e.g., subgrade preparation, lime addition, flex base materials and compaction, HMAC, etc.);
  - Recommendations to improve drainage of subgrade/base layers (i.e., edge drains);
  - Proposed detour pavement thickness (widened pavement or separate detour);
  - If existing pavement is to be used as a detour, provide recommendations as to suitability of use and recommended traffic flow diagram; and
  - Construction recommendations including drainage and groundwater control;
- Appendices:
  - Flexible Pavement Designs: FPS-21 output with mechanistic check and modified Texas Triaxial check; and
  - Rigid Pavement Designs: Streetpave12 output.

The above listed outline shall be considered the minimum requirements. Additional information, based on existing site conditions or alternate pavement designs may be required and shall be documented in the PDR to be submitted to the City for approval.

The PDR shall address constructability issues and appropriate measures. Examples include, allowing adequate mellowing time prior to final rolling and confirmatory index testing; potential need for a double treatment process for lime treated subgrade; completion of City-required subgrade recompaction and proofrolling; and, compaction of subbase materials.

In general, the proposed pavement design should be consistent with the representative sections presented in Tables 3-9, 3-10 or 3-11.

Other pavement designs may be used in some circumstances, but only if previously approved, and it can be demonstrated to be adequate through appropriate engineering calculations (considering traffic, environmental, and subgrade conditions). Furthermore, there must be supporting evidence that the previously approved design has been constructed and is performing satisfactory.

## 3.7 SUBGRADE IMPROVEMENT CONSIDERATIONS

### 3.7.1 Design Criteria

Subgrade improvement is required whenever the geotechnical investigation indicates the presence of in-situ soils with effective plasticity index ($PI_{eff}$) and/or potential vertical rise (PVR) values exceeding those specified in Section 3.4, and shall be designed to reduce these parameters to acceptable values.

Subgrade improvement may also be required where weak subgrades yield pavement sections that are uneconomically thick. In general, thick base layers over 16" may not be a cost effective treatment to reduce stresses/strains in the pavement. The stresses at the bottom of the base layer do not justify the thick layer of very stiff base material. Improved subgrade or select fill is a better investment and a more effective layering of materials of progressively reducing stiffness in the pavement design. It is important to balance constructability, consistency, and level of complexity and use an optimization process to find the most cost effective solution.

The Geotechnical Engineer is responsible for identifying when subgrade improvement is required, and which improvement alternatives should be considered. The Pavement Design Report (PDR) shall include these recommendations to improve the subgrade, if necessary.

### 3.7.2 Limits of Improvement

Where subgrade stabilization is provided, the stabilized subgrade and succeeding subbase and base courses shall typically extend a minimum of three feet behind the back of curb. Where subgrade stabilization is not provided, subbase and base courses shall typically extend a minimum of 24

inches behind the back of curb. Modifications to limits of improvement may be required where existing buried utilities are present.

### 3.7.3 Traditional Subgrade Improvement Methods

#### 3.7.3.1 Removal and Replacement

The simplest form of subgrade improvement consists of removal of unsuitable subgrade materials and replacement with engineered, non-expansive fill. Removal and replacement can be effective to remove weak subgrade materials and/or to limit PVR and effective PI to acceptable values.

Removal and replacement depths of 18 to 24 inches are common, but greater depths may be required to limit the effective PI and PVR to acceptable values. Further, in highly-expansive geologic formations that extend to great depth, the required removal/replacement depth to meet PI and PVR criteria can exceed several feet, in which case removal/replacement may not be economically feasible.

Replacement fill should consist of engineered fill meeting recommendations of the Geotechnical Engineer. In general, engineered fill should meet $4 \leq PI \leq 15$ to limit potential for volume change.

General considerations in evaluating the feasibility of this alternative are as follows:

1. Requirements for temporary excavation slopes in accordance with OSHA criteria;
2. Availability of ROW / construction limits to meet OSHA requirements, and potential need for temporary shoring if sloping is not achievable;
3. Haul distance and cost for disposal of excavated subgrade;
4. Haul distance and cost for replacement materials;
5. Construction schedule impacts; and
6. Construction sequencing and traffic control impacts.

#### 3.7.3.2 Lime Treatment

Lime stabilization can be an effective method of soil stabilization. Properly executed, lime stabilization will act to reduce the shrink/swell potential of clayey soils, maintain a higher strength during moisture increases, and impede infiltration into deeper strata.

In general, thorough mixing of lime with clayey soils results in mixtures that display decreased plasticity, improved workability, reduced volume change characteristics, and increased strength. Improvement in soil strength, however, does not always develop with the addition of lime. It should be noted that a number of variables, including soil type, lime type, lime percentage and curing conditions can affect the properties of soil-lime mixtures.

Lime stabilization is most effectively undertaken following bench-scale treatability testing. The type of lime treatment proposed, including additive

rates, should be indicated in a mix design report (i.e., lime stabilization for strength increase or lime conditioning for plasticity reduction).

Guidelines and requirements for lime stabilization are provided below:

- Treatment Depth. The minimum depth of lime treatment shall be 8 inches, with greater depths required depending on traffic loads and the material PI.
- Strength Increase. Significant strength increase (lime stabilization) is typically associated with treatment of lime-reactive soils, typically soil with pH ≥ 7.
- Reduction of Plasticity. Reduction in plasticity (lime conditioning) is typically associated with treatment of non-lime-reactive soils. This typically applies to soils with pH ≤ 7.
- Application Rate. Most fine-grained soils can generally be conditioned/ stabilized effectively with three (3) to ten (10) percent of lime addition by weight (dry weight of soil basis). The lower percent lime additions are normally identified with lime conditioning (with minimal strength increases), while the higher percent lime additions are normally necessary to achieve lime/soil mixtures with significant strength increases.
- Mix Design. Lime treatment mixture design for the City of Round Rock shall be developed using one of the following procedures appropriate for the intended purpose of lime treatment:
    - Lime Conditioning Mix: TxDOT Test Method Tex-112-E, “Method of Admixing Lime to Reduce Plasticity Index of Soils”.
    - Lime Stabilizing Mix: TxDOT Test Method Tex-121-E, “Soil-Lime Testing”, shall be used to establish the lime content that would produce a twenty-eight (28) day unconfined compressive strength (TxDOT Test Method Tex-117-E). Minimum compressive strengths are fifty (50) psi for a lime-stabilized subgrade, and one hundred (100) psi for a lime-stabilized base layer.
- Application Rate. The actual design application rate shall be determined by the Geotechnical Engineer or Pavement Engineer on the basis of bench-scale lime series testing conducted under their direct supervision. Typical specified rate of lime solids application shall be 5% by weight (mass) for non-lime-reactive materials (pH of 7.0 or less); or 7% by weight (mass) for lime-reactive materials (pH greater than 7.0), unless indicated otherwise in the mix design process or as directed by the City. Lime stabilization of subgrade soils shall be in slurry form unless otherwise approved by the City.
- Compressive Strength. The minimum required 7-day compressive strength of lime-treated soil is 100 psi to be considered for structural credit in pavement design.

- Sulfate Content. Soils with elevated soluble sulfate content are not suitable for lime treatment due to the risk of sulfate-induced heave. The following sulfate content guidelines shall be observed when considering lime treatment:
  - Soluble Sulfate < 3,000 ppm: Subgrade is compatible with lime treatment.
  - Soluble sulfate between 3,000 ppm and 8,000 ppm: Subgrade shall be identified as generally compatible with lime treatment, though the Pavement Engineer or Roadway Designer should consult with the City for approval to use lime treated subgrade in these cases. Refer to TxDOT's "Guidelines for Modification and Stabilization of Soils and Base for Use in Pavement Structures" and "Guidelines for Treatment of Sulfate-Rich Soils and Bases in Pavement Structures" for more information.
  - Soluble sulfate > 8,000 ppm: Subgrade shall be identified as being incompatible with lime treatment.

#### 3.7.3.3 Cement Treatment

A wide range of soil types may be stabilized using cement. The greatest effectiveness is with sands, sandy and silty soils, and clayey soils of low to medium plasticity. However, cement is difficult to mix into soils with PI >30.

Soils mixtures that are acidic, neutral, or alkaline may well respond to cement treatment; however the higher pH soils react more favorably to cement addition and undergo significant strength increases. Although some organic matter (e.g., un-decomposed vegetation) may not influence stabilization adversely, other organic compounds of lower molecular weight (e.g., nucleic acid and dextrose) act as hydration retarders and reduce strength gain.

General guidance and design criteria for cement treatment of soil subgrades are provided as follows:

- pH. Soil pH testing shall be performed to provide an indication of the impact of organics on normal hardening of the cement stabilized soil mixture in accordance with TxDOT TEX-128-E. In summary, a 10:1 mixture (by weight) of soil and cement is mixed with distilled water for a minimum of fifteen (15) minutes and the pH of the combined mixture is then measured. If the pH value is at least 12.1, then it is probable that organic matter, if present, will not interfere with normal hydration/ hardening of a soil-cement mixture. This pH measurement is a principal feature in identifying the soil mixtures that can likely be stabilized with cement and are candidates for development of a cement-soil mix design (see the mix design flow diagram presented in TxDOT 2011).
- Sulfate. Since sulfate attack is known to adversely affect some cement stabilized soil, the sulfate content of a soil should be considered in the selection of cement as a stabilizer. The impact of the sulfate factor on the mix design is also identified in TxDOT 2011, where cement

stabilization of soils with sulfate contents greater than 0.9 percent is discouraged. Procedures for determining sulfate content of soils are presented in TxDOT 2011.

- Soil Plasticity and Fines Content. There are additional selection criteria based on gradation and Atterberg limits test results that should be used in establishing the acceptability of a soil mixture for cement stabilization, specifically:
  - Fine-grained soils (CL, ML, CL-ML): Plasticity Index should be less than twenty (20) and the Liquid Limit less than forty (40);
  - Sandy soils (SC, SM, SP, SW, and dual-symbols): Plasticity Index should be PI < 30;
  - Gravelly soils (GC, GM, GP, GW, and dual-symbols): Minimum of forty (40) percent passing the no. 4 sieve; and
  - All soils: Plasticity Index should not exceed the number calculated in the following equation:

$$N = \frac{50 - (\text{Percent Passing \#200 Sieve})}{4}$$

  - High-plasticity and Organic Soils (CH, MH, OL, OH): These soil types are not suitable for cement-treatment.
- Moisture-Density Relationship. The properties of cement-treated soils are principally dependent on cement content, density, moisture content and confining pressure. It should also be noted that the addition of cement to a soil mixture commonly produces a change in both the optimum water content and maximum dry density for a given compactive effort. The principal goal of the cement stabilization mixture design process is therefore the establishment of (i) the appropriate cement additive rate, and (ii) the resultant moisture-density relationship.
- Application Rate. Most soils can generally be stabilized effectively with five (5) to sixteen (16) percent of cement addition (dry weight of soil basis). The lower percent cement additions are normally identified with coarser soil mixtures (AASHTO classifications A1 and A2), while the higher percent cement additions are normally necessary for the fine-grained soils (AASHTO A6 and A7). The actual design application rate shall be determined by the Geotechnical Engineer or Pavement Engineer on the basis of bench-scale treatability testing conducted under their direct supervision.
- Mix Design. In development of a cement stabilized soil mix design for the City, the procedures specified in TxDOT Test Method Tex-120-E, “Soil-Cement Testing”, shall be used to establish the design cement content that would produce a mix that meets the durability requirements presented in TxDOT 2011. The mix design report should include the molding moisture content, the dry density to the nearest

0.1 pcf, 7-day unconfined compressive strength to the nearest psi and the recommended cement content to the nearest whole percent.

- Compressive Strength. The 7-day compressive strength associated with the recommended cement content should be used as the field control measure during construction. The 7-day compressive strength for cement stabilized soils can vary between one hundred (100) psi for fine-grained soils to more than a one thousand (1000) psi for coarse-grained soils. The minimum required 7-day compressive strength is 100 psi to be considered for structural credit in pavement design.

#### 3.7.3.4 Lime-Cement Treatment

Cement stabilization alone is normally not desired with high plasticity soil mixtures (i.e., soils with PI > 30) because of difficulties in the mixing phase. In this instance, combinations of lime and cement can often produce an acceptable combination. Lime is initially added to the soil mixture to increase the workability and mixing characteristics of the soil, as well as to reduce its plasticity. Cement is subsequently added to the lime–soil mixture to provide rapid strength gain. The lime-cement combination stabilization of high plasticity soils is especially advantageous when rapid strength gain is required for placement during cooler weather conditions.

General guidance and design criteria for lime-cement treatment of soil subgrades are provided as follows.

- Soil Plasticity. The lime content to reduce the stabilized soil to PI < 30 should be established using TxDOT Test Method Tex-112-E, “Method of Admixing Lime to Reduce Plasticity Index of Soils”, while the TxDOT Test Method Tex-120-E, “Soil-Cement Testing”, shall be used to establish the design cement content that would produce a mix that meets the allowable durability requirements TxDOT 2011.
- Reporting. The mix design report should include the following:
  - Molding moisture content;
  - Dry density to the nearest 0.1 pcf;
  - Seven (7)-day unconfined compressive strength to the nearest psi; and
  - Recommended lime and cement additive rates to the nearest whole percent.
- Application Rate: Typical lime contents range from one (1) to three (3) percent, while the typical subsequent cement contents range from three (3) to ten (10) percent. The amount of lime and cement additions is dependent upon the type of soil. The actual design application rate shall be determined by the Geotechnical Engineer or Pavement Engineer on the basis of bench-scale treatability testing conducted under their direct supervision.

- Quality Control. The 7-day compressive strength associated with the recommended lime and cement contents should be used as the field control measure during construction. A minimum 7-day value of 100 psi shall be required.

### 3.7.4 Alternative Subgrade Improvement Methods

#### 3.7.4.1 Moisture Treatment

The objective of moisture treatment is to “pre-swell” high-plasticity expansive soil subgrades prior to pavement construction to minimize post-construction expansion potential. This method involves compacting the subgrade at a moisture content several points above optimum moisture to reduce expansion potential. This generally includes installation of a moisture barrier following wetting to protect the subgrade from natural cycles of wetting and drying.

#### 3.7.4.2 Geogrid

The City's experience has shown that geogrids are effective at controlling environmental cracking and should be considered at the base/subgrade interface when the PI > 35. The grid holds the granular base material in a tight matrix allowing the shrinking/swelling subgrade to move and limit subgrade cracking from propagating to the pavement surface. More recently, Triaxial Geogrids have also been introduced (Tensar TX5 or equal) as the recommended geogrid type for subgrade improvement. The Engineer should strongly consider the performance improvements offered by the use of triaxial geogrid in high PI soils. Triaxial Geogrid shall be specified in the plans to be pinned during installation.

Several geogrid vendors offer software which can be used to develop an optimized design with geosynthetics by estimating a section with equivalent performance (e.g., SpectraPave4-PRO by TENSAR® Corporation). The design steps are as follows:

1. Determine soil strength parameters;
2. Develop pavement thickness (criteria) with standard procedures;
3. Determine Resilient Modulus;
4. Determine Enhanced Structural Layer Coefficient for Mechanically Stabilized Layer (MSL);
5. Use Vendor Software to find geogrid optimized section equivalent to unreinforced; and
6. Check severity of swelling soils and serviceability criteria.

Geotextiles have been widely used to control the movement of fine materials and to provide moisture barriers.

General guidance and design criteria for geosynthetic applications in soil subgrades are provided as follows:

- General. The typical geogrid design approach is to reduce the base layer thickness rather than incorporating a thicker layer of material that

has low volume change potential. This is an important advantage since there will be specific situations that limit the overall depth of the pavement section, and will necessitate considerations of geogrid to offset the required additional base thickness.

- Reduction of Base Layer Thickness. For pavement designs the reduction in base thickness when considering geogrid reinforcement must be supported by calculations submitted with design report and shall be limited to a maximum of 4 inches of flexible base thickness reduction until more performance data is available.
- Crack Reduction. Geogrid has been used in the Austin area for base layer thickness reduction and pavement structural enhancement. Additionally, it has been used over high plasticity clay soils (especially in areas with high sulfate content) to minimize reflective cracking caused by post-construction environmental shrink/swell, or as a factor of safety to extend pavement service life.
- Management of Expansive Soil Conditions. The use of geogrid alone is not expected to eliminate cracking and distortion, but is expected to help to manage pavements on expansive clays and potentially on subgrades with poor bearing capacity. Geogrids should limit crack widths and minimize differential distortion by spreading out both subgrade swelling forces and occasional pavement overloads on softer spots. However, stabilization and moisture control strategies are highly encouraged in addition to the consideration of the use of a high quality geogrid.

Table 3-11 presents representative flexible pavement sections incorporating a single layer of Tensar TriaxialTX5 geogrid placed directly on top of the lime-treated subgrade layer. The thicknesses presented in Table 3-11 were developed using SpectraPave4-PRO by TENSAR® Corporation, using similar geotechnical parameters that were used to develop the flexible pavement sections using the FPS-21 software and as presented earlier in Table 3-9.

Due to several variances in the calculation procedures of different software used (SpectraPave-4 and FPS-21), it is the responsibility of the Pavement Design Engineer to evaluate project specific geotechnical parameters, traffic data and appropriate pavement types prior to determining the reduction in base layer thickness by incorporating geogrid in the pavement design.

**Table 3-11. Representative Flexible Pavement Sections by Subgrade Type and Street Category (with Tensar Triaxial TX5 Geogrid)**

| Street Classification | Existing Subgrade Conditions | Flexible Pavement Layer Thickness | | |
|---|---|---|---|---|
| | | HMAC (in.) | Flexible Base (in.) | Treated Subgrade (in.) |
| ARTERIALS | | | | |
| Urban Arterial (High Traffic) | Very High Swell | RAR | RAR | RAR |
| | High Swell | 10.0 | 15.5 | 10.0 |
| | Moderate Swell | 6.0 | 13.5 | 10.0 |
| | Low Swell | 5.0 | 13.5 | 10.0 |
| Urban Arterial (Low Traffic) | Very High Swell | RAR | RAR | RAR |
| | High Swell | 7.0 | 17.0 | 10.0 |
| | Moderate Swell | 5.0 | 16.0 | 10.0 |
| | Low Swell | 5.0 | 8.0 | 10.0 |
| COLLECTORS | | | | |
| Urban Collector (High Traffic) | Very High Swell | RAR | RAR | RAR |
| | High Swell | 6.5 | 17.0 | 10.0 |
| | Moderate Swell | 4.0 | 15.0 | 10.0 |
| | Low Swell | 4.0 | 7.0 | 10.0 |
| Urban Collector (Low Traffic) | Very High Swell | RAR | RAR | RAR |
| | High Swell | 5.0 | 12.0 | 10.0 |
| | Moderate Swell | 4.0 | 9.0 | 8.0 |
| | Low Swell | 4.0 | 6.0 | 8.0 |
| LOCALS | | | | |
| Urban Local | Very High Swell | RAR | RAR | RAR |
| | High Swell | 3.0 | 10.0 | 8.0 |
| | Moderate Swell | 3.0 | 6.0 | As Needed |
| | Low Swell | 3.0 | 6.0 | As Needed |

Notes:

1. RAR – Remove And Replace existing subgrade material with suitable non-expansive fill material per the recommendations of the geotechnical engineer.
2. Very High Swell: Subgrade with very high swelling potential, represented by PI > 50. Such cases will likely require deep treatment to reduce PVR to acceptable values.
3. High Swell: Subgrade with high swelling potential, represented by PI = 36 to 49.
4. Moderate Swell: Subgrade with moderate swelling potential, represented by PI = 20 to 35.
5. Low Swell: Subgrade with low swelling potential, represented by PI < 20.
6. The pavement sections in this table should be considered representative for each street classification. Different pavement sections may be required based on the results of a project-specific Pavement Design Report or as directed by the City.
7. All materials shall be in accordance with TxDOT Specifications.
8. Minimum HMAC pavement thickness is 3 inches.
9. Pavement sections are based on Tensar Triaxial TX5 Geogrid and SpectraPave-4 Pro software.

## 3.8 FLEXIBLE PAVEMENT DESIGN PROCEDURE

### 3.8.1 Methodology Overview

The FPS-21 software program shall be used for the design of flexible pavement. FPS-21 is a mechanistic-empirical design procedure that provides for multiple pavement design strategies. These strategies allow the Pavement Engineer to input various pavement layer thicknesses, material properties, traffic loading conditions, and cost considerations (initial and future). New construction, overlay options, and reconstruction strategies are provided as available options. The Roadway Designer will then select a design strategy based on cost, constructability, user delay, past performance, and City of Round Rock preferences based on budgetary constraints. Refer to the Flexible Pavement Design System (FPS) 21: User's Manual and the TxDOT Pavement Design Guide for documentation concerning this software and methodology for developing pavement strategies.

### 3.8.2 Pavement Section Model Options

TxDOT's FPS 21 software allows for seven basic design types as shown in Table 3-12. Although the number of distinct layers is limited to that shown in the table, the user can consolidate two or more layers if needed. However, the combining of layers will require assumption of a consolidated modulus. The Pavement Engineer should seek approval from the City prior to consolidating layers.

**Table 3-12. FPS-21 Pavement Section Options**

| Layer No. | Design Type | | | | | | |
|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Layer 1 | Surface Treatment | HMAC Surface | HMAC Surface | HMAC Surface | HMAC Surface | HMAC Overlay | User Defined (less than 7 layers) |
| Layer 2 | Flexible Base | Flexible Base | Asphalt-Treated Base | Asphalt-Treated Base | Flexible Base | Existing HMAC | |
| Layer 3 | Subgrade | Subgrade | Subgrade | Flexible Base | Treated Subgrade | Subgrade | |
| Layer 4 | --- | --- | --- | Subgrade | Subgrade | Subgrade | |

Notes:
1. The flexible pavement design examples presented in this manual use Design Type 5 as the recommended pavement section.

The most common pavement design options are Types 1, 2 and Type 5. However, Design Type 3 may be evaluated as an alternate pavement design, for example at intersections where minimizing traffic closures would be a consideration.

The pavement designer shall use historical bid-based data, adjusted for inflation, to develop cost inputs for the program.

### 3.8.3 FPS-21 Software Inputs

Key material inputs include back-calculated in-place materials, using the MODULUS 6 software with the Falling Weight Deflectometer (FWD) data, and

realistic average moduli values for newly placed materials used for the main structural layers. FPS 21 includes a mechanistic design check for fatigue life and subgrade rutting potential. The Modified Texas Triaxial design check evaluates the impact of the anticipated heaviest wheel load on the proposed pavement structure.

Unless otherwise approved by the Transportation Director, the following design inputs should be used to develop flexible pavement thickness designs:

**Table 3-13. Required FPS-21 Analysis Inputs**

| Input Parameter | Units | Input Value | Comment |
|---|---|---|---|
| **BASIC DESIGN CRITERIA** | | | |
| Length of Analysis Period | Yrs | 20 | |
| Min Time to First Overly | Yrs | 20 | |
| Min Time Between Overlays | Yrs | 10 | |
| Design Confidence Level Code | - | See Table 3-3 | |
| Initial Serviceability Index | - | See Table 3-3 | |
| Final (Terminal) Serviceability Index (P1) | - | See Table 3-3 | |
| Serviceability Index After an Overlay (P2) | - | See Table 3-3 | |
| District Temperature Constant | - | 31.0 | Typical for TxDOT District 14 |
| Subgrade Elastic Modulus | Ksi | See Table 3-5. | |
| Interest Rate or Time Value of Money | % | 7 | Used to generate user delay costs during overlay. Cost analysis to be performed using FHWA LCCA when possible. |
| **PROGRAM CONTROLS AND CONSTRAINTS** | | | |
| Number of Summary Output Pages | 8 designs/ page | User preference | |
| Max Funds available per SY for Initial Design | $ | 99 | Use sufficiently high value to maximize output design combinations. |
| Maximum Allowed Thickness of Initial Construction | Inches | 99 | Default value; use to constrain design to meet profile limitations or total number of designs. |
| Accumulated Max Depth of All Overlays (excluding level-up) | Inches | 6 | Use to constrain design to meet profile limitations. |
| **TRAFFIC DATA** | | | |
| Beginning ADT | Veh./ day | See Table 3-3 | Two-direction volume parameter used to generate user delay costs during overlay. |
| Ending ADT | Veh./ day | See Table 3-3 | Same as above at end of 20-year analysis period. Assumed to increase linearly over time. |
| One-Direction 20-yr 18-kip ESAL | millions | See Table 3-3 | If the analysis period is other than 20 years, internal equations will adjust and correct for specified analysis period. |
| Average Approach Speed to Overlay Zone | MPH | Site dependent | Typically the posted speed limit. |
| Average Speed Through Overlay Zone (Overlay Direction) | MPH | Site dependent | Based on detour model used. Used to estimate user delay costs during overly. Can be set equal to Average Approach Speed to prevent calculation of user delay costs. |
| Average Speed Through Overlay Zone (Non-overlay Direction) | MPH | Site dependent | |

| Table 3-13. Required FPS-21 Analysis Inputs | | | |
|---|---|---|---|
| **Input Parameter** | **Units** | **Input Value** | **Comment** |
| Proportion of ADT Arriving Each Hours of Construction | % | 4 | |
| Percent Trucks in ADT | % | See Table 3-3 | Used to convert traffic (of all vehicle types) into the 18-kip equivalent single axle loadings used for pavement structural design. |
| **CONSTRUCTION AND MAINTENANCE DATA / DETOUR DESIGN** | | | |
| Minimum Overlay Thickness | Inches | 2.0 | Used to generate user delay costs during overlay. Cost analysis to be performed using FHWA LCCA when possible. |
| Overlay Construction Time | Hours / Day | 12 | Used to generate user delay costs during overlay. Cost analysis to be performed using FHWA LCCA when possible. |
| Asphaltic Concrete Compacted Density | Tons / CY | 1.9 | Used to generate user delay costs during overlay. Cost analysis to be performed using FHWA LCCA when possible. |
| Asphaltic Concrete Production Rate | Tons / Hr | 200 | Used to generate user delay costs during overlay. Cost analysis to be performed using FHWA LCCA when possible. |
| Width of Each Lane | Feet | 12 | Used to generate user delay costs during overlay. Cost analysis to be performed using FHWA LCCA when possible. |
| First Year Cost of Routine Maintenance | Dollars/ Lane-Mile | 0 | Used to generate user delay costs during overlay. Cost analysis to be performed using FHWA LCCA when possible. |
| Annual Incremental Increase in Maintenance Cost | Dollars/ Lane-Mile | 0 | Used to generate user delay costs during overlay. Cost analysis to be performed using FHWA LCCA when possible. |
| **DETOUR DESIGN FOR OVERLAYS** | | | |
| Detour Model Used During Overlaying | - | - | Based on Street Classification Type |
| Total Number of Lanes of the Facility | - | - | Based on Street Classification Type |
| Number of Open Lanes in Restricted Zone (Overlay direction) | - | - | Based on Street Classification Type |
| Number of Open Lanes in Restricted Zone (Non-overlay direction) | - | - | Based on Street Classification Type |
| Distance Traffic is Slowed (Overlay Direction) | Miles | 0.6 | |
| Distance Traffic is Slowed (Non-overlay direction) | Miles | 0.0 | |
| Detour Distance around Overlay Zone | Miles | 1.0 | |
| **PAVING MATERIALS INFORMATION** | | | |
| Cost per Cubic Yard | $/CY | 0 | Used to generate user delay costs during overlay. Cost analysis to be performed using FHWA LCCA when possible. |
| Layer Modulus | | See Table 3-8. | Estimate using the TTC or CBR data provided by the geotechnical investigation. Alternatively, the elastic modulus may be back calculated using pavement deflection data. Note that Layer Modulus (EFPS) is not equal to Resilient Modulus (MR). |
| Poisson Ratio | | See Table 3-8. | |

| Table 3-13. Required FPS-21 Analysis Inputs | | | |
|---|---|---|---|
| **Input Parameter** | **Units** | **Input Value** | **Comment** |
| Min Depth<br>-Asphalt Conc Pvmt<br>-Flexible Base<br>-Stabilized Subgr<br>-Subgrade | | -<br>3<br>8<br>8<br>200 | Varies such that the Mechanistic Design check provides optimum tensile strains for HMAC surface and compressive strains for Treated subgrade |
| Max Depth<br>-Asphalt Conc Pvmt<br>-Flexible Base<br>-Stabilized Subgr<br>-Subgrade | | -<br>12<br>18<br>12<br>200 | Varies such that the Mechanistic Design check provides optimum tensile strains for HMAC surface and compressive strains for Treated subgrade |
| Salvage Pct.<br>-Asphalt Conc Pvmt<br>-Flexible Base<br>-Stabilized Subgr<br>-Subgrade | | -<br>30<br>75<br>90<br>90 | Depends on the requirements of the CORR Pavement Maintenance Department |

### 3.8.4 Modified Texas Triaxial Check

The modified Texas Triaxial Check establishes the minimum total combined pavement thickness required to prevent general shear failure in the subgrade. This is based on the following input parameters:

- Average Ten Heaviest Wheel Loads (ATHWLD). Defined as one of the following: (1) load carried by the dual tires at each end of the drive or trailer axles; (2) a single wheel load on each tire of the steering axle; or (3) tire load on drive or trailer axles equipped with wide-base radials. The following values are recommended based on ESAL range:
  - ESALs < 900,000: ATHWLD=10,000; and
  - ESALs < 10,000,000: ATHWLD=11,500.
- Percentage of Tandem Axles. The following input categories apply:
  - Tandem axles < 50%: No adjustment to wheel load required. This option should be selected for projects with design ESALs < 5,000,000; and
  - Tandem axles > 50%: FPS-21 internally increases wheel load by 30%.
- Modified Cohesiometer Value ($C_m$). This parameter accounts for the presence of engineered material (lime-treated subgrade, subbase, etc.) above native subgrade which will protect subgrade from shear failure. The following values are recommended for various materials:
  - Lime-Treated Base >3" thick 300;
  - Lime-Treated Subgrade >3" thick 250;
  - Cement Treated Base >3" thick 1000;
  - Cold Mixed Bituminous materials > 3" thick 300;
  - HMAC > 6" thick 800;

- HMAC between 4” and 6” thick 550;
- HMAC between 2” and 4” thick 300; and
- Untreated materials 100.

- Subgrade Texas Triaxial Class (TTC). This shall be estimated either based on Tex-117-E, or input of soil PI and program’s internal correlations.

### 3.8.5 Evaluating Results of FPS-21

Results of FPS-21 should be examined to ensure the following criteria are met:

1. Mechanistic Check:
   a. Rutting: $ESAL_{Design} \leq ESAL_{Rutting\ Life}$;
   b. Cracking: $ESAL_{Design} \leq ESAL_{Crack\ Life}$;
   c. Limiting Tensile Strain in HMAC: ≤ 70 με (Arterial Streets Only)
   d. Limiting Compressive Strain in Subgrade: ≤ 200 με (Arterial Streets Only)
2. Modified Texas Triaxial Check: $Thickness_{(FPS\ Design)} \geq Thickness_{(Modified\ Triaxial\ Required)}$

As indicated above, all Arterial streets shall be designed to meet the limiting tensile and compressive strain requirements of Perpetual Flexible Pavements as described in the FPS-21 User’s Manual and TxDOT Pavement Design Guide Manual (2011). These criteria were established based on the expectation that the 20-year design life to first overlay could result in significant traffic loading distress/deformation, and similar to Perpetual Pavements, limiting the predicted strains should serve to extend pavement life to meet minimum performance criteria.

## 3.9 RIGID PAVEMENT DESIGN PROCEDURE

### 3.9.1 Methodology Overview

Rigid pavement designs shall be developed utilizing the most recent version of American Concrete Pavement Association's (ACPA's) StreetPave12. The software may be obtained from http://www.acpa.org/streetpave/. StreetPave12 is based on the 1960's Portland Cement Association (PCA) method and is tailored for streets and roads (not highways or interstates) with the failure models being: (1) cracking; and (2) faulting. Description of software analysis methods for these two failure modes are provided below.

#### 3.9.1.1 Cracking Analysis

StreetPave12 performs pavement cracking analysis by examining the stresses at the edge of the slab generated by the traffic loads. The software uses the concept of equivalent moment due to traffic loads, which differs for single, tandem, or tridem axle loading, and considers cases with and without pavement edge support. The calculated moment depends on pavement thickness, concrete elastic modulus, Poisson's ratio, and pavement support k-value. Included in the equivalent edge stress calculations are adjustment factors for the effect of axle loads and contact area, adjustments for slabs with no concrete shoulder, adjustment for the effect of truck wheel placement at the slab edge, and adjustment to account for increases in concrete strength with age after the 28th day (approximately 23.5%), and reduction of one coefficient of variation (COV) to account for materials variability.

The software methodology is based on empirical data in which the occurrence of pavement fatigue (i.e., cracking) is related to the number of traffic load repetitions and a parameter termed Stress Ratio (SR). The SR is expressed as follows:

$$\text{Stress Ratio (SR)} = \frac{\text{Stress}}{\text{Concrete Strength}}$$

StreetPave12 internally limits the Stress Ratio (SR) to a value below which fatigue is predicted to occur, as illustrated in Figure 3-4, to achieve the target traffic load repetitions design value. The program achieves this by iteratively increasing thickness of the concrete slab until an acceptable SR is obtained.

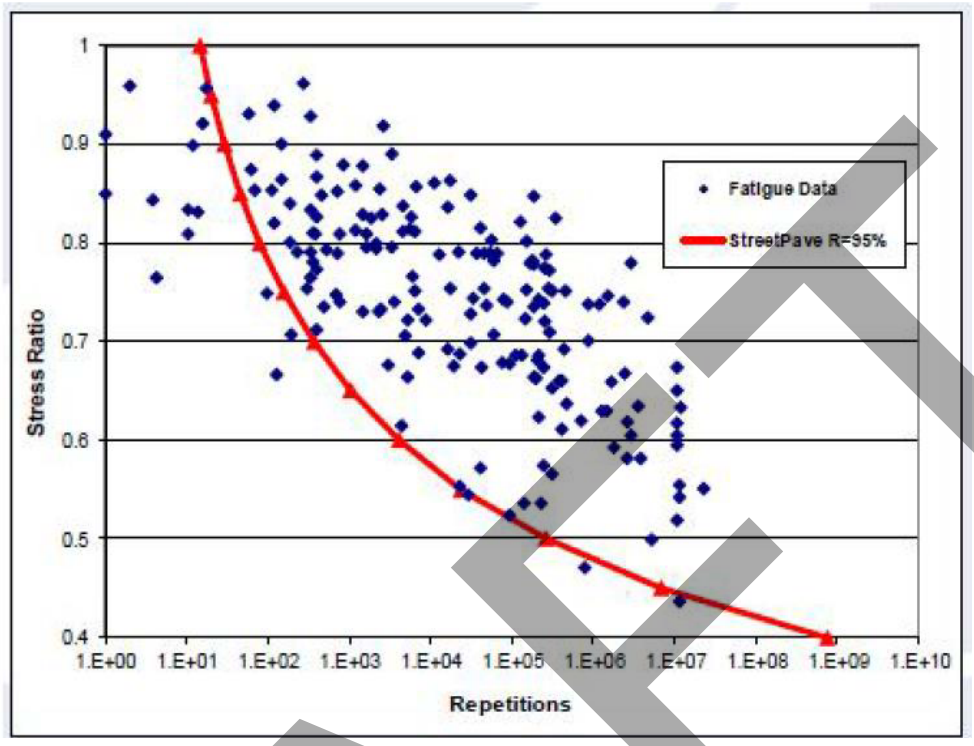


**Figure 3-4. StreetPave12 Cracking Analysis Methodology (from CAPEC 2016, after Rodden 2014).**

#### 3.9.1.2 Faulting Analysis

Faulting refers to the failure mode by which the adjacent pavement slabs shift vertically relative to each other at a joint, forming a "bump". StreetPave12 performs pavement faulting analysis using empirical methods developed from field performance data developed in the 1980's from sites in Wisconsin, Minnesota, North Dakota, Georgia, and California. StreetPave12 internally increases concrete slab thickness until faulting is not predicted to occur. Note that in pavements where dowels are used at pavement joints, the faulting failure mode is precluded from occurring, and failure is controlled by cracking only.

### 3.9.2 Pavement Section Model Options

StreetPave12 permits modelling of several different pavement layer types. Layers underlying the slab are internally referred to as "subbase types", but include both treated subgrade and subbase materials. The optional materials are listed below. While asphalt-based subbases are required for use as bond breaker layer, the LCB, ATB, and asphalt subbase materials are not commonly used in Round Rock area for pavement support, and other materials (lime- and cement-treatment) should be given first consideration.

- Cement-Stabilized Subgrade: Permitted in combination with non-erodible subbase;
- Lime-Stabilized Subgrade: Permitted in combination with non-erodible subbase;

- Unstabilized subbase (e.g., crushed stone): Not permitted (erodible subbase);
- Cement-Treated Subbase (CTB): Recommended;
- Lean Concrete Subbase (LCB): Permitted upon approval by City;
- Asphalt-Treated Subbase (ATB): Recommended; and
- Hot-Mix or Warm-Mix Asphalt Subbase: Permitted upon approval by City.

### 3.9.3 Traffic Spectrums

StreetPave12 calculates 18 Kip ESALs based on either predetermined traffic spectrums with counts, or user input traffic distributions for the specific functional class of pavement for which a design is being calculated. These traffic spectrums establish the truck factors to be used in the ESAL calculations, which are internal to the program.

- Predetermined Traffic Spectrums. Predetermined spectrums are identified by street classifications as follows:
  - Residential: ACI 330 Category A;
  - Collector: ACI 330 Category B;
  - Minor Arterial: ACI 330 Category C; and
  - Major Arterial: ACI 330 Category D.
- User-Defined Traffic Spectrums. Custom traffic spectrums are entered by identifying the axle load by single, tandem, and tridem axle type, and number of axles per 1000 trucks.

### 3.9.4 Traffic Inputs

The truck traffic over the pavement design life is calculated and use in pavement thickness design based on the traffic spectrums defined previously and by providing the following inputs parameters:

- Trucks per day — See Table 3-3
- Traffic growth rate per year — See Table 3-3
- Design life — 30 years
- Directional distribution — See Table 3-3
- Design lane distribution — See Table 3-1.

### 3.9.5 Pavement Layer Inputs

The primary input parameters for pavement layers required include the following:

- Percent of Slabs Cracked at End of Design Life. This input reflects the allowable percent of concrete slab that are cracked at the end of the design life of pavement. Alternatively, this input could be viewed as the percent of slabs that are intended to be replaced in determining

future rehabilitation of pavement for life cycle cost analysis. Design values for different street classifications shall be as follows, based on findings of FHWA-RD-97-131 "Common Characteristics of Good and Poorly Performing PCC Pavements":

- Arterials 4%;
- Collector Streets: 15%; and
- Local Streets: 25%.

- Composite Modulus of Subgrade Reaction (Static k-value). The properties of subbase such as the modulus of elasticity and the layer thicknesses are used to calculate the composite static modulus of subgrade reaction (K-value). This value estimates the support of the layers below the concrete slab. While field measurements are recommended, the k-value is more typically calculated based on the thickness and layer strengths as described below.
  - Subgrade Modulus: can either be given as a direct field-measured input, or calculated through correlations presented previously with appropriate use of engineering judgment. The equations developed from NRHCP 128, "Evaluation of the AASHTO Interim Guide for the Design of Pavement Structure" is used to estimate the subgrade modulus. Refer to Table 3-4 for more details on subgrade modulus and k-value ranges based on soil type.
  - Subbase Modulus: The layer thickness and layer modulus of elasticity is input for each subbase layer and the composite k-value is thus calculated. Background details on the calculations of composite k-value are included in Section 3.4.4. StreetPave12's allowable range of modulus values for each material type is generally equivalent to the material strengths included in Table 3-4. The subbase material directly under the concrete shall be non-erodible material.
- Concrete Material Properties. The 28-day flexural strength and the Modulus of Elasticity of Concrete are required for the rigid pavement design. Typical 28-day flexural strength ranges from 500-700 psi. Concrete pavement shall be constructed to TxDOT Item 360 "Concrete Pavement", therefore use Class "P" concrete with flexural strength of 570 psi at 28 days.
- Edge Support. The critical load location on a concrete slab is at an unsupported edge. Consequently, reduced pavement thickness can be achieved by providing additional edge support such as specifying a concrete curb and gutter, tied concrete shoulder, or widened lane. A widened lane consists of a lane edge stripe that is placed a minimum of 1 foot from the pavement edge. If edge support is to be provided, that should be indicated so on in the PDR and design plans.

### 3.9.6 Evaluating the Results of Streetpave12

When the design solution is run, the StreetPave12 outputs the Rigid ESALs over the design life along with the minimum required concrete thickness for doweled and undoweled condition, with an indication of the controlling failure criteria noted. The results of Streetpave12 should be examined to ensure appropriate pavement design recommendations are documented in the PDR:

- Calculated design ESALs meet project criteria;
- Controlling failure mechanism;
- Maximum joint spacing;
- Whether or not dowel bars are required, and bar diameter;
- Whether or not edge support is required; and
- Regardless of the StreetPave12 output value, the minimum concrete pavement thickness shall be 6 inches.

All construction joints in a rigid pavement section must be dowelled for successful long term performance. StreetPave12 provides guidance regarding maximum joint spacing and dowel bar recommendations for jointed plain concrete pavement. These recommendations shall be compared to the following ACI guidance documents to avoid cracking due to improperly located and constructed joints:

- ACI 325.12R-02 Guide for Design of Jointed Concrete Pavements for Streets and Local Roads, by ACI Committee 325, American Concrete Institute, Reapproved 2013; and
- ACI 330R-08 Guide for the Design and Construction of Concrete Parking Lots.

Concrete pavement shall be in accordance with TxDOT Standard “Concrete Pavement Contraction Design-CPCD”.

## 3.10 LIFE CYCLE COST ANALYSIS

### 3.10.1 Overview

LCCA is typically used as a decision support tool to select pavement type, determine structure and mix type (for flexible pavements), construction methods, as well as maintenance and rehabilitation strategy. LCCA includes first cost, long term costs as well as asset renewal. The initial construction cost (first cost) is based on developer contribution and/or agency (re)construction. Long term costs include routine repairs, preventative maintenance, rehabilitation, and salvage value. Each agency will need to provide agency specific assistance and guidance on maintenance unit costs and typical timing (i.e., agency specific maintenance profile) Asset renewal is reconstruction that starts the cycle again. .The pavement designer shall use historical bid-based data, adjusted for inflation, to develop cost inputs for the program.

LCCA is an engineering economic analysis that allows engineers to quantify the differential costs of alternative investment options for a given project. LCCA can be used to compare alternate pavement sections or pavement types (flexible versus rigid) on new construction and rehabilitation projects. LCCA considers all agency expenditures and user costs throughout the life of the facility, not just the initial capital construction investment, and allows for cost comparison of options with varying design lives to be compared on an equivalent basis.

The intended results of the LCCA are to lower the life cycle costs and increase the Level of Service throughout the life of the street. As a consequence, the first cost will be increased and additionally may cause some difficulty during reconstruction in developed areas. In many cases the first cost of initial construction is born by the developer and the life cycle costs of street maintenance is born by the agency (and public). The user "cost" and the impact and inconvenience for premature street repairs need to be considered. A balance must be reached between private development and public agency and public user costs, since the public perception overall regarding street conditions affects both the developer and the agency.

### 3.10.2 Procedure

Pavement options shall be compared using the FHWA's LCCA program RealCost 2.5 (deterministic procedure) (Ref 3). FHWA references (Technical Bulletin, User's Manual, and Primer are available in electronic format on the FHWA's LCCA Web page:

(www.fhwa.dot.gov/infrastructure/asstmgmt/lcca.htm)

or by request from the FHWA's Office of Asset Management. Complete details are provided in the Real Cost 2.5 User's Manual (Ref 4). RealCost 2.5 reports life cycle costs on a total project cost. User costs may also be included.

The FHWA's LCCA program RealCost 2.5 is a simplified system that allows the user to enter up to 24 unique activities over the life cycle of 2 different alternatives. It can compare HMAC and concrete alternatives on the same cost basis. Input variables are as follows:

### 3.10.3 Criteria

These are the analysis criteria which determine the analysis guidelines by which the program calculates costs. Requirements for several of the variables are as follows:

- Analysis Period (Years) – a minimum of a 40 year analysis period, with the initial cross section designed for 20 years until the first overlay.
- Discount Rate – This value is determined using the estimated interest rate (%) and inflation rate (%).
- User Cost Computation Method (Calculated or Specified) – default built-in models are recommended to calculate the user delay costs.

- Probability Functions – The deterministic option should be used instead of one of the probability functions.

## 3.11 DESIGN AND IMPLEMENTATION OF CONSTRUCTION QUALITY CONTROL PROGRAM

### 3.11.1 General

Construction quality control is a key factor in the success of the pavement performance. As such, it is critical to adequately define the required specifications and testing to be followed during construction as well as thorough inspections at critical points during construction. Material specifications and testing requirements contained in the PDR and/or Geotechnical Report should be incorporated into the design documents and adhered to in the field during construction.

### 3.11.2 Qualifications

The testing laboratory and field technicians shall hold the proper accreditation and Certificate of Qualification as appropriate for the scope of the project, and shall be approved by the City of Round Rock.

### 3.11.3 Field Testing Procedures

All materials shall be sampled and tested by a Testing Laboratory independent of the Contractor in accordance with the approved design documents. Certified copies of test results shall be furnished to the relevant agency. Any material which does not meet the minimum required test specifications shall be removed and re-compacted or replaced unless alternative remedial action is approved in writing from the City.

### 3.11.4 Design of Testing Program

The following material design properties are critical inputs to the pavement design procedure and to pavement performance, however are not historically included in the pavement construction material specifications and required testing. Consequently, the Geotechnical Engineer and Pavement Engineer must determine the required types of field tests which can be practically and expediently performed and be reliably correlated to the following parameters.

- Hot Mix Asphalt Concrete (HMAC):
  - Resilient Modulus of HMAC layers;
  - Resilient Modulus of Base/Subbase layers; and
  - Resilient Modulus of Subgrade; and
- Concrete Pavement:
  - Flexural Strength of concrete pavement;
  - Resilient Modulus of concrete pavement;
  - K-value of subbase layers; and
  - Resilient Modulus of Subgrade.

It is recommended that material specifications consider these tests either by required testing during construction or by establishing relationships at the time of mix design preparation to allow confirmation during construction that the basis of design is being met.

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## SECTION 4 – SIDEWALKS, CURB RAMPS AND BICYCLE FACILITIES

### 4.1 SIDEWALKS AND CURB RAMPS - GENERAL

This section addresses sidewalk and curb ramp design for roadways within public rights-of-way (ROW) in order to provide accessible route(s) in the design and construction of City streets.

Early consideration of pedestrian facilities should be studied at the planning stages of a roadway system as later installations might be costly and/or unfeasible.

Accessible routes shall comply with Texas Accessibility Standards as administered by the Texas Department of Licensing and Regulation. Public rights-of-way and facilities are required to be accessible to persons with disabilities through the following statutes: Section 504 of the Rehabilitation Act of 1973 (Section 504) (29 U.S.C. §794) and Title II of the Americans with Disabilities Act of 1990 (ADA) (42 U.S.C. §§ 12131-12164). The laws work together to achieve this goal. When a public or private agency provides a pedestrian facility, it must be accessible to persons with disabilities to the extent technically feasible.

A SIDEWALK is a pathway constructed to provide for pedestrian traffic; such traffic is generally non-motorized and may include self-propelled wheeled vehicles and devices, if not prohibited; but may also include vehicles such as motorized wheelchairs and personal transport devices, if not prohibited. A CURB RAMP is a connection between a sidewalk and a roadway surface that is constructed with special surface, visual, and geometric characteristics. The WIDTH of a sidewalk or curb ramp is the dimension of the surface measured perpendicular between the sides of the sidewalk or curb ramp exclusive of any abutting curb or flared sides. CLEAR WIDTH is the width of the surface and the space to a point eighty inches (80”) perpendicularly above the surface that is void of obstructions or protruding objects.

Sidewalks and curb ramps shall be constructed to comply with Chapter 4: “Accessible Routes” of the latest edition of the Texas Accessibility Standards (TAS) of the Architectural Barriers Act Article 9102, Texas Civil Statutes; the latest edition of the Americans with Disabilities Act (ADA) Accessibility Guidelines (ADAAG) for Public Rights-of-Way; or the standards herein, whichever is more restrictive. The geometry and tolerances of the surface of a roadway between curb ramps on either side of the roadway, or of a driveway between the points where sidewalk intersects the driveway edges on either side of the driveway, shall also comply with the aforementioned standards. The “Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way”, available from the United States Access Board, is also a design source for sidewalk and general pedestrian facility design.

Sidewalks and curb ramps constructed within City of Round Rock (CORR) right-of-way or sidewalk easements shall be constructed in accordance with the CORR Design and Construction Standards (DACS) and the Standard Specification Manual (CORR Specifications). Construction material for sidewalk other than reinforced hydraulic cement concrete in accordance with CORR Specifications will not be allowed except through separate license agreement with the CORR, to include maintenance responsibilities. Construction material for curb ramps other than reinforced hydraulic cement concrete with cast-in-place detectable

warning pads, in accordance with CORR Specifications, will not be allowed except through separate agreement with the CORR.

A design variance is required whenever the design guidelines specified in the ADAAG and the TAS are not met. The Project Engineer who is sealing the construction plans is responsible for obtaining approval of design variances from the Texas Department of Licensing and Regulation (TDLR). Contact the CORR Transportation Director prior to proceeding with the variance request to obtain concurrence that specific criteria cannot be met and a request for variance is reasonable.

Sidewalk requirements are also defined in the Code of Ordinances, specifically Section 36-108, and Chapter 6, Article III of the Zoning and Development Code of the CORR (the code). Where discrepancies occur, these codes as adopted or amended by the City Council shall govern.

Refer to the Bibliography for reference documents pertaining to accessibility requirements and curb ramp standards.

## 4.2 SIDEWALK REQUIREMENTS

For the specific roadway classifications, sidewalks shall typically be constructed on both sides of the road and parallel to the roadway with a minimum width specified herein. For sidewalks constructed with a width equal to or greater than ninety-six inches (96”), the clear width may be comprised of two sections on either side of an obstruction provided that each section has a clear width no less than forty-two inches (42”).

Obstructions or protrusions in or over a sidewalk shall be kept to a minimum. When unavoidable, an obstruction or protrusion in or over a sidewalk shall not be longer than twenty-four inches (24”) longitudinally along the sidewalk. The longitudinal distance between separate obstructions or protrusions shall not be less than sixty inches (60”). Detection and/or protection barriers shall be provided for objects with a height above the finished sidewalk surface greater than twenty-seven inches (27”) and less than eighty inches (80”) that protrude more than four inches (4”) into the area above a sidewalk or into the area above surfacing abutting or adjacent to a sidewalk that is not readily distinguished from the sidewalk area due to the surfacing characteristics.

Sidewalks and curb ramps constructed to provide for public pedestrian traffic shall be constructed within public right-of-way or sidewalk easements dedicated for public use.

Unless excluded in the Ordinance or approved by the CORR Transportation Director, sidewalks are required on both sides of the street.

Sidewalk widths shall be as described in Sec. 36-108. – Sidewalks of the City Ordinance, and CORR Standard Detail ST-01.1. The minimum sidewalk width shall be four feet (4’) for local and collector street classifications however, a 5 foot by 5 foot (5’ x 5’) passing space must be provided at 200 foot intervals in accordance with TAS. The minimum width for arterial street classifications (MAD 4 or MAD 6) shall be six feet (6’). Wider sidewalks may be required if a street is to have a shared use path.

Items such as street furniture, signal poles, illumination poles, trees, utilities, and other obstructions shall be located in order to provide the minimum clear width and height per TAS/ADAAG.

With the approval of the CORR Transportation Director, an alternative sidewalk design (such as a hike and bike trail or shared-use path) may be substituted for a conventional sidewalk, provided that maintenance and public access agreements are provided and that they are accessible to persons with disabilities as defined and required in the ADA. Meandering sidewalks are encouraged in order to avoid trees or other natural features, provided that sufficient right-of-way is dedicated to accommodate them.

Sidewalk locations shall be coordinated with the driveway design in order to provide an accessible route across the driveway. The maximum grade of the drive at the accessible route shall be 2% which corresponds to the maximum cross slope of the accessible route.

Sidewalks constructed within TxDOT's ROW shall be as approved by TxDOT.

The width and alignment of sidewalks within the public ROW shall be as shown on the typical sections in Section 1 – Street Design Criteria and Table 1-1. For local residential, local rural and local collector streets, the minimum sidewalk width shall be four feet (4') when separated by a distance of at least three feet (3') from the curb. Sidewalks closer than three feet (3') to the roadway shall be a minimum of five feet (5') in width. If there are ROW limitations and the sidewalk is adjacent to the back of curb, a six foot (6') wide sidewalk shall be used. Variances from these widths and clearances shall be approved by the CORR Transportation Director.

## 4.3 SHARED-USE PATH REQUIREMENTS

City policy is to provide a 10 foot-wide shared use path adjacent to arterial streets and 8 feet adjacent to collector streets. A shared-use path is a physically separated sidewalk from the roadway and may be located either within the street ROW, or outside in a meandering alignment or easement. Shared-use paths may be used by bicyclists and pedestrians and therefore shall meet the design requirements of a bike facility and the ADA/TAS. Minimum width for a two-way facility is ten feet (10'), however an eight foot (8') width may be provided in rare instances, as approved by the CORR Transportation Director.

The path shall include a two foot (2') wide graded area at a maximum slope of 1:6 adjacent to both sides of the path. Three foot horizontal clearance shall be maintained. Refer to Figure 4-1 for a typical section of a shared-use path and CORR Standard Detail ST-01.2.

The shared-use path shall have a minimum vertical clearance of eight feet (8'), however where practical, ten feet (10') should be provided.

Railings, fences or barriers adjacent to a shared-use path shall be a minimum of forty-two inches (42") high.

## 4.4 CURB RAMPS

Sidewalks shall include a curb ramp whenever an accessible route crosses a curb. Ramps shall be constructed in accordance with the CORR Design and Construction Standards (DACS), ADAAG, and TAS. TxDOT Standard Drawings for Pedestrian Facilities include curb ramps for various conditions and shall be included in the construction drawings.

The City Standard for a detectable warning surface is a cast-in-place or surface-mounted panel with truncated domes compliant with TAS Section 705 (Detectable Warnings). Truncated dome panels shall conform to the following ASTM Standards: D 695, D 790, D570, C 1028, E 84, B 117, 1308, C 501, G 155, D 638, C 903 and C1026. Concrete pavers with truncated domes are not allowed due to maintenance requirements. The preferred alignment for new curb ramps is perpendicular to vehicular flow. All curb ramps shall be constructed perpendicular to the curb as shown on the TxDOT Standard Drawings for the various types of curb ramps.

The curb ramp width shall match the width of the adjoining sidewalks or shared use paths to avoid a bottleneck condition as the pedestrian or other user approaches the ramp. In no case shall the curb ramp width be less than forty-eight inches (48”). Curb ramps shall be installed at all street intersections and for every sidewalk connection to the travel surface of a roadway. Curb ramps shall not be required at driveways but may be provided if the driveway is controlled by a traffic signal. At four-way street intersections, a total of eight curb ramps shall be provided (two ramps at each intersection corner). At three-way street intersections, a total of six curb ramps shall be provided (two ramps at each intersection corner, and two ramps on the through street each of which will be across the street from one of the intersection corners). Curb ramps shall typically be “Type 1 Perpendicular Curb Ramp” as shown in TxDOT Design Division Standard “Pedestrian Facilities-Curb Ramps”, sheet 1 of 4. Under special circumstances, curb ramps may be the other types shown in the aforementioned TxDOT Standard. Curb ramp Types 4, 8 and 9 in the aforementioned TxDOT Standard shall not be used unless approved by the CORR Transportation Director.

Curb ramp slopes, widths and landing areas shall be as shown on the Standard Drawings. A five foot by five foot (5’ x 5’) landing area shall be provided at the top of the ramp.

At signalized intersections, the curb ramp location and pedestrian detector locations shall be properly coordinated. Refer to Part IV of the TMUTCD, latest edition.

## 4.5 SAFETY CONSIDERATIONS

Drop-off hazards are defined as steep or abrupt downward slopes that can be perilous to pedestrians and bicyclists. The design engineer should consider shielding any drop-off determined to be a hazard. Railings or fences should be provided for vertical drop-off hazards or where shielding is required as described in this section.

The horizontal clearance for the sidewalk, shared-use path or roadway shall be maintained when designing the railing or fence. Only crash-tested barriers are allowed within the clear zone of roadways.

The following guidelines will be used to standardize the identification and treatment of drop-off hazards for pedestrians and bicyclists.

There are two cases that require shielding. As shown in Figure 4.2 (Case 1), a drop-off greater than ten inches (10") that is closer than two feet (2') from the pedestrians' or bicyclists' pathway or edge of sidewalk is considered a hazard and shall be shielded. Also, as shown in Figure 4.2 (Case 2), a slope steeper than 2H:1V that begins closer than two feet (2') from the pedestrians' or bicyclists' pathway or edge of sidewalk is considered a hazard and shall be shielded when the total drop-off is greater than sixty inches (60"). Also, depending on the depth of the drop-off and severity of the conditions below, shielding may be necessary for cases other than described above.

The height of railings for bicyclists are generally the same as the minimum pedestrian railing height of forty-two inches (42"), except a minimum fifty-four inch (54") railing or fence should be considered on bridges and retaining walls for special circumstances as identified in the commentary of the AASHTO LRFD Bridge Design Specifications Section 13.9.

## 4.6 BICYCLE FACILITIES - GENERAL

The City of Round Rock requires shared-use paths on arterial and collector streets. This section addresses the design of bicycle facilities or bicycle accommodations within the street cross section.

A bicycle lane is defined as a portion of a roadway which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists.

Bicycle paths and shared use paths are physically separated from vehicular traffic and may be shared with pedestrians.

These shared-use paths, which are separate paths used by pedestrians, runners, skaters, wheelchair users, and other non-motorized users, are covered in paragraph 4.3 of this Section.

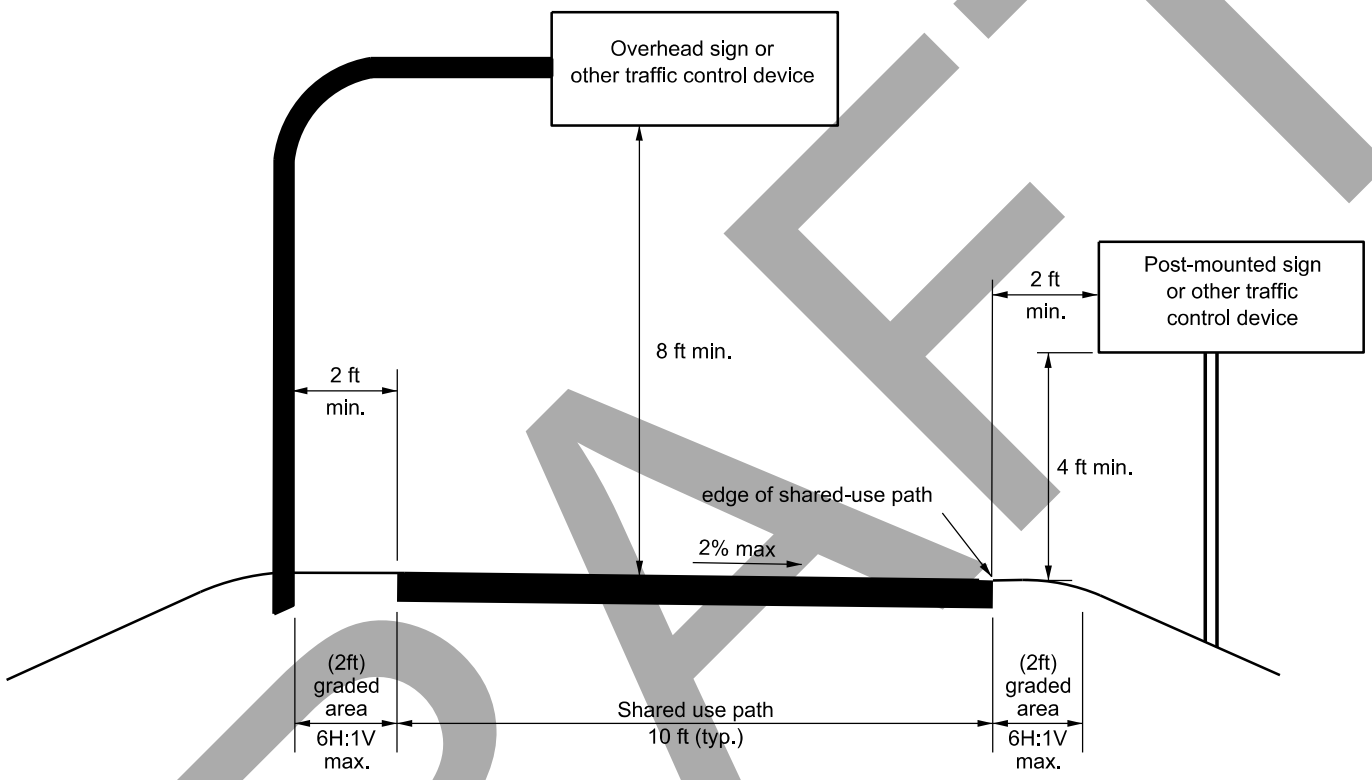
City of Round Rock's preferred option is to provide separate, 10-foot wide (arterial) or 8-foot wide (collector) shared-use paths for arterial and collector streets.

Refer to the typical sections in Section 1 for the configuration of the various classifications of roadway with bike lanes incorporated adjacent to the outside lane.

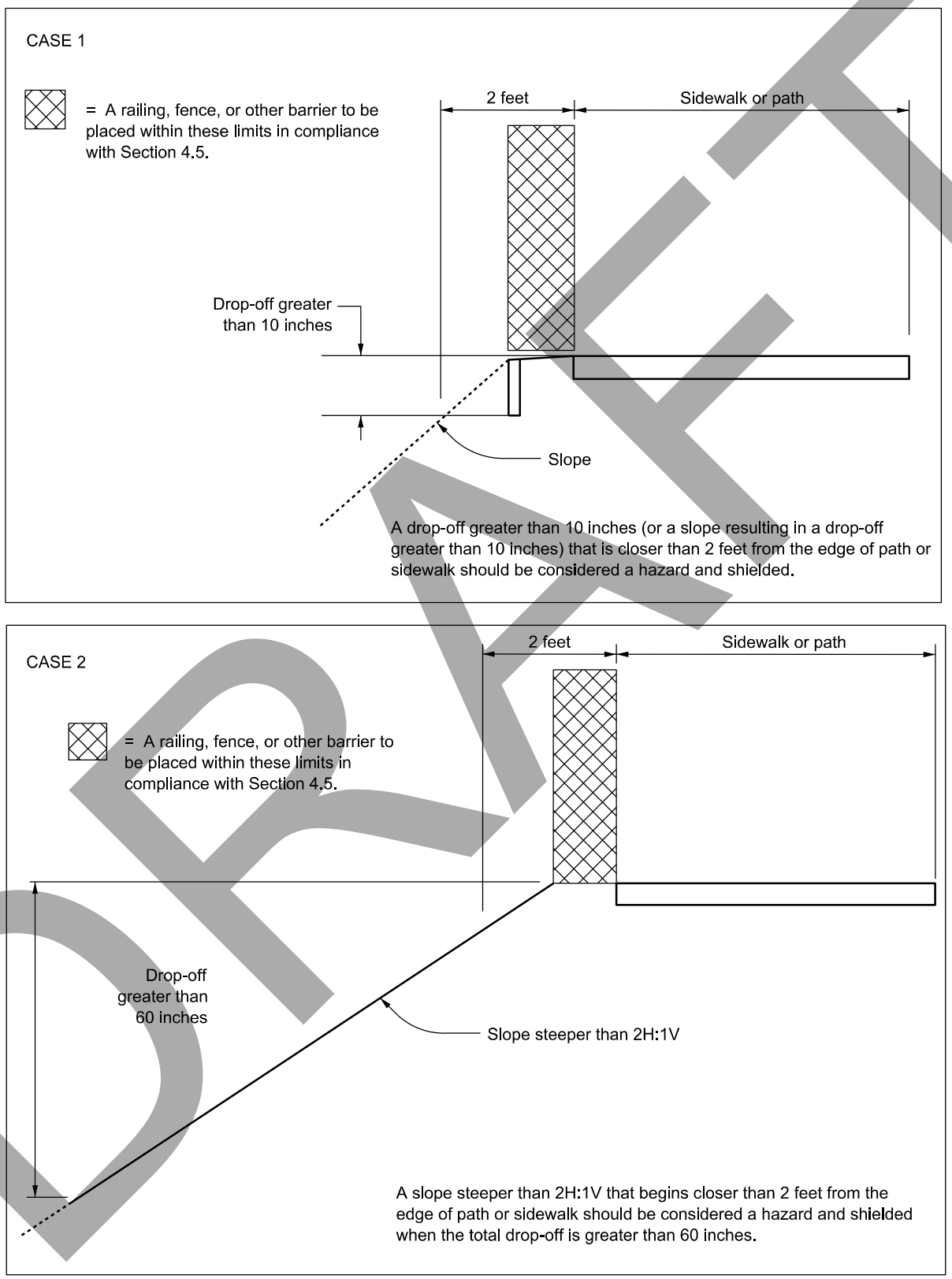
Streets within the City of Round Rock shall incorporate bicycle lanes or a shared-use path in accordance with the City's Trail Master Plan, and Transportation Master Plan. The applicant for a subdivision plat or Planned Unit Development (PUD) is encouraged to coordinate with the City Planning Department concerning bicycle and pedestrian accommodation early in the planning process.

Refer to published design guidance such as AASHTO Guide for the Development of Bicycle Facilities for further information. Another primary design reference for design of bicycle facilities is the National Association of City Transportation Officials (NACTO) Urban Bikeway Design Guide.

# Figure 4-1 Sign Placement on Shared-Use Paths



# Figure 4-2 Drop-Off Hazards for Pedestrians and Bicyclists



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## SECTION 5 – DRIVEWAY DESIGN AND ACCESS MANAGEMENT

### 5.1 GENERAL

The design and location of driveways must balance the need for access to and from an abutting property with the safe, efficient flow of traffic on the adjoining street. This section provides both the design criteria for driveways and the access management policy for driveways that provide access from abutting property to streets and highways within the City of Round Rock.

The number, location, or spacing of driveways may be limited for arterial street classifications to ensure their primary function of mobility. Conversely, the primary function of local streets is to provide access, and therefore driveway spacing is less restrictive.

Site plans submitted to the City for review shall include dimensions, radii, and grades for all proposed driveways.

When a development is located adjacent to a public street, the parking facility must accommodate full internal vehicular circulation and storage. Vehicular circulation must be located completely within the property and vehicles within one portion of the development must have access to all other portions of the same development without using the adjacent street system.

Adequate storage areas must be provided for both inbound and outbound vehicles to facilitate the safe and efficient movement between the street and the development. Inbound vehicle storage areas must be of sufficient size to ensure that vehicles will not obstruct the adjacent street, sidewalk, or circulation within the facility. Outbound vehicle storage areas must be provided to eliminate backup and delay of vehicles within the development.

All site/civil and building plans shall meet the submittal requirements of the City of Round Rock Planning Department and Fire Department. The driveway and fire lane dimensions, percent grades, turning radii and design specifications, including load capacity, shall be clearly identified on the plans. The following criteria shall apply to the design of driveways and fire lanes:

- Thirteen and one-half feet (13’-6”) minimum vertical clearance;
- Existing and proposed traffic patterns of driveways, and/or proposed fire lanes identifying and labeling all physical barriers to vehicular access including, but not limited to, gates, bollards, landscaping and similar items. The driveway and fire lane must provide access to all aspects of the building within one hundred fifty feet (150’) of the fire lane;
- Fire lanes shall have a minimum unobstructed width of twenty feet (20’) for one way traffic, and twenty six feet (26’) for two-way traffic with twenty five feet (25’) inside turning radii and fifty feet (50’) outside turning radii;
- Dead-end fire lanes shall be a maximum length of one hundred fifty feet (150’);
- No grade breaks greater than seven percent (7%); and,
- Driveways and fire lanes shall have all-weather surface during and after construction.

Emergency access drives shall be at least twenty four feet (24’) in width.

These are the primary design criteria for driveway design. The Planning Department, Transportation Department, Fire Department or Transportation Director reserve the right to modify or add design criteria as necessary to enforce the applicable life and fire safety codes during plan review or construction inspection.

## 5.2 TYPES OF DRIVEWAYS

There are three types of driveways used in the City of Round Rock:

### 5.2.1 Type I:

A concrete driveway approach intended to provide vehicular access from a roadway to a lot or parcel of land which is a location for a one (1) or two (2) family residence. Refer to Table 5-1: Type I Driveway Criteria for further information.

### 5.2.2 Type II:

A concrete driveway approach intended to provide vehicular access from a roadway to a lot or parcel of land used for any development or purpose other than one or two family residences. Refer to Table 5-2: Type II Driveway Criteria for further information.

### 5.2.3 Type III:

A temporary asphalt driveway approach intended to provide vehicular access to a lot or parcel of land, such access being from a roadway not yet constructed to permanent lines and grades or a roadway not having curb and gutter. Typically, these driveways will be reconstructed as a Type I or Type II driveway as part of a project that reconstructs the abutting street to permanent line and grade with concrete curb and gutter.

Type III driveways serving one or two-family residences shall be designed using Type I criteria. Type III driveways serving other land uses shall be designed using Type II criteria.

## 5.3 DRIVEWAY DESIGN CRITERIA

Driveways constructed within public ROW shall conform to the following criteria:

A. If a curb inlet is present, the driveway shall be located such that the gutter depression is maintained and ten feet (10') of separation remains between the inlet opening and the driveway.

B. The angle of driveway approach shall be between 80 and 90 degrees for two-way driveways and 60 to 90 degrees for one-way driveways. Under special situations, a driveway angle as acute as 75 degrees will be permitted for two-way driveways.

C. On all streets and alleys where Type I driveways are not appropriate, head-in/back-out parking is generally prohibited. Such a condition requires the approval of the Transportation Director. Other alternatives, however, should be encouraged when possible.

D. All driveways must be constructed within the street frontage of the subject property, as determined by extending the side property lines perpendicular to the curb line. Neither the driveway nor the curb returns shall overlap adjacent property frontage.

E. Joint-use (common) driveways may be approved provided that a permanent, dedicated access easement is obtained. The developer must include a plat note and provide dedication documents indicating that maintenance of the joint-use driveway shall be the responsibility of the lot owners served by the joint-use driveway. If three (3) or more residences are to be served by a single joint-use driveway, the following requirements apply:

1. The developer must post fiscal surety for the construction of the joint-use driveway prior to plat approval and must construct the driveway during the construction of the streets within the same subdivision, or within the term of the fiscal instrument if no public or private streets are to be constructed within the subdivision. The driveway construction shall be subject to City inspection and obtain City approval before the fiscal surety will be released.

2. The developer must construct a driveway that is designed by a Professional Engineer to have an all-weather surface and a pavement structure meeting, at a minimum, the design standards of a private street as defined in the Code of Ordinances. The driveway must be designed to have no more than nine inches (9") of water overtopping the driveway during the one-hundred year storm event as defined in the City of Round Rock Design and Construction Standards Drainage Specifications and the Code of Ordinances, latest editions.

3. The developer must construct a turnaround at the end of the driveway, or no further than two hundred feet (200') from the end of the driveway, meeting City of Round Rock Fire Department Criteria.

4. The developer must obtain, in writing, acknowledgement and approval from the area fire service providers regarding the proposed joint-use driveway.

5. The joint-use access easement will be required to be dedicated as a public utility easement and may be required to be dedicated as a drainage easement, unless otherwise approved by the Transportation Director. In those cases where the joint-use access easement is to be combined as a public utility and drainage easement, the access agreement for the driveway must include a clause indicating that the driveway may be used by public service personnel and equipment for servicing public utilities.

6. If the developer does not use a restrictive covenant to require homeowners to park all vehicles off the joint-use driveway surface, then the joint-use driveway surface must be at least twenty-four (24) feet wide. Otherwise, the driveway surface may be no less than twenty (20) feet wide.

7. The developer must erect signs, approved by the City of Round Rock, indicating "private driveway" at the driveway entrance and include a plat note stipulating that maintenance of the driveway will not be the responsibility of the City.

F. Driveways may not exceed seventy percent (70%) of roadway frontage.

G. All Type II and III driveways on arterial streets shall be designed to align with opposing streets or driveways or be offset by a minimum of two hundred and fifty feet (250', measured from edge to edge).

All Type II and III driveways on collector streets shall be designed to align with opposing streets or driveways or be offset by a minimum of two hundred feet (200', measured from edge to edge).

Alignment of driveways with opposing streets is discouraged for signalized intersections unless approved by the Transportation Director. When such a design is approved, the driveway approach may be constructed without an apron and the maximum driveway widths in Table 5-2 may be increased to match the cross-section of the opposing street.

H. Driveway approaches constructed in public ROW for premises used as a drive-through bank or parking garage shall be as approved by the Transportation Director.

I. The throat lengths in Table 5-2 may be reduced, if approved by the Transportation Director, after considering the following factors:

1. Physical constraints on the site, such as existing structures;
2. The impact upon on-site circulation;
3. Shallow lot depths or unusual lot configurations;
4. Existing or potential traffic movements which are unsafe or which have an adverse effect on traffic operations;
5. Traffic volumes and classification on the driveway and the intersecting street;
6. Alternatives to the proposed design;
7. Other information presented by the applicant; and,
8. For existing sites, the extent of redevelopment proposed.

Throat lengths in excess of those shown in Table 5-2 may be required by the Transportation Director, if justified by the findings of a city-approved TIA or queuing study.

Throat length shall be measured from the ROW line to the point of first conflict within the parking lot on the site.

J. Acceleration/deceleration lanes shall be provided along existing and proposed arterial streets when required by the findings of a city-approved TIA or per Section 1.13 of the Transportation Criteria Manual.

Additional ROW shall be dedicated by plat or separate instrument if required to accommodate acceleration/deceleration lanes or turning lanes.

For commercial and industrial sites, if it is determined that a right-turn deceleration lane is not warranted, a minimum of one driveway shall be designated as a truck delivery access drive and shall meet the minimum turning path for a WB-62 design vehicle, or another appropriate design vehicle as designated by the Transportation Director, without requiring maneuvering outside of the travel lane.

K. Driveway spacing shall conform to the dimensions shown in Tables 5-1 and 5-2. The minimum distance from a cross street to an adjacent driveway shall be fifty feet (50') for residential, one hundred feet (100') for local, two hundred feet (200') for collector and two hundred fifty feet (250') for arterial, measured from the curb line of the cross street to the edge of the nearest driveway, measured at the property line.

L. Site topography, design vehicle characteristics, traffic volume, and site circulation must be considered in the driveway design process. The maximum grade for driveways should be limited to ten percent (10%) for residential driveways and seven percent (7%) for commercial driveways.

The maximum change in grade should be limited to ten percent (10%) for residential driveways and seven percent (7%) for commercial driveways. If excessive grades or grade breaks are used, a tangent length between grade breaks shall be required in order to reduce the possibility of vehicle underbodies striking the pavement surface. Typically, a change in grade of three percent (3%) or less and a distance between grade changes of at least eleven feet (11') accommodates most vehicles.

Where a driveway crosses or adjoins a sidewalk, walkway, or an accessible path of travel, as defined by the ADA, the driveway grade shall not exceed two percent (2%), over a minimum throat length of three feet (3') contiguous with the sidewalk, thereby effectively matching the cross slope of the sidewalk or accessible path of travel across the full width of the driveway.

Driveways adjacent to roadways without sidewalks shall meet these criteria such that an accessible route is provided across the driveway at such time that the sidewalk is constructed.

The City of Round Rock Fire Department shall be consulted when a grade change of greater than seven percent (7%) is proposed.

Driveways shall not include grade breaks which contain a high point that will cause vehicle or trailer 'high centering'.

Abrupt grade changes, which result in vehicles entering and exiting driveways at extremely slow speeds, shall be avoided.

Refer to Figure 5-2, Driveway Profiles, for further information.

M. Channelized islands for limited movement driveways may be utilized, provided that the applicant establishes a maintenance agreement with the City.

Where a sidewalk, walkway, or an accessible route, as defined by the Americans With Disabilities Act, crosses a limited movement driveway island, the sidewalk shall be a minimum of four feet (4') wide across the island and shall provide a continuous, uninterrupted detectable warning at the boundaries between the sidewalks and the driveways.

N. Driveway design and location shall provide safe sight distance for vehicles entering the roadway from the driveway in accordance with Section 1.

O. Existing driveways may be required to conform to the standards in this Manual, including driveway closing, or sidewalk and curb construction where appropriate, as a condition of the approval of any application for zoning, rezoning, or site plan approval.

P. The most common design vehicle for driveways is the Passenger Car (P) and the Single Unit Truck (SU), however if larger vehicles will use the driveway more frequently than four (4) per hour, the larger design vehicle shall be used.

## 5.4 CRITERIA FOR VARIOUS TYPES OF DRIVEWAYS

Table 5-1 and Table 5-2 summarize the design criteria for the various driveway classes.

**TABLE 5-1:**
**TYPE I DRIVEWAY CRITERIA**

| | Minimum | Desirable | Maximum |
|---|---|---|---|
| **SINGLE FAMILY** | | | |
| Width[d] | 12’ | 18’ | 25’ |
| Curb Return Radius | 5’ | 5’ | 10’ |
| Throat Length[a] | | Extended to property ROW line-minimum | |
| Spacing Between Driveways[b] | | Limited to one driveway per property (except where a circular driveway is approved, then the maximum is two) | |
| Distance from Intersecting Street[e] | | 50’ | |
| **DUPLEXES AND TOWNHOMES[c]** | | | |
| Width[d] | 15’ | 18’ | 27’ |
| Throat Length[a] | | (Extended to property R.O.W. line-minimum) | |
| Spacing Between Driveways [b,c] | 10’ | - | - |
| Distance from Intersecting Street[e] | | 50’ | |

[a] Distance from street to first conflict point.

[b] Semicircular driveways acceptable with minimum spacing between driveway entrance and exit of thirty-five feet (35’). (measured from inside edge to inside edge of driveway approach at the property line). Minimum lot width for semicircular drives is one hundred feet (100’).

[c] When two (2) driveways are used (one (1) per unit; two (2) maximum), single family standards for width and curb return radius shall apply. Distances are measured edge to edge.

[d] Driveway width is the width of the paved surface exclusive of curb radii or wings.

[e] Distance from intersection measured edge to edge.

| TABLE 5-2: TYPE II COMMERCIAL DRIVEWAY CRITERIA | | | | | | |
|---|---|---|---|---|---|---|
| | **Roadway Type** | | | | | |
| **Driveway Type** | Local Street | | Collector | | **Arterial** | |
| | **Min.** | **Max.** | **Min.** | **Max.** | **Min.** | **Max.** |
| **ONE WAY** | | | | | | |
| Width | 15'[a] | 20' | 15'[a] | 20' | 18'[a] | 25'[b] |
| Curb Return Radius | 10' | 25' | 15' | 25'[c] | 20' | 30'[c] |
| Throat Length[d] | – | – | 50' | – | 50' | – |
| Distance Between Entry and Exit Drive | 50' | – | 50' | – | 75' | – |
| Driveway Spacing[g] | 100' | – | 200' | – | 250' | – |
| Distance from Intersecting Street[h] | 100' | – | 200' | – | 250' | – |
| **TWO WAY UNDIVIDED** | | | | | | |
| Width | 25' | 40' | 25' | 40' | 30' | 45' |
| Curb Return Radius | 10' | 25' | 15' | 25'[c] | 20' | 30'[c] |
| Throat Length[d] | – | – | 50' | – | 50' | – |
| Driveway Spacing[g] | 100' | – | 200' | – | 250' | – |
| Distance from Intersecting Street[h] | 100' | – | 200' | – | 250' | – |

[a] Greater width may be required for Fire Department emergency access.

[b] Thirty foot (30') minimum width may be required on state highways.

[c] Radius shall be increased to accommodate appropriate design vehicle using full driveway width. Use WB-62 vehicle unless otherwise approved by the Transportation Director.

[d] Distance from the ROW to first conflict point. Provide minimum stated herein unless another value is required by the findings of a City-approved TIA.

[e] Refer to TxDOT Standards for driveways constructed on TxDOT roadways.

[f] When a divided driveway is the fourth leg of an intersection, a thirty-six foot (36') width may be permitted to match the opposing street configuration.

[g] Driveway spacing may be reduced as required due to pre-existing use or developmental conditions, as approved by the Transportation Department.

[h] Distance from intersection measured edge to edge.

| TABLE 5-2 (Continued): TYPE II COMMERCIAL DRIVEWAY CRITERIA | | | | | | |
|---|---|---|---|---|---|---|
| | **Roadway Type** | | | | | |
| **Driveway Type** | **Local Street** | | **Collector** | | **Arterial** | |
| | **Min.** | **Max.** | **Min.** | **Max.** | **Min.** | **Max.** |
| **TWO WAY DIVIDED** | | | | | | |
| Width (each side of median)[e] | 20’ | 24’[f] | 20’ | 24’[f] | 20’ | 30’[f] |
| Curb Return Radius | 15’ | 25’[c] | 15’ | 25’[c] | 20’ | 30’[c] |
| Throat Length[d] | 50’ | – | 50’ | – | 50’ | – |
| Median Width[e] | 4’ | 15’ | 4’ | 15’ | 4’ | 15’ |
| Median Length | 10’ | – | 10’ | – | 20’ | – |
| Driveway Spacing[f,g] | 100’ | – | 200’ | – | 250’ | – |
| Distance from Intersecting Street[h] | 100’ | – | 200’ | – | 250’ | – |

[a] Greater width may be required for Fire Department emergency access.

[b] Thirty foot (30’) minimum width may be required on state highways.

[c] Radius shall be increased to accommodate appropriate design vehicle using full driveway width. Use WB-62 vehicle unless otherwise approved by the Transportation Director.

[d] Distance from the ROW to first conflict point. Provide minimum stated herein unless another value is required by the findings of a city-approved TIA.

[e] Refer to TxDOT standards for driveways constructed on TxDOT roadways.

[f] When a divided driveway is the fourth leg of an intersection, a thirty-six foot (36’) width may be permitted to match the opposing street configuration.

[g] Driveway spacing may be reduced as required due to pre-existing use or developmental conditions, as approved by the Transportation Department.

[h] Distance from intersection measured edge to edge.

## 5.5 DROP-OFF AND TURNAROUND DRIVEWAY TYPES

When a site plan proposes use of a drop-off or turn around type driveway for a commercial use such as drive-through bank, car wash, or school drop-off, the designer shall consider the vehicle queuing length and storage requirements so that the queue does not extend back onto the street impeding free flow of traffic. Depending on the nature of the project, the City may require a TIA or queuing analysis to ensure the site plan design provides adequate storage and internal circulation to mitigate traffic impacts. Refer to Figure 5-1 for further information.

## 5.6 ACCESS MANAGEMENT

### 5.6.1 Access Management for State Highways

Driveway design and location for State Highways within the City limits and extraterritorial jurisdiction is covered by current policy as described in the document: Access Management Manual for State Highways (see Bibliography). The City of Round Rock grants permits for driveways providing access to State Highways.

### 5.6.2 Access Management for City Streets

Single-family lots shall have only one driveway to one abutting roadway, except when a circular driveway is approved by the City.

Single-family, two-family and single-unit townhouse residences are permitted on local streets and local collector streets only. Residential driveways for double frontage lots and corner lots must be located on the lesser classification street. Driveways serving single-family, two-family or single-unit townhouse residences are not permitted on major collectors or arterial streets unless the Transportation Director determines no other access is possible.

Multi-unit townhouse, multi-family and nonresidential driveways are permitted on all streets; however, the driveways must have a minimum of two hundred foot (200') spacing between driveways on arterial streets and from the street centerline at an intersection.

Access to alleys requires approval by the Transportation Director. Access to and from unimproved alleys is not allowed.

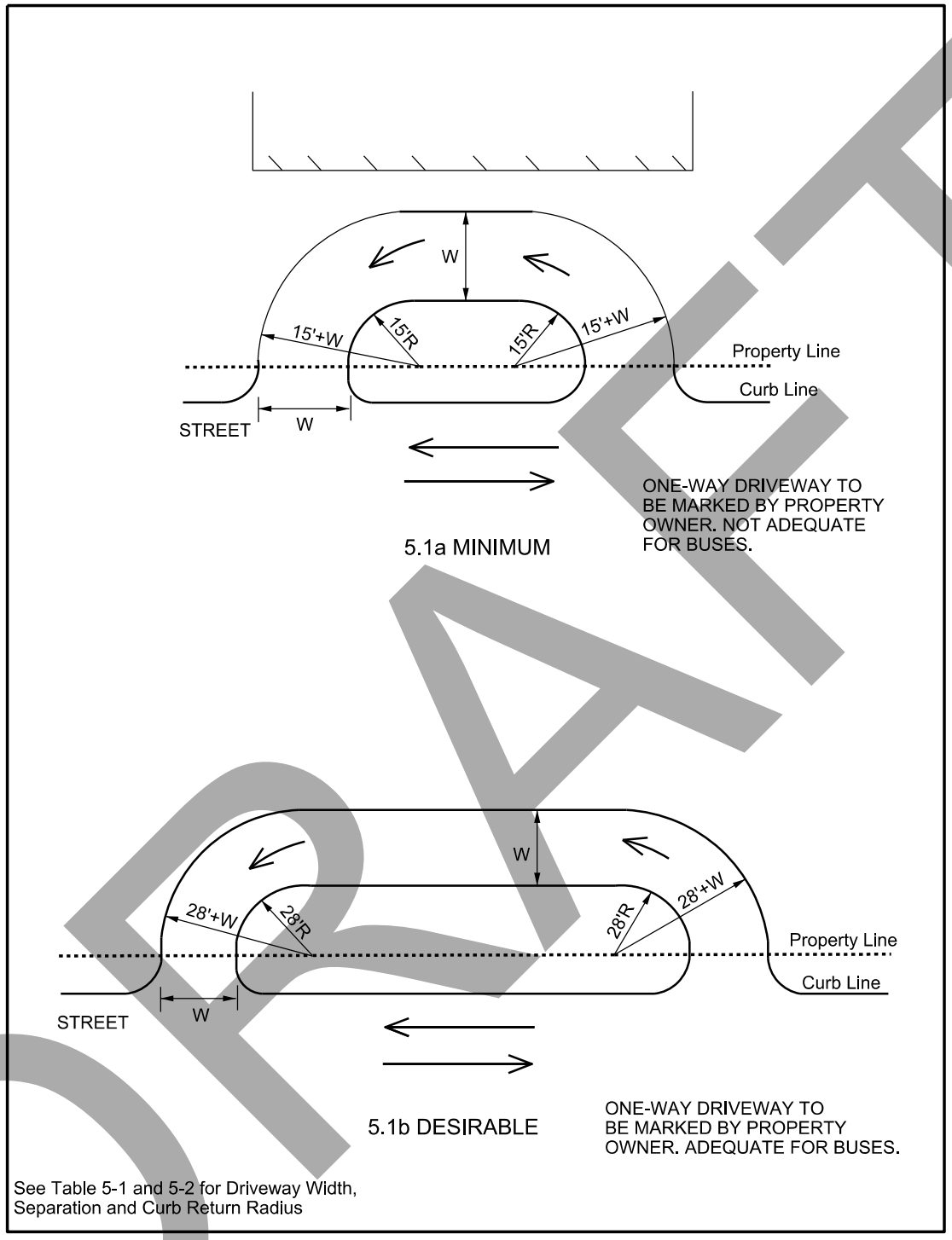
Unless approved by the Transportation Director, one-way driveways shall be prohibited on two-way undivided streets. In addition, one-way driveways are limited to developments where two-way access is unfeasible because of special design considerations, such as severe site constraints, the need for circular drop-offs or other circumstances where one-way circulation may be preferred to two-way access. Examples of such developments include public and private schools, day care uses, car wash facilities and existing developments or small sites where two-way circulation is impractical. Where one-way access is proposed, developments shall be designed to promote one-way, on-site circulation in support of the one-way drives. Circular drop-offs and one-way driveways shall be designed to prevent conflicts with traffic access, parking, on-site circulation and fire lanes. Priority, however, shall be directed towards reducing the number of driveway approaches along principal roadways and arterial streets to limit conflict points and enhance traffic flows along such roadways. All one-way driveways separated by more than fifteen feet (15', measured from inside edge to inside edge) must be signed for one-way operation.

Type I driveways are to be located no closer to the corner of intersecting rights-of-way than sixty percent (60%) of parcel frontage or fifty feet (50'), whichever is less. All other driveways are to be located no closer to the corner of intersecting rights-of-way than

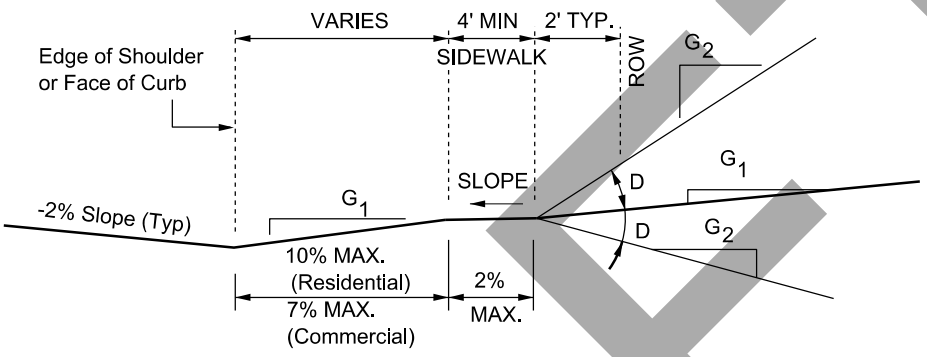
sixty percent (60%) of parcel frontage or one hundred feet (100') for a local road, two hundred feet (200') for a collector and two hundred fifty feet (250') for an arterial; whichever is less. Also, driveways shall not be constructed within the curb return of a street intersection.

It is desirable to minimize the number of driveways on an arterial street to reduce the number of conflict points and facilitate traffic flow. The dimension in Table 5-2 for spacing between driveways should be increased whenever possible so that the number of driveways can be reduced. It is recognized, however, that certain existing tracts may not be able to fully comply with these standards due to limited frontage or other constraints. When compliance with criteria stated in Table 5-2 is precluded due to the location of driveways on adjoining properties, attempts should be made to obtain alternative access where feasible, including joint access driveways, access easements to adjoining properties or access to intersecting streets.

# Figure 5.1 Design Criteria for Semicircular Drop-offs



# Figure 5-2 Driveway Profiles




| DRIVEWAY VOLUME (ADT) | D = GRADE CHANGE | |
|---|---|---|
| | STANDARD | MAXIMUM |
| > 1500 | 0% | 3% |
| 500-1500 | 3% | 7% |
| < 500 | 7% | 15% |

NOTE: THE FIRE DEPARTMENT SHOULD BE CONSULTED WHEN A GRADE CHANGE OF GREATER THAN 7% IS PROPOSED.

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# SECTION 6 – TRAFFIC ENGINEERING

## 6.1 GENERAL

This section covers traffic engineering standards and requirements for the following items:

- Reference standards pertaining to traffic engineering;
- Traffic Control Request Procedures;
- Traffic Control Plans for Construction;
- Signing and Pavement Markings;
- Signalization; and,
- Street Lighting.

## 6.2 REFERENCE STANDARDS

The design and construction of streets and roadways shall be in accordance with this section and the applicable standards and reference documents in order to maintain uniform standards for traffic elements throughout the City. The designer shall refer to City of Round Rock, Texas Department of Transportation or related standards; however, where discrepancies occur, the City of Round Rock Design and Construction Standards (DACS) shall take precedence. The Transportation Director shall make any final determinations, should there be conflicts between the DACS and other referenced standards described herein.

Refer to the bibliography for further information.

## 6.3 TRAFFIC CONTROL REQUEST PROCEDURES

### 6.3.1 Requests for Temporary Traffic Control

Any person wishing to perform any work within the public right-of-way must submit a traffic control plan and obtain the proper permit(s) prior to starting such work.

In order to ensure proper advance planning and coordination, except in emergency situations as noted in the following section, all requests for temporary traffic controls require advance notice be given to the Transportation Department. Written notification shall be given to the City for all temporary traffic control zones. The advance notification requirements depend on the type of street the activity will occupy and the duration of the activity. The following minimum advance notifications are required for all temporary traffic control zones.

In all areas of the City the following notifications requirements shall apply:

<u>Long-term stationary</u> - Work that occupies a location more than three (3) days. Two (2) weeks advance notice for all street types and detours;

Intermediate-term stationary - Work that occupies a location from overnight to three (3) days. Three (3) working days advance notice for Arterial and Collector streets, one (1) working day advance notice for Local streets and two (2) weeks for detours;

Short-term stationary - Daytime work that occupies a location from one (1) to twelve (12) hours. Three (3) working days advance notice for Arterial and Collector streets, one (1) working day advance notice for Local streets and two (2) weeks for detours;

Short Duration - Work that occupies a location up to one (1) hour. Three (3) working days advance notice for Arterial streets, one (1) working day advance notice for Collector and Local streets; or,

Mobile - Work that moves intermittently or continuously. Three (3) working day advance notice for all streets.

When arterial streets are to be completely closed in one or both directions, portable, changeable message signs (PCMS) shall be installed a minimum of one (1) week before the closure to provide advance warning to the public. The size, location and wording shall be determined by the Transportation Director.

For the purpose of this Section, Arterial streets are any street with striping to provide two-lanes or more of traffic in one direction or streets located in the Central Business District. Collector streets are any street connecting two (2) or more arterial streets. All other streets are considered Local streets.

### 6.3.2 Special Events

Special events such as festivals, run/walk, block parties, street fairs, parades, school events, or film industry production, shall be planned for and properly coordinated with the City. Proper temporary traffic control shall be provided for these events. Procedures for special events are as follows:

a. Applicants shall make application to the City of Round Rock as required under the current City of Round Rock Code of Ordinances, using the City's Special Event Permit Application Form. Application shall be made at least 45 days prior to the event, and shall include any required traffic control plan(s) and the application fee;

b. The City's Special Event Coordinator will distribute the application to each City Department and return any comments to the applicant. Any conditions required by the City for approval of the permit shall be noted on the permit;

c. If the event will require a road closure, a Traffic Control Plan prepared by a Professional Engineer licensed in the State of Texas is required and shall be submitted by the applicant and approved by the Transportation Director;

d. Once the Traffic Control Plan is approved by the Transportation Director, the City's Police Department will determine how many officers will be required for the road closures.

e. The applicant is required to hire a Traffic Control company, approved by the City, to implement the Traffic Control Plan for the event. All traffic control devices shall be in accordance with the approved Traffic Control Plan and TMUTCD, latest edition.

f. The applicant is responsible for all costs associated with the Traffic Control Plan, including overtime costs for the Police Officers..

The applicant shall identify the proposed location of parking areas and the number of spaces provided for the event.

The organization or individual responsible for the special event, block party, or parade shall adhere to the requirements of the applicable City of Round Rock Ordinance.

## 6.4 TRAFFIC CONTROL PLANS FOR CONSTRUCTION

### 6.4.1 General – Reference checklists as necessary

Temporary traffic control for construction activities on public right-of-way shall be in accordance with the TMUTCD and the guidelines contained within this manual.

A Traffic Control Plan (TCP) describes temporary traffic controls to be used for facilitating vehicle and pedestrian traffic through a temporary traffic control zone. The TCP may range in scope from being very detailed, to merely referencing typical drawings contained in the TMUTCD, TxDOT Standard Drawings, or specific drawings contained in the contract documents. For more complex projects, then a narrative of work shall be provided as well as phasing. The degree of detail in the TCP depends entirely on the complexity of the situation, and TCPs shall be prepared by a Professional Engineer knowledgeable about the fundamental principles of temporary traffic control and the work activities to be performed.

If a traffic setup shown on standard detail sheets does not address the traffic controls needed for a specific site, then a TCP shall be prepared that is specific to the site. A standard detail or TCP which shows the proposed method of warning, directing and guiding traffic, shall be approved by the Transportation Director, prior to installing any devices on the right-of-way. The following information shall be provided with the standard detail or TCP:

a. Activity location, right-of-way and curb-lines, and existing traffic controls of the street sought to be closed or blocked;

b. Areas of the street to be closed or blocked;

c. Proposed pedestrian and vehicular detour routes;

d. Location and type of all barricades, signals, signs, channelizing devices, pavement markings and other warning devices to be used to direct traffic; and,

e. A schedule of construction showing each phase of work, start and completion dates for each phase, and proposed work hours.

Plans which propose to detour traffic to another roadway shall demonstrate that such impacts cannot be reasonably avoided and that impacts to the detour route have been mitigated to the extent practicable. Impacts to the detour route shall be evaluated including, without limitation, intersection level of service, traffic speed and volume in residential neighborhoods and school zones, and impacts to all modes of transportation.

All Traffic Control Plans necessary for maintenance of traffic during construction shall be prepared in accordance with the latest edition of the Texas Manual on Uniform Traffic Control, Part VI (TMUTCD) and the TxDOT Standard Drawings.

### 6.4.2 Time Restrictions

The Transportation Director or their designee may restrict the hours of construction, repair or other activities affecting the free flow of traffic to nights, weekends or restricted hours due to potential congestion, other construction activities, hazards to pedestrians or motorists, etc..

Daily lane closures on arterial roadways shall not be permitted during the hours of 6:00 a.m. to 9:00 a.m. and 4:00 p.m. to 7:00 p.m. Monday through Friday, except in emergencies or situations where it can be demonstrated that traffic flow or safety will not be adversely affected.

### 6.4.3 Special Requirements

The Transportation Director or their designee may require that any of the following special traffic control devices, working hours, project layout and operations be imposed on any temporary traffic control zone:

a. The use of additional barricades, signals, signs, flaggers, police officers or other traffic control devices or safety procedures;

b. That the activity be performed only at certain hours during the day or night or during specified days of the week, month or year;

c. That only a specified area or not more than a specified number of traffic lanes, parking meters and/or parking lanes shall be blocked or closed at the same time or at specified times of day;

d. That material and equipment used in the activity and materials removed from any excavation be located other than in the vehicle traffic lane of such a street; and

e. Any other restrictions deemed necessary to ensure management of the rights-of-ways and the free flow of vehicular, bicycle and pedestrian traffic.

Any changes in the plan shall be approved by the Transportation Director, or their designated representative, in advance of the change in accordance with the Contract Documents governing the construction project.

### 6.4.4 Pedestrian Accommodation

Pedestrians shall be provided with a safe, convenient travel path that replicates as nearly as possible the most desirable characteristics of sidewalks. Every effort shall be made to separate pedestrian movement from both work site activity and adjacent traffic. Whenever possible, signing should be used to direct pedestrians to safe street crossings in advance of an encounter with a temporary traffic control zone. Signs should be placed at intersections so that pedestrians, particularly in high-traffic-volume areas, are not confronted with mid-block work sites that will induce them to skirt the temporary traffic control zone or make a mid-block crossing. All pedestrian passageways or routes shall comply with the requirements of an accessible route in accordance with the ADA. A covered temporary walkway shall be used in areas where pedestrians are in proximity to overhead construction.

Plans which require the closure of sidewalks or shared-use paths shall incorporate the necessary barricades, signs and other measures as needed to ensure the safety of pedestrians and bicyclists. The closure of sidewalks, bike lanes, and shared-use paths will be allowed only if impacts cannot be avoided through alternative construction methods. The detour route must be of similar width and surface type to the permanent facility, and shall meet the requirements of an accessible route in accordance with the ADA.

### 6.4.5 Access Requirements

Local access shall be maintained to all properties on all streets during construction and maintenance activities. The TCP shall provide for access to all sidewalks, business and residence entryways and driveways. If access cannot be maintained, the contractor, utility, department or supervisor shall notify the affected property owner, resident or tenant a minimum of one (1) week in advance of the pending work unless the work is of an emergency nature. Access shall, in all cases, be restored as soon as possible. To ensure this, the contractor or work crew shall only perform the work affecting the restricted access areas while access is not maintained.

Access to fire stations, hospitals, EMS facilities and police stations shall be maintained at all times. If work activities require some access restrictions or access cannot be maintained, the contractor or work crew shall provide a minimum of two (2) weeks notice, to the affected emergency service facility prior to commencing the work, unless the work is of an emergency nature.

Access to schools shall be maintained at all times. If work activities require access restrictions in the proximity of a school, the contractor or work crew shall provide a minimum of two (2) weeks notice, to the affected school facility prior to commencing the work. Contractor shall refer to Section 6.4.4 of this Manual for safe pedestrian accommodation for work areas in proximity of schools.

For emergencies, the contractor, utility, department or supervisor shall notify the occupant of the emergency service facility of the need to restrict their access and shall as soon as possible restore access to the property with steel plates or temporary pavement repairs.

### 6.4.6 Traffic Control Requirements During Construction

It is the responsibility of the permit-holder for private activities or the job supervisor for public projects to ensure that all policies, procedures and requirements set forth in this Manual and the TMUTCD are met. Each work site shall have a designated English speaking competent person responsible and available on the project site or in the immediate area to ensure compliance with the traffic control plan and the provisions of this Manual. The competent person shall be required to demonstrate sufficient training in traffic control and competency in setting traffic control devices. Training Certificates shall be provided to the Transportation Services Department prior to setting any traffic control devices. Training certificates for competent persons shall be good for four (4) years from the date of training. After such time the competent person must show that additional training or re-certification has been achieved in order to maintain competent person status. The City reserves the right to request replacement of the competent person who continually fail to demonstrate competence in setting temporary traffic controls.

Failure or refusal to comply with the provisions of this manual and/or those set by the Transportation Director or their designee shall be unlawful and grounds for suspension or revocation of the permit for the work or activity.

A permit holder or owner shall comply with each provision of this Manual, and any other rule or regulation adopted by the Transportation Director. No activity may take place in the rights-of-way without first obtaining a proper permit. All un-permitted activity in the rights-of-way will be halted, and work may not resume until a proper permit is obtained.

A permit holder or owner who repeatedly fails to comply with the following:

1) a permit provision;

2) a provision of this manual;

3) traffic control plans and specifications;

4) a traffic control device inspection report; or

5) commits a violation that may negatively impact a person's safety and welfare may be suspended from work for a period not to exceed four (4) work days.

A suspended permit holder or owner shall halt all worksite activity immediately upon receipt of the order from the Transportation Director or their designee. The permit holder or owner is directed to remedy any immediate hazards to public safety and welfare, and may be allowed to correct the deficiency that caused the suspension. The suspension period will not commence until all the violations are addressed to the satisfaction of the Transportation Director or their designee.

Any activity occurring within the public right-of-way, for which a valid permit cannot be produced on the site, shall be halted immediately. Work shall not resume until a permit has been produced or issued.

Notice of noncompliance shall be made on Traffic Control Device Inspection Reports and shall be issued on site to the job site supervisor, foreman or crew leader.

### 6.4.7 Steel Plates

Where traffic must cross trenches, the Contractor shall provide suitable bridges. For trenches less than 18 inches (18”) in width, sheet steel plates having a minimum thickness of three-quarter inches (¾”) shall be used. For trench widths from twenty-four inches (24”) to seventy-two inches (72”), sheet steel plates having a minimum thickness of one inch (1”) shall be used.

The thickness of plates for trench widths exceeding seventy-two inches (72”) shall be established in an analysis completed by a Licensed Professional Engineer registered in the State of Texas.

The sheet steel plating will be installed in a "surface placement" configuration with an asphalt taper on all sides. Long term stationary installations and/or plating installations in high-trafficked portions of roads/streets shall include consideration of "flush placement" of the plates (i.e. milling of the pavement surface is undertaken to insure that the top-of-plate elevations essentially match the existing elevations of adjacent pavement surfaces) to minimize the impact on vehicular traffic.

In either installation configuration, the sheet steel plates shall extend beyond the edge of the trench a minimum of eighteen inches (18”) but no more than thirty

inches (30”) on both sides. Transition ramping shall be provided for all "surface placement" configurations by the installation of cold mix asphalt on all sides.

For safe traverse of plating installations during the term of service, the top surface of the installed plates shall be flat and free of any clips, chains, attachments, weldments or surface irregularities.

When the plate dimension in the direction of traffic flow exceeds six feet (6’), a non-skid coating, approved by the Transportation Director or their designated representative, shall be applied to the entire surface area of all plates.

Additional methods of securing plates may be required depending on field conditions. The contractor should avoid using a long series of plates that run parallel to traffic wheel paths. If allowed, the length of a series of plates that run parallel to traffic wheel paths shall not exceed thirty feet (30’).

The use of steel plates shall be approved by the Transportation Director prior to construction.

## 6.5 SIGNING AND PAVEMENT MARKINGS

### 6.5.1 Signing

All signing shall be designed and installed in accordance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD) and Standard Highway Sign Designs for Texas (SHSD), latest editions.

The construction plans for public streets shall include the following information:

- Location, size, and designation for all required signs;
- Type of sign mount;
- Sign details for non-standard signs;
- Provision for street name signs i.e. sign brackets on STOP signs;
- Standard details for applicable sign types; and,
- Quantities and specifications.

All new projects shall include standard street name signs on public streets. These must conform to the TMUTCD.

### 6.5.2 Pavement Markings

All pavement markings shall be designed and installed in accordance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

The construction plans for public streets shall include the following information:

- Type of pavement marking, size, color, and alignment for each marking;
- Spacing and lane widths;

- Raised pavement markings type, color, and spacing, if used on the project;
- Detail dimensions for crosswalks, lane tapers, etc;
- Standard details for pavement markings; and,
- Quantities and specifications.

## 6.6 SIGNALIZATION

Traffic signal warrants will need to be satisfied prior to installation of new traffic signals and/or removal of existing traffic signals. Traffic signal warrants shall be prepared in accordance with the latest edition of Texas Manual on Uniform Traffic Control Devices (TMUTCD) and submitted to the City for approval.

Mast arm signal poles shall be used for all permanent locations. Timber pole shall be used for only temporary signal poles.

Traffic signals shall be designed and installed in accordance with the latest edition of TMUTCD and City of Round Rock standards and specifications. TxDOT signal standard and specifications may be used, where City standards and specifications are not available.

Prior to designing a traffic signal, the Applicant will schedule a pre-design meeting with the Transportation Director and City's traffic signal staff to discuss the design requirements. The items to be discussed shall include, but not be limited to, the following:

- Type of signal pole (mast arm, span wire, or special poles)
- Type of detection (loop, camera, microwave, etc)
- Signal heads and back plates (color, material, etc.)
- Type of signal controller and cabinet
- Ground box type and size
- Illumination on signal poles
- Pedestrian elements (regular, accessible, count down, etc.)
- Curb ramps (shall be ADA compliant)
- Power source and location
- Connectivity to adjacent signals (fiber optic, radio, etc.)
- Pre-emption (emergency vehicles or rail)
- Signal specifications (City, TxDOT, or both)
- Other special requirements from the City (specific signal equipment product, agreements, etc.)
- Submission requirements (number of submittals to be determined by City depending on nature and size of project, plan size: 11"x17" or full size)

The design plans will be prepared by a professional engineer with experience in signal design and will include the following construction plans as a minimum:

- Title Sheet (include project location map)

- Existing Intersection Layout (include all existing utilities)
- Proposed Intersection Layout (required if intersection is modified to include pedestrian ramps, pavement marking, signing, addition of lanes, utility, etc.)
- Proposed Signal Layout
- Street name signs, signal phasing diagram, signs on mast arms and push buttons
- Wiring diagram
- Conductor conduit schedule
- Signal elevation sheet
- Signal interconnect details, if required
- Signal foundation design and details
- Signal general notes
- Signal quantities
- Signal standards (include all applicable standards)
- Traffic control plans, if required

## 6.7 STREET LIGHTING

Street lights in the City of Round Rock are typically owned and operated by Oncor Electric Delivery. Confirm utility company service areas prior to start of design.

The Developer of a new street within the City shall furnish and install street lighting along all streets including cul-de-sacs and at all intersections. The street lighting construction requirements shall be in conformance with the City of Round Rock Design and Construction Standards (DACS) and Oncor Electric Delivery Standard Details and Specifications, available from Oncor.

Provide new, unused materials. Luminaires, foundations, ground boxes, and conduit materials and installation methods shall comply with the applicable articles of the National Electrical Code (NEC), CORR DACS, Oncor, National Electrical Manufacturers Association (NEMA), and are listed by Underwriters Laboratories (UL), and the American Association of the State Highway and Transportation Officials (AASHTO) criteria.

An illumination plan for all streets within the Plat shall be filed with the Construction Plans. The plan shall show the proposed location of the street lights and any electrical facilities, including service locations, within the street ROW or public utility easements. The illumination plans shall include a photometric layout and appropriate calculations to demonstrate that the design criteria in this section have been met. See example photometric layouts at the end of this section.

The street lighting facilities shall be complete and operational prior to acceptance of the Public Improvements.

The proposed streetlight design shall be as approved by the Transportation Director, the Transportation Engineer, and Oncor Electric Delivery or other electric utility company, if not Oncor.

Streetlights shall be provided at or near intersections and at or near the end of cul-de-sacs. Luminaires shall be provided as part of the traffic signal pole assembly for signalized intersections.

The clear distance measured from the back of curb to the face of the pole/face of drill shaft foundation shall be as detailed in the City of Round Rock Standard Construction Details.

The City must obtain the approval of TxDOT for all lighting systems to be installed on state facilities. Such installations must be in accordance with municipal maintenance agreements and TxDOT CAD Standards and Specifications. Any agreement between the City and TxDOT for lighting must be accompanied by an ordinance, passed by City Council.

All poles shall be identical along an entire continuous street or throughout a subdivision with public roadways.

The City is in the process of converting to LED luminaires. LED fixtures shall be equivalent to high pressure sodium (HPS) bulbs.

Basis of Design:

Street light wattage and spacing for the roadway classifications are summarized below and shall be used as the basis of design. The photometric analysis and layout shall be submitted and approved by the Transportation Director prior to finalizing the street lighting design.

**Table 6-1: Street Lighting Spacing and Heights**

| Road Classification (1) | Wattage | Luminaire Height (ft) | Maximum Spacing Allowed |
|---|---|---|---|
| Local | 100 | 25 | 300 |
| Collector | 150 | 30 | 300 |
| Arterial | 250 | 30 | 250 |

Notes:
1. See Transportation Criteria Manual and Transportation Master Plan for additional information.

Street Illumination Requirements:

All illumination shall be designed in accordance with the latest requirements of the Illuminating Engineering Society of North America: “American National Standards Practice for Roadway Lighting”.

The following table provides the minimum design criteria for illumination and uniformity ratio for all streets:

| Table 6-2: Street Lighting Design Criteria | | | | |
|---|---|---|---|---|
| | RESIDENTIAL | | COMMERCIAL/ INDUSTRIAL | |
| **Roadway Classification (1)** | **Minimum Maintained Foot-Candles** | **Uniformity Average to Minimum** | **Minimum Maintained Foot-Candles** | **Uniformity Average to Minimum** |
| Local | 0.2 | 6:1 | 0.6 | 3:1 |
| Collector | 0.4 | 4:1 | 0.9 | 3:1 |
| Arterial | 0.6 | 4:1 | 1.2 | 3:1 |

Notes:

1. See Transportation Criteria Manual and Transportation Master Plan for additional information.
2. Commercial/Industrial – characterized by heavy vehicular and pedestrian traffic and heavy demand for parking during peak periods. This includes densely developed apartment areas, hospitals, civic facilities, and neighborhood recreational centers. Residential – includes residential development, or a mixture of residential and commercial characterized by few pedestrians and low parking demand at night. This includes single family homes, townhouses, small apartments, and regional parks.

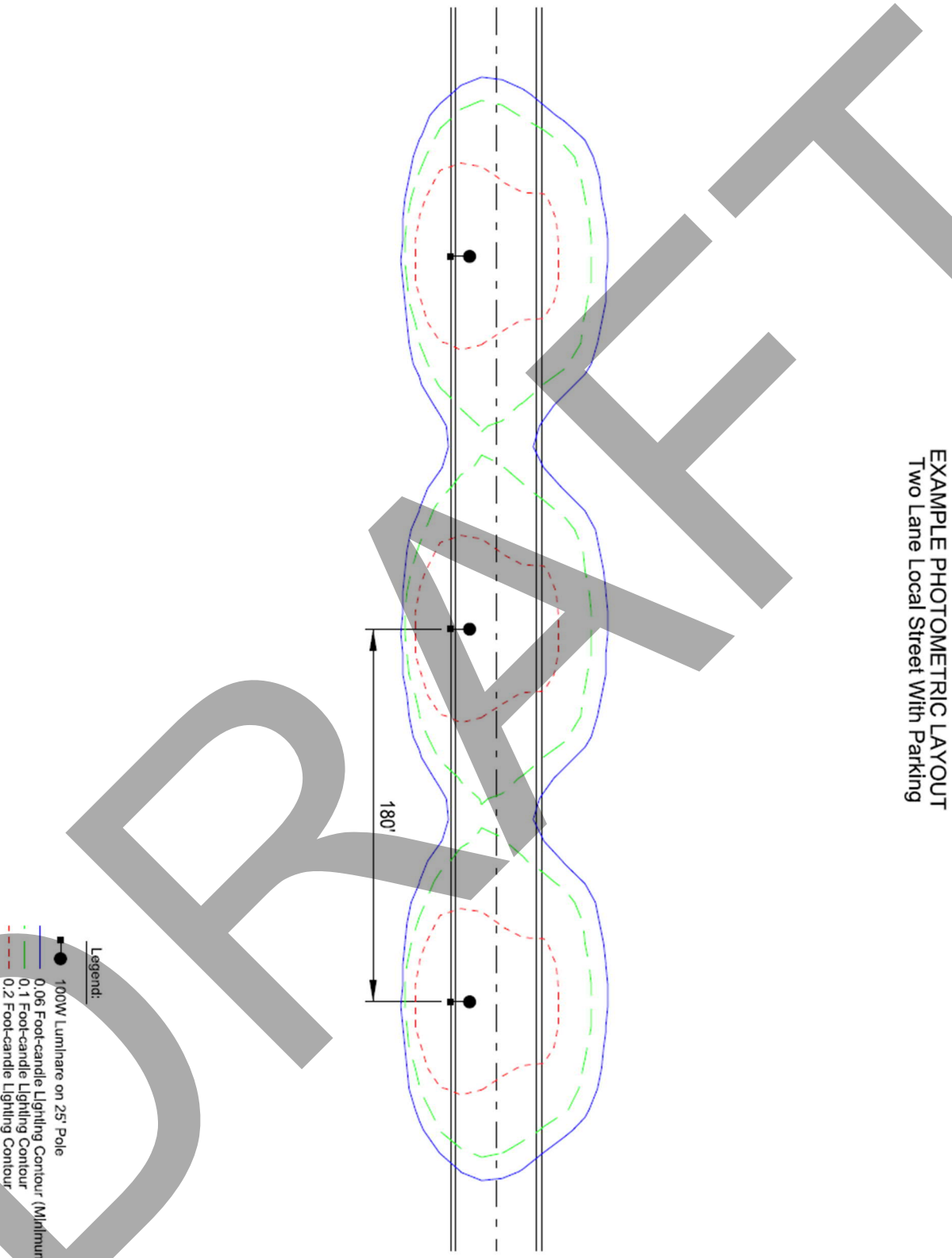


Figure 6-1: Example Photometric Layout – Local Roadway

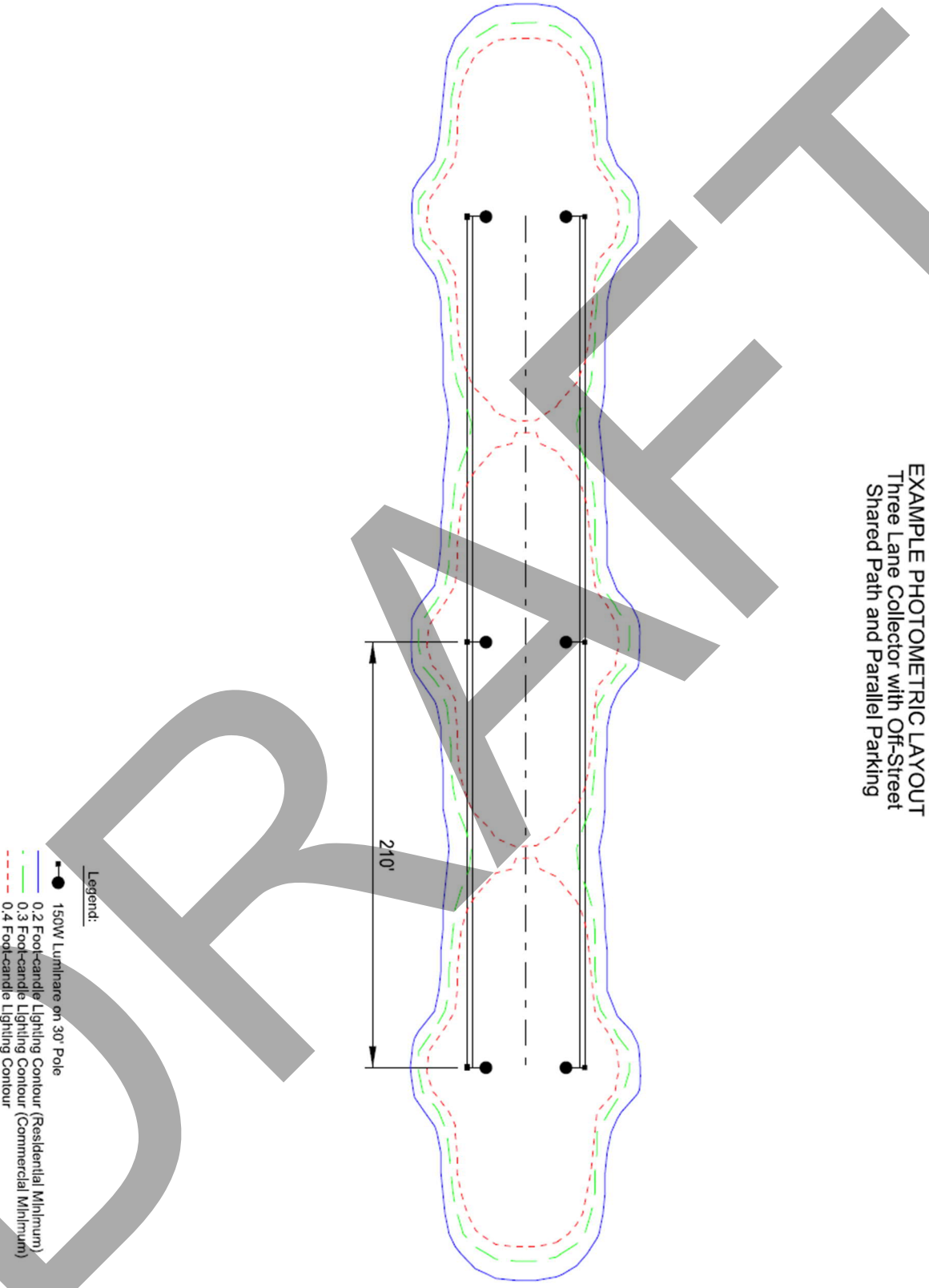




Figure 6-2: Example Photometric Layout – Collector Roadway

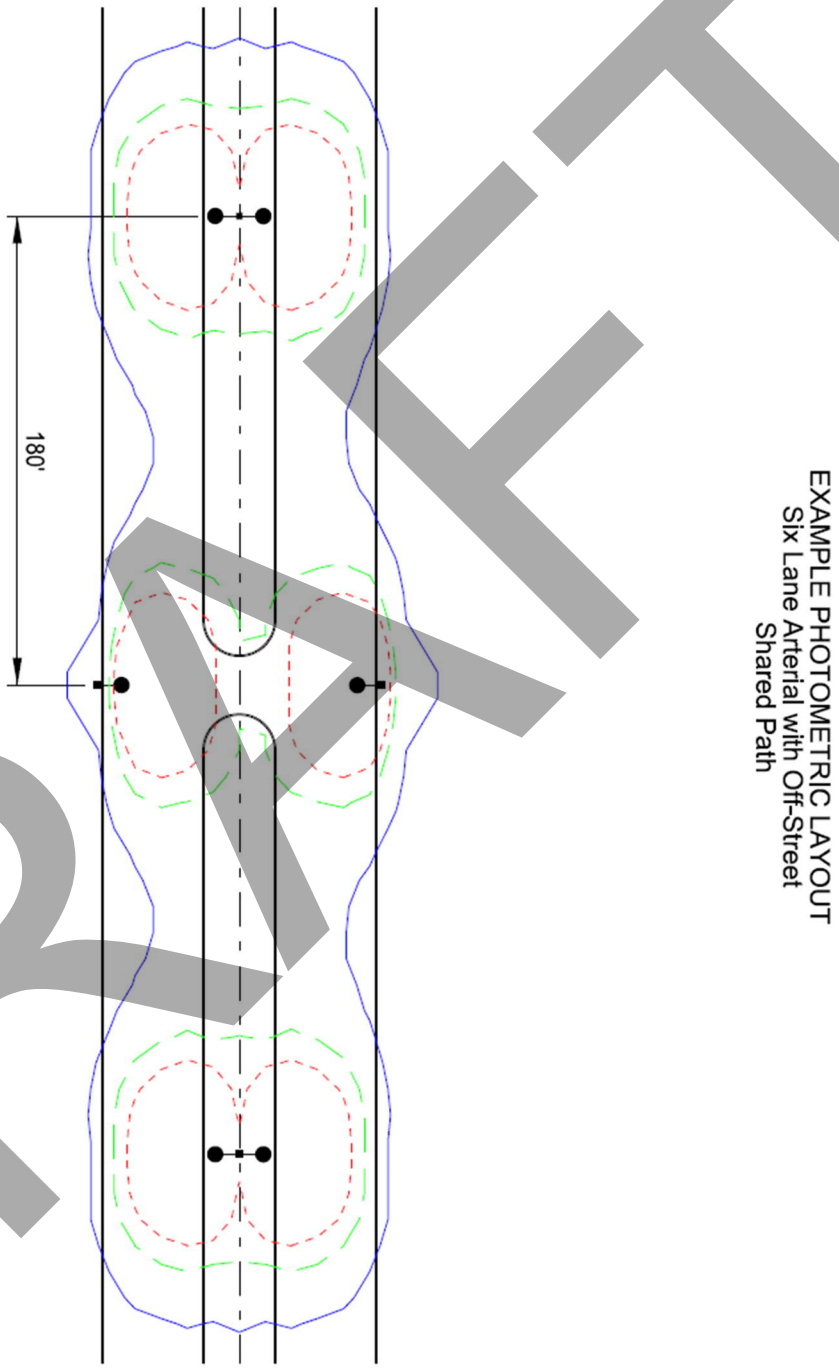




Figure 6-3: Example Photometric Layout – Arterial Roadway

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# SECTION 7 – STRUCTURES IN THE RIGHT OF WAY AND IN EASEMENTS

## 7.1 GENERAL

This section presents the structural design criteria for culverts, retaining walls, and bridges to be constructed in the ROW and easements.

## 7.2 ABBREVIATIONS

The following abbreviations are used in this section. Refer to the Glossary for a complete list of terms used in the Manual.

AASHTO: American Association of State Highway and Transportation Officials

AREMA: American Railway Engineering and Maintenance-of-Way Association

ACI: American Concrete Institute

ASTM: American Society for Testing and Materials

FHWA: Federal Highway Administration

MSE: Mechanically Stabilized Earth (Retaining Walls)

NCMA: National Concrete Masonry Association

## 7.3 CULVERTS

This section addresses the design criteria for off-site, cross drainage structures. Refer to the City of Round Rock Design and Construction Standards: Drainage Criteria Manual for further information regarding culvert hydraulics and storm sewer design.

Culverts may be precast or cast-in-place construction, and shall be constructed in accordance with the City of Round Rock Standard Specifications. Usual practice is to provide for either (alternate) precast or cast-in-place details in the contract documents. All culverts shall be designed according to the latest edition of AASHTO *LRFD Bridge Design Specifications* and HL 93 Loading. When approved by the Transportation Director, culverts may be designed and constructed in accordance with TxDOT Specifications and Standard Details.

Culvert layouts for cross drainage structures in the public ROW or easements shall be approved by the Transportation Director / Transportation Engineer. The culvert length shall be sufficient to accommodate the ultimate roadway configuration, sidewalk, shared-use path, necessary grading, utilities and railings or barriers.

Protect the ends of bridge-class pipe and box culverts by providing, in order of preference, safety end treatments, metal beam guard fence, or bridge railing.

## 7.4 RETAINING WALLS

### 7.4.1 Definitions

7.4.1.1 Conditional / Incomplete Design

In a “conditional design”, the designer defers essential elements of the design to another entity i.e. wall fabricator or Contractor’s Engineer. An example of conditional design is one in which, by a note on the drawings, the designer makes the Contractor responsible for determining whether the subsurface materials will support the applied wall footing loads. An “incomplete” design does not address all of the requirements in this section. An example of incomplete design is one in which the designer checks only global wall stability, and the internal stability of the particular wall system becomes the responsibility of the wall system manufacturer.

7.4.1.2 Excavation / Backfill Zone

The excavation / backfill zone of a utility is the wedge-shaped area above the utility formed by two inclined planar surfaces, one on each side of the utility, sloping upward at a forty five degree (45°) angle (1:1 slope) from the outermost edge of the utility to the ground surface. No retaining structure is required to retain the inclined surfaces as long as a 1:1 slope is maintained.

7.4.1.3 Fascia Wall

A fascia wall is constructed over the face of a stable slope or wall to enhance its appearance or to protect the slope from degradation due to weathering. The slope may be stable naturally or may be made stable by soil or rock nailing, tiebacks, drilled shafts, soldier piles or other forms of reinforcement. Fascia walls do not contribute to the overall stability of the slope.

7.4.1.4 Retaining Wall

A retaining wall is a structure used to support a soil or rock embankment or slope in a vertical or near-vertical configuration in which it would otherwise be unstable because of gravitational forces or applied loads.

7.4.1.5 Standard Retaining Wall

A standard retaining wall is a free-standing, cantilever or counterfort wall consisting of cast-in-place, reinforced concrete design according to the latest edition of the AASHTO LRFD Bridge Design Specifications.

7.4.1.6 Non-Standard Retaining Wall

A non-standard retaining wall is any wall not meeting the definition of a standard wall.

7.4.1.7 Wall Systems

Wall systems are described as retaining walls whose performance relies on multiple components acting together as an integral unit. Examples are MSE retaining walls or walls with underdrains, filter media and porous backfill.

7.4.1.8 Mechanically Stabilized Earth (MSE) Retaining Wall

An MSE retaining wall is a proprietary wall system composed of facing units (panels) and metal strips or geosynthetic (geogrid) reinforcement connecting to the facing units and extending behind the wall into special backfill. The internal and external stability of these walls depends on the interaction of the facing units, strips or geogrid, and backfill, acting as a system.

7.4.1.9 Soil or Rock Nail

Nailing is the reinforcement of slopes by installing anchors in horizontal or near-horizontal, pre-drilled holes in the soil or rock, usually followed by shotcreting of the slope face and installation of a cast-in-place concrete closure pour and a fascia wall.

7.4.1.10 Product-Specific Information

Product-specific information describes the behavior, performance characteristics or qualities of a material or interacting materials or components and is based on results of standardized tests.

7.4.1.11 Utility Assignments

Utility Assignments refers to the pre-assigned horizontal and vertical position of the utilities in the street ROW or easement.

7.4.1.12 Wall Height

Wall height is the vertical distance from the bottom of the footing, leveling pad or lowest structural component, to the top of the wall.

### 7.4.2 Use of Standard / Non-Standard Walls

Any standard retaining walls or wall systems in the street ROW or easements shall meet the requirements in this Section. Non-standard walls may be considered on a case-by-case basis and shall be approved by the Transportation Director.

### 7.4.3 General Requirements

Retaining walls, regardless of type, over 3' in height, must be designed by a Professional Engineer licensed in the State of Texas. Retaining walls must be constructed in accordance with TxDOT Standard Specifications. Alternatively, when approved by the Transportation Director, TxDOT Standard Specifications and Standard Drawings shall be used. Walls for which there are no published, nationally recognized, design criteria or for which there are no standard materials or test specifications will not be permitted.

Conditional or incomplete designs will only be accepted if, in the opinion of the Transportation Director, the wall system relies on proprietary manufacturer information, and the Contract Documents clearly state how the Contractor is to furnish a complete wall design for review and approval prior to constructing the wall system.

Retaining walls must be designed for global (external) stability and internal stability. The design must include, as appropriate, the effects of utilities, floodwater inundation and rapid drawdown, detention/retention, hydrostatic pressures, internal erosion, settlement, alteration of site conditions over time, behavior of foundation and backfill materials. The walls must be designed to support, where applicable, surcharge loads from traffic.

Walls consisting of pre-cast segmental units, whether these units are facing or structural elements, must have a coping or capstone at the top of the wall. The coping may be pre-cast or cast-in-place. The coping or capstone must extend above the adjacent ground at least 4 inches. Precast or cast-in-place coping shall contain reinforcing steel. Coping shall be affixed to the upper layer of the wall using epoxy, non-shrink grout or as recommended by the wall manufacturer.

Walls constructed using flexible facing elements, such as welded or woven wire, will be permitted only in drainage channel applications and not supporting roadway embankments. Metal prefabricated modular walls will not be permitted.

Where retaining walls are used as the exterior walls in stormwater detention structures, the walls must be cast-in-place reinforced concrete made watertight by using water stops in joints and using underdrains behind the walls. Where retaining walls are used as the exterior walls in stormwater detentions structures and the walls are not watertight, then the walls must be designed to provide free drainage of the backfill following drawdown.

### 7.4.4 Geotechnical Information

The design engineer shall furnish to the City for review a geotechnical report including the results of the field investigation, soil borings, design parameters, recommended wall type, and construction recommendations. The report shall include backfill requirements and parameters, factor of safety calculations,

underdrain recommendations, and predicted long-term performance of the system. The design engineer shall refer to TxDOT standards for boring locations.

### 7.4.5 Wall Location and Layout

The Transportation Director shall approve all wall locations, types, and heights for walls to be constructed in public ROW or easements.

The City will assume maintenance responsibility only for those walls in the public ROW or easement that support roadway embankment, cut slopes that require a wall for stability, or channel slopes in drainage easements.

Retaining walls that are located in the public ROW and which support private property must first be approved by the Transportation Director. A license agreement shall be required for these cases.

Wall systems such as MSE, or block walls with geogrid reinforcement shall have a minimum thirty six inches (36”) of cover to the upper layer of the reinforcement.

Utility lines shall not pass through a retaining wall at any point and must leave room to perform any future maintenance on the retaining wall and the utility line, or the utility shall have encasement where it is unavoidable.

Utility lines that are located beneath a wall shall be installed in an encasement pipe meeting the specifications of the utility owner. The encasement pipe must extend far enough beyond the wall such that future excavation, if needed will not affect the wall stability.

Utilities, utility appurtenances, pavement, sidewalks, and related roadway improvements have priority over retaining walls in street ROW and easements. As a consequence, retaining wall layout must take into account utility assignments in addition to allowing for future utility installation and future excavation for utility maintenance and repair, including mains and service laterals. No component of the retaining wall that is essential to the stability of the wall or wall system (footings, underdrains, reinforcement, etc) can be within the excavation / backfill zone of any utility main or service regardless of the type of utility. The wall or wall system must be stable under any scenario involving utility excavation in the excavation / backfill zone. External components of the retaining wall, such as geogrid, anchors, strips, tie bars or buried pre-cast units, which are essential to stability of the wall, cannot extend beyond the back of curb, under the street, or into utility easements unless the external components are at least ten feet (10’) below the street surface and at least three feet (3’) below the deepest utility.

The distance between the street-side face of the wall and the back of curb must be such that sidewalk and ramps can be accommodated, but in no case can this distance be less than ten feet (10’), with provisions for pedestrian and vehicular railing, as needed.

### 7.4.6 Structural Design Criteria

The design engineer shall submit design calculations for all walls taller than three feet (3') to the City for review and approval.

Retaining wall backfill must be free-draining, non-expansive material. Weep holes and underdrains must be provided as necessary to prevent hydrostatic pressures caused by local groundwater seepage, surface water infiltration, floodwater inundation or by water and wastewater line breaks. Geotextile fabric or graded granular filters must be provided as necessary to prevent migration of fine-grained soil particles from the surrounding soils into the backfill and drainage media. The fabric or granular filter must be designed not only to prevent migration of fine-grained soil particles but also not to become clogged. Underdrains shall not discharge where drainage can flow onto an adjacent sidewalk or into the street. Weep holes in MSE walls are not permitted.

Surface runoff that flows toward the retaining wall must be collected in a vegetated or paved interceptor ditch behind the wall and transmitted away from the wall.

Retaining walls shall be designed in accordance with current and interim AASHTO *LRFD Bridge Design Specifications*. The following additional design criteria shall apply:

#### 7.4.6.1 Design Life

The design life for all retaining walls shall be a 100-year service life, that from a structural standpoint, is essentially maintenance-free.

#### 7.4.6.2 Cast-In-Place Concrete Walls

All concrete and reinforcing steel shall be in accordance with current and interim AASHTO LRFD *Bridge Design Specifications.*

Concrete, reinforcing and joints, including waterstops, must be provided according to the latest edition of the CRSI *Manual of Standard Practice*

Walls shall be designed assuming a unit weight of soil = 120 pcf, and coefficient of active horizontal earth pressure = 0.33 unless specific values are provided by a geotechnical engineer.

The minimum sliding factor of safety shall be 1.5.

The minimum overturning factor of safety shall be 2.0.

The base pressure resultant shall fall within the middle third of the retaining wall.

7.4.6.3 Conventional Segmental Gravity Walls (with or without mechanically stabilized backfill)

Internal stability of segmental gravity retaining units must be analyzed according to NCMA *Design Manual for Segmental Retaining Walls*, latest edition.

Walls may be constructed without earth reinforcements if all stability criteria are met with the blocks alone. If all stability criteria are not satisfied, earth reinforcements shall be provided.

The minimum sliding factor of safety along the base of the structure shall be 1.5.

The minimum overturning factor of safety shall be 2.0.

Walls shall be designed based on the following design parameters unless specific parameters have been provided by a geotechnical engineer:

Random Backfill or Select Backfill: Unit weight = 120 pcf

Embankment or Existing Soils: $\phi = 30°$ c=0 psf

Select Backfill: $\phi = 34°$ c=0 psf

The base pressure resultant shall fall within the middle third of the retaining wall.

Wall batter shall be a maximum of three inches per foot (3”/1’). Blocks shall be placed horizontally, and a positive means of obtaining batter such as pins, keyways, or concrete lips shall be provided.

7.4.6.4 Mechanically Stabilized Earth Wall (MSE Wall)

The minimum sliding factor of safety along the base of the structure shall be 1.5.

The minimum overturning factor of safety shall be 2.0.

The base pressure resultant shall fall within the middle third of the retaining wall.

The minimum factor of safety against pullout of the earth reinforcements shall be 1.5 at each level. Pullout resistance shall be determined from test data evaluated at three quarter inch (3/4”) strain.

Corrosion Criteria: The earth reinforcement elements shall be designed to have a minimum design life of one hundred (100) years. Stress

calculations (rupture) shall be done on the calculated earth reinforcement section remaining after one hundred (100) years. Pullout calculations may be based on non-corroded section.

The design of the MSE wall shall be based on the following design parameters unless specific parameters have been provided by a geotechnical engineer:

Random Backfill, Foundation Soil:
unit weight = 125 pcf
$\phi = 30°$ c = 0 psf

Select Backfill
unit weight = 105 pcf for pullout, sliding, overturning, eccentricity
unit weight = 125 pcf for rupture, bearing
$\phi = 34°$ c = 0 psf

Cement Stabilized Select Backfill:
unit weight = 125 pcf
$\phi = 45°$ c = 0 psf

Stress in steel and concrete shall be in accordance with current and interim AASHTO *LRFD Bridge Design Specifications.*

The minimum length of earth reinforcements shall be eight feet (8') or 70% of the wall design height, whichever is greater.

Panel size, configuration, and surface finish shall be as approved by the Transportation Director. Provide a coping at the top of all walls.

Provide two-foot (2') minimum cover from the top of the leveling pad to finish grade at the bottom of the wall.

7.4.6.5 Soil or Rock Nail Walls

Soil nail walls must be designed according to FHWA Report No. FHWA-NHI-14-007 Geotechnical Engineering Circular No. 7 "Soil Nail Walls – Reference Manual", latest edition. Rock Nail Walls must be designed according to University of Texas Center for Transportation Research Report 1407-1F, "Rock Nail Design Guidelines for Roadway Cuts in Central Texas, latest edition.

To control groundwater seepage, composite geosynthetic face drains must be installed on the exposed rock face before shotcreting. The face drains must extend the full height of the wall and must connect to a base drain that discharges from behind the wall in a manner that water is not directed onto the adjacent sidewalk or street.

### 7.4.7 Material Requirements and Technical Specifications

Materials used in retaining walls shall meet the requirements of the City of Round Rock Standard Specifications Manual, where applicable. Alternatively, TxDOT Standard Specifications may be used, with prior approval of the Transportation Director.

Unless otherwise approved by the City, use the MSE Wall Systems or Concrete Retaining Wall Systems on the current TxDOT's pre-approved list.

Railing type and aesthetic considerations shall be approved by the Transportation Director.

### 7.4.8 Maintenance Provisions

A twenty foot (20') wide, truck-accessible maintenance access zone must be provided at the base of walls higher than ten feet (10') that support roadway embankment. The maintenance access zone must be free of obstacles to vehicles, relatively smooth and level, all-weather accessible, and able to support loads from maintenance vehicles. The maintenance access zone may be ROW or an easement, or both.

### 7.4.9 Safety Provisions

Railing or fence must be provided to shield pedestrians or bicyclists from drop-off hazards. Refer to Section 4 for safety considerations related to drop-off hazards.

Fencing materials shall conform to the requirements of City of Round Rock Standard Specification RR701 – Fencing, and shall be reviewed and approved by the Transportation Director.

A roadside barrier such as concrete barrier or metal beam guard fence shall be provided for retaining walls located within the clear zone of an adjacent roadway. Refer to Section 1 for additional information concerning clear zones and appropriate design criteria.

### 7.4.10 Warning Devices

All retaining walls having structural components such as geogrid, strips, tie bars, or pre-cast units extending behind the wall must have plaques placed in the coping or capstone along the top of the wall at 100-foot intervals. The plaques must be made of durable metal, at least eight inches by five inches (8" x 5"), with half inch (1/2") lettering that reads "Do not excavate between the retaining wall and street / No excave entre el muro de contención y la calle". The plaque shall be permanently mounted to the top of the wall.

Walls not supporting roadway embankment, but having structural components such as geogrid, strips, tie bars, or pre-cast units extending behind the wall must have warning plaques as described above but which say "Do not excavate behind the wall within ___ feet / No excave detrás del muro de contención dentro de una distancia de ___ meters".

Warning tape must be placed six inches above the uppermost layer of reinforcement. The tape shall be placed in a criss-cross pattern on twenty four inch (24") spacing.

### 7.4.11 Supplemental Construction

Provide two, four-inch (4") PVC conduits behind retaining walls that support roadway embankment. Install pull-boxes at each end of the retaining wall and at intermediate points not to exceed two hundred feet (200') between pull-boxes. Provide additional conduits or sleeves as required by the City.

## 7.5 BRIDGES

### 7.5.1 Preliminary Design Considerations

Bridge width for proposed bridges shall carry the full roadway width including shoulders across the bridge. Bridge width shall also be sized to accommodate the full width of sidewalk or shared-use path across the bridge.

Bridge length and span configuration shall consider existing topography, width of roadway, railroad, or floodplain being crossed, roadway alignment, highway design criteria, and economics.

Vertical alignment shall be determined based on the roadway geometric criteria and shall consider deck drainage.

Bridge skew, if necessary should be limited to thirty degrees (30°) or fifteen degrees (15°), if possible.

Horizontal and vertical clearance envelopes shall be in accordance with the design criteria for the roadway or railroad being crossed.

Cross slope for bridges is one percent (1%) minimum and two percent (2%) desirable. The cross slope of the bridge shall match the cross slope of the approach roadway. If required by roadway design, cross slope transitions may be located on the bridge with approval from the Transportation Engineer. It is desirable to begin and end transitions at bent locations to ease deck construction.

Bridge low chord elevation shall be determined based on the design high water elevation. Maintain two feet (2') of freeboard.

If a bridge is being replaced, it must be determined if the existing bridge will be closed during construction. If the bridge is to remain open during construction, it must be determined if the bridge will be constructed in phases or if the roadway alignment will be shifted to accommodate full-width bridge construction.

Alternate bridge types may be considered that utilize precast, modular elements, upon approval of the City of Round Rock.

### 7.5.2 Structural Requirements

Vehicular bridges must be designed according to the current and interim AASHTO *LRFD Bridge Design Specifications*. TxDOT CAD Standards may be used to develop bridge designs and are available for download on the TxDOT website.

Railroad bridges must be designed according to the current AREMA *Manual for Railway Engineering*.

Bridge layouts for bridges in public ROW shall be approved by the City prior to proceeding with detail design. See Section 9 for checklists of the minimum information to be provided on Bridge Layouts or on bridge detail sheets.

Bridge decks may be constructed with precast, prestressed deck panels per TxDOT standards.

A geotechnical engineer should be consulted to provide soil test boring logs, foundation recommendations and design parameters.

Projects that include a highway-rail grade separation must have an executed railroad agreement prior to letting the project for bids.

All bridges shall be assigned a National Bridge Inventory (NBI) Number. This includes both on-system and off-system structures.

All bridge rails shall be crash tested and approved by the City. Design speeds of 50 mph and greater require a rail rated at least TL-3. Design speeds of 45 mph and less require a rail rated at least TL-2. Refer to the TxDOT Bridge Railing Manual for crash tested rails and ratings.

### 7.5.3 Material Requirements

Materials must meet the requirements for bridge construction in the latest TxDOT Standard Specifications For Construction And Maintenance Of Highways, Streets, And Bridges or the City of Round Rock Standard Specifications (DACS) as appropriate.

All precast, prestressed concrete girders shall be TxDOT Class H with a minimum 28-day compressive strength of f'c = 5,000 psi and a maximum desirable of f'c = 8,500 psi, as dictated by the design requirements. The concrete strength required at release should not be greater than 6,000 psi. Design strength for Class H concrete shall be noted clearly on the plans. All girders will be designed with 0.6 in diameter strands.

The use of No. 14 or No. 18 reinforcing bars should generally be avoided. The use of these bars shall be approved by the City of Round Rock during the design phase.

List names and address of manufacturers of proprietary designs, approved for use by TxDOT.

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## SECTION 8 – BUS STOPS

### 8.1 GENERAL

All bus stops shall be fully accessible with a concrete landing and access to a sidewalk or pathway. ADA accessibility standards require that each bus stop include a landing pad with a minimum width of sixty inches (60”) and minimum depth of ninety six inches (96”). Bus stops shall also connect to adjacent sidewalks or pedestrian paths where they exist.

### 8.2 SPACING

#### 8.2.1 Design Considerations

Bus stop spacing is based on several factors including customer convenience, ridership demand, and service type.

Customer convenience involves a tradeoff between proximity to stops and bus travel time. Closely spaced stops reduce customer walking distance but result in slower bus speeds. Few stops spaced further apart increase walking distance but result in faster, more reliable service.

Sufficient ridership demand is necessary to support the investment of stops. Details on ridership thresholds that warrant amenity investments are in Section 8.5, Amenities.

Specific service types such as limited stop, rapid, and express require increased stop spacing to maintain higher speeds, while radial and crosstown services have frequent stops to maximize ridership potential and convenient access to local activity centers and/or residences.

Table 8.1 lists recommended spacing for bus stops and is included to serve as a guide for planning bus routes. Spacing and location of bus stops shall be as approved by the Transportation Director.

| Table 8.1: Recommended minimum distance between bus stops | |
|---|---|
| Area type: | Bus Stop spacing range (min-max): |
| Regular local stops in Downtown or on arterial streets | 800 - 1,600 feet |
| Suburban and other low-density areas | 1,200 - 2,500 feet |

### 8.3 PLACEMENT

#### 8.3.1 Design Considerations

Bus stop placement involves a balance of customer safety, accessibility, and operational efficiency. All bus stops shall be fully accessible with a concrete landing and access to

sidewalk or pathway. Bus stops shall be compatible with adjacent land use and minimize adverse impacts on the built and natural environment.

Bus stops shall optimally be placed at intersections to maximize pedestrian safety; however, infrastructure considerations that can affect bus stop placement may include: right-of-way availability, cost of installation and maintenance, potential future changes to stop location, City, County, State or Federal laws and regulations, or other operational reasons. Infrastructure considerations for bus stop placement include lighting, topography, and roadside constraints such as driveways, trees, poles, fire hydrants, etc.

Near-side and far-side stops are generally preferred over mid-block stops. Specific ridership generators may determine the placement of a bus stop.

### 8.3.2 Near-Side Stops

Near-side stops, which are located immediately before an intersection, allow passengers to board and alight closer to intersection crosswalks, which may facilitate better transfers. Near-side stops also eliminate the potential of alighting passengers waiting through a red light.

### 8.3.3 Far-Side Stops

Far-side stops, which are located immediately after an intersection, are preferred at intersections in which buses make left turns and intersections with a high volume of right turning vehicles. Far-side stops are also preferred on corridors with transit signal priority. Far-side stops encourage pedestrians to cross behind the bus.

### 8.3.4 Mid-Block Stops

Mid-block stops shall be considered when pedestrian crosswalks are present. If pedestrian crossings are not present, the City of Round Rock will work with appropriate entities to address the potential of installing treatments like flashing pedestrian beacons to accommodate this issue. Mid-block stops may be the only option between major intersections with dedicated turn lanes.

## 8.4 SIGNAGE

### 8.4.1 Design Considerations

Well-designed bus stop signage has the opportunity to provide useful customer information while simultaneously marketing transit service. Route signage should be limited to one design to minimize inventory and materials costs.

### 8.4.2 Signage Requirements

Bus stop signage shall include the following:

- Round Rock Transit logo
- Unique panels or stickers with route number/name/endpoint
- Unique stop identification number, which can be used to access schedule information

- Appropriate sign color indicating route as provided by the City
- Route and schedule display panel

## 8.5 AMENITIES

### 8.5.1 Design Considerations

Bus stop amenities improve customer comfort, convenience, and safety. They also have the potential to increase ridership. Bus stop improvements promote system-wide equity. All amenities are considered optional; however, the City of Round Rock may require that the following amenities are included in design and construction scope of work and will determine this on a case-by-case basis.

### 8.5.2 Shelters

Bus stops generating at least twenty (20) daily boardings qualify for a shelter. Shelter size and type shall be determined by the City of Round Rock. Foundation design may be required depending on shelter type.

### 8.5.3 Benches

Bus stops generating at least fifteen (15) boardings per weekday qualify for a bench.

### 8.5.4 Waste Containers

All bus stops with shelters or benches should also have a waste container. Other stops may have a waste container installed upon request. Waste containers shall be engineered to withstand a high level of abuse and vandalism.

### 8.5.5 Bike Racks

Bike racks may be installed at stops in areas of high demand or in concert with other local entities.

### 8.5.6 Amenity Restrictions

Circumstances that might preclude installation of amenities at a bus stop that otherwise meets the threshold warrant are as follows:

- Amenities would threaten pedestrian or operational safety;
- Adequate right-of-way is not available;
- Regulations enforced by City, County, State, or Federal government;
- Service to the location is subject to potential changes;
- Installation and maintenance costs are excessive; and,
- Other circumstances that would negatively impact operations or service

It is the Project Engineer's responsibility to ensure that the design and placement of amenities will not restrict or obstruct pedestrian sidewalk flow. For minimum requirements on boarding and alighting areas, please refer to United States Access Board, Public Right-of-Way Accessibility Guidelines.

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## SECTION 9 - PLAN PREPARATION AND PROJECT AUTHORIZATION

### 9.1 INTRODUCTION

Plans are defined as construction drawings prepared and approved by the Project Engineer, defined here as the Engineer of Record, that clearly show the location, character, dimensions, and details of all proposed work to be performed by the contractor. These plans, along with a project manual, are part of the plans, specification, and estimate (PS&E) assembly. The PS&E assembly shall be prepared by the Project Engineer and submitted to the City of Round Rock (CoRR) upon the completion of design for each roadway project.

These plans shall be prepared using the guidelines provided in this chapter. Following these guidelines will produce plan sheets that are accurate, neat, and presentable that will reproduce legibly. An accurate and well-organized plan set shall be created to give potential bidders an opportunity to prepare as accurate a bid as possible, to allow efficient overseeing of construction performance, and to form a record copy for future construction reference. Inaccurate or unclear plans, however, may result in an increase in costs due to incorrect interpretations or omission of the plan information. Therefore, it is important that well-organized and efficient plan assemblies be prepared on all projects.

It is recognized that the level of design needed will vary by project. Therefore, the City and the Project Engineer will determine the need for Schematic Design and other design review submissions at a pre-design meeting. This will ensure an appropriate development of the design with corresponding reviews by the City.

#### 9.1.1 References

The publications listed in this section provided much of the fundamental source information used in the development of this chapter. This list is not all-inclusive and there are numerous manuals, documents, and journals that explain the techniques and formats required to prepare accurate, clear, and presentable construction plans. Note that these publications and the standards and specifications they contain are not static documents, but are expected to be revised continually. Therefore, Project Engineers shall always check the appropriate website for the most recent versions.

Federal Highway Administration (FHWA):

- *Project Development and Design Manual (PDDM)*

Texas Department of Transportation (TxDOT):

- *PS&E Preparations Manual*
- *Project Development Process Manual*

PS&E assemblies prepared for roadway projects in the CoRR shall be produced in accordance with the criteria, guidelines, and data requirements included herein. Where discrepancies occur between the information provided herein and any of the above references, the following descending order of priority shall govern: (1) *City of Round Rock Design and Construction Standards*, (2) TxDOT's *Project Development Process Manual*, and (3) FHWA's *Project Development and Design Manual*. For additional guidance not covered in this chapter, refer to TxDOT's *PS&E Preparations Manual*.

## 9.2 PROJECT-SPECIFIC QUALITY ASSURANCE / QUALITY CONTROL (QA/QC) PLAN FOR CIP PROJECTS

Quality Control (QC) is the process of quality checks and reviews performed on all project deliverables prior to submitting to the client to check the conformance, accuracy, scope, and style of a project deliverable. This includes detailed checking of plans, calculations, specifications, reports, and studies for accuracy and consistency, detecting and correcting design omissions and errors, confirming product meets the required level of completeness for the phase/milestone being submitted, and assessing and verifying compliance with design criteria, applicable computer aided design and drafting (CADD) standards and requirements, and other project requirements.

Quality Assurance (QA) is the process of reviewing the quality control process for use and effectiveness at preventing mistakes and ensuring compliance. This process includes designing and using guidelines, procedures, roles, and responsibility assignments to ensure that approved quality control practices are properly and consistently implemented, executed, and monitored. The QA is the final quality review completed on project deliverables to assure that all other required quality checks and reviews have been completed and resulting comments have been resolved and verified.

The purpose of the QA/QC plan is to prevent errors from being introduced to the engineering, design, plans, and cost estimates and to ensure decisions are supported by comprehensive studies and sound engineering judgment. The plan shall also identify key individuals and their unique methods and experience that reflect best quality control practices and the application of those methods uniformly across the design process.

The Project Engineer will submit a project-specific QA/QC plan for review within 30 days of the notice to proceed (NTP) or executed work authorization. This plan must outline the measures that will be employed to ensure that the City will receive an accurate product that matches industry quality standards. At a minimum, the submitted plan shall define the following:

- General project description and scope;
- The major components of the approved project scope and deliverables,
- Typically, deliverables will be submitted at the 30%, 60% and 90% design completion stage prior to 100%, or final, submission;
- The QA/QC responsibilities of the submitted organizational chart by position, name, and company for the various levels of review and accountability within those defined areas;
- The components of QA and QC required to develop this City project;
- The frequency of specific QA activities and QC reviews;
- The methods of documenting QA/QC activities/reviews and individual accountability including, but not limited to the submittal of redline markups at each subsequent submittal level; and,
- The relationship of these procedures with project milestones and schedule.

## 9.3 SCHEMATIC PREPARATION

The submission of schematic layouts shall include the basic information necessary for the proper review and evaluation of the proposed improvement. On some projects, and only with written approval from the City, schematic submissions may be substituted for 30% plans. Due to the varied agency approval processes for preliminary projects, it is essential that schematics contain the required basic information for review. Schematics shall include the following:

- General project information, including project designation, project limits, length, design speed, description, and functional classification;
- Title section on both ends of the schematic roll;
- Existing and proposed roadway and bridge typical sections;
- Locations of interchanges, main lanes, grade separations, frontage roads, turnarounds, ramps, intersections, major driveways, bridges, side streets, water bodies rail crossings;
- Existing and proposed profiles and horizontal alignments of main lanes, ramps, and crossroads at proposed interchanges or grade separations (frontage road alignment data does not need to be shown on the schematic; however, it shall be developed in sufficient detail to determine right-of-way (ROW) needs);
- All proposed roadway alignments shall increase stationing from south to north and west to east unless there is a need to match existing stationing;
- Lane lines and/or arrows indicating the number of lanes;
- Sequence of work outline for traffic control showing basic concept of traffic handling during construction, including preliminary phasing;
- Existing and proposed ROW limits;
- Bridges, bridge class culverts, and other drainage features;
- Geometrics (i.e. pavement cross slope, superelevation, lane and shoulder widths, slope ratio for fills and cuts) of the typical sections of proposed highway main lanes, ramps, frontage roads, and cross roads;
- Location of retaining walls and/or noise walls;
- Existing and proposed traffic volumes and, as applicable, turning movement volumes;
- Existing and proposed control of access lines (if applicable);
- Direction of traffic flow on all roadways;
- Location and width of median openings (if applicable);
- Geometrics of speed change and auxiliary lanes;
- Existing roadways and structures to be closed or removed;
- Existing or proposed railroad lines;
- Edwards Aquifer Recharge/Contributing/Transition Zones;
- Environmental Constraints; and,
- 100 Year Flood Plains.

### 9.3.1 Schematic Checklist

A checklist is required with each schematic submittal on all projects. All items on the checklist shall be checked or labeled as N/A with an appropriate explanation. The Project Engineer must complete, sign, date and submit the checklist along with each schematic submittal. All unchecked items are considered missing. Refer to the checklist appended to this Section for required items.

## 9.4 PLAN PREPARATION

Construction plans for roadway and bridge projects in the City of Round Rock must be prepared in accordance with the sheet sequence, content, and guidelines indicated in the subsequent sections utilizing 11” x 17” sheet size.

### 9.4.1 Organization And Content Of Plans

The plan set can be divided into main sections to reflect the elements of the proposed work.

Standard drawings and standard details cover various design elements that have been approved by agencies, such as TxDOT, incorporated cities, or other local government agencies, for use within their jurisdictional limits. These standard drawings have a fixed format and each drawing has its own unique identification number. If changes are made, they cannot be used as a standard drawing. Instead, they become special details.

Special details are plan sheets detailing various project elements and shall follow each corresponding section of the plan set (i.e. roadway, drainage, structures, utility, erosion control, etc.). These drawings are generated by the Project Engineer and shall include all details necessary to construct the project elements.

Standard drawings, standard details, and project-specific special details shall be incorporated into the plan set and not issued as a separate booklet. The standard drawings, standard details, and special details shall be arranged in an order that best clarifies the work to be accomplished. Typically, these sheets shall follow the plan drawings for each specific element of the project.

Following is a list of these sections in sequential order. Unless directed otherwise, the Project Engineer shall follow this section sequence and adhere to the guidelines regarding the content of each section and each plan sheet within the section.

Refer to the checklist in the Appendix for a summary of items that shall be included in each section.

**9.4.1.A Title Sheet**
**9.4.1.B Index Of Sheets**
**9.4.1.C Project Layout**
**9.4.1.D Typical Sections**
**9.4.1.E General Notes**
**9.4.1.F Survey Data / Project Control Points**
**9.4.1.G Alignment Data Sheets**

**9.4.1.H Estimate And Quantity Sheets**
**9.4.1.I Summary Sheets**
**9.4.1.J Traffic Control Plan / Construction Sequence**
**9.4.1.K Traffic Control Plan Standards & Details**
**9.4.1.L Roadway Plans (Plan View and Profile View)**
**9.4.1.M Roadway Standards & Details**
**9.4.1.N Drainage Plans**
**9.4.1.O Drainage Standards and Details**
**9.4.1.P Utility Plans**
**9.4.1.Q Utility Standards & Details**
**9.4.1.R Structural Plans**
**9.4.1.S Structural Standards & Details**
**9.4.1.T Traffic Signals And Illumination**
**9.4.1.U Traffic Signal And Illumination Standards & Details**
**9.4.1.V Pavement Markings And Signing Plans**
**9.4.1.W Pavement Markings And Signing Standards & Details**
**9.4.1.X Erosion Control – Permanent / Temporary and SW3P**
**9.4.1.Y Erosion Control Standards And Details**
**9.4.1.Z Cross Sections**
**9.4.1.AA Other**

### 9.4.1.A Title Sheet

The purpose of the Title Sheet is to establish the project location, describe the nature of the proposed work, identify the funding authority and Project Engineer, and show agency and utility approvals.

A complete Title Sheet shall contain the following:

- Proper title and project designation;
- Statement of the project length;
- City logo;
- Roadway classification, design speed, and traffic data;
- Vicinity map;
- Signature blocks for approving officials;
- Governing specifications and date of adoption;
- Copyright statement;
- Exceptions, equations, and railroad crossings; and,
- Registered Accessibility Specialist (RAS) inspection note.

The project designation includes the project name, project number, and the roadway name and number, if applicable. The limits of the proposed construction in relation to the nearest county or state roadway shall also be shown in miles to the third decimal place if the project is contiguous. Plans for multiple-site projects shall refer to, and

include, plan sheets showing the locations or a single exhibit with each site designated by an alpha-numeric label and legend to all designators. A description of the proposed work shall also be included under the project designation.

The project length shall be shown in feet to two decimal places and in miles to three decimal places. The project length shall also be shown inclusive and exclusive of the bridge length and any equations, exceptions, or railroad crossings shall be listed by station numbers and lengths. Show as “NONE” if not applicable.

For a single roadway or contiguous roadways and on all segments of multiple-site or segmental projects, the design roadway classification shall be stated along with the design speed and traffic data. Current average daily traffic (ADT), design year ADT, design hourly volume (DHV), directional distribution (D), and percent of trucks (T) shall be indicated for all segments of each main roadway.

The vicinity map shall be of suitable size showing the project location in relation to nearby highways, nearest towns, railroads, and major streams. County and city boundaries, applicable scale, and north arrow shall also be shown. The beginning and ending stations shall be clearly identified.

Signature blocks are required for approving officials to sign and date the plans. Signature blocks for the Project Engineer and the City of Round Rock Transportation Director shall be provided as a minimum. Signature blocks shall also be provided for local utility interests, where applicable.

Projects that include sidewalks and other pedestrian facilities with an estimated construction cost of $50,000 or more will require an RAS inspection. The following note shall appear on the Title Sheet:

***"Registered Accessibility Specialist (RAS) Inspection Required TDLR No. EABPRJ_____."***

Include a statement on the Title Sheet if the RAS inspection is not required.

Any governing specifications or specification reference applicable to the project shall also be stated on the Title Sheet. The following copyright statement shall also be added to the Title Sheet:



### 9.4.1.B Index Of Sheets

The index includes the sheet number and title as they appear on each sheet contained within the plan set. All sheets are to be listed, including omitted sheet numbers. The responsible Project Engineer’s approval note for the use of standard sheets included in the plans must also be incorporated on the Index of Sheets as follows:

*The Standard Sheets specifically identified above have been selected by me or under my supervision as being applicable to the project.

_____, P.E._____Date

### 9.4.1.C Project Layout

The project layout shall depict the proposed and existing project features. A suitable scale shall be utilized to clearly show project features, such as the beginning and the end of the project, street names, baseline stations, horizontal alignment data, existing and proposed ROW, advance project warning signs, or any other pertinent information not shown elsewhere in the plan set. The project layout shall not be smaller than 1 inch = 400 ft. scale.

The station and coordinates of the beginning and ending project points shall be labeled.

### 9.4.1.D Typical Sections

Roadway typical sections provide a general illustration, by cross sectional view, of the nature of construction in every segment of the project. The objective is to present all the elements and dimensions of the roadway for every change of existing features or proposed roadway in as simple a way as possible. These sections shall be specific enough to describe the elements of the proposed work, their location, and the material to be utilized.

All plans shall show typical sections for the project, including bridge plans. On projects requiring more than one typical section, the limiting stations for each section shall be shown and may require additional plan sheets for clarification.

The existing typical section shows the approximate widths, depths, and station limits of the existing roadway included in the project. Proposed sections illustrate the depths, dimensions, and station limits for every type of material in the proposed pavement structure. Features, such as ramps, detours, crossroads, barrier, and metal beam guard fence (MBGF), must also be included. Other applicable items with limits that may be shown on the typical sections are retaining walls, curb and gutter, and topsoil and seeding.

Identify all functional elements of the typical section to a relative scale. Show widths in feet, thickness or depth in inches, pavement cross slopes in percent to two decimal places, and side slopes in horizontal to vertical ratios. Show the thickness of each element in the pavement structure in inches. Use notes or tables on the typical section sheet to cover where different pavement structure layers are necessary due to different soil conditions.

For phased construction projects, identify the ultimate typical section. Clearly distinguish the work to be performed under the contract and future construction work. Typical sections reflecting construction phasing shall be shown on the sequence of construction/traffic control plans.

Include tables or notes to illustrate curve widening, relationship of slope ratios to cut and fill heights, slope rounding, and other special treatments.

The grade line shown on the plan and profile sheet, which represents the vertical location of the roadway, is known as the profile grade line (PGL). The PGL and other necessary control points, such as the project baseline and centerline, the roadway centerline, pavement cross slope, and superelevation pivot point, shall be clearly identified on the typical section.

Existing and proposed typical sections shall show existing and proposed ROW.

Every typical section shall contain a set of section limits to which it corresponds along the roadway. These limits are shown through station ranges. The entire project shall be checked to ensure that a typical section has been shown for every segment of the roadway.

Additional information, such as the following, may also be shown on the typical section sheet(s):

- Location of predominant utility lines and their approximate depths;
- Location of storm sewer trunk lines.

Use supplemental typical sections to show variations in special ditches, clearing widths, and rock cuts. Also, use supplemental typical sections to detail curbs, median treatments, slope protection, and channel changes. Place these supplemental typical sections on separate sheets, if necessary, listing the stations where the typical sections apply. Place a note on the plan and profile sheet describing the site-specific work and referencing the appropriate typical section. The Project Engineer's seal, signature, and date are required.

#### 9.4.1.E General Notes

Included in General Notes are items such as basis of estimate, environmental management, tree protection notes, concrete surface finish, traffic control details, variations in slopes, and protection system for structures. The City of Round Rock maintains a master set of general notes from which the Project Engineer can select applicable notes that relate to the project-specific issues.

Quantities for supplementary items shall be shown, and when shown, labeled, "*For Contractor's Information Only*." No quantities that are subject to change due to sequence of construction operations shall be shown. The wording of all general notes needs to be clear, concise, and have only one meaning for uniform interpretations.

General Notes shall be written using active voice and imperative mood whenever possible. Refer to the latest version of TxDOT's Style Guide for Construction and Maintenance Specifications for further information when writing General Notes and Specifications. The Project Engineer's seal, signature, and date are not required.

#### 9.4.1.F Survey Data

Survey data sheet(s) will be required on all projects where an actual field survey has been performed. The survey data includes reference to and description of the horizontal and vertical control used on the project.

Reference to the horizontal coordinate system and the vertical datum used shall be stated. The following statement along with the combined scale factor shall be added:

*All distances and coordinates shown are grid/surface values and may be converted to surface/grid by multiplying with/dividing by a combined scale factor of____.*

Coordinates, elevation, and descriptions of all project control points shall be included. Description and elevation of all bench marks used to establish project elevations shall also be added to the survey data sheet.

On small projects, the survey data may be included on the project layout sheet. On large projects, it may be beneficial to show the construction alignment or survey alignment in

relation to the control points and bench marks on separate sheets. The project Registered Professional Land Surveyor (RPLS) seal, signature, and date are required.

#### 9.4.1.G Alignment Data Sheets

Alignment data sheets shall (at a minimum) include the following information:

- Curve data (if applicable):
  - PC, PI, PT station and coordinates;
  - Curve radius and degree of curve;
  - Deflection angle;
  - Tangent bearings and lengths.
- Stations and station equations (if applicable);
- Station/offset information (in relation to other alignments within the project limits);
- Project Engineer's seal, signature, and date.

An imported coordinate geometry (COGO) output file is recommended.

#### 9.4.1.H Estimate And Quantity Sheets

The Estimate and Quantity (E&Q) sheet provides a list of all pay items and estimated quantities in the contract. This sheet also provides a space for final quantities once the project is complete. Item numbers, descriptive codes, special provision numbers, item descriptions, units of measurement, and bid alternates are also shown. This sheet is prepared using the Project Quantity Spreadsheet as defined in Section 9.4.1.I.

An E&Q sheet also summarizes the work to be done, if there is more than one project in the plans or if local participation is required to be quantified separately. They also simplify the plans by showing the total quantities of each item of work involved in the construction of the roadway. The Project Engineer’s seal, signature, and date are not required.

#### 9.4.1.I Summary Sheets

These sheets tabulate, combine, and summarize quantities of the various construction items. This summary informs prospective bidders of where to locate work within the plan sheets, the difference between plan quantities and bid schedule quantities, if any, and expands on contract bid schedule information. It also serves as a helpful checklist to the designer to ensure that all elements of the design receive consideration. The Project Engineer shall use a tabulation format that presents the work items in a clear and concise manner that can be easily checked and verified.

Summary of quantity sheets may also show item numbers, descriptive codes, special provision numbers, item descriptions, units of measurement, and bid alternates. In the preparation of the summary sheets, bid items shall be described exactly as shown in the corresponding agency standard item description.

Summary sheets will be prepared using a Project Quantity Spreadsheet in Microsoft Excel to tabulate the various pay items. All of the pay items are to be listed in numerical order and identified by appropriate descriptions. Show any pertinent information by use of remarks or footnotes at the bottom of the summary plan sheet. The engineer’s seal, signature, and date are not required on summary sheets.

### 9.4.1.J Traffic Control Plan / Construction Sequence

A traffic control plan (TCP) is a special drawing that graphically portrays all traffic control measures required to assure safe passage of traffic and pedestrians through and/or around a specific project construction zone. It also ensures the safety of construction personnel, provides protection to construction equipment, and minimizes the accident level within the project limits.

TCP's may range from simple line diagrams for low-volume rural roads to complex plan sheets detailing every stage of the project work on high-volume urban highways. Refer to the Transportation Criteria Manual Section 6 for guidance on TCP content and layout.

If different construction stages or intricate traffic movements are needed, then suggested sequence of work sheets shall be provided. In addition, in order to clarify the work zone widths and traffic handling methods, typical cross sections shall be provided for each construction phase. Barricade and construction standard sheets shall also be included within the plansets.

A narrative summarizing the general traffic operations and general construction operations for all phases shall be provided. The steps within each phase shall also be included for the suggested sequence of construction. All applicable traffic control and work sequence general notes shall be added, including the working hours. Per Sec. 44-277 in the Code of Ordinances, working hours in the public right-of-way are generally limited to the hours between 7:00 a.m. and 6:00 p.m., Monday through Friday, with lane closures on major thoroughfares limited to the hours between 9:00 a.m. and 4:00 p.m.

The Sequence of Construction shall include construction staging plans that detail the recommended phasing of project improvements. Staging should maximize mobility and safety during construction, while considering ease of construction.

Detours may be required to maintain traffic during certain construction stages. The Sequence of Construction shall consider safe operation for pedestrians and bicyclists in all stages of construction as well as continuous, safe access to all properties. Construction markings, traffic control devices, and barriers should be designed with this goal.

Detailed layout and arrangement of work zone signs, work zone pavement markings, traffic control devices, and drainage facilities should be provided for each construction stage.

TCP's shall be prepared in accordance with TMUTCD Chapter 6, "Temporary Traffic Control." The Project Engineer's seal, signature, and date are required.

### 9.4.1.K Traffic Control Standards & Details

Special traffic control details may include drawings detailing construction phasing, traffic control device applications, temporary shoring, or slope treatments.

### 9.4.1.L Roadway Plans

Roadway plans are also known as the plan and profile (P&P) sheets. The objective of P&P sheets is to show the existing topographic features, the horizontal and vertical alignment of the proposed roadway, and the location and limits of the proposed work. The plan and

profile are typically shown on the same sheet, unless impractical, in which case they may be presented on separate sheets. If the profile is modified, provide P&P sheets for connecting roadways.

P&P sheets shall be prepared at a scale that is adequate to show the necessary details as governed by the topography and the complexity of the work. A scale of 1 inch = 100 ft. or 1 inch = 50 ft. is typically used for roadway plans. Depending on the plan size and amount of information required for the project, varying graphic scales may be utilized. Profiles usually have the same horizontal scale as the plan, but the vertical scale shall be 5 to 10 times the horizontal scale. Where elevation differences are large, a vertical scale of 2 times the horizontal may be more appropriate.

Attempt to place 1,200 ft. *(1 inch = 100 ft.)* on a sheet and always break sheets at even 100 ft. stations. Increasing stationing shall run from left to right. Avoid breaking sheets or placing match lines within intersections.

At a minimum, the following shall be shown on the plan portion of the P&P sheets:

- North arrow, scale, and legend;
- Boundary, county, and city lines;
- Control of access lines, if applicable.
- Bodies of water, such as streams, lakes, swamps, estuaries, or creeks;
- Beginning and ending points and their respective stations;
- Centerline or baseline stationing with labels and tick marks every 100 ft.;
- Horizontal curve and point of intersection data if not shown on the project layout;
- Existing and proposed ROW lines and widths at each break within the project limits;
- Property lines and property ownership;
- Easement lines and widths;
- Full superelevation, normal crown, transition locations and limits with stations;
- All drainage structures with reference numbers;
- Intersection stations of all driveways and connecting roadways;
- Proposed radii at intersection with driveways and connecting roadways;
- Retaining wall locations, if applicable;
- Existing roadway and roadway width;
- Proposed roadway and shoulders, including proposed widths;
- Pavement removal (separate sheets for large projects);
- Limits of Milling (separate sheets for large projects);
- Demolition of structures (separate sheets for large projects);
- Location of borings, test pits, or other sites where subsurface investigations have been made;
- Summary of items and estimated quantities, including excavation, embankment, MBGF, and terminus, which are not detailed on other sheets.

At a minimum, the following shall be shown on the profile portion of the P&P sheets:

- Stations along the bottom and elevations along the sides;
- Proposed profile grade and existing ground lines with labels;
- Points of vertical intersection and vertical curve data;
- Gradients in percent to two decimal places for the PGL;
- K values for each vertical curve;
- Proposed and existing elevations at 50 ft. intervals to two decimal places;
- Culverts, structures, or other proposed facilities;
- Utilities with elevation or depth dimensions, if known, and over and under clearances;
- Existing and proposed bridges and major structures with appropriate reference notation;
- Clearances for railroads, highways, and streambeds under proposed and existing structures.

In order to improve the clarity of P&P sheets, some of the aforementioned information, such as the intersection and driveway details that show pavement contours, sidewalks, shared-use paths, pedestrian ramps, pavement structure, and grades, may be placed on additional sheets.

Driveway quantities shall be tabulated and summarized by driveway, indicating the corresponding plan sheet number. Pavement, roadway incidentals, MBGF, pavement markings, bridges, retaining walls, erosion control, and all other pay items shall be tabulated and summarized on the appropriate plan sheets. These plan sheet quantities shall then be included in the Project Quantity Spreadsheet summary tabulation of the various pay items. It is the intent of this requirement that a Project Quantity Spreadsheet be produced that includes all sheet quantities, tabulation of these individual quantities to produce the summary sheets and the E&Q sheets. The Project Engineer is requested to submit this spreadsheet for assistance in the review process at the 90% and 100% submittals. The Project Engineer's seal, signature, and date are required.

### 9.4.1.M Roadway Standards & Details

Special roadway details may include drawings detailing grade crossings, turnouts, disposal and borrow site grading treatments, material source locations, removal plans, intersection details, and driveway details. The Project Engineer's seal, signature, and date are required.

### 9.4.1.N Drainage Plans

Drainage plans generally consist of four elements: (1) drainage area map and hydrologic and hydraulic (H&H) data, (2) hydraulic computations, (3) culvert or drainage structure layouts, and (4) drainage plan and profile sheets. Following is a brief content and format discussion for each of these elements.

**Drainage Area Map and Hydrologic & Hydraulic Data:**

The size and location of watersheds within the project area are documented on this sheet and used to develop the design flow, which in turn will determine the size of the proposed drainage structures and appurtenances. The contents of an area map include

major tributaries or streams being crossed, major highways and streets, and drainage area limits. Each drainage area needs to be labeled for runoff table cross-referencing and the location of structures and/or stream crossings.

**Hydraulic Computations:**

This sheet is used to verify the structure design and to present calculations. Culvert hydraulic calculations consist of a runoff table and a culvert computation table. Additional tables shall be shown for storm sewer runs, inlet computations, and ditch capacity/velocity calculations. In general, runoff computations shall indicate the method used (Rational or United States Geological Survey (USGS), the intensity values, runoff coefficients, and the design storm. Projects containing ditches shall include a listing by station of ditch depth, capacity, and velocity calculations for all proposed ditches. Including the computer generated analysis results in the plans is preferred for culvert sizing, storm sewer runs, and inlet computations.

For major stream-crossing bridge structures, the hydrologic and hydraulic (H&H) computations are summarized in a drainage report, also referred to as the H&H Report. The results of the study are also summarized on a drainage area map that is included in the plans. One drainage area map sheet is required per structure. This sheet shall include a drainage area map showing the location and limits of the watershed, a typical stream cross section, a bridge summary table showing peak discharges and water surface elevations, a cross section summary table, gage station analysis and summary (if applicable), design storm frequency, hydraulic software utilized, and runoff computation method used.

**Culvert or Drainage Structure Layouts:**

Each proposed crossing culvert, including bridge-class culverts, shall have a cross section/profile showing the work to be done and the description of the culvert. Bridge-class culverts, which are culverts with a width of 20 ft. or more along centerline of the roadway, must include a National Bridge Inventory (NBI) number. This sheet is also referred to as the culvert layout. Below is a list of items that shall be shown on the culvert layout sheet.

- North arrow and horizontal and vertical scales;
- Existing ground and proposed grade lines;
- Direction of flow and flowline elevations;
- Centerline of roadway, structure centerline, and skew angle;
- Beginning and ending stations of the structure with flowline elevations;
- Structure slope and upstream and downstream channel slopes;
- Length of structure;
- Type of end treatment including details;
- Roadway cross section along culvert, roadway width and clear zone dimension;
- Description of existing and proposed structure with appropriate standards;
- Hydraulic data (headwater and tailwater elevations for design year and 100-year events);

- ROW and easement lines

Culvert layout sheets are generally prepared at a scale big enough to fit the structure graphics and all the associated labels. The vertical to horizontal scale ratio is generally 2:1. The horizontal scale for drainage structure cross sections is typically *1 inch = 10 ft*. Smaller scales may be used in order to fit long culverts on a single sheet.

**Drainage Plan and Profile Sheets:**

The drainage plan and profile (P&P) sheets are required mainly on roadways with storm sewers. On projects with open roadside ditches, drainage P&P are not required, but ditch profiles shall be included on roadway P&P sheets. The drainage P&P sheets are typically prepared at the same horizontal and vertical scales of the roadway plans. The plan view shall show the location of inlets, storm sewers, culverts, and ditches, while the profile view shall show the storm sewer run information, such as length, size, and type. Existing ground, proposed grade lines, design year and 100-year hydraulic grade line (HGL), existing utilities, and trench excavation protection limits shall also be shown on the profile view. The Project Engineer's seal, signature, and date are required.

### 9.4.1.O Drainage Standards & Details

Special drainage details may include drawings detailing inlet modifications, pipe bedding, reinforced concrete pipe connections, flume, or channel details. The Project Engineer's seal, signature, and date are required.

### 9.4.1.P Utility Plans

Include existing utilities on roadway P&P sheets, unless proposed utilities are needed, then separate utility plan sheets should be considered. In general, utility owners are responsible for utility adjustments/relocations within existing ROW. Thus, utility plans are not required. Refer to the Transportation Criteria Manual Section 8 for additional information on the process and preparation of the utility adjustment/relocation plans. Utility P&P sheets shall be prepared at the same scale as the roadway P&P sheets. The Project Engineer's seal, signature, and date are required.

### 9.4.1.Q Utility Standards & Details

Special utility details may include drawings detailing water and wastewater pipe connections, thrust blocks, joints and other appurtenances. The Project Engineer's seal, signature, and date are required.

### 9.4.1.R Structural Plans

Structural plans are required on all projects with proposed structures. Proposed structures include either retaining walls or bridges.

**Retaining Walls:**

Structural plans for retaining walls include wall layouts, typical sections, geometry data, and details. Retaining wall layouts shall include plan and profile views prepared typically at *1 inch = 20 ft.* utilizing a vertical scale factor of 2:1. The profile

view shall show the front face of wall. All applicable items mentioned below for the bridge layouts shall be considered in the preparation of the retaining wall layout sheets. In addition, wall layouts shall include top of wall elevations as well as existing and proposed ground lines and elevations.

Typical sections for retaining walls shall include information such as pavement and graded slopes and widths, barrier or rail type and location, and proposed roadway reference. Geometry data sheets for retaining walls shall include sufficient information to enable the contractor to construct the walls. For mechanically stabilized earth (MSE) type walls, this information shall include tieback identification and location, wall height, panel width and length, and panel area.

Details for retaining walls may include structural, drainage, or miscellaneous drawings detailing the design and construction of these elements. The Project Engineer's seal, signature, and date are required.

**Bridges:**

Structural plans for bridges consist of bridge layouts, typical sections, foundation data, bearing seat elevations, and structural details. Each bridge shall have a bridge layout sheet that includes a plan view and a profile view (elevation). Bridge layouts shall be prepared at *1 inch = 20 ft.* scale with 2:1 vertical scale factor. The following is a list of items that shall be included on the bridge layout plan view:

- Centerline or PGL (bearing and location)
- Structure's beginning and ending stations and elevations
- All bent stations and bearings
- Armor joint type, location, and size of seal (if needed)
- Width of roadway and shoulders
- Approach slab and curb returns
- Direction of traffic and/or stream flow
- North arrow and plan scale
- Identification and location of test holes
- Horizontal clearances (i.e. for structures, utilities, railroad tracks, etc.)
- ROW (if applicable)
- Horizontal alignment data (if applicable)
- Cross slope and/or superelevation (if applicable)
- Limits of riprap and blockout around column
- Skew angle(s) of structure and/or bents
- Railing type (specify rail type and show nominal face of rail)
- Exterior beam line numbers (consistent with span details)
- Pedestrian / bicycle accommodation (if applicable)
- Features being crossed
- Utility identification and locations

- Summary of bid items and estimated quantities (can be a separate sheet)
- Railroad Exhibit A (if applicable)

The profile view of the bridge layout shall have the following:

- Overall length of structure;
- Lengths and types of units/spans;
- Overall length, limits of payment, and type of railing (rail post spacing if needed to clear slab joints);
- Vertical curve data and grade;
- Beginning and ending structure stations and elevations;
- Fixed/expansion conditions at all bents;
- Beam ends marked doweled or open;
- Minimum calculated vertical clearances and other clearances as required (e.g. structures, utilities, railroad tracks, etc.);
- Existing and proposed ground lines clearly marked;
- Appropriate hydraulic data (if applicable);
- High-water elevation (if applicable);
- Scour information (if applicable);
- Datum elevations and stations;
- Column heights;
- Number, size, length, and type of foundations;
- Test holes, data, and information;
- Bent numbers clearly marked;
- Clearance sign(s) and any other needed signs attached to bridge(s);
- NBI number or the permanent structure number (PSN);
- Limits and type of riprap;
- Design speed, ADT, and functional classification.

Bridge typical sections shall include an overall roadway width, shoulder width, curbs, concrete medians, sidewalks, cross slopes, and railings. The section shall also include reference to its location and shall highlight the main elements of the structure, such as the beams, deck, railing, and barrier.

Structural details pertain to drawings detailing the design and construction of abutments, bents, slabs, footings, framing plans, and wing walls.

Applicable TxDOT standard drawings may be used in lieu of preparing structural detail sheets. The Project Engineer's seal, signature, and date are required.

### 9.4.1.S Structural Standards & Details

Special structural details may include drawings detailing prestressed concrete panels, permanent metal deck forms, optional drilled shaft reinforcing, and concrete riprap for

embankment slopes under bridge ends. Refer to Transportation Criteria Manual Section 8 "Structures in the Right Of Way and in Easements" for additional information. The Project Engineer's seal, signature, and date are required.

### 9.4.1.T Traffic Signals, Illumination & Traffic Management Systems

This section includes proposed project elements in the following three main areas: (1) traffic signals, (2) electrical and illumination work, and (3) traffic management systems (TMS). The following is a brief discussion and a list of the plans that shall be included for each of these areas.

A traffic signal plan shall be prepared for each intersection or approach that includes the following proposed traffic signal elements:

- Signal layout sheet (e.g. signal pole and mast arm locations, conduit runs, loop detectors, traffic lanes, signal head arrangements, etc.);
- Signal elevation sheet (e.g. elevation views from all directions showing signal head arrangement, signal pole types, and appendances);
- Signal wiring and signal phasing sheet;
- Summary sheet.

Similar drawings will be required for temporary traffic signals required during the various construction phases. Signal layouts shall be prepared utilizing 1 inch = 40 ft. scale.

Electrical and illumination layout sheets shall include:

- Layouts of lighting pole and luminaire;
- Lighting details;
- Electrical service;
- Conduit run locations.

These plans shall be prepared at the same scale as the roadway plans. On small projects, the proposed electrical and illumination elements can be shown on the pavement markings and signing plans. A quantity summary with sheet totals shall be included on each sheet. Voltage drop calculations for the various circuits will be a requirement at the 60%, 90%, and 100% submissions.

TMS plans, if needed, denote surveillance and control system items, such as traffic cameras, changeable message signs, vehicle detection, conduit runs, and any other intelligent transportation system. These plans shall also be prepared at the same scale as the roadway plans. The Project Engineer's seal, signature, and date are required.

### 9.4.1.U Traffic Signal And Illumination Standards & Details

Special traffic signal details may include drawings detailing signal pole foundation, signal support structures (single mast arm assembly), and electrical details-conduit.

### 9.4.1.V Pavement Markings And Signing Plans

The pavement markings and signing plans depict the location, type, color, dimensions, and standard number of all proposed markings and signs. These plans shall include both pavement marking and signing elements on the same plan and shall be prepared at the same scale as the roadway plans. On large and complex projects, the pavement markings and signs may have to be placed on separate plans for clarity and simplicity.

In addition to the pavement marking and sign plans, this section shall also include overhead sign and elevation details, bridge sign details, large and small sign details, and miscellaneous sign details. These details shall show the location, size, and dimension of the panel, support, mounts, and accessories of all proposed sign structures as necessary. These details shall be developed at a scale sufficient to clearly show the proposed elements and labels.

All pavement markings and sign plans shall be in accordance with the latest edition of the TMUTCD. SignCAD software shall be used to create customized signs not included in the Standard Highway Sign Designs for Texas. The Project Engineer's seal, signature, and date are required.

### 9.4.1.W Pavement Marking And Signing Standards & Details

Special pavement marking and signing details may include drawings detailing delineators, object markers, pavement markings, pavement markers, sign mounting, and signs.

### 9.4.1.X Erosion Control

The plan sheets for the erosion control plan, including the Storm Water Pollution Prevention Plan (SW3P), are drawings that detail the measures required to protect resources and to comply with environmental permit stipulations. These drawings shall be prepared in accordance with the City's Stormwater Management Program and MS4 Permit, and shall be in compliance with the stipulations in the Texas Pollutant Discharge Elimination System (TPDES) permit.

These sheets address temporary erosion control measures during project construction as well as any permanent erosion controls that are required. An SW3P sheet and erosion control plans are required for any project with soil disturbance. As a minimum, the first sheet of the erosion control plan is the SW3P, which is the narrative portion, and any additional sheets would show the locations and types of any erosion control features needed. Erosion control plans shall be prepared at the same scale as the roadway plan. The SW3P shall comply with the approved Water Pollution Abatement Plan (WPAP), if applicable.

While not a required plan sheet, a WPAP is required for any regulated (i.e. construction) activity conducted in the Edwards Aquifer Recharge Zone. A WPAP is a detailed plan that outlines best management practices (BMPs) that will be implemented in order to protect water quality when a regulated activity is conducted in the Edwards Aquifer Recharge Zone. The WPAP must be submitted and approved by Texas Commission

on Environmental Quality (TCEQ) prior to construction for any project located over the Edwards Aquifer Recharge Zone.

#### 9.4.1.Y Erosion Control Standards & Details

Special erosion control details may include drawings detailing sediment control fence, rock filter dams, and tree protection. Additional special details may be necessary to detail grading, wetland restoration, and vegetation replacement for projects with wetland impacts or/and mitigation.

Commitments for environmental mitigation features, which are contained in the environmental documentation, shall be detailed as necessary and included in the project plans as special details and/or shown at the end of the Erosion Control Standards and Details section. The Project Engineer's seal, signature, and date are required.

#### 9.4.1.Z Cross Sections

Sufficient information shall be shown on each of the sections to accurately determine the extent of the proposed work. A scale of *1 inch = 20 ft.* is typically used for cross sections. The horizontal to vertical scale is typically 2:1 resulting in a vertical scale of *1 inch = 10 ft.* If this scale is unsuitable, use more appropriate scale to show the extent of the proposed work.

Cross sections shall be cut at 50 ft. intervals and at all cross streets. Earthwork quantities on all projects shall be based on cross sections spaced at 50 ft. maximum.

Cross sections shall also show the existing and proposed grade lines depicting the slopes, widths, and depths of proposed material. Offsets and elevations of all critical segment points shall also be shown. ROW and easement lines shall be clearly marked.

#### 9.4.1.AA Other

Additional plan sheets may be required to address issues, such as material source rehabilitation, disposal or borrow area restoration, intersection details, special landscaping plantings, and other enhancements. If there is a substantial amount of demolition work to be done, separate plan sheets (removal layouts) showing the proposed demolition work shall be utilized.

### 9.4.2 Sealing Plans

All original final plan drawings, except for Estimate and Quantity, Summary, and Standard sheets, are to be signed, sealed, and dated by a registered Professional Engineer (P.E.) or a registered Professional Land Surveyor (RPLS) as appropriate under current Texas law.

Either an original signature or an electronic signature will be accepted as detailed in Statutes' *Regulation of Engineering, Architecture, Land Surveying, and Related Practices* (6 Tex. OCC).

All interim submittals shall include a preliminary stamp with the registered professional name and license number along with the submittal date. This stamp shall state the preliminary nature of the plans and that they shall not be used for bidding or construction.

Any changes made to the plans prior to letting will have to be coordinated between the City and Project Engineer, approved by the Project Engineer, and plans shall be signed, sealed, and dated as stated above. The Project Engineer shall be aware of any necessary changes made to the plans after letting; however, the Project Engineer will not be liable for any changes made to the plans without his/her consultation.

### 9.4.3 Copyright Data

As mentioned previously, the County copyright statement shall be added to the Title Sheet:

© 20xx by City of Round Rock, Texas. All rights reserved.

On all other sheets, except for the standard plan and standard detail sheets, an abbreviated form of the copyright statement can be used:

© 20xx City of Round Rock, Texas.

### 9.4.4 Plan Checklist

A checklist is required for each PS&E submittal on all projects, which is provided by the City. See Section 9.6 for more information. All items on the checklist shall be checked or labeled as *N/A* with an appropriate explanation. All unchecked items are considered missing.

### 9.4.5 PS&E Package

A PS&E package shall be submitted for each project at various submittal levels. The PS&E package is to be prepared by the Project Engineer and shall include the following (refer to corresponding checklists):

- Plans – Refer to Transportation Criteria Manual Section 9.4.1 for more information. Plans shall be signed and sealed for the Final PS&E submittal.
- Technical Specifications – The Project Engineer is responsible for the preparation of all special contract requirements, including special specifications and modifications to standard specifications relating to an individual project.
- Project Manual – The Project Engineer shall obtain the current project manual and bidding documents from the City for use in the preparation of the final PS&E package. The template indicates where project information is inserted by the Project Engineer. No other revisions to standard bidding documents are to be made by the Project Engineer.
- Project Engineer's Cost Estimate – The Cost Estimate shall be prepared for construction quantities covering all items of the proposed work. The Cost Estimate shall include, according to bid item order, a separate line for each item, and a total block at the end of the last page. The total block shall include a summary of each of the section subtotals and a grand total. The item line shall

include the item code, item description, unit, quantity, estimated unit cost, and total item amount. Cost Estimates shall include appropriate non-bid items, including force account items. The Project Engineer is not required to estimate costs for preliminary engineering, construction engineering, utility relocation, or ROW acquisition. A statement shall be included that defines the prices as current or contains inflation percentages for future date consideration.

- Geotechnical Engineering Report – Use acceptable standard practices in performing and documenting the geotechnical engineering work for all City roadway projects. These practices include field surveys, field operations, soil and rock classifications, wall and structure design, soil stability, and undercutting recommendations (refer to the Transportation Criteria Manual Section 8 and TxDOT's Geotechnical Manual for more detailed information regarding geotechnical engineering). The geotechnical engineering report shall also include pavement design for the project. Refer to Transportation Criteria Manual Section 3 for detailed information on required design effort.
- Drainage Report – Use acceptable standard practices in performing and documenting the hydrology and hydraulics used to design drainage structures and systems throughout the project. These practices include data collection, field surveys, hydrologic and hydraulic analysis, and a summary of conclusions and recommendations. Refer to the TxDOT Hydraulic Design Manual for more detailed information regarding drainage reports.

### 9.4.6 Bid Documents

In addition to the PS&E package, the Project Engineer will be responsible for the preparation of the Project Manual (Bid Documents) including:

- Cover Page (signed and sealed)
- Bid Addenda (refer to Section 9.5.1.1)
- Bid Form
- Technical Specifications
- Plan Drawings
- Geotechnical Report (refer to Section 9.4.5)

A typical Table of Contents will include the following, at a minimum:

| Section | Description |
|---|---|
| 00020 | Notice to Bidders |
| 00100 | Instructions to Bidders |
| 00200 | Bid Bond |
| 00300 | Bid Form |
| 00410 | Statement of Bidders Safety Experience |
| 00500 | Agreement |
| 00600 | Insurance and Construction Bond Forms<br>Performance and Payment Bond Instructions<br>Insurance Instructions |
| 00610 | Performance Bond |
| 00620 | Payment Bond |
| 00650 | Certificate of Liability Insurance |

| | |
|---|---|
| 00700 | General Conditions |
| 00800 | Supplemental General Conditions |
| 00900 | Special Conditions |
| 01000 | Technical Specifications (refer to Section 9.4.5) |
| 02000 | Plans, Details and Notes (refer to Section 9.4.1) |

The Project Engineer shall furnish one (1) hardcopy of the original signed and sealed Title Sheet and Project Manual cover page of the final bid documents to the City along with PDF and required native file formats.

## 9.5 PROJECT BIDDING PHASE

The purpose of this section is to outline the basic steps that must be taken in preparation for the advertising, bid opening, and awarding of City projects.

### 9.5.1 Process

After the PS&E assembly is deemed complete and the City gives approval to advertise the project, the following steps must be taken:

#### 9.5.1.1 Advertisement

The City will notify the Project Engineer of the scheduled pre-bid meeting and bid opening date. The Project Engineer must attend the pre-bid meeting. The Project Engineer shall bring one (1) set of bid documents (plans and project manual) and be prepared to respond to Contractor questions. The Project Engineer will prepare and distribute addenda as needed.

#### 9.5.1.2 Bidding

The Project Engineer shall attend the bid opening and receive one (1) copy of each bid submitted.

#### 9.5.1.3 Award

The Project Engineer shall review the bids and check for errors or obvious imbalances. The Project Engineer shall also prepare and submit the bid tabulation and written recommendation regarding award of the contract to the City.

#### 9.5.1.4 Post-Award / Pre-Construction

The Project Engineer will attend the pre-construction meeting with the Contractor if requested by the City and shall be prepared to answer any questions the Contractor may have regarding the bid documents.

#### 9.5.1.5 Construction

The Project Engineer will review submittals and shop drawings on request. The Project Engineer will respond to Requests for Information (RFI) submitted by the Contractor in a timely manner and prepare requested plan revisions.

For projects requiring a WPAP, Project Engineer will be required to inspect BMPs and provide a certification letter as required by TCEQ when Construction is complete.

# 9.6.A Design Summary Report

# DESIGN SUMMARY REPORT (DSR)

The DSR summarizes a basic project information in one document. Use judgment in completing the report since it covers a wide range of items that may not apply to all projects.

This report can be partially completed during the *Preliminary* Design Conference and updated throughout project development. The DSR will be reviewed in detail during the Design Conference.

Note: This Form is a record of the plan development and shall be retained for the life of the project.

---

Highway No.: _____

Name: _____

Length: _____

Project No.: _____

Limits From: _____

To: _____

Is project on National Highway System (NHS)? ☐ Yes ☐ No

If yes, does project require: ☐ State oversight ☐ Federal oversight

Type of work: _____

_____

Layman's description: _____

_____

Estimated construction cost:_____ Date of estimate: _____

Estimated right of way cost:_____ Date of estimate: _____

# Table of Contents

# Programming and Funding Data

Working Program: _____ Authorized Funds: _____ STIP Year: _____

**Breakdown of Funding Participation**

| | Preliminary Engineering | | Construction | | Right of Way | | Eligible Utility Relocation | |
|---|---|---|---|---|---|---|---|---|
| | % | $ | % | $ | % | $ | % | $ |
| Federal | | | | | | | | |
| State | | | | | | | | |
| County | | | | | | | | |
| City | | | | | | | | |
| | | | | | | | | |
| **Totals** | | | | | | | | |

Sidewalk funded by: _____

Curb and gutter funded by: Storm _____

drain system funded by: _____

Illumination to be maintained by: _____

List and describe active Minute Orders and agreements: _____

_____

Are advance funding agreements required? If yes, describe: ☐ Yes ☐ No

_____

Is unusual financing required? If yes, explain: ☐ Yes ☐ No

_____

If program estimate differs from authorized amount, explain overrun/underrun: _____

_____

_____

**See attached copy of current cost estimate.**

Tentative letting date: _____ Date of PS&E submission to City: _____

Should letting date be rescheduled? ☐ Yes ☐ No If yes, recommended letting date: _____

# Existing Elements

A. Existing typical section

1. No. of traffic lanes: _____ 2. Lane Width: _____ 3. Shoulder Width: _____

4. Median Width: _____ 5. Curb & Gutter: ☐ Yes ☐ No

B. Existing bridge data (including bridge-class culverts)

| Stream Name | Structure Number | Structure Length | Structure Type | Date of Construction | Sidewalk Width | Clear Rdwy. Width | Sufficiency Rating |
|---|---|---|---|---|---|---|---|
| | | | | | | | |
| | | | | | | | |

C. Existing cross drainage culvert data

| Station | Number of Barrels | Sizes | Type (shape & material) |
|---|---|---|---|
| | | | |
| | | | |

D. Stream Data

1. Will channel work be required? If yes, linear feet disturbed? _____ ☐ Yes ☐ No Are permits needed? ☒ Yes ☐ No

2. If bridge shafts must be drilled in channel or stream bed, how will drilling rigs gain access? (e.g., cofferdams, drilling pads, or access roads) _____

E. Other (e.g., stock pass): _____

F. ROW Data

1. Existing ROW width: _____ 2. Estimated number of land owners: _____

3. Predominant land use: _____ 4. Soil types: _____

G. Existing constraints

1. Eligible historical structures: _____
2. Schools: _____
3. Parks: _____
4. Archeological sites: _____
5. Potential hazardous material sites: _____
6. Ecological (wetlands, habitats, etc.): _____
7. Airport (notify FAA, FAA Form 7460-1): _____
8. Other: _____

H. Highway-railroad (RR) grade crossings

1. Owner of RR: _____
2. Type of RR crossing surface material: ☐ concrete ☐ rubber ☐ wood
3. Type of warning devices: : ☐ passive ☐ cantilever flashing lights ☐ lights and gates ☐ mast signals
4. Do opportunities exist for consolidating or closing RR crossings? ☐ Yes ☐ No
5. Is there a highway-RR grade crossing adjacent (i.e., within about 500 ft) to a signalized highway intersection? ☒ Yes ☐ No
6. If yes, responsible office for determining the need for preemption: _____

I. Has crash analysis been performed? ☐ Yes ☐ No

# Advanced Project Development Elements

A. Surveying

1. Is planimetric needed? ☐ Yes ☐ No
2. Status of aerial photography: ☐ Complete ☐ In progress ☐ Not started ☐ Not proposed
3. Status of field surveys: ☐ Complete ☐ In progress ☐ Not started
4. Has vertical and horizontal control been established on the ground? ☐ Yes ☐ No
5. Additional elements to be surveyed (drainage channels, intersecting streets, etc.)

   _____

6. Is existing ROW staking required? ☐ Yes ☐ No
   Status: ☐ Complete ☐ In progress ☐ Not started Responsible office: _____
7. Comments: _____

B. Schematic development

1. Is a geometric schematic required? ☐ Yes ☐ No If yes, responsible office: _____
2. Is a signing schematic required? ☐ Yes ☐ No If yes, responsible office: _____
3. Schematic status
   a. Percent Complete _____%
   b. Approval authority: ☐ FHWA ☐ TxDOT ☐ CoRR
   c. Need preliminary schematic by: _____
   d. Need approved schematic by: _____
   e. Approval date: _____
4. Comments: _____
5. Public Hearing: ☐ Scheduled ☐ Opp. Afforded ☐ Held ☐ Not Required Date: _____
6. What type of 3D model will be developed? (Choose all that apply) ☐ Basic Corridor Model ☐ Automated Machine Guidance ☐ Visualization Model ☐ Contract Model Comments: _____

C. Environmental Commitments & Issues

1. Anticipated type of environmental document required: ☐ CE ☐ EA ☐ EIS
2. Office responsible for preparing environmental document: _____
3. Has environmental document been approved? ☐ Yes ☐ No
4. Public Meetings: ☐ Proposed ☐ Not Proposed ☐ Scheduled ☐ Held ☐ MAPO
   Dates: _____
5. Public Hearing: ☐ Scheduled ☐ Opp. Afforded ☐ Held ☐ Not Required Date: _____
6. Environmental commitments
   a. Noise _____
   b. Air quality _____
   c. Wetlands/Section 404 Permit: _____
      1. Individual permit required? _____
      2. Nationwide permit required? _____
   d. Water quality: _____
   e. Natural Resources: _____
      1. Vegetation: _____
      2. Endangered species: _____
      3. Other: _____
   f. Cultural resources _____
      1. Archeology: _____
      2. Historical: _____
   g. Social, economic, environmental justice: _____
   h. 4f, 6f: _____
   i. Other: _____
7. Are hazardous materials issues anticipated? ☐ Yes ☐ No
8. Environmental Issues Permits Commitments (EPIC) Sheet completed? ☐ Yes ☐ No
9. Office responsible for fulfilling commitments: _____
10. Comments _____

# Proposed Right of Way & Utility Elements

A. Right of way elements

1. Usual ROW width:_____
2. Additional ROW needed to accommodate design features (side slopes, sound walls, etc.)

   _____
3. Have adjacent property owners been identified? ☐ Yes ☐ No
4. Is additional ROW required? ☐ Yes ☐ No
5. How many parcels will be involved in ROW acquisition? _____
6. Are easements required (drainage or construction? ☐ Yes ☐ No
7. Is control of access needed? ☐ Yes ☐ No
8. Have ROW map/plats/descriptions been prepared for parcels? ☐ Yes ☐ No
9. Is relocation assistance required? ☐ Yes ☐ No
   a. Number of residences:_____
   b. Number of businesses:_____
   c. Other improvements: _____
10. Comments:_____

   _____

   _____

B. Major utility facilities

1. Preliminary utility inventory

| Utility | Type | Describe potential conflict |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

2. Have utility conflicts been determined? ☐ Yes ☐ No
3. Has Subsurface Utility Engineering been requested or performed to locate utilities? ☐ Yes ☐ No
4. Have utility agreements been prepared through district ROW office? ☐ Yes ☐ No

   Comments:_____

   _____

# Proposed Geometric Design Elements

*Note: Design features listed in tables may not apply to every project.*

Functional classification (select one):

☐ freeway ☐ arterial ☐ major collector ☐ minor collector ☐ local

Highway type (select one): ☐ urban freeway ☐ urban frontage road ☐ rural freeway ☐ rural frontage road

☐rural two-lane ☐ suburban roadway ☐ urban street ☐ bike/pedestrian trail ☐ rural multilane

Proposed work (select one): ☐ 4R/new construction ☐ 3R ☐ 2R Terrain (choose all that apply): ☐ level ☐ rolling

---

A. Traffic

| Street | Existing ADT | ADT (letting year) | ADT (design year) |
|---|---|---|---|
| | | | |
| | | | |

Unless the City of Round Rock provides this data, submit five-year and twenty-year forecasts of average daily traffic volumes including traffic loadings by axle load spectrum or vehicle classifications as defined by the FHWA on existing and proposed roads and streets within or affected by the facility.

B. Design criteria

| | Design Guidelines | | | Existing Value | Proposed Value |
|---|---|---|---|---|---|
| Design Elements | Minimum | Desirable | Figure/Table | | |
| Design speed | | | | | |
| Maximum horizontal curvature | | | | | |
| Maximum superelevation rate | | | | | |
| K value - sag | | | | | |
| K value - crest | | | | | |
| Maximum grade | | | | | |
| Minimum grade | | | | | |
| Other: | | | | | |

C. Roadside features **(See attached typical sections.)**

| Roadside Feature | Unit | Value | Comments |
|---|---|---|---|
| Border | width | | |
| Sidewalk Location: | width | | |
| Cross slope - sidewalk | % | | |
| Ditch front slope -usual | ratio | | |
| Ditch front slop - maximum | ratio | | |
| Ditch back slope - usual | ratio | | |
| Ditch back slope - maximum | ratio | | |
| Maximum fill height before retaining wall | height | | |
| Clear zone | width | | |
| Other: | | | |

# Proposed Geometric Design Elements (continued)

**D.** Roadway surface features **(See attached typical sections.)**

| Roadway Feature | | Dimension | Comments |
|---|---|---|---|
| **Thru Lanes** | **Proposed** | | |
| | **Ultimate** | | |
| **Other Longitudinal elements** | **Bike Lane (on-street)** | | |
| | **Shared-use curb lane** | | |
| | **Parking** | | |
| | **Bridge width** | | |
| | **Curb offset** | | |
| **Shoulders (ML)** | **Inside** | | |
| | **Outside** | | |
| **Median** | **Raised** | | |
| | **Flush** | | |
| | **Depressed** | | |
| | **Opening spacing** | | |
| | **Opening width** | | |
| **Speed Change Lanes** | **Lane width** | | |
| | **Storage length** | | |
| | **Taper length** | | |
| | **Shoulders** | | |
| **Cross Slopes** | **Thru lanes** | | |
| | **Shoulders** | | |
| **Structure clearances** | **Horizontal** | | |
| | **Vertical** | | |

In order to accommodate OS/OW loads on frequently permitted routes, design consideration for vertical clearance on new structures should not be limited to other vertical clearances along the route. Even though it may take a generation or longer to increase vertical clearance throughout a frequently permitted route, progression toward that goal has to be considered for each new structure in conversation with the Transportation Director's office and City Highway maintenance personnel.

When selecting lane widths, horizontal and vertical clearances, pavement designs and turning radii at intersections consideration should be given to whether the facility is already a permitted or possibly permitted as an oversize and overweight (OS/OW) load route. The Transportation Director's office or the City's Maintenance Records could provide useful information in making this determination. To accommodate the overheight loads increased vertical clearance could be considered, as well as consider the option to design the facility carrying the OS/OW loads to go over the other facilities. Providing increased lane widths and performing evaluations of the pavement designs using the "Modified Texas Triaxial Design Method" will ensure accommodation of wide and overweight loads and help with deterioration of pavements and save on the system's maintenance costs.

**E.** Connecting roadways **(See attached typical sections.)**

| Design Element | Ramps | Direct Connectors | Crossroads |
|---|---|---|---|
| Design speed | | | |
| Maximum horizontal curve | | | |
| Maximum grade | | | |
| Minimum grade | | | |
| Proper number of lanes | | | |
| Lane width | | | |
| Inside shoulder | | | |
| Outside shoulder | | | |
| Other: | | | |

F. Are design exceptions/waivers required? ☐ Yes ☐ No

If yes, what design elements? _____

_____

# Proposed Bridge Design Data

A. Design data for structures

| | Structure Number | Structure Location | Clearance | | Clear Rdwy. width | Length | Over-pass OR under-pass | Foundation type | Super-structure type | Sub-structure type |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Horiz. | Vert. | | | | | | |
| 1 | | | | | | | | | | |
| 2 | | | | | | | | | | |
| 3 | | | | | | | | | | |
| 4 | | | | | | | | | | |
| 5 | | | | | | | | | | |
| 6 | | | | | | | | | | |

| **Structure Number** (repeat from above) | **Railroad crossing?** (Yes/No) | **Type of Existing Rail** | **Type of Proposed Rail** | **Proposed approach treatment** | **Turn-arounds provided?** (width) | **Retaining walls proposed?** (type) | **Bridge widening** (describe existing & proposed) | **Are bridge design exceptions/ waivers required? If yes, for what design elements?** | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 1 |
| | | | | | | | | | 2 |
| | | | | | | | | | 3 |
| | | | | | | | | | 4 |
| | | | | | | | | | 5 |
| | | | | | | | | | 6 |

B. Bridge widths are for: ☐ proposed number of lanes ☐ ultimate number of lanes

C. Are bridge widths controlled by traffic handling? ☐ Yes ☐ No

# Proposed Hydraulic Elements

A. TxDOT design frequency

**Notes:**
Table shown below is in the TxDOT Hydraulic Design Manual.

Shaded boxes denote recommended design frequencies.

When multiple design frequencies are given, select a frequency by checking a box (☐).

Federal law requires interstate highways to be provided with protection from the 50-year flood event, and facilities such as underpasses and depressed roadways where no overflow relief is available should be designed for the 50-year event.

| **Functional Classification and Structure Type** | | | | | | **Check 100-yr Flood?** |
|---|---|---|---|---|---|---|
| | 2 | 5 | 10 | 25 | 50 | |
| **Freeways** (main lanes) | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Culverts | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| Bridges | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| **Principal arterials** | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Culverts | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| Small bridges | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| Major river crossings | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| **Minor arterials and collectors** (including frontage roads) | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Culverts | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| Small bridges | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| Major river crossings | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| **Local roads and streets** (off-system projects) | ☐ | ☐ | ☐ | ☐ | ☐ | |
| Culverts | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| Small bridges | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| **Storm drain systems** | | | | | | |
| Controlled access highways (main lanes) | | | | | | Yes |
| inlets and drain pipe | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| inlets for depressed roadways | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| Other highways and frontage | | | | | | |
| inlets and drain pipe | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| inlets for depressed roadways | ☐ | ☐ | ☐ | ☐ | ☐ | Yes |
| **Other:** | ☐ | ☐ | ☐ | ☐ | ☐ | |

# Proposed Hydraulic Elements (continued)

B. If design frequency is other than TxDOT guidelines, where it is to be used and the reason (e.g., to use in designing off system facilities or to comply with FEMA requirements)?

_____

C. Comments on special hydrologic considerations (e.g., Basin is regulated by reservoirs, unit hydrograph and routing techniques in HEC-HMS used in lieu of regression equations):

_____

D. Safety end treatment proposed

Parallel drainage structures: _____

Cross drainage structures: _____

E. Will outfall channels be provided? ☐ Yes ☐ No

If yes, by whom? _____

F. Will outfall channels be maintained by others? ☐ Yes ☐ No

If yes, by whom? _____

G. Will others have to approve hydraulic design? ☐ Yes ☐ No

If yes, by whom? _____

H. Will others participate in funding hydraulic structures (e.g., joint ditch agreements with railroads)? ☐ Yes ☐ No

If yes, who? _____

I. For storm drain design, is there potential for future development that may redirect flows normally away from the project back to the project?

☐ Yes ☐ No

If yes, will the actual "modified" contributing drainage area be used if known or will an estimate of a 150' wide area be used instead when the actual modification is not known?

_____

J. Will pump stations be required? ☐ Yes ☐ No

If yes, approximate locations? _____

K. Is this an evacuation route where roadway elevation is critical? ☐ Yes ☐ No

If yes, explain? _____

L. Is the design of any special drainage facility required? ☐ Yes ☐ No

If yes, explain? _____

M. Which hydraulic programs will be required for analysis? _____

_____

N. Are flood insurance study streams within project limits? ☐ Yes ☐ No

If yes, which streams and what type of map is designated (e.g., Flood Hazard and Boundary Map)?

_____

_____

# Proposed Hydraulic Elements (continued)

O. Informal FEMA coordination should always be initiated early in project development to identify any pertinent issues such as the availability or loss of the accumulative 1-foot rise to previous development. Has the informal FEMA coordination revealed any special issues that may require formal coordination (e.g., such as a no remaining rise or the presence of a designated floodway)? ☐ Yes ☐ No

P. Is there any existing development in the floodplain that may be impacted at any stage by changes (no matter how small) brought about by the project, regardless of whether the project meets FEMA standards? ☐ Yes ☐ No

# Proposed Pavement Structure Elements

A. Describe existing pavement: _____

B. Is existing roadway load zoned? ☐ Yes ☐ No

Limits From: _____

To: _____

C. Has pavement design been prepared? ☐ Yes ☐ No

Responsible office: _____ Been approved? ☐ Yes ☐ No

**D.** Proposed pavement structure **(See attached typical sections.)**

Describe thickness and material type of each layer.

| Pavement Structure Element | Roadway | Shoulder |
|---|---|---|
| Widen existing | | |
| Main lanes | | |
| Frontage roads | | |
| Direct connectors | | |
| Ramps | | |
| Detours | | |
| Crossroads | | |
| Other: | | |

# Proposed Traffic Operations Elements

A. Are signing, delineation, and pavement markings to be included in construction plans? ☐ Yes ☐ No

If yes, responsible office: _____

B. Is signalization proposed? ☐ Yes ☐ No

If yes, are traffic signals warranted? ☐ Yes ☐ No Resp. office for developing plans: _____

C. Is there a highway-railroad grade crossing adjacent (i.e., within about 500 ft. (152 m)) to a signalized highway intersection?

☐ Yes ☐ No If yes, responsible office for determining the need for pre-emption: _____

D. Is safety lighting proposed? ☐ Yes ☐ No

If yes, is illumination warranted? ☐ Yes ☐ No Resp. office for developing plans: _____

E. Is continuous lighting proposed? ☐ Yes ☐ No

If yes, is illumination warranted? ☐ Yes ☐ No Resp. office for developing plans: _____

F. Are Intelligent Transportation System (ITS) items proposed? ☐ Yes ☐ No

If yes, are proposed ITS items included in the regional ITS plan? ☐ Yes ☐ No

Comments: _____

ROUND ROCK TEXAS

# Proposed Miscellaneous Elements

A. Geotechnical exploration

1. Roadway

Is geotechnical investigation needed? ☐ Yes ☐ No

If yes, explain: _____

Is geotechnical investigation available? ☐ Yes ☐ No

2. Bridges (list bridges requiring foundation exploration)

_____

3. Walls (list retaining walls or noise walls requiring foundation exploration)

_____

4. Storm drains

_____

5. Miscellaneous (e.g., overhead sign bridges, high mast illumination)

_____

6. Office responsible for geotechnical exploration (borings): _____

7. Is a $D_{50}$ (grain size determination) for scour analysis on the proposed structure at the stream crossing required from the lab?
☐ Yes ☐ No

B. Sequence of construction (Outline probable stages. **See attached typical sections.**)

1. Stage I: _____

2. Stage II: _____

3. Additional stages: _____

C. Will median openings require approval by others? ☐ Yes ☐ No

If yes, by whom? _____

D. Are requirements satisfied for the Americans with Disabilities Act Accessibility Guidelines (ADAAG) and the Texas Accessibility Standards (TAS)? ☐ Yes ☐ No
Comments: _____

E. Are railroad agreements needed? ☐ Yes ☐ No

If yes, where? _____

F. Are airway/highway clearance permits required? ☐ Yes ☐ No

1. For roadway: _____

2. For other (e.g., high mast illumination: _____

G. What type of erosion control is proposed?

1. Fills: _____

2. Is a stormwater pollution prevention plan (SW3P) proposed? ☐ Yes ☐ No

3. Other: _____

H. Does the project require a Value Engineering Study? ☐ Yes ☐ No

I. Is a Safety Review Committee (or multi-discipline team) review required? ☐ Yes ☐ No

J. Does design address requirements of environmental permits and environmental concerns? ☐ Yes ☐ No

K. Comments: _____

# Appendix

# Comments and Concurrence

CoRR Comments: _____

_____

_____

_____

_____ Signed _____ Date

_____ Title

TxDOT Comments: _____

_____

_____

_____

_____ Signed _____ Date

_____ Title

FHWA Comments: _____

_____

_____

_____

_____ Signed _____ Date

_____ Title

**Note:** Concurrence with this report does not imply approval of any design exceptions or waivers referred to herein.

# Suggested Attendance

Date of conference: _____ Location of conference: _____

| | **INVITED** (name) | **ATTENDED** (name) |
|---|---|---|
| City of Round Rock staff | | |
| Transportation Director | | |
| Highway Engineer | | |
| Highway Supervisor | | |
| Traffic Engineer | | |
| | | |
| TxDOT division offices | | |
| FHWA | | |
| bicycle groups | | |
| city and county | | |
| consultants | | |
| environmental resource agencies | | |
| federal transit authority | | |
| MPO director or staff | | |
| transit operators | | |
| trucking industry | | |
| utility companies | | |
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| Others (e.g., Chamber of Commerce) | | |
| 1) | | |
| 2) | | |
| 3) | | |

# Suggested Agenda

**Prior to the Preliminary Design Conference, experienced district representatives from traffic operations, design, construction and maintenance should visit the site together to review existing conditions.**

Background
- existing elements
- funding
- surveys, studies, and data
- agreements and permits
- problematic features
- Feasibility Study or Major Investment Study Findings

Project Scope Corridor

issues
- mobility & transportation
- operations & maintenance
- planned/funded projects

Environmental issues

Multimodal issues Alternatives

Schematics

Public Involvement Plan
- stakeholders
- public meeting and public hearing

Environmental Documents and Commitments made

Detailed Design Criteria Project

development criteria
- Level of Service
- control of access
- geometric design
- hydraulic design
- bridge design
- pavement design
- traffic operations design
- landscape and aesthetic design
- constructability

Right of Way
- new ROW required
- easements required
- utility adjustments
- control of access

Maintenance

Permits, agreements, and coordination with:
- outside entities
- Federal, State, City, or County
- railroads

# Site Visit

Planning Stage site analysis of land, location, and possible environmental impacts can improve scope development and reduce key feature(s) oversight. Documents and media files gathered during a site visit by subject matter experts can aid preliminary design and project estimate development.

| Site Visit Date(s) | Name | Company/Organization | Role |
|---|---|---|---|
| | | | |
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## Suggested Report Material

Consider attaching the following to this report:

PURPOSE AND NEED STATEMENT

*

DRAFT ALTERNATIVES SCREENING AND EVALUATION CRITERIA

*

PUBLIC INVOLVEMENT PLAN

*

PROJECT DEVELOPMENT SCHEDULE

*

DESCRIPTION OF KEY STAFF ROLES AND RESPONSIBILITIES

*

AGREEMENTS REACHED BETWEEN CONFERENCE PARTICIPANTS

*

ATTACHMENTS

Conference minutes or notes
Typical Sections
Proposed Basic Design Data Form
Location Map (optional)

# 9.6.B Design Exception / Waiver Request

# DESIGN EXCEPTION / DESIGN WAIVER REQUEST

## Project Description

Project Name: Enter project name

Description of Work: Enter project location and description. Use shift+enter to start a new paragraph.

## General Information

Type of Request: Design Exception☐ Design Waiver☐

Route and Design Classification:

| | | | |
|---|---|---|---|
| Rural | ☐ | Local | ☐ |
| Suburban | ☐ | Collector | ☐ |
| Urban | ☐ | Arterial | ☐ |

Traffic: Posted Speed: Speed mph
Design Speed: Speed mph

Current ADT: Enter ADT.
Design ADT: Enter ADT.
D: D %
K: K %
T: T %

Other traffic considerations: Provide description.

## Work Classification

Work Type

- ○ New / Reconstruction
- ○ Spot Replacement
- ◉ Major Rehabilitation
- ○ Minor Rehabilitation
- ○ Structural Improvement
- ○ Preventive Maintenance

Applicable Design Guideline: Choose an item.

Provide supporting documentation/exhibits for the request. (Exhibits may include typical sections, geometric details, correspondence from other sections, agencies, etc.)

1. Design Exception/Design Waiver for the following element(s) of work. Mark all requested.

Controlling Criteria

| | | | |
|---|---|---|---|
| Design Speed * | ☐ | Clear Zone | ☐ |
| Lane Width * | ☐ | Cross Slope * | ☐ |
| Super elevation * | ☐ | Guardrail | ☐ |
| Shoulder Width * | ☐ | Vertical Clearance * | ☐ |
| Vertical Alignment * | ☐ | Bridge Width * | ☐ |
| Horizontal Alignment * | ☐ | Structural Capacity * | ☐ |
| Stopping Sight Distance * | ☐ | Horizontal Clearance | ☐ |
| Grade * | ☐ | Hydraulic Design Storm | ☐ |
| Median Width | ☐ | | |
| Lateral Offset to Obstruction * (FHWA criteria only) | | | ☐ |

* FHWA Controlling Design Criteria. An exception from FHWA is required. Note that FHWA only requires that the minimum values cited in the *Green Book* be met.

Other ☐

Explain: Provide explanation of other elements requested.

2. *Provide a synopsis of the scope of the project, the situation encountered and the problem to be mitigated.*
   Provide description.

3. *Describe the proposed design exception/waiver. Provide the proposed and standard values of the design exception/waiver element, citing City of Round Rock Transportation Criteria Manual, TxDOT Roadway Design Manual, AASHTO, TMUTCD or other criteria.*
   Provide description.

4. *Discuss the project's compatibility with adjacent roadway sections.*
   Provide description.

5. *Discuss alternatives to the exception that were considered.*
   Provide description.

6. *Provide a safety review of the project and as it relates to the proposed design exception/waiver. All Design Exceptions must have a Safety Review and Crash Analysis.*
   Provide description.

7. *Discuss the cost of the project (construction and right of way) and the cost differential between proposed design and a design that would meet guidelines.*
   Provide description.

8. *Discuss impacts other than costs of bringing the features up to standard (such as impacts to other design features, the natural and built environment, historical features, construction issues, social concerns, reduction of design life, etc.)*
   Provide description.

9. *Discuss proposed mitigation to address design exception feature, if applicable. Possible countermeasures may include advisory signs, lighting, guardrail, signing, rumble strips, future work to address design exception, incremental improvement, etc.*
   *See link: FHWA - Mitigation Strategies for Design Exceptions*
   Provide description.

Required Signatures

| | |
|---|---|
| Prepared By: | Printed Name: |
| | Title: |
| Date: | Firm: |

| | |
|---|---|
| Approved By City of Round Rock Transportation Director: | Date: |

# 9.6.C Design Checklists

Project Name/Number: _____

Type of Work: _____

Schematic Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

**Completed Checklist Must be Submitted with Plans**

### General

_____ City name & logo, Project name, roadway name and limits, Project length, Bridge length (if applicable) and Project description

_____ Design block including roadway classification, design speed, and traffic data, including current and design ADT, truck percent, directional distribution, and design DHV

_____ Vicinity map

_____ If applicable, the existing and proposed control of access lines

_____ Existing and proposed traffic volumes and, as applicable, turning movement volumes

_____ Direction of traffic flow on all roadways

_____ Geometrics of speed change and auxiliary lanes

_____ Governing specifications and date of adoption

### Project Layout

_____ A suitable scale shall be utilized to clearly show project features, such as the beginning and end of the project, street names, baseline stations, horizontal alignment data, existing and proposed ROW, advance project warning signs, or any other pertinent information not shown elsewhere in the plan set.

_____ Scale shall not be smaller than 1 inch = 400 ft.

_____ The station and coordinates of the beginning and ending project points shall be labeled.

_____ The location of interchanges, mainlanes, grade separations, frontage roads, turnarounds, and ramps

_____ For freeways, the location and text of the proposed mainlane guide signs should be shown. Lane lines and/or arrows indicating the number of lanes should be shown

_____ Location of retaining walls and/or noise walls

### Typical Sections

_____ Existing section shows the existing ROW, approximate lane and median widths, lane direction, shoulders, curbs, rail, border width, pavement structure and Station limits.

_____ Proposed sections illustrate the depths, dimensions, and station limits for every type of material in the proposed pavement structure.

_____ Proposed Typical Section including ROW, lane widths, lane direction, shoulders, curbs, rail, border width, Horizontal Control, Design Values, Minimum Design Values, Design Exception (if applicable), and Station limits for all roadways (main roadways, major and minor side streets, and ramps)

_____ Exclude bridge limits and ensure typical bridge section is included, if applicable

_____ Type and depth for all pavement layers including any subgrade preparation

_____ Show incidental roadway items such as curb and gutters, sidewalk, guardrail, underdrains, geotextile fabrics, barriers, etc.

_____ Control point for the Profile Grade Line (PGL)

_____ Project baseline and roadway centerline locations

_____ Cross slopes in percent (%) on roadway and shoulders; Side slopes as ratio (H:V) outside of shoulders.

_____ Include a typical section for each unique section of roadway.

Project Name/Number: _____

Type of Work: _____

Schematic Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Traffic Control

_____ Sequence of construction general notes

_____ Sequence of work outline for Traffic Control (showing basic concept of how to handle traffic during construction, including preliminary phasing)

_____ Preliminary Intersection Layouts

### Roadway Plans

_____ North arrow, scale and legend

_____ Existing roadway features including: roadway alignments, edge of pavement and curb, medians, driveways, drainage structures, utilities, sidewalks, etc. Existing roadways and structures to be closed or removed.

_____ Boundaries (city, county, etc.), bodies of water (streams, lakes, rivers, etc.), street and roadway names.

_____ Alignment baseline stationing tick marks and labels every 100 ft, curve and point of intersection data, bearings, equations, and critical points stations such as PIs, PCs, PTs, etc.

_____ Intersection data (Stations, edge of pavement radius, etc.) of all proposed driveways and connecting roadways

_____ Begin & end project notation and Stations to cover all proposed work

_____ Existing and proposed ROW and permanent easement lines and widths at each break within project limits

_____ Proposed pavement (lane and shoulder) widths and cross slopes at all break points and transitions, lane direction arrow, prop. curb and sidewalks

_____ Indicate structure number, quantity, location, type, size of all proposed drainage structures

_____ Show location, type, and limits or lengths of proposed roadway elements with appropriate notation

_____ Ensure Minimum Design Values are met

_____ Show all work constrained to ROW and/or easements, including temporary construction easements and structure demolition limits

### Roadway Profiles

_____ Stations along bottom at 50 ft intervals and datum elevations along the sides

_____ Profile grade line (PGL) and existing ground line with elevations at 50' to 2 decimal places

_____ Vertical alignment data (Grades in percent to 2 decimal places, VPI Station, elevation, curve length, K value, begin and end curve Station and elevation, etc.)

_____ Show all proposed drainage or other structures

_____ Show existing utilities

_____ Vertical Clearances (where applicable)

_____ Ensure Minimum K-values are met

Project Name/Number: _____

Type of Work: _____

Schematic Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Bridge Typical Sections

_____ Roadway width and cross slope, shoulder width and cross slope
_____ Type, location, and width of barriers or bridge railing
_____ Show sidewalks, curbs, medians, etc.
_____ Type, location, depth, and width of structural elements (deck, railing, beams, etc.)
_____ Show baseline location and applicable station ranges
_____ Show control point for Profile Grade Line (PGL)

### Design Submittal Supplements

_____ Design Summary Form
_____ Design schedule – update
_____ Construction cost estimate
_____ Construction time determination estimate
_____ Geotechnical investigations report, if applicable
_____ Drainage report, if applicable

Notes or comments:



_____ _____
ENGINEER OF RECORD Date

Print Sign

Project Name/Number: _____

Type of Work: _____

30% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

**Completed Checklist Must be Submitted with Plans**

### Title Sheet

_____ City name & logo, Project name, roadway name and limits, Project length, Bridge length (if applicable) and Project description

_____ Design block including roadway classification, design speed, and traffic data, including current and design ADT, truck percent, directional distribution, and design DHV

_____ Vicinity map

_____ Sheet index (sheet numbers and descriptions – if not separate sheet)

### Project Layout

_____ A suitable scale shall be utilized to clearly depict and label existing and proposed project features.

_____ The station and coordinates of the beginning and ending project points shall be labeled.

### Typical Sections

_____ Existing typical section showing the ROW, approximate lane and median widths, lane direction, shoulders, curbs, rail, border width, pavement structure and Station limits.

_____ Proposed Typical Section including ROW, lane widths, lane direction, shoulders, curbs, rail, border width, Horizontal Control, Design Values, Minimum Design Values, Design Exception (if applicable), and Station limits for all roadways (main roadways, major and minor side streets, and ramps)

_____ Proposed sections illustrate the depths, dimensions, and station limits for every type of material in the proposed pavement structure, including subgrade preparation.

_____ Exclude bridge limits and ensure typical bridge section is included, if applicable

_____ Type and depth for all pavement layers including any subgrade preparation

_____ Show incidental roadway items such as curb and gutters, sidewalk, guardrail, underdrains, geotextile fabrics, barriers, etc.

_____ Control point for the Profile Grade Line (PGL)

_____ Project baseline and roadway centerline locations

_____ Cross slopes in percent (%) on roadway and shoulders; Side slopes as ratio (H:V) outside of shoulders.

_____ Include a typical section for each unique section of roadway.

### General Notes

_____ General design notes applicable to the project.

### Survey Data

_____ Benchmark locations and numbers

_____ Control point coordinates, locations, elevations, and detailed descriptions

_____ Notation to vertical datum and the horizontal coordinate system

_____ Horizontal alignment and annotation (Stations, bearings, PC's, PT's, etc.)

Project Name/Number: _____

Type of Work: _____

30% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Quantity Sheets

_____ Preliminary Summary Sheets (Major Bid Items and Totals)

### Traffic Control

_____ Sequence of construction general notes

_____ Sequence of work outline for Traffic Control (showing basic concept of how to handle traffic during construction, including preliminary phasing)

_____ Preliminary Intersection Layouts

### Roadway Plans

_____ North arrow, scale and legend

_____ Show existing roadway features including: roadway alignments, edge of pavement and curb, medians, driveways, drainage structures, utilities, sidewalks, etc. Existing roadways and structures to be closed or removed.

_____ Boundaries (city, county, etc.), bodies of water (streams, lakes, rivers, etc.), street and roadway names

_____ Alignment baseline stationing tick marks and labels every 100 ft., curve and point of intersection data, bearings, equations, and critical points stations such as PIs, PCs, PTs, etc.

_____ Intersection data (Stations, edge of pavement radius, etc.) of all proposed driveways and connecting roadways

_____ Begin & end project notation and Stations to cover all proposed work

_____ Existing and proposed ROW and permanent easement lines and widths at each break within project limits

_____ Proposed pavement (lane and shoulder) widths and cross slopes at all break points and transitions, lane direction arrow, prop. curb and sidewalks

_____ Indicate structure number, quantity, location, type, size of all proposed drainage structures

_____ Show location, type, and limits or lengths of proposed roadway elements with appropriate notation

_____ Ensure Minimum Design Values are met

_____ Show all work constrained to ROW and/or easements, including temporary construction easements and structure demolition limits

### Roadway Profile

_____ Stations along bottom at 50 ft. intervals and datum elevations along the sides

_____ Profile grade line (PGL) and existing ground line with elevations at 50' to 2 decimal places

_____ Vertical alignment data (Grades in percent to 2 decimal places, VPI Station, elevation, curve length, K value, begin and end curve Station and elevation, etc.)

_____ Show all proposed drainage or other structures

_____ Show existing utilities

_____ Vertical Clearances (where applicable)

_____ Ensure Minimum K-values are met

Project Name/Number: _____

Type of Work: _____

30% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Culvert Layouts

_____ Plan and profile view for bridge class culverts or cross section for regular culverts

_____ Plan view – north arrow, begin & end of structure Stations and elevations, structure & roadway baselines with skew angle, traffic flow direction, etc.

_____ Roadway cross section along culvert centerline

_____ Existing & proposed grade lines, ROW lines and width, easements, etc.

_____ Roadway baseline, skew angle, and flow direction

_____ Structure slope & flow line elevations, upstream and downstream soil slopes, and structure dimensions from baseline

_____ Length, size, type, skew, and slope of structure

_____ End treatment size, type, and dimensions

### Drainage Plan and Profile

_____ Show legend for plan and profile elements

_____ Plan – north arrow, baseline stations, ROW

_____ Plan – show drainage area boundaries

_____ Plan – show drainage structures (number, type, length, layout, station, offset, etc.), links (number, type, length, flow direction, etc.), and outlet pipes (number, flow direction, etc.)

_____ Profile – show drainage structures (number, layout, type, control elevations), links (layout, size, type, length, design flow, flow capacity, etc.), and hydraulic grade line (HGL)

_____ Profile – show natural ground and PGL

### Utilities

_____ Include utility layout sheets showing latest information for existing utilities

### Retaining Walls

_____ Preliminary retaining wall layouts showing limits, ranges in height, and type of wall

_____ Orientation: place walls on the plan sheet such that the elevation is looking at the "Front face" of the retaining wall. Rotate the plan view to correspond with the elevation. Show appropriate roadway stationing and north arrow

_____ Plot the soil core boring locations

_____ Show ROW where applicable

Project Name/Number: _____

Type of Work: _____

30% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Bridge Layout – Plan View

_____ Baselines with stations, bearings, alignment data, and north arrow

_____ Pavement width (roadway & shoulders), and traffic flow or stream flow

_____ Cross slope and superelevation data

_____ Begin and end structure stations

_____ ROW & easement lines

_____ Bent stations and bearings

_____ Skew angle of structure and bents

_____ Existing contours

_____ Railing type, location, and limits

_____ Limits & slope of riprap or erosion control treatment

### Bridge Layout – Profile View

_____ Provide national bridge inventory (NBI) number, if applicable

_____ Type, length, and size of units or spans

_____ Overall length, payment limits, railing type & post spacing

_____ Existing & proposed ground lines with elevations

_____ Existing & proposed water surface elevations for design year storm if applicable

_____ Vertical curve data and grades

_____ Begin and end structure stations and elevations

_____ Bent numbers & fixed/ expansion conditions at all bents

_____ Column heights and type, length, size, and number of foundation elements

_____ Limits & slope of riprap or erosion control treatment

### Bridge Typical Sections

_____ Roadway width and cross slope, shoulder width and cross slope

_____ Type, location, and width of barriers or bridge railing

_____ Show sidewalks, curbs, medians, etc.

_____ Type, location, depth, and width of structural elements (deck, railing, beams, etc.)

_____ Show baseline location and applicable station ranges

_____ Show control point for Profile Grade Line (PGL)

Project Name/Number: _____

Type of Work: _____

30% Submission

## Design and Construction Standards - Plan Checklist

### Design Submittal Supplements

_____ Design Summary Report (DSR)

_____ Design schedule - update

_____ Initial construction cost estimate

_____ Initial construction time determination

_____ Special Provision form for right-of-way acquisition

_____ Special Provision form for utility relocations

_____ Special Provision form for environmental clearance

_____ Geotechnical investigations report

_____ Drainage report, if applicable

_____ Database of property owner information and executed Right-of-Entry forms

_____ Submittal package in pdf format

Notes and comments:



_____ _____

ENGINEER OF RECORD Date

Print Sign

Project Name/Number: _____

Type of Work: _____

60% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

**Completed Checklist Must be Submitted with Plans**

### Title Sheet

_____ City name & logo, Project name, roadway name and limits, Project length, Bridge length (if applicable) and Project description

_____ Design block including roadway classification, design speed, and traffic data, including current and design ADT, truck percent, directional distribution, and design DHV

_____ Project length (roadway length, bridge length, and total length) in feet to 2 decimal places and in miles to 3 decimal places

_____ Vicinity map (north arrow, project location, project limits, equations, exceptions to project length, city and county names, highway designation, road and street names, and name and description of adjoining projects

_____ Key map (City map and Project location)

_____ Signature blocks (provisions for signatures of officials approving the plans – Design Engineer, City of Round Rock officials)

_____ Miscellaneous (watershed names, area of disturbed soil in acres, and design exceptions)

_____ Copyright statement

_____ Applicable Standard Specifications

_____ Complete sheet index (sheet numbers & descriptions with no number overlaps or gaps)

### Project Layout

_____ A suitable scale shall be utilized to clearly depict and label existing and proposed project features.

_____ The station and coordinates of the beginning and ending project points shall be labeled.

_____ Project control point locations with coordinates, station/ offsets, and descriptions

_____ Horizontal alignment with annotation of all entities (bearings, PC's, PT's, etc.)

_____ Horizontal and vertical control data or reference

### Typical Sections

_____ Existing typical section showing the ROW, approximate lane and median widths, lane direction, shoulders, curbs, rail, border width, pavement structure and Station limits.

_____ Proposed Typical Section including ROW, lane widths, lane direction, shoulders, curbs, rail, border width, Horizontal Control, Design Values, Minimum Design Values, Design Exception (if applicable), and Station limits for all roadways (main roadways, major and minor side streets, and ramps)

_____ Proposed sections illustrate the depths, dimensions, and station limits for every type of material in the proposed pavement structure, including subgrade preparation.

_____ Exclude bridge limits and ensure typical bridge section is included, if applicable

_____ Type and depth for all pavement layers including any subgrade preparation

Project Name/Number: _____

Type of Work: _____

60% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Typical Sections (Cont.)

_____ Show incidental roadway items such as curb and gutters, sidewalk, guardrail, underdrains, geotextile fabrics, barriers, etc.

_____ Control point for the Profile Grade Line (PGL)

_____ Project baseline and roadway centerline locations

_____ Cross slopes in percent (%) on roadway and shoulders; Side slopes as ratio (H:V) outside of shoulders.

_____ Include a typical section for each unique section of roadway.

_____ Proposed sections for commercial and residential driveways

_____ Quantity rates and basis of estimate notes as necessary

_____ Topsoil and seeding widths, if applicable

_____ Superelevation pivot point location

_____ All transitions with Station limits

_____ Limits of material to be disposed or salvaged

_____ Approximate location and depth of main utilities with appropriate notes

_____ Typical sections for temporary construction if not included in TCP plans

### General Notes

_____ General design notes applicable to the project. See list of General Notes to be provided by the City of Round Rock

_____ Applicable notes for construction, traffic control, drainage, excavation, grading, embankment, utility relocation, right-of-way, tree protection, rigid & flexible pavement, roadway incidentals, signals, lighting, pavement markings, signs, etc.

### Survey Data

_____ Benchmark locations and numbers

_____ Control point coordinates, locations, elevations, and detailed descriptions

_____ Notation to vertical datum and the horizontal coordinate system

_____ Horizontal alignment and annotation (Stations, bearings, PC's, PT's, etc.)

### Quantity Sheets

_____ Preliminary Summary Sheets (Major Bid Items and Totals)

_____ All pay items are included on the summary sheet(s)

_____ Item descriptions agree with standard agency item descriptions and units

_____ All items have item code number, description, unit, quantities, and total

_____ Items for bid alternates

_____ Different summary tables for different project elements (roadway, drainage, etc.)

_____ Special notes or remarks

_____ All quantities per plan sheet (drainage & driveway items per structure & each)

_____ Acceptable culvert pipes & pipe type, class and thickness

Project Name/Number: _____

Type of Work: _____

60% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Traffic Control / Construction Sequence

_____ Sequence of construction general notes

_____ Sequence of work outline for Traffic Control (showing basic concept of how to handle traffic during construction, including preliminary phasing)

_____ Preliminary Intersection Layouts

_____ Traffic control plans, typical sections, and narrative for each construction phase

_____ Plans show proposed phase work, construction zones, temporary signs with standard numbers, temporary markings & markers with standard numbers, barricades, detours, traffic flow direction, location and dimension of all temporary traffic items, legend, scale, and seal or preliminary stamp

_____ Typical sections showing phase number and stations ranges, proposed and constructed work with dimensions for each phase, lane widths and flow direction of all traffic lanes, applicable channelizing devices between traffic lanes and construction zone, clear zones, baselines, and slopes of temporary and permanent graded and paved segments

_____ Narrative includes necessary steps for construction, traffic pattern changes, and day & time restrictions for lane reductions, roadway closures, or general work

_____ Apply appropriate plan legend and hatching to distinguish proposed work from constructed elements

_____ Verify all pavement drop-offs have proper treatment

_____ Verify all temporary barriers have proper end treatment

_____ Check for necessary speed reductions and apply signage accordingly

_____ Verify that all aspects of the whole project and its phases are constructible based on the information provided in the traffic control sheets

_____ Show or reference typical & modified traffic control application diagrams in accordance with TMUTCD and TxDOT Standards

### Roadway Plans

_____ North arrow, scale and legend

_____ Show existing roadway features including: roadway alignments, edge of pavement and curb, medians, driveways, drainage structures, utilities, sidewalks, etc. Existing roadways and structures to be closed or removed.

_____ Boundaries (city, county, etc.), bodies of water (streams, lakes, rivers, etc.), street and roadway names

_____ Alignment baseline stationing tick marks and labels every 100 ft, curve and point of intersection data, bearings, equations, and critical points stations such as PIs, PCs, PTs, etc.

_____ Intersection data (Stations, edge of pavement radius, etc.) of all proposed driveways and connecting roadways

_____ Begin & end project notation and Stations to cover all proposed work

_____ Existing and proposed ROW and permanent easement lines and widths at each break within project limits

_____ Proposed pavement (lane and shoulder) widths and cross slopes at all break points and transitions, lane direction arrow, prop. curb and sidewalks

Project Name/Number: _____

Type of Work: _____

60% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Roadway Plans (cont.)

_____ Indicate structure number, quantity, location, type, size of all proposed drainage structures

_____ Show location, type, and limits or lengths of proposed roadway elements with appropriate notation

_____ Ensure Minimum Design Values are met

_____ Show all work constrained to ROW and/or easements, including temporary construction easements and structure demolition limits

_____ Access control lines, notes, and limits

_____ Temporary construction or slope easements lines showing widths and limits

_____ Property lines and ownership data

_____ Superelevation, normal crown, and transition locations and limits

_____ Notation for structure removal, structure repair, or proposed structure (location, begin and end stations, type, dimensions, etc.) including bridges, retaining walls, sound walls, and sign bridges

_____ Location of borings or test pits for subsurface investigations

_____ Show erosion control items (location, type, limits, etc.) with labels, if separate plans are not provided

_____ Limits for ROW clearing, unsuitable material, pavement removal, etc.

### Roadway Profile

_____ Stations along bottom at 50 ft. intervals and datum elevations along the sides

_____ Profile grade line (PGL) and existing ground line with elevations at 50' to 2 decimal places

_____ Vertical alignment data (Grades in percent to 2 decimal places, VPI Station, elevation, curve length, K value, begin and end curve Station and elevation, etc.)

_____ Show all proposed drainage or other structures

_____ Show existing utilities

_____ Vertical Clearances (where applicable)

_____ Ensure Minimum K-values are met

_____ Show left and right ditch flow lines if not shown on Drainage P&P sheets

_____ Clearances for railroads, roads, streambeds, and between structures and/or utilities

_____ Show profiles for connecting roadways and driveways

_____ Show limits of proposed and existing grades

_____ Show begin and end Stations for proposed structures

Project Name/Number: _____

Type of Work: _____

60% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Drainage Area Map

_____ Watershed area, limits, and directional flow arrows

_____ Tributaries, highways, etc.

_____ County and city boundaries

_____ North arrow & project location

_____ Peak discharge computation method and flow values for 25 & 100 year storm events

### Hydraulic Data

_____ Peak discharge computation method and flow values for all design year storm events

_____ For bridges, show bridge cross section summary table (velocity, water surface elevation, energy grade line, flow area, and top width for the natural, existing, and proposed conditions for the design and 100-year flows at the various sections along the reach being modeled)

_____ For bridges, show bridge summary table (existing, proposed, and difference of water surface elevations for the design and 100-year storm events)

_____ For bridges, show typical stream cross section at the bridge location with proposed road profile

_____ For culverts, show input and output culvert hydraulic parameters

_____ For storm sewers, show input and output parameters for storm sewers

_____ For ditches, show input and output for open channel flow analysis data

### Culvert Layouts

_____ Plan and profile view for bridge class culverts or cross section for regular culverts

_____ Plan view – north arrow, begin & end of structure Stations and elevations, structure & roadway baselines with skew angle, traffic flow direction, etc.

_____ Roadway cross section along culvert centerline

_____ Existing & proposed grade lines, ROW lines and width, easements, etc.

_____ Roadway baseline, skew angle, and flow direction

_____ Structure slope & flow line elevations, upstream and downstream soil slopes, and structure dimensions from baseline

_____ Length, size, type, skew, and slope of structure

_____ End treatment size, type, and dimensions

_____ Show roadway elements (pavement depth & width, barriers, guardrail, slope treatment, etc.)

_____ Description of existing and proposed structure elements with proper labels for agency standards

_____ Erosion control treatment type, size, and depth

_____ Peak discharge, velocity, and upstream and downstream WSE of design storm

_____ Utilities and clearances to proposed elements

_____ Limits of trench excavation protection

Project Name/Number: _____

Type of Work: _____

60% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Drainage Plan and Profile

_____ Show legend for plan and profile elements

_____ Plan – north arrow, baseline stations, ROW

_____ Plan – show drainage area boundaries

_____ Plan – show drainage structures (number, type, length, layout, station, offset, etc.), links (number, type, length, flow direction, etc.), and outlet pipes (number, flow direction, etc.)

_____ Profile – show drainage structures (number, layout, type, control elevations), links (layout, size, type, length, design flow, flow capacity, etc.), and hydraulic grade line (HGL)

_____ Profile – show natural ground and PGL

_____ Plan – show ditch and channel alignments

_____ Profile – show flow lines for ditches and channels

_____ Reference to other roadway or drainage plans

### Utilities

_____ Include utility layout sheets showing latest information for existing utilities

### Retaining Walls

_____ Preliminary retaining wall layouts showing limits, ranges in height, and type of wall

_____ Orientation: place walls on the plan sheet such that the elevation is looking at the "Front face" of the retaining wall. Rotate the plan view to correspond with the elevation. Show appropriate roadway stationing and north arrow

_____ Plot the soil core boring locations

_____ Show ROW where applicable

_____ If flume or mowing strip is used, show limits if they vary from the wall limits.

_____ Present horizontal curve data

_____ When underdrains are used, show flowline elevations and outfall locations & elevations

_____ Groundwater levels for walls in cut sections

### Bridge Layout – Plan View

_____ Baselines with stations, bearings, alignment data, and north arrow

_____ Pavement width (roadway & shoulders), and traffic flow or stream flow

_____ Cross slope and superelevation data

_____ Begin and end structure stations

_____ ROW & easement lines

_____ Bent stations and bearings

_____ Skew angle of structure and bents

## Bridge Layout – Plan View (cont.)

_____ Limits & slope of riprap or erosion control treatment

_____ Existing contours

_____ Railing type, location, and limits

## Bridge Layout – Profile View

_____ Provide national bridge inventory (NBI) number, if applicable

_____ Type, length, and size of units or spans

_____ Overall length, payment limits, railing type & post spacing

_____ Existing & proposed ground lines with elevations

_____ Existing & proposed water surface elevations for design year storm if applicable

_____ Vertical curve data and grades

_____ Begin and end structure stations and elevations

_____ Bent numbers & fixed/ expansion conditions at all bents

_____ Column heights and type, length, size, and number of foundation elements

_____ Limits & slope of riprap or erosion control treatment

## Bridge Typical Sections

_____ Roadway width and cross slope, shoulder width and cross slope

_____ Type, location, and width of barriers or bridge railing

_____ Show sidewalks, curbs, medians, etc.

_____ Type, location, depth, and width of structural elements (deck, railing, beams, etc.)

_____ Show baseline location and applicable station ranges

_____ Show control point for Profile Grade Line (PGL)

Project Name/Number: _____

Type of Work: _____

60% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Design Submittal Supplements

_____ Design Summary Report (DSR)

_____ Design schedule - update

_____ Initial construction cost estimate

_____ Initial construction time determination

_____ Special Provision form for right-of-way acquisition

_____ Special Provision form for utility relocations

_____ Special Provision form for environmental clearance

_____ Geotechnical investigations report

_____ Drainage report, if applicable

_____ Database of property owner information and executed Right-of-Entry forms

_____ Submittal package in pdf format

Notes and comments:



_____ _____

ENGINEER OF RECORD Date

Print Sign

Project Name/Number: _____

Type of Work: _____

90% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

**Completed Checklist Must be Submitted with Plans**

### Title Sheet

_____ City name & logo, Project name, roadway name and limits, Project length, Bridge length (if applicable) and Project description

_____ Design block including roadway classification, design speed, and traffic data, including current and design ADT, truck percent, directional distribution, and design DHV

_____ Project length (roadway length, bridge length, and total length) in feet to 2 decimal places and in miles to 3 decimal places

_____ Vicinity map (north arrow, project location, project limits, equations, exceptions to project length, city and county names, highway designation, road and street names, and name and description of adjoining projects

_____ Key map (City map and Project location)

_____ Signature blocks (provisions for signatures of officials approving the plans – Design Engineer, City of Round Rock officials)

_____ Miscellaneous (watershed names, area of disturbed soil in acres, and design exceptions)

_____ Copyright statement

_____ Applicable Standard Specifications

_____ Complete sheet index (sheet numbers & descriptions with no number overlaps or gaps)

### Project Layout

_____ A suitable scale shall be utilized to clearly depict and label existing and proposed project features.

_____ The station and coordinates of the beginning and ending project points shall be labeled.

_____ Project control point locations with coordinates, station/ offsets, and descriptions

_____ Horizontal alignment with annotation of all entities (bearings, PC's, PT's, etc.)

_____ Horizontal and vertical control data or reference

### Typical Sections

_____ Existing typical section showing the ROW, approximate lane and median widths, lane direction, shoulders, curbs, rail, border width, pavement structure and Station limits.

_____ Proposed Typical Section including ROW, lane widths, lane direction, shoulders, curbs, rail, border width, Horizontal Control, Design Values, Minimum Design Values, Design Exception (if applicable), and Station limits for all roadways (main roadways, major and minor side streets, and ramps)

_____ Proposed sections illustrate the depths, dimensions, and station limits for every type of material in the proposed pavement structure, including subgrade preparation.

_____ Exclude bridge limits and ensure typical bridge section is included, if applicable

_____ Type and depth for all pavement layers including any subgrade preparation

_____ Show incidental roadway items such as curb and gutters, sidewalk, guardrail, underdrains, geotextile fabrics, barriers, etc.

Project Name/Number: _____

Type of Work: _____

90% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Typical Sections (cont.)

_____ Control point for the Profile Grade Line (PGL)

_____ Project baseline and roadway centerline locations

_____ Cross slopes in percent (%) on roadway and shoulders; Side slopes as ratio (H:V) outside of shoulders.

_____ Include a typical section for each unique section of roadway.

_____ Proposed sections for commercial and residential driveways

_____ Quantity rates and basis of estimate notes as necessary

_____ Topsoil and seeding widths, if applicable

_____ Superelevation pivot point location

_____ All transitions with Station limits

_____ Limits of material to be disposed or salvaged

_____ Approximate location and depth of main utilities with appropriate notes

_____ Typical sections for temporary construction if not included in TCP plans

### General Notes

_____ General design notes applicable to the project. See list of General Notes to be provided by City of Round Rock

_____ Applicable notes for construction, traffic control, drainage, excavation, grading, embankment, utility relocation, right-of-way, tree protection, rigid & flexible pavement, roadway incidentals, signals, lighting, pavement markings, signs, etc.

_____ Basis of estimate

### Survey Data

_____ Benchmark locations and numbers

_____ Control point coordinates, locations, elevations, and detailed descriptions

_____ Notation to vertical datum and the horizontal coordinate system

_____ Horizontal alignment and annotation (Stations, bearings, PC's, PT's, etc.)

### Quantity Sheets

_____ Preliminary Summary Sheets (Bid Items and Totals)

_____ All pay items are included on the summary sheet(s)

_____ Item descriptions agree with standard agency item descriptions and units

_____ All items have item code number, description, unit, quantities, and total

_____ Items for bid alternates

_____ Different summary tables for different project elements (roadway, drainage, etc.)

_____ Special notes or remarks

_____ All quantities per plan sheet (drainage & driveway items per structure & each)

_____ Acceptable culvert pipes & pipe type, class and thickness

Project Name/Number: _____

Type of Work: _____

90% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Traffic Control / Construction Sequence

_____ Sequence of construction general notes

_____ Sequence of work outline for Traffic Control (showing basic concept of how to handle traffic during construction, including preliminary phasing)

_____ Preliminary Intersection Layouts

_____ Traffic control plans, typical sections, and narrative for each construction phase

_____ Plans show proposed phase work, construction zones, temporary signs with standard numbers, temporary markings & markers with standard numbers, barricades, detours, traffic flow direction, location and dimension of all temporary traffic items, legend, scale, and seal or preliminary stamp

_____ Typical sections showing phase number and stations ranges, proposed and constructed work with dimensions for each phase, lane widths and flow direction of all traffic lanes, applicable channelizing devices between traffic lanes and construction zone, clear zones, baselines, and slopes of temporary and permanent graded and paved segments

_____ Narrative includes necessary steps for construction, traffic pattern changes, and day & time restrictions for lane reductions, roadway closures, or general work

_____ Apply appropriate plan legend and hatching to distinguish proposed work from constructed elements

_____ Verify all pavement drop-offs have proper treatment

_____ Verify all temporary barriers have proper end treatment

_____ Check for necessary speed reductions and apply signage accordingly

_____ Verify that all aspects of the whole project and its phases are constructible based on the information provided in the traffic control sheets

_____ Show or reference typical & modified traffic control application diagrams in accordance with TMUTCD and TxDOT Standards

### Roadway Plans

_____ North arrow, scale and legend

_____ Show existing roadway features including: roadway alignments, edge of pavement and curb, medians, driveways, drainage structures, utilities, sidewalks, etc. Existing roadways and structures to be closed or removed.

_____ Boundaries (city, county, etc.), bodies of water (streams, lakes, rivers, etc.), street and roadway names

_____ Alignment baseline stationing tick marks and labels every 100 ft, curve and point of intersection data, bearings, equations, and critical points stations such as PIs, PCs, PTs, etc.

_____ Intersection data (Stations, edge of pavement radius, etc.) of all proposed driveways and connecting roadways

_____ Begin & end project notation and Stations to cover all proposed work

_____ Existing and proposed ROW and permanent easement lines and widths at each break within project limits

_____ Proposed pavement (lane and shoulder) widths and cross slopes at all break points and transitions, lane direction arrow, prop. curb and sidewalks

Project Name/Number: _____

Type of Work: _____

90% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Roadway Plans (cont.)

_____ Indicate structure number, quantity, location, type, size of all proposed drainage structures

_____ Location, type, and limits or lengths of proposed roadway elements with appropriate notation

_____ Ensure Minimum Design Values are met

_____ Show all work constrained to ROW and/or easements, including temporary construction easements and structure demolition limits

_____ Access control lines, notes, and limits

_____ Temporary construction or slope easements lines showing widths and limits

_____ Property lines and ownership data

_____ Superelevation, normal crown, and transition locations and limits

_____ Notation for structure removal, structure repair, or proposed structure (location, begin and end stations, type, dimensions, etc.) including bridges, retaining walls, sound walls, and sign bridges

_____ Location of borings or test pits for subsurface investigations

_____ Erosion control items (location, type, limits, etc.) with labels, if separate plans are not provided

_____ Limits for ROW clearing, unsuitable material, pavement removal, etc.

### Roadway Profile

_____ Stations along the bottom at 50 ft. intervals and datum elevations along the sides

_____ Profile grade line (PGL) and existing ground line with elevations at 50' to 2 decimal places

_____ Vertical alignment data (Grades in percent to 2 decimal places, VPI Station, elevation, curve length, K value, begin and end curve Station and elevation, etc.)

_____ All proposed drainage or other structures

_____ Existing utilities

_____ Vertical Clearances (where applicable)

_____ Ensure Minimum K-values are met

_____ Left and right ditch flow lines if not shown on Drainage P&P sheets

_____ Clearances for railroads, roads, streambeds, and between structures and/or utilities

_____ Profiles for connecting roadways and driveways

_____ Limits of proposed and existing grades

_____ Beginning and end Stations for proposed structures

Project Name/Number: _____

Type of Work: _____

90% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Drainage Area Map

_____ Watershed area, limits, and directional flow arrows

_____ Tributaries, highways, etc.

_____ County and city boundaries

_____ North arrow & project location

_____ Peak discharge computation method and flow values for 25 & 100 year storm events

### Hydraulic Data

_____ Peak discharge computation method and flow values for all design year storm events

_____ For bridges, show bridge cross section summary table (velocity, water surface elevation, energy grade line, flow area, and top width for the natural, existing, and proposed conditions for the design and 100-year flows at the various sections along the reach being modeled)

_____ For bridges, show bridge summary table (existing, proposed, and difference of water surface elevations for the design and 100-year storm events)

_____ For bridges, show typical stream cross section at the bridge location with proposed road profile

_____ For culverts, show input and output culvert hydraulic parameters

_____ For storm sewers, show input and output parameters for storm sewers

_____ For ditches, show input and output for open channel flow analysis data

### Culvert Layouts

_____ Plan and profile view for bridge class culverts or cross section for regular culverts

_____ Plan view – north arrow, begin & end of structure Stations and elevations, structure & roadway baselines with skew angle, traffic flow direction, etc.

_____ Roadway cross section along culvert centerline

_____ Existing & proposed grade lines, ROW lines and width, easements, etc.

_____ Roadway baseline, skew angle, and flow direction

_____ Structure slope & flow line elevations, upstream and downstream soil slopes, and structure dimensions from baseline

_____ Length, size, type, skew, and slope of structure

_____ End treatment size, type, and dimensions

_____ Roadway elements (pavement depth & width, barriers, guardrail, slope treatment, etc.)

_____ Description of existing and proposed structure elements with proper labels for agency standards

_____ Erosion control treatment type, size, and depth

_____ Peak discharge, velocity, and upstream and downstream WSE of design storm

_____ Utilities and clearances to proposed elements

_____ Limits of trench excavation protection

Project Name/Number: _____

Type of Work: _____

90% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Drainage Plan and Profile

_____ Show legend for plan and profile elements

_____ Plan – north arrow, baseline stations, ROW

_____ Plan – show drainage area boundaries

_____ Plan – show drainage structures (number, type, length, layout, station, offset, etc.), links (number, type, length, flow direction, etc.), and outlet pipes (number, flow direction, etc.)

_____ Profile – show drainage structures (number, layout, type, control elevations), links (layout, size, type, length, design flow, flow capacity, etc.), and hydraulic grade line (HGL)

_____ Profile – show natural ground and PGL

_____ Plan – show ditch and channel alignments

_____ Profile – show flow lines for ditches and channels

_____ Reference to other roadway or drainage plans

### Utilities

_____ Include utility layout sheets showing latest information for existing utilities

_____ Include proper notation and reference to other utility drawings, if applicable

### Retaining Walls

_____ Preliminary retaining wall layouts showing limits, ranges in height, and type of wall

_____ Final retaining wall layouts showing typical sections, geometry data, and detail sheets

_____ For bridges show bridge layouts (plan and profile), typical sections, foundation data, and detail sheets

### Bridge Layout – Plan View

_____ Baselines with stations, bearings, alignment data, and north arrow

_____ Pavement width (roadway & shoulders), and traffic flow or stream flow

_____ Cross slope and superelevation data

_____ Begin and end structure stations

_____ ROW & easement lines

_____ Bent stations and bearings

_____ Skew angle of structure and bents

_____ Existing contours

_____ Railing type, location, and limits

_____ Limits & slope of riprap or erosion control treatment

_____ Armor joint type, location, and seal size

_____ Approach slab and curb returns

Project Name/Number: _____

Type of Work: _____

90% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Bridge Layout – Plan View (cont.)

_____ Location of test holes

_____ Horizontal clearances (structure, utilities, railroad, etc.)

_____ Bridge Protection Assembly

_____ Type and limits of riprap (and blockouts, if required)

_____ Locate bridge drain and/or lighting brackets stations, when applicable.

_____ Show existing structure (dashed) on plan view, with existing National Bridge Inventory (NBI) number

_____ For staged (or phased) construction, show dimension to staged construction joints

_____ For widenings, show existing structure, existing NBI number, overall and roadway widths of existing and new structures

### Bridge Layout – Profile View

_____ Provide national bridge inventory (NBI) number, if applicable

_____ Type, length, and size of units or spans

_____ Overall length, payment limits, railing type & post spacing

_____ Existing & proposed ground lines with elevations

_____ Existing & proposed water surface elevations for design year storm if applicable

_____ Vertical curve data and grades

_____ Begin and end structure stations and elevations

_____ Bent numbers & fixed/ expansion conditions at all bents

_____ Column heights and type, length, size, and number of foundation elements

_____ Limits & slope of riprap or erosion control treatment

_____ Minimum clearances to proposed and existing elements

_____ Test holes, data, and information

_____ Identify all traffic elements (detectors, conduits, etc.) in structure elements

### Bridge Typical Sections

_____ Roadway width and cross slope, shoulder width and cross slope

_____ Type, location, and width of barriers or bridge railing

_____ Show sidewalks, curbs, medians, etc.

_____ Type, location, depth, and width of structural elements (deck, railing, beams, etc.)

_____ Show baseline location and applicable station ranges

_____ Show control point for Profile Grade Line (PGL)

Project Name/Number: _____

Type of Work: _____

90% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Traffic Signals & Illumination

_____ Signals – signal layouts, signal elevation, signal wiring, and signal phasing

_____ Signals - show proposed and existing signal elements (pole, mast arm, signal heads, conduits, detectors, traffic boxes, etc.)

_____ Show all applicable TMS elements (cameras, changeable message signs, vehicle detection, etc.)

_____ Illumination – show layouts that include lighting poles, mounted luminaire, lighting details, electric service, etc.

### Signing & Pavement Markings

_____ North arrow, street names, legend, pavement lines and traffic lanes, shoulders, alignment with stations, ROW, etc.

_____ Show existing elements to be removed, relocated, re-striped, or to remain in place

_____ Show proposed elements (markings, markers, signs, delineators, etc.)

_____ Show begin and end stations for proposed striping

_____ Standard number, size, type, color, and dimensions of proposed elements

_____ Spacing and width of lane lines

_____ Spacing and width of markings lines for crosshatched areas

_____ Show permanent elements only, temporary items should be shown on TCP

_____ Label elements according to legend or reference other drawings as appropriate

### Erosion Control

_____ Include a narrative (site description, list of applicable soil stabilization and other erosion control devices, offsite requirements, general notes, and special requirements)

_____ Show north arrow, street names, legend, pavement lines and traffic lanes, shoulders, alignment with stations, ROW, etc. on plans

_____ Show ROW, proposed pavement lines, and all drainage structures

_____ Show existing topo features and existing contours

_____ Show and label temporary & permanent erosion control devices and measures

_____ Include legend as appropriate (silt fence, rock filter dam, construction exit, etc.)

### Cross Sections

_____ Cut sections at 50' intervals and place 2 to 3 sections per sheet

_____ Show existing ground and proposed segments with appropriate labels

_____ Show roadway name, left and right grid distances, and datum elevations

_____ Show cross section station and PGL elevation

_____ Show width and slope (% or ratio) of all proposed segments

_____ Show elevations at break points (shoulders, ditch flow line, catch point, etc.)

Project Name/Number: _____

Type of Work: _____

90% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Cross Sections (Cont.)

_____ Show dimensions from baseline to ROW

_____ Show retaining walls, railing, barrier, and guardrail as necessary

_____ Indicate begin and end project station

### Design Submittal Supplements

_____ Design Summary Report (DSR)

_____ Design schedule - update

_____ Initial construction cost estimate

_____ Initial construction time determination

_____ Special Provision form for right-of-way acquisition

_____ Special Provision form for utility relocations

_____ Special Provision form for environmental clearance

_____ Geotechnical investigations report

_____ Drainage report, if applicable

_____ Database of property owner information and executed Right-of-Entry forms

_____ Submittal package in pdf format

_____ Electronic (CAD) design files for earthwork calculations, .zip file

Notes and comments:



_____ _____

ENGINEER OF RECORD Date

Print Sign

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

**Completed Checklist Must be Submitted with Plans**

### Title Sheet

_____ City name & logo, Project name, roadway name and limits, Project length, Bridge length (if applicable) and Project description

_____ Design block including roadway classification, design speed, and traffic data, including current and design ADT, truck percent, directional distribution, and design DHV

_____ Project length (roadway length, bridge length, and total length) in feet to 2 decimal places and in miles to 3 decimal places

_____ Vicinity map (north arrow, project location, project limits, equations, exceptions to project length, city and county names, highway designation, road and street names, and name and description of adjoining projects

_____ Key map (City map and Project location)

_____ Signature blocks (provisions for signatures of officials approving the plans – Design Engineer, City of Round Rock officials)

_____ Miscellaneous (watershed names, area of disturbed soil in acres, and design exceptions)

_____ Copyright statement

_____ Applicable Standard Specifications

_____ Complete sheet index (sheet numbers & descriptions with no number overlaps or gaps)

### Project Layout

_____ A suitable scale shall be utilized to clearly depict and label existing and proposed project features.

_____ The station and coordinates of the beginning and ending project points shall be labeled.

_____ Project control point locations with coordinates, station/ offsets, and descriptions

_____ Horizontal alignment with annotation of all entities (bearings, PC's, PT's, etc.)

_____ Horizontal and vertical control data or reference

### Typical Sections

_____ Existing typical section showing the ROW, approximate lane and median widths, lane direction, shoulders, curbs, rail, border width, pavement structure and Station limits.

_____ Proposed Typical Section including ROW, lane widths, lane direction, shoulders, curbs, rail, border width, Horizontal Control, Design Values, Minimum Design Values, Design Exception (if applicable), and Station limits for all roadways (main roadways, major and minor side streets, and ramps)

_____ Proposed sections illustrate the depths, dimensions, and station limits for every type of material in the proposed pavement structure, including subgrade preparation.

_____ Exclude bridge limits and ensure typical bridge section is included, if applicable

_____ Type and depth for all pavement layers including any subgrade preparation

_____ Show incidental roadway items such as curb and gutters, sidewalk, guardrail, underdrains, geotextile fabrics, barriers, etc.

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Typical Sections (cont.)

_____ Control point for the Profile Grade Line (PGL)

_____ Project baseline and roadway centerline locations

_____ Cross slopes in percent (%) on roadway and shoulders; Side slopes as ratio (H:V) outside of shoulders.

_____ Include a typical section for each unique section of roadway.

_____ Proposed sections for commercial and residential driveways

_____ Quantity rates and basis of estimate notes as necessary

_____ Topsoil and seeding widths, if applicable

_____ Superelevation pivot point location

_____ All transitions with Station limits

_____ Limits of material to be disposed or salvaged

_____ Approximate location and depth of main utilities with appropriate notes

_____ Typical sections for temporary construction if not included in TCP plans

### General Notes

_____ General design notes applicable to the project. See list of General Notes to be provided by City of Round Rock.

_____ Applicable notes for construction, traffic control, drainage, excavation, grading, embankment, utility relocation, right-of-way, tree protection, rigid & flexible pavement, roadway incidentals, signals, lighting, pavement markings, signs, etc.

_____ Basis of estimate

### Survey Data

_____ Benchmark locations and numbers

_____ Control point coordinates, locations, elevations, and detailed descriptions

_____ Notation to vertical datum and the horizontal coordinate system

_____ Horizontal alignment and annotation (Stations, bearings, PC's, PT's, etc.)

### Quantity Sheets

_____ Final Summary Sheets (All Bid Items and Totals)

_____ All pay items are included on the summary sheet(s)

_____ Item descriptions agree with standard agency item descriptions and units

_____ All items have item code number, description, unit, quantities, and total

_____ Items for bid alternates

_____ Different summary tables for different project elements (roadway, drainage, etc.)

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Quantity Sheets (cont.)

_____ Special notes or remarks

_____ All quantities per plan sheet (drainage & driveway items per structure & each)

_____ Acceptable culvert pipes & pipe type, class and thickness

### Traffic Control / Construction Sequence

_____ Sequence of construction general notes

_____ Sequence of work outline for Traffic Control (showing basic concept of how to handle traffic during construction, including preliminary phasing)

_____ Preliminary Intersection Layouts

_____ Traffic control plans, typical sections, and narrative for each construction phase

_____ Plans show proposed phase work, construction zones, temporary signs with standard numbers, temporary markings & markers with standard numbers, barricades, detours, traffic flow direction, location and dimension of all temporary traffic items, legend, scale, and seal or preliminary stamp

_____ Typical sections showing phase number and stations ranges, proposed and constructed work with dimensions for each phase, lane widths and flow direction of all traffic lanes, applicable channelizing devices between traffic lanes and construction zone, clear zones, baselines, and slopes of temporary and permanent graded and paved segments

_____ Narrative includes necessary steps for construction, traffic pattern changes, and day & time restrictions for lane reductions, roadway closures, or general work

_____ Apply appropriate plan legend and hatching to distinguish proposed work from constructed elements

_____ Verify all pavement drop-offs have proper treatment

_____ Verify all temporary barriers have proper end treatment

_____ Check for necessary speed reductions and apply signage accordingly

_____ Verify that all aspects of the whole project and its phases are constructible based on the information provided in the traffic control sheets

_____ Show or reference typical & modified traffic control application diagrams in accordance with TMUTCD and TxDOT Standards

### Roadway Plans

_____ North arrow, scale and legend

_____ Show existing roadway features including: roadway alignments, edge of pavement and curb, medians, driveways, drainage structures, utilities, sidewalks, etc. Existing roadways and structures to be closed or removed.

_____ Boundaries (city, county, etc.), bodies of water (streams, lakes, rivers, etc.), street and roadway names

_____ Alignment baseline stationing tick marks and labels every 100 ft, curve and point of intersection data, bearings, equations, and critical points stations such as PIs, PCs, PTs, etc.

_____ Intersection data (Stations, edge of pavement radius, etc.) of all proposed driveways and connecting roadways

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Roadway Plans (cont.)

_____ Existing and proposed ROW and permanent easement lines and widths at each break within project limits

_____ Proposed pavement (lane and shoulder) widths and cross slopes at all break points and transitions, lane direction arrow, prop. curb and sidewalks

_____ Indicate structure number, quantity, location, type, size of all proposed drainage structures

_____ Location, type, and limits or lengths of proposed roadway elements with appropriate notation

_____ Ensure Minimum Design Values are met

_____ Begin & end project notation and Stations to cover all proposed work

_____ Show all work constrained to ROW and/or easements, including temporary construction easements and structure demolition limits

_____ Access control lines, notes, and limits

_____ Temporary construction or slope easements lines showing widths and limits

_____ Property lines and ownership data

_____ Superelevation, normal crown, and transition locations and limits

_____ Notation for structure removal, structure repair, or proposed structure (location, begin and end stations, type, dimensions, etc.) including bridges, retaining walls, sound walls, and sign bridges

_____ Location of borings or test pits for subsurface investigations

_____ Erosion control items (location, type, limits, etc.) with labels, if separate plans are not provided

_____ Limits for ROW clearing, unsuitable material, pavement removal, etc.

### Roadway Profile

_____ Stations along the bottom at 50 ft. intervals and datum elevations along the sides

_____ Profile grade line (PGL) and existing ground line with elevations at 50' to 2 decimal places

_____ Vertical alignment data (Grades in percent to 2 decimal places, VPI Station, elevation, curve length, K value, begin and end curve Station and elevation, etc.)

_____ All proposed drainage or other structures

_____ Existing utilities

_____ Vertical Clearances (where applicable)

_____ Ensure Minimum K-values are met

_____ Left and right ditch flow lines if not shown on Drainage P&P sheets

_____ Clearances for railroads, roads, streambeds, and between structures and/or utilities

_____ Profiles for connecting roadways and driveways

_____ Limits of proposed and existing grades

_____ Beginning and end Stations for proposed structures

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Drainage Area Map

_____ Watershed area, limits, and directional flow arrows

_____ Tributaries, highways, etc.

_____ County and city boundaries

_____ North arrow & project location

_____ Peak discharge computation method and flow values for 25 & 100 year storm events

### Hydraulic Data

_____ Peak discharge computation method and flow values for all design year storm events

_____ For bridges, show bridge cross section summary table (velocity, water surface elevation, energy grade line, flow area, and top width for the natural, existing, and proposed conditions for the design and 100-year flows at the various sections along the reach being modeled)

_____ For bridges, show bridge summary table (existing, proposed, and difference of water surface elevations for the design and 100-year storm events)

_____ For bridges, show typical stream cross section at the bridge location with proposed road profile

_____ For culverts, show input and output culvert hydraulic parameters

_____ For storm sewers, show input and output parameters for storm sewers

_____ For ditches, show input and output for open channel flow analysis data

### Culvert Layouts

_____ Plan and profile view for bridge class culverts or cross section for regular culverts

_____ Plan view – north arrow, begin & end of structure Stations and elevations, structure & roadway baselines with skew angle, traffic flow direction, etc.

_____ Roadway cross section along culvert centerline

_____ Existing & proposed grade lines, ROW lines and width, easements, etc.

_____ Roadway baseline, skew angle, and flow direction

_____ Structure slope & flow line elevations, upstream and downstream soil slopes, and structure dimensions from baseline

_____ Length, size, type, skew, and slope of structure

_____ End treatment size, type, and dimensions

_____ Roadway elements (pavement depth & width, barriers, guardrail, slope treatment, etc.)

_____ Description of existing and proposed structure elements with proper labels for agency standards

_____ Erosion control treatment type, size, and depth

_____ Peak discharge, velocity, and upstream and downstream WSE of design storm

_____ Utilities and clearances to proposed elements

_____ Limits of trench excavation protection

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Drainage Plan and Profile

_____ Show legend for plan and profile elements

_____ Plan – north arrow, baseline stations, ROW

_____ Plan – show drainage area boundaries

_____ Plan – show drainage structures (number, type, length, layout, station, offset, etc.), links (number, type, length, flow direction, etc.), and outlet pipes (number, flow direction, etc.)

_____ Profile – show drainage structures (number, layout, type, control elevations), links (layout, size, type, length, design flow, flow capacity, etc.), and hydraulic grade line (HGL)

_____ Profile – show natural ground and PGL

_____ Plan – show ditch and channel alignments

_____ Profile – show flow lines for ditches and channels

_____ Reference to other roadway or drainage plans

### Utilities

_____ Include utility layout sheets showing latest information for existing utilities

_____ Include proper notation and reference to other utility drawings, if applicable

### Retaining Walls

_____ Preliminary retaining wall layouts showing limits, ranges in height, and type of wall

_____ Final retaining wall layouts showing typical sections, geometry data, and detail sheets

_____ For bridges show bridge layouts (plan and profile), typical sections, foundation data, and detail sheets

### Bridge Layout – Plan View

_____ Baselines with stations, bearings, alignment data, and north arrow

_____ Pavement width (roadway & shoulders), and traffic flow or stream flow

_____ Cross slope and superelevation data

_____ Begin and end structure stations

_____ ROW & easement lines

_____ Bent numbers, stations and bearings

_____ Skew angle of structure and bents

_____ Existing contours

_____ Railing type, location, and limits

_____ Limits & slope of riprap or erosion control treatment

_____ Armor joint type, location, and seal size

_____ Traffic direction and stream flow

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Bridge Layout – Plan View (cont.)

_____ Approach slab and curb returns

_____ Location of test holes

_____ Horizontal clearances (structure, utilities, railroad, etc.)

_____ Bridge Protection Assembly

_____ Type and limits of riprap (and blockouts, if required)

_____ Locate bridge drain and/or lighting brackets stations, when applicable.

_____ Show existing structure (dashed) on plan view, with existing National Bridge Inventory (NBI) number

_____ For staged (or phased) construction, show dimension to staged construction joints

_____ For widenings, show existing structure, existing NBI number, overall and roadway widths of existing and new structures

### Bridge Layout – Profile View

_____ Provide national bridge inventory (NBI) number, if applicable

_____ Type, length, and size of units or spans

_____ Overall length, payment limits, railing type & post spacing

_____ Existing & proposed ground lines with grid elevations and stations

_____ Existing & proposed water surface elevations for design year storm if applicable

_____ Vertical curve data and profile grade line(s)

_____ Begin and end structure stations and elevations

_____ Bent numbers & fixed/ expansion conditions at all bents

_____ Column heights and type, length, size, and number of foundation elements

_____ Hydraulics data (100 year and design flood elevations) and calculated scour depth

_____ Limits & slope of riprap or erosion control treatment

_____ Minimum clearances to proposed and existing elements

_____ Test holes, data, and information such as bridge foundation notes (if required by geotechnical engineer)

_____ Identify all traffic elements (detectors, conduits, etc.) in structure elements

### Bridge Typical Sections

_____ Roadway width and cross slope, shoulder width and cross slope

_____ Type, location, and width of barriers or bridge railing

_____ Show sidewalks, curbs, medians, etc.

_____ Type, location, depth, and width of structural elements (deck, railing, beams, etc.)

_____ Show baseline location and applicable station ranges

_____ Show control point for Profile Grade Line (PGL)

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Traffic Signals & Illumination

_____ Signals – signal layouts, signal elevation, signal wiring, and signal phasing

_____ Signals - show proposed and existing signal elements (pole, mast arm, signal heads, conduits, detectors, traffic boxes, etc.)

_____ Show all applicable TMS elements (cameras, changeable message signs, vehicle detection, etc.)

_____ Illumination – show layouts that include lighting poles, mounted luminaire, lighting details, electric service, etc.

### Signing & Pavement Markings

_____ North arrow, street names, legend, pavement lines and traffic lanes, shoulders, alignment with stations, ROW, etc.

_____ Show existing elements to be removed, relocated, re-striped, or to remain in place

_____ Show proposed elements (markings, markers, signs, delineators, etc.)

_____ Show begin and end stations for proposed striping

_____ Standard number, size, type, color, and dimensions of proposed elements

_____ Spacing and width of lane lines

_____ Spacing and width of markings lines for crosshatched areas

_____ Show permanent elements only, temporary items should be shown on TCP

_____ Label elements according to legend or reference other drawings as appropriate

### Environmental / Erosion Control

_____ Include a narrative (site description, list of applicable soil stabilization and other erosion control devices, offsite requirements, general notes, and special requirements)

_____ Show north arrow, street names, legend, pavement lines and traffic lanes, shoulders, alignment with stations, ROW, etc. on plans

_____ Show ROW, proposed pavement lines, and all drainage structures

_____ Show existing topo features and existing contours

_____ Show and label temporary & permanent erosion control devices and measures

_____ Include legend as appropriate (silt fence, rock filter dam, construction exit, etc.)

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Cross Sections

_____ Cut sections at 50' intervals and place 2 to 3 sections per sheet

_____ Show existing ground and proposed segments with appropriate labels

_____ Show roadway name, left and right grid distances, and datum elevations

_____ Show cross section station and PGL elevation

_____ Show width and slope (% or ratio) of all proposed segments

_____ Show elevations at break points (shoulders, ditch flow line, catch point, etc.)

_____ Show dimensions from baseline to ROW

_____ Show retaining walls, railing, barrier, and guardrail as necessary

_____ Indicate begin and end project station

### General

_____ All information contained within printing margins

_____ Correct lettering size – minimum text size (Leroy 80)

_____ Notes reference correct sheet number or drawing name

_____ No blank spaces or missing information

_____ Ensure all Standard Details and Drawings pertaining to the contract are added

_____ Drawings & Details are clear and legible

_____ Title block is correct (sheet title & number, project number, etc.)

_____ Professional (PE, RPLS, etc.) seal or preliminary stamp along with the date on all drawings except for Standard Drawings & Standard Details

_____ All applicable standards are included and use of standards is noted in plans

_____ All modified Standard Details and Drawings have been checked and sealed.

_____ Design features are consistent with design standards and design speed

_____ Conformance with previously approved design submissions and comments

_____ Conformance to commitments made in the environmental assessment

_____ Clear zone requirements are met

_____ Roadside safety requirements have been addressed (concrete barriers, impact attenuators, guardrail and guardrail terminals, etc.)

_____ Conformance with applicable standards, regulations, or manuals (ADA, TMUTCD, AASHTO, City of Round Rock Design and Construction Standards, etc.)

_____ All pay items shown in the plans (unless noted to be placed at the engineer's discretion)

_____ All bid items identified

_____ Details included for items not covered by standards

_____ No conflicts between plans, general notes, specifications, standards, provisions, etc.

_____ Sidewalks and ramps meet ADA requirements (4' minimum width and 2% max cross slope, etc.)

_____ Drainage structures are adequate for design storm

Project Name/Number: _____

Type of Work: _____

100% Submission

ROUND ROCK TEXAS

## Design and Construction Standards - Plan Checklist

### Design Submittal Supplements

_____ Design Summary Report (DSR)

_____ Design schedule - update

_____ Initial construction cost estimate

_____ Initial construction time determination

_____ Special Provision form for right-of-way acquisition

_____ Special Provision form for utility relocations

_____ Special Provision form for environmental clearance

_____ Geotechnical investigations report

_____ Drainage report, if applicable

_____ Database of property owner information and executed Right-of-Entry forms

_____ Submittal package in pdf format

_____ Electronic (CAD) design files for earthwork calculations, .zip file

Notes and comments:



_____ _____

ENGINEER OF RECORD Date

Print Sign

Project Name/Number: _____

Type of Work: _____

# Pavement

ROUND ROCK TEXAS

## Pavement Design Checklist

**Completed Checklist Must be Submitted with 60%, 90% and 100% Design**

### Project Information

_____ Narrative discussing the overall project, scope of work, site particulars, drainage, and topographic features

_____ Project location map and description of proposed improvements

_____ Existing pavement section (if applicable)

_____ Existing subgrade conditions (referenced from Geotechnical Report);

_____ Traffic data and any adjustments

_____ Project specific factors used for selecting the pavement type

_____ Summary of discussions with City officials and waivers received (if any);

### Pavement Design Summary

_____ Summary of all pavement design input values

_____ Design output values for typical pavement sections

_____ Recommended subgrade stabilization measures (if applicable)

_____ Recommended pavement section or sections

_____ Recommended pavement related specifications (e.g., subgrade preparation, lime addition, flex base materials and compaction, HMAC, etc.)

_____ Recommendations to improve drainage of subgrade/base layers (i.e., edge drains)

_____ Proposed detour pavement thickness (widened pavement or separate detour);

_____ If existing pavement is to be used as a detour, provide recommendations as to suitability of use and recommended traffic flow diagram

_____ Construction recommendations including drainage and groundwater control

### Appendices

_____ Flexible Pavement Designs: FPS-21 output with mechanistic check and modified Texas Triaxial check

_____ Rigid Pavement Designs: Streetpave12 output

_____ _____

ENGINEER OF RECORD Date

Print Sign

# 9.6.D Clearance Forms

Project Name/Number: _____

# City of Round Rock
## CERTIFICATIONS

**Project :** _____

**Hwy. :** _____

**Limits :** **From:** _____

**To:** _____

### ENCROACHMENT CERTIFICATION

This is to certify that no right-of-way encroachments existed within the limits of this project or all removals of right-of-way encroachments have been completed.

---

### ROW CERTIFICATION

This is to certify that acquisition of right-of-way was not required for this project.

---

### UTILITY CERTIFICATION

This is to certify that utility adjustments were not required or have been completed for this project.

---

### RAILROAD CERTIFICATION

This is to certify that no railroad work was required for this project.

---

Recommended By:

_____Date: _____
Engineer of Record

Submitted By:

_____ Date: _____
City of Round Rock
Transportation Director

Project Name/Number: _____

# City of Round Rock
## ENVIRONMENTAL CLEARANCE CERTIFICATION

**Project :** _____

**Hwy. :** _____

**Limits :** **From:** _____

**To:** _____

**ENVIRONMENTAL CERTIFICATION**

This is to certify that all necessary environmental permits for the subject project have been acquired or have been identified within the limits of this project.

---

Recommended By:

_____Date: _____
Engineer of Record

Submitted By:

_____ Date: _____
City of Round Rock
Transportation Director

Project Name/Number: _____

# City of Round Rock
## UTILITY CLEARANCE LETTER

**Project :** _____

**Hwy. :** _____

**Limits :** **From:** _____

**To:** _____

The purpose of this Utility Clearance Letter is to inform the **City of Round Rock** of the anticipated dates by which **Utility's** facilities that are in conflict with the above project limits will be adjusted. The dates below assume that the **City** has acquired all necessary right-of-way for the project, that sufficient plans indicating the proposed highway improvements have been submitted to **Utility**, and that design changes necessitating material utility facility redesign do not occur.

Utility Company Name: _____

Anticipated Construction Start Date: _____

Anticipated Duration of Construction: _____

Anticipated Construction Completion Date: _____

The information provided above is strictly an estimate and is provided to the **City** solely for **the City's** planning purposes. This letter is not intended to create any legally binding commitments on either **Utility** or **City,** nor to waive any rights **Utility** or **City** might otherwise possess.

If there is a conflict between prior submitted dates and those shown in this letter, the dates set forth above should be used for **City's** planning purposes.

_____ _____

Authorized Utility Representative Date

# 9.6.E Design Comment / Response Log

**DESIGN REVIEW COMMENT AND RESOLUTION FORM**

City of Round Rock Transportation Department

PROJECT NO.: _____

Reviewer Name: _____

DESCRIPTION: _____

Date: _____

DESIGNER: _____

SUBMITTAL: (Sample Text - 60% Design Submission)

ROUND ROCK TEXAS

| Item No. | Sheet or Page No. | Comment | Initial Action | Response | QC Review (Initials) | Final Action Verified |
|---|---|---|---|---|---|---|
| Completed by Reviewer | | | Completed by Designer | | | Reviewer |
| | | | | | | |
| P-1 | 12 | (Sample Text - No North Arrow)<br>(Sample Text - Stationing Font Too Small)<br>(Sample Text - Etc.) | A | (Sample Text - See attached Sheet 12 with revision) | | |
| | | | | | | |
| P-2 | 24 | (Sample Text - Existing ROW not shown) | B | (Sample Text - Will include in 90%) | | |
| | | | | | | |
| P-3 | 36 | (Sample Text - Left turn vehicle queue appears short) | C | (Sample Text - Will discuss at progress meeting) | | |
| | | | | | | |
| E-1 | 2 | (Sample Text - Units for Lime Slurry must be tons) | D | (Sample Text - Lime Slurry will not be used on this project) | | |
| E-2 | 3 | (Sample Text - Reduce Contingency to 15%) | A | | | |
| S-1 | 5 | (Sample Text - Special Provisions Missing) | B | (Sample Text - Appropriate Special Provisions will be provided with 90% Submission) | | |
| | | | | | | |
| | | | | | | |
| S-2 | 7 | (Sample Text - Special Provisions Missing) | B | (Sample Text - Appropriate Special Provisions will be provided with 90% Submission) | | |
| | | | | | | |

PREFIX FOR COMMENT NO'S - PLANS =P, SPEC. PROVS OR SPECIFICATIONS=S, EST.=E, OTHER = O

ACTION A= AGREE, WILL INCORPORATE, B=AGREE, WILL INCORPORATE NEXT SUBMITTAL C=WILL EVALUATE/DISCUSS D=DELETE COMMENT

**DESIGN REVIEW COMMENT AND RESOLUTION FORM**

City of Round Rock Transportation Department

PROJECT NO.: _____

Reviewer Name: _____

DESCRIPTION: _____

Date: _____

DESIGNER: _____

SUBMITTAL: (Sample Text - 60% Design Submission)

| Item No. | Sheet or Page No. | Comment | Initial Action | Response | QC Review (Initials) | Final Action Verified |
|---|---|---|---|---|---|---|
| Completed by Reviewer | | | Completed by Designer | | | Reviewer |
| S-3 | 8 | (Sample Text - Special Provisions Missing) | B | (Sample Text - Appropriate Special Provisions will be provided with 90% Submission) | | |
| | | | | | | |

PREFIX FOR COMMENT NO'S - PLANS =P, SPEC. PROVS OR SPECIFICATIONS=S, EST.=E, OTHER = O

ACTION A= AGREE, WILL INCORPORATE, B=AGREE, WILL INCORPORATE NEXT SUBMITTAL C=WILL EVALUATE/DISCUSS D=DELETE COMMENT

# BIBLIOGRAPHY


Alliance for Solid State Illumination Systems and Technologies (ASSIST), Recommendations for Evaluating Street and Roadway Luminaires http://bit.ly/2KbQzZY

American Association of State Highways and Transportation Officials (AASHTO), A Policy on Geometric Design of Highways and Streets (The "Green Book"). http://transportation.org/

American Association of State Highways and Transportation Officials (AASHTO), Roadside Design Guide. http://transportation.org/

American Association of State Highways and Transportation Officials (AASHTO), Guide for Design of Pavement Structures. http://transportation.org/

American Association of State Highways and Transportation Officials (AASHTO), Guide for the Planning, Design, and Operation of Pedestrian Facilities. http://transportation.org/

American Association of State Highways and Transportation Officials (AASHTO), Guide for the Development of Bicycle Facilities. http://transportation.org/

American Association of State Highways and Transportation Officials (AASHTO), Manual on Uniform Traffic Control Devices. http://transportation.org/

American Association of State Highways and Transportation Officials (AASHTO), AASHTO LRFD Bridge Design Specifications. http://transportation.org/

American Association of State Highways and Transportation Officials (AASHTO), AASHTO Load and Resistance Factor Design Guide Specifications for the Design of Pedestrian Bridges. http://transportation.org/

American Association of State Highways and Transportation Officials (AASHTO), Roadway Lighting Design Guide http://bit.ly/2KbPDVn

American Concrete Institute (ACI), Manual of Standard Practice Concrete Reinforcing Steel Institute (CRSI). http://www.concrete.org

American Concrete Institute (ACI), Building Code Requirements for Structural Concrete (ACI 318) http://www.concrete.org

American Concrete Institute (ACI), 325.12R-02: Guide for Design of Jointed Concrete Pavements for Streets and Local Roads, (Reapproved 2013). http://concrete.org

American Concrete Institute (ACI), 330R-08: Guide for the Design and Construction of Concrete Parking Lots. http://concrete.org

American Concrete Pavement Association (ACPA) StreetPave12. http://www.acpa.org/streetpave/

Capital Area Pavement Engineers Council (CAPEC), Phase 1, Phase 1 Addendum, Phase 2, and Phase 3 Final Reports. http://capectx.org

Federal Highway Administration (FHWA), Geotechnical Engineering Circular No. 7 Soil Nail Walls. www.fhwa.dot.gov

Federal Highway Administration (FHWA), Highway Capacity Manual. www.fhwa.dot.gov

Federal Highway Administration (FHWA), FHWA Lighting Handbook http://bit.ly/2IxVqaD

Federal Highway Administration (FHWA), Pedestrian Facilities Users Guide: Providing Safety and Mobility. www.fhwa.dot.gov

Federal Highway Administration (FHWA), Publication FHWA NHI-05-037 Geotechnical Aspects of Pavements. http://www.fhwa.dot.gov

Federal Highway Administration (FHWA), Life Cycle Cost Analysis Primer, Technical Bulletin, RealCost Software and Users Manual. http://bit.ly/2IvRVl2

Federal Highway Administration (FHWA). Life-Cycle Cost Analysis RealCost User Manual – Version 2.1. Office of Asset Management. May 2004.

HVJ Associates, Inc. ("CAPEC 2012"). Capital Area Pavement Engineers Council Initiative, Phase 1 Interim Report. Contract No. PS100298JE, TNR No. 3103-CAPEC0000-07B000A. Prepared for City of Austin and Travis County. August 30, 2012.

HVJ Associates, Inc. ("CAPEC 2015a"). Capital Area Pavement Engineers Council Initiative, Phase 2 Interim Report. Contract No. PS100298JE, TNR No. 3103-CAPEC0000-07B000A. Prepared for City of Austin and Travis County. July 1, 2015.

HVJ Associates, Inc. ("CAPEC 2015b"). Capital Area Pavement Engineers Council Initiative, Phase 1 Interim Report ADDENDUM. Contract No. PS100298JE, TNR No. 3103-CAPEC0000-07B000A. Prepared for City of Austin and Travis County. July 10, 2015.

HVJ Associates, Inc. ("CAPEC 2016"). Capital Area Pavement Engineers Council Initiative, Phase 3 Report – Pavement Design Manual FINAL DRAFT FOR PEER REVIEW. Contract No. PS100298JE, TNR No. 3103-CAPEC0000-07B000A. Prepared for CAPEC Member Agencies. September 28, 2016.

Illuminating Engineering Society (IES), ANSI/IES RP-8-14 Roadway Lighting http://bit.ly/2wv35Bx

Illuminating Engineering Society (IES), The Lighting Handbook http://bit.ly/2K7MJRC

Institute of Transportation Engineers (ITE), Guidelines for Urban Major Street Design, 1983. Out of print

Institute of Transportation Engineers (ITE), Trip Generation: Latest Edition: An ITE Informational Report. http://www.ite.org

Institute of Transportation Engineers (ITE), Designing Walkable Urban Thoroughfares: A Context Sensitive Approach, An ITE Recommended Practice. http://www.ite.org

Institute of Transportation Engineers (ITE), Traffic Engineering Handbook. http://www.ite.org

Institute of Transportation Engineers (ITE), Urban Street Geometric Design Handbook. http://www.ite.org

Institute of Transportation Engineers (ITE), Design and Safety of Pedestrian Facilities. http://www.ite.org

National Association of City Transportation Officials (NACTO), Urban Bikeway Design Guide. http://nacto.org

National Cooperative Highway Research Program (NCHRP) Report 568, Riprap Design Criteria, Recommended Specifications, and Quality Control. http://www.trb.org/NCHRP/NCHRP.aspx

National Concrete Masonry Association (MCMA), Design Manual for Segmental Retaining Walls. http://www.ncma.org

National Lime Association, Lime-Treated Soil Construction Manaual Lime Stabilization & Lime Modification. http://lime.org/documents/publications/free_downloads/construct-manual2004.pdf

City of Round Rock, Design and Construction Standards (DACS)
http://www.roundrocktexas.gov/

- General Guidelines
- Standard Specification Manual
- Transportation Criteria Manual (this document)
- Drainage Criteria Manual
- Utilities Criteria Manual

City of Round Rock, Access Management Plan for State Highways
http://www.roundrocktexas.gov/docs/rr_access_manual_plan_070105.pdf

City of Round Rock "Special Requirements" Attachment to Access Management Plan for State Highways

City of Round Rock, Transportation Master Plan and Transportation Master Plan Map
http://www.roundrocktexas.gov/

City of Round Rock, Tree Technical Manual: Standards and Specifications

Texas Commission on Environmental Quality (TCEQ), Complying with the Edwards Aquifer Rules: Technical Guidance on Best management Practices. http://www.tceq.texas.gov

Texas Department of Licensing and Regulation (TDLR) Architectural Barriers, Texas Accessibility Standards (TAS). http://www.license.state.tx.us/ab/abtas.htm

Texas Department of Transportation (TxDOT) Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges. (Including Special Specifications, Special Provisions, and Special Provisions to Special Specifications, as applicable). http://www.dot.state.tx.us/

Texas Department of Transportation (TxDOT) Design Manuals: http://www.dot.state.tx.us/

- Bridge Design Manual – LRFD
- Bridge Detailing Manual
- Bridge Railing Manual
- Highway Illumination Manual
- Hydraulic Design Manual
- Pavement Design Guide
- Roadway Design Manual
- Traffic Signals Manual

Texas Department of Transportation (TxDOT) Test Procedures: http://www.txdot.gov/inside-txdot/division/construction/testing.html

Texas Department of Transportation (TxDOT) Material Producer Lists: http://www.txdot.gov/inside-txdot/division/construction/producer-list.html

Texas Department of Transportation (TxDOT) Departmental Material Specification (DMS): http://www.txdot.gov/inside-txdot/division/construction/dms.html

Texas Department of Transportation (TxDOT) Traffic Planning Publications: http://www.dot.state.tx.us/

- Standard Highway Sign Designs for Texas (SHSD) http://www.txdot.gov/inside-txdot/forms-publications/publications/highway-signs.html
- Texas Manual on Uniform Traffic Control Devices (TMUTCD) http://www.txdot.gov/inside-txdot/division/traffic/signs/tmutcd.html

Texas Department of Transportation (TxDOT) Statewide CAD Standard Plan Files: http://www.txdot.gov/inside-txdot/division/design/cad.html

Texas Department of Transportation (TxDOT), Flexible Pavement Design FPS21 http://pavementdesign.tamu.edu/fps21.htm

Texas Department of Transportation (TXDOT). Geotechnical Manual. December 2012.

Texas Department of Transportation (TXDOT). Pavement Manual (DRAFT). May 2016.

Transportation Research Board (TRB), Highway Capacity Manual. http://books.trbbookstore.org/

United States Access Board, ADA Accessibility Guidelines (ADAAG). http://www.access-board.gov/ada/

United States Access Board, Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAC). http://www.access-board.gov/prowac/

University of Texas Center for Transportation Research Report 1407-1F, Rock Nail Design Guidelines for Roadway Cuts in Central Texas. https://www.ntis.gov/search/product.aspx?abbr=PB96183587

Notes:

All references to published documents, reference manuals, and software programs shall refer to the latest edition or version.