NORTH TEXAS TOLLWAY AUTHORITY

Design Criteria Manual

June 9, 2014

Revision 0

Preface

NTTA Mission

The North Texas Tollway Authority's (NTTA) mission is to provide a safe and reliable toll road system, increase value and mobility options for our customers, operate the Authority in a businesslike manner, protect our bondholders, and partner to meet our region's growing need for transportation infrastructure.

Development

In keeping with the NTTA's mission, a Design Criteria Manual has been developed to set forth standard design criteria for use by Design Engineers engaged in the preparation of NTTA projects. This manual replaces the NTTA Maintenance Design Guidelines, which has been archived.

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Chapter 1 – Introduction

Overview

The purpose of this manual is to supplement highway design requirements of the Texas Department of Transportation (TxDOT). Although the North Texas Tollway Authority (NTTA) relies heavily upon TxDOT design publications and TxDOT standard drawings for NTTA project design, the NTTA has published this manual to implement NTTA policies that add to and/or change those guiding documents. Use the most current version of the guiding documents, unless otherwise specified. This manual is not intended to replace the referenced guiding documents; this manual is a supplementary document.

Where in conflict, this NTTA Design Criteria Manual, NTTA Standard Drawings, and other NTTA manuals, take precedence over the TxDOT manuals and TxDOT Standard Drawings for all NTTA projects. Where NTTA documents are in conflict, NTTA Standard Drawings (in unmodified form as published by NTTA) shall take precedence over this manual, and this manual shall take precedence over all other NTTA manuals.

The manual is not intended to be a substitute for engineering experience, knowledge, or judgment. Special situations may arise that appear to call for variation from the policy requirements herein. Such variation will be subject to approval of the NTTA. To request a deviation, the Design Engineer shall submit the NTTA's Deviation Approval Form, QM-06-F1, found in NTTA's QMS Manual.

Updates

Updates to this manual are summarized in the following table:

Manual Revision History

Revision	Publication Date	Summary of Changes
0	June 9, 2014	New manual, superseding and replacing the NTTA Maintenance Design Guidelines Manual, MAN-03

Organization

Each chapter in this manual references "Guiding Documents" which are required for NTTA project designs, followed by additions and revisions to the guiding documents under the heading "Supplementary NTTA Criteria to Guiding Documents". The criteria contained in the NTTA Design Criteria Manual are applicable to all corridors within the NTTA System.

External Reference Documents

Manuals

NTTA has several manuals to assist the designers with providing the necessary information in the plans. Use the following NTTA publications, which can be found on the NTTA website at http://www.ntta.org, in conjunction with TxDOT manuals and standard drawings.

- *NTTA QMS Manual*
- *NTTA PS&E Preparations Manual*
- *NTTA CAD Guidelines*
- *NTTA Design Guidelines*
- *NTTA Pavement Design Manual*
- *NTTA Roadway Electrical System Manual*
- *NTTA Sign and Traffic Control Device Guidelines*
- *NTTA Sign Policy Manual*
- *NTTA Project Communications Manual*
- *NTTA Utility Relocation Manual*
- *NTTA Project Delivery Method Implementation Manual*

- *NTTA Environmental Manual*

Standards and Specifications

The NTTA maintains collections of standards and specifications for use on NTTA system corridors. Copies of these standards and specifications may be made available by making a request to the NTTA Project Delivery Department.

Chapter 2 – Roadway

Overview

This chapter provides NTTA supplementary criteria on roadway typical sections and plan and profile sheets.

Application

Guiding Documents:
TxDOT Roadway Design Manual
TxDOT Hydraulic Design Manual

Supplementary NTTA Criteria to Guiding Documents:

Roadway Typical Sections

Slopes

- Front slopes (slopes adjacent to the shoulder) within the horizontal clear zone shall be 6H:1V (horizontal to vertical) or flatter, unless traffic barrier or rail is provided. Also see "Traffic Barrier and Rails" Section and "Maintenance Access" Section, both in this chapter.
- Sodded or landscaped back slopes and ditch slopes shall be 4H:1V or flatter.
- Concrete riprap is required on slopes steeper than 4H:1V.
- Slopes steeper than 3H:1V will not be permitted.
- See "Ditches and Sodded Slopes" Subsection under Drainage Section in this chapter.

Pavement Design

- Design shall be in accordance with current NTTA pavement design methodology.
- If the pavement design requires moisture barrier treatments, coordination with NTTA's Design Guidelines Manager is required to discuss how this could affect proposed landscape and irrigation.
- Longitudinal joints shall be within one (1) foot of lane lines.
- Specify Class A surface aggregate classification (SAC) aggregates for Asphalt Concrete (AC) Pavements and Overlays.

Embankments and Retaining Walls

- In addition to typical cross sectional elements, show all embankment material and materials relating to retaining wall construction including select backfill, retained soil, soil reinforcements, and foundation material. Refer to "Retaining Wall" section of Chapter 4, Geotechnical.
- Show pavement and base course where pavement extends over retaining wall backfill. Over the Item 423 select backfill, either use bituminous base under concrete pavement directly over the backfill or use soil base separated from backfill with filter fabric (DMS-6200, Type 2). Do not place concrete pavement directly over backfill. Refer to Figure 4.1 in Chapter 4, Geotechnical.

Mow strips

- Mow strips are required at all areas where sod is adjacent to vertical structures (including but not limited to retaining walls, foundations, sound walls, traffic rail/barrier, MBGF, ROW fence, etc.) and landscape areas. The intent of mow strips is to simplify mowing operations along structures and reduce the need for herbicidal treatments.
- Mow Strips are not required in landscape areas (i.e. plants, groundcover excluding sod) adjacent to retaining walls and concrete railing.
- Show all surface treatments (i.e. mow strips, gabions, riprap (stone or concrete), etc.) on the typical sections.

Vegetation

- Ensure all vegetation areas (i.e. between mainlanes and frontage roads, frontage roads and ramps, center medians, etc.) are clearly marked on all sections with a minimum and maximum width labeled where width varies.
- See Chapter 9, "Landscape", for additional requirements.

Plan and Profile

Riprap

- All riprap shall be concrete except as noted in this manual.
- Specify 4" riprap for areas having non-vehicular traffic and equipment, i.e. mowers; 5" riprap for maintenance access or vehicular traffic.
- Specify riprap in areas that:
  - are less than eight (8) feet in width and that will not receive landscape (i.e. plants and ground cover),
  - are less than eight (8) feet in width, and/or less than twenty-five (25) feet in length,
  - have less than eight (8) feet of clear distance between obstructions, such as structures, drainage easements and foundations.
- Show riprap (five (5) feet wide minimum) along back of U-turn curb from point-of-curvature (PC) to point-of-tangency (PT); follow current NTTA standards for limits of riprap between U-turns and abutments.
- Install riprap around ground boxes, all sign foundations, grate/area inlets, ITS and ETC sites (including camera support poles and dynamic message sign columns), illumination structures/poles, vertical concrete foundations/structures, and MBGF.
- Install riprap in areas for future U-turn lanes as shown in NTTA Underbridge Riprap Standard, URD-201-2009.
- For riprap on either slopes or subject to erosion, evaluate toe wall depth. Extend bottom of toe walls one (1) foot below scour depth.
- Minimize use of riprap that contributes to a visually unattractive appearance; see NTTA's Design Guidelines and NTTA standards for additional requirements.

Gores

- Flush gores are required at mainlane gore locations.
- Used tapered median noses at curbed gores.

Turning Movements

- Turning movements, specifically U-turns and left turns, shall be navigable by a WB-62 design vehicle.

Fencing

- Refer to the latest edition of NTTA's Design Guidelines.
- Fencing shall be installed at areas subject to toll avoidance, these areas include:
  - Traversable areas between the mainlane and frontage road,
  - Between frontage roads or intersecting roadways,
  - Potential safety area concerns in residential, schools, parks or other public use areas.
- No horizontal supports are to be located within clear zone of traffic; angled supports are permitted.
- Install fence outside of clear zone.
- See NTTA ROW Fence Standards.

Traffic Barrier and Rail

Barriers adjacent to the travel lanes provide a safety component for the traveling public as well as for protection for personnel performing maintenance related activities behind the barriers. Because barriers are also obstructions, designers should make every attempt to minimize their use.

Concrete Traffic Barrier and Rail

- Use concrete barrier and concrete rail in lieu of MBGF except as otherwise noted (see "MBGF" subsection below) or approved by NTTA.
- To avoid the accumulation of trash, fill areas behind concrete rails/barriers with rock aggregate capped with concrete riprap where traffic rail/barrier is less than eight (8) feet another rail/barrier or wall.

Crash Attenuators

- Select crash attenuators for appropriate design speed, application and location. For permanent installations, SMART Cushion attenuators shall be installed on high speed roadways where the device is warranted within 12' from edge of traveled way such as at an exit ramp or directly adjacent to the shoulder. TRACC Cushion attenuators shall be used on low speed roadways, such as a cross streets.
- Avoid the use of roadside barriers if the fixed object can be relocated or eliminated.
- All blunt ends, obstacles, steep slopes, retaining wall ends, etc. shall be properly protected.
- Provide a minimum ten (10) foot wide opening for mowing and landscape maintenance of vegetation areas.

MBGF (where permitted)

- MBGF may be used in short (less than 200 feet), isolated lengths to provide protection from obstructions such as sign structures. Gaps less than 100 feet between runs of MBGF will not be permitted. The use of all MBGF is subject to approval by NTTA.
- Except as noted in this manual, adhere to TxDOT standards and guidelines for appropriate application and location of MBGF. Follow NTTA guidelines for proper barrier/rail usage on ramps and frontage roads.
- MBGF posts shall be steel.
- A 10H:1V cross slope is required for two (2) feet minimum behind MBGF.
- Thrie beams are not to be placed on downstream ends of concrete rail/barrier transitions to MBGF unless it will be within the clear zone of opposing traffic.
- MBGF end treatments shall be hinged break-away types conforming to current TxDOT standards.
- MBGF end treatments shall be evaluated for usage with respect to manufacturer's recommendations and field conditions.

Maintenance Access

Properly designed access points are required to provide safe access for maintenance personnel to perform activities such as mowing and landscape maintenance, while not compromising the safety and well-being of the traveling public.

Basic details

- Provide ten (10) foot clear openings in railing for maintenance access.
- Access "driveway" adjacent to pavement will consist of five (5) inch thick riprap.
- Access point gates are to be provided in toll avoidance fences; gates shall be ten (10) feet wide (minimum).
- Cross slopes at access areas shall be 10:1 or flatter.
- Access shall be a minimum of ten (10) feet from the edge of pavement to maintain shoulder width.
- Tapered (20:1) railing offsets are acceptable; gaps in railing are prohibited.

- Access points should provide adequate access and positive protection for personnel and equipment performing maintenance activities.
- See Appendix A for example designs.

Location of access points

- General order of preference:
  1. From frontage road
  2. From mainlanes
  3. From ramp
- Order of preference for gantry access locations:
  1. From mainlanes
  2. From ramp
  3. From frontage roads
- Access points shall be located in the safest possible place based on roadway design geometrics and sight distance.
- When access is provided from the mainlanes, it should be located on the downstream end of the area for both safety and consistency.
- Provide at least one access point for every area that is isolated by non-traversable obstructions.

Drainage

The design engineer shall use "Best Management Practices" in designing roadway drainage systems. Coordinate with the city(s) before any drainage design is conducted along the frontage road(s).

Drainage Structures

- Match the new drainage structure to the natural contour/grade of the drainage channel/ditch/swale; this may reduce siltation in the structure and erosion along the outfall.
- All culvert aprons shall include minimum eighteen (18) inch toe walls in accordance with TxDOT standard details. Estimate scour and extend bottom of toe walls one (1) foot below scour depth. Provide energy dissipaters as needed.
- Concentrated flow from outfall to grass or landscape areas or channel banks will not be permitted; riprap or flumes shall be used to prevent or minimize erosion.
- Provide upstream and downstream protection (stone riprap or gabions) at all culverts and drainage outfalls within proposed grading limits.
- Provide access (twelve (12) foot wide minimum) to culvert from the right-of-way. All drainage structures (i.e. pipes/boxes/culverts) shall be installed at least one (1) foot below the bottom of the treated subgrade.
- In proposed fill areas, structurally analyze existing cross drainage structures (i.e. culverts under existing frontage roads) for surcharge adequacy.
- Collect all runoff from retaining wall flumes and transport utilizing paved and/or pipe system to prevent direct runoff to vegetation.

Pipes

- Pipes shall be twenty-four (24) inch minimum diameter, Reinforced Concrete Pipe (RCP). Eighteen (18) inch minimum diameter RCP is permitted for storm pipe risers at retaining walls only.
- Structurally design a foundation under risers to accommodate loads from risers.
- Pipes shall be selected based on proper design load and class of RCP for intended use.
- Laterals shall tie into trunk lines pointing downstream.
- Include cement stabilized backfill around all laterals with slopes greater than ten (10) percent.
- Velocities within pipe shall be a minimum of two feet per second (fps).

- Within 50 feet of toll gantries, pipes shall not be located beneath proposed or future pavement to prevent possible interference with loop detectors in pavement.
- Contractor shall video (on DVD media) drainage system upon construction completion per general notes/specs; video (which will include date and identified trunk run) will become the property of NTTA.

Inlets

- Inlets are to be placed outside the mainlanes pavement (proposed and future expansion), and spaced so that ponding width does not encroach onto mainlanes.
- Ponding is prohibited on all mainlane travel lanes and all ramp lanes during a 50 year storm.
- Inlets shall not be located within 50 feet of a toll gantry.
- All drain inlets located within or adjacent to landscape beds shall have a two (2) foot wide by eight (8) inch deep rock riprap installed around the inlet perimeter; see NTTA Design Guidelines Manager for locations.
- For inlets located in ditches, inlet grates must be depressed six (6) inches minimum over a four (4) to six (6) foot range, from the flow line of the ditch.
- Buttons/tiles are required on all frontage road inlets indicating "No Dumping".

Manholes

- Manholes are to be placed along trunk lines (± 300 feet) to provide access for cleaning.
- Manhole access is to be placed outside of the proposed and future mainlane pavement and ramp pavement. For other roadways, avoid manhole access in pavement or, at the least, wheel path.
- Manholes shall not be located within 50 feet of a toll gantry.

Bridges

- Deck Drainage. For mainlane bridges, overpasses and direct connector bridges, the allowable ponding width shall not exceed the width of the low shoulder during a 50 year storm. When drainage design requires drain inlets located on the bridge superstructure, provide bridge deck drains. Convey runoff through piping under the deck (behind outside girder/beam) and inside columns. Do not use exposed piping on the outside of columns nor under the deck overhang. The use of an open rail system or slotted rails is prohibited on mainlane bridges, underpasses, overpasses and direct connector bridges and is allowed on frontage road bridges.
- Capture runoff from the end of a bridge in an inlet; do not allow concentrated runoff to flow down the surface of embankments with or without riprap. Use of flumes will be subject to approval by the NTTA.
- All internal bridge column drain pipes shall discharge into a storm sewer system or concrete riprap (10 foot square minimum). Do not reduce the downstream pipe sizes, i.e. from deck drains flowing to columns.
- On stream crossings, deck drains may be directly discharged 4” below bottom of superstructure. Discharge onto or adjacent to substructure elements is not permitted.
- Rock riprap shall be required below slotted rail drains or individual deck drains (where permitted) that are less than twenty-five (25) feet above ground (measured from deck to finished grade).

Flumes

- Install flumes behind slotted concrete rail if adjacent to landscape areas.
- See Chapter 4 Geotechnical, “Retaining Wall” section for requirements requiring flume behind retaining walls.
- Flumes shall have adequate expansion/contraction joints.

Ditches and Sodded Slopes

- Six (6) foot minimum flat bottom ditches are required for ease of maintenance. Alternatively, if a six (6) foot flat bottom ditch is not feasible, use a V-bottom ditch, or as a last option (which requires approval by the NTTA), use less than six (6) foot flat bottom ditch.
- Sodded ditches shall maintain a 0.5% longitudinal grade (unless required for permitting).
- The flowlines of ditches parallel to roadway shall be below the pavement subgrade, measured transversely to the roadway.
- Permanent best management practices (BMPs) shall be used for post-construction storm water control to address potential erosion on grassed side slopes or into landscape planting beds.

Detention ponds

- Maintenance access is required at all detention ponds.
- Must be concrete lined on bottom only.
- Must be designed to drain completely.
- Proper warning signage must be placed around the perimeter of the pond.
- Fencing shall conform to the latest edition of the NTTA's Design Guidelines and placed around the entire perimeter of the pond; fence must include a mow strip and a ten (10) foot gate for maintenance access.

Chapter 3 – Visual Quality

Overview

This chapter provides criteria for the visual quality of the highway design elements associated with NTTA facilities. The design of these elements is critical to achieving the desired operational and safety features of roadway, as well as the desired visibility and aesthetics. For requirements for integrating visual quality elements in design work, see QMS Manual, SD-06 Procedure.

Application

Guiding Documents:
NTTA Design Guidelines
NTTA QMS Manual

NTTA Design Guidelines

The NTTA Board of Directors adopted *NTTA Design Guidelines* to establish and maintain a consistent high quality image, enhance the customer experience, and promote aesthetic continuity and operational efficiencies on NTTA Tollway facilities. This vision for excellence also maintains and improves highway operational functions through a predictable roadside treatment process that places emphasis on solutions that are visually appealing, practical, and cost-effective.

Chapter 4 – Geotechnical

Overview

This chapter provides criteria for geotechnical investigation and design associated with NTTA project development.

All NTTA criteria either revise or add to the TxDOT Geotechnical Manual. Assume requirements from the TxDOT manual omitted herein are in force, unless in conflict with the supplementary criteria.

Application

Guiding Documents:
TxDOT Geotechnical Manual
NTTA Pavement Design Manual

Supplementary NTTA Criteria to Guiding Documents:

Soil Surveys

Exploration Plan

- Obtain NTTA approval for the boring exploration plan before proceeding with borings. The following boring criteria represent minimum requirements. Boring locations shall be appropriate for the anticipated subsurface conditions.

Bridges

- Provide borings (test holes) within 150 feet of each foundation element (drilled shafts, piles, footings, etc.) and not less than two borings per bridge.
- Provide depth to groundwater measurements for each boring.
- Obtain soil and rock samples for laboratory testing of each boring.

Retaining Walls

- Provide borings such that no portion of wall is more 100 feet from a boring (measured from wall face) and not less than two borings per wall.
- Provide depth to groundwater measurements for each boring. Install and monitor observation wells as needed to characterize groundwater condition for cut walls when groundwater is encountered in borings or local experience indicates that groundwater is likely to be present at depths affecting wall stability.
- Obtain soil and rock samples for laboratory testing of each boring.
- In formations with the potential for having soluble sulfates, such as the Eagle Ford Formation, perform soluble sulfate tests.
- For weathered/unweathered shale or marl, perform direct shear testing for the bearing material.

Other Structures

- Provide borings within 100 feet of each foundation elements for high-mast illumination, radio towers, toll gantries, buildings, and overhead sign structures.
- Provide depth to groundwater measurements for each boring.

Slopes and Embankments

- Provide borings such that no portion of a slope is more 100 feet from a boring for slope heights of 10 feet or more.
- Provide not less than two borings per embankment or cut slope for slope heights of 10 feet or more.
- Provide depth to groundwater measurements of each boring.
- Obtain soil and rock samples for laboratory testing of each boring.

Field Operations

Drill Hole Filling

- Except as otherwise specified, soil and rock cuttings may be used to backfill the borings.
- For borings through pavement, patch pavement with materials similar to the removed pavement surface materials.
- Comply with the appropriate governmental agency's guidelines in areas which are under the jurisdiction of these agencies.

Sampling

- The sampling program shall be planned and executed to obtain relatively undisturbed samples of cohesive soils and rock and obtain samples of granular deposits.
- Suitable tools include Shelby tube samplers, seamless tube samplers, California Sampler, Pitcher Barrel, standard penetration test (SPT), NX or PQ diamond core or other appropriate sampling device approved by NTTA.
- All sampling shall be in accordance with either ASTM or AASHTO standards.
- In rock, measure percent recovered and RQD values; include results on boring logs.
- Provide continuous samples between TCP testing as appropriate for obtaining soil samples for definition of soil and rock strata boundaries.
- All samples except bulk samples shall be protected from moisture change, excessive heating or cooling, and handling disturbance and be labeled to clearly identify the Project, Boring No., and depths where the samples were obtained.

In-Situ Testing

- Where subsurface conditions warrant, in-situ testing should be considered.
- Suitable in-situ testing methods include cone penetration soundings, dilatometer testing, pressuremeter testing, and geophysical methods.
- Other appropriate in-situ testing methods approved by NTTA.

Soil and Bedrock Logging

- For descriptive adjectives specified in the TxDOT Geotechnical Manual, include presence of organics and odor.
- In addition to TCP methods, the consistency of cohesive soil may be described based on the pocket penetrometer values (PPV) and the density of the cohesionless soil may be described based on the Standard Penetration Test (SPT) blow counts.
- Identify on the boring log legend sheets the method used for describing the soil density or consistency.
- Use the following tables for describing soils based on standard penetration (SPT) blow counts and pocket penetrometer values:

Consistency of Cohesive Soil

Pocket Penetrometer, TSF	Consistency
< 1	Soft
1 – 2	Firm
2 – 3	Stiff
3 – 4	Very Stiff
> 4	Hard

Relative Density of Non-Cohesive Soil

SPT, blows/ft.	Density
0 – 4	Very Loose
4 – 10	Loose
10 – 30	Medium Dense
30 – 50	Dense
> 50	Very Dense

- Borings shall be logged in the field by either a geotechnical engineer or geologist, qualified and trained in drilling and sampling procedures, soil and bedrock classification, and local geology. Logging by drilling personnel shall not be permitted.

Laboratory Testing

Develop laboratory testing program appropriate for the structure(s) being designed. The laboratory testing program shall include:

- Total stress (undrained strength) and effective stress strength tests for global stability, bearing capacity, sliding, earth pressures and lateral load analyses.
- Consolidation test for settlement analyses.
- Swell tests for volume change analyses in expansive clays.
- In formations with potential for having soluble sulfates, such as the Eagle Ford Formation, perform soluble sulfate tests.
- For soil classification, perform laboratory tests such as Atterberg Limits and percent passing No. 200 sieve.
- For scour analysis information, perform gradation tests including hydrometer tests.
- Provide all soil survey, test results, and geotechnical analyses in a geotechnical report sealed by a Texas registered professional engineer.

Foundation Design

Drilled Shafts

In addition to TxDOT design methods, the following publications for alternative methods may be used for drilled shaft design if approved by the NTTA in advance:

- FHWA-IF-99-025, Drilled Shafts: Construction Procedures and Design Methods.
- FHWA-NHI-10-016, Drilled Shafts: Construction Procedures and LRFD Design Methods.

Piling

In addition to TxDOT design methods, the publication FHWA-HI-97-013, Design and Construction of Driven Pile Foundations and AASHTO LRFD Bridge Design, may be used for the design of driven piles if approved by the NTTA in advance.

Retaining Walls

Retaining Wall Selection

- Economics: Evaluate the total cost of wall, including needed right-of-way, excavation shoring, utilities, foundation improvement, and groundwater control.
- Stability: Assess impacts of groundwater on stability.
- Constructability: Determine whether walls are near water or subject to inundation. Identify access limitations for equipment. Consider restrictions to construction created by overhead and underground utilities. Ensure adequate horizontal and vertical clearances are provided for installation of retaining wall types, particularly tied-back, nailed, and drilled shaft walls. Also evaluate impact of

construction sequence, such as underground utility installation and traffic control sequencing requirements on wall installation and stability.

- Aesthetics: See NTTA Design Guidelines for NTTA preferences regarding wall aesthetics and layout.
- Soil Nail Walls: Permanent soil nail walls are permitted only if approved in advance by the NTTA. When permitted, design these walls in accordance with the design method included in FHWA-IF-03-017, "Geotechnical Engineering Circular No. 7, Soil Nail Walls", AASHTO LRFD Bridge Design Specifications, or other methods approved by NTTA.
- Concrete Block or Segmental Block Walls. Concrete block walls or segmental block walls are prohibited.
- Tied-Back Walls. Permanent tied-back walls are permitted only if approved in advance by the NTTA. When permitted, design these walls in accordance with the design method included in FHWA-IF-99-015, "Geotechnical Engineering Circular No. 4, Ground Anchors and Anchored Systems", AASHTO LRFD Bridge Design Specifications, or other methods approved by NTTA.

Retaining Wall Layouts

For NTTA retaining wall layouts, add the following items to those required by TxDOT:

Plan View

- Locations of adjacent existing and proposed structures (bridges, buildings, pavements, signs, ITS, message boards, etc.) and foundations (drilled shafts, piles, footings, etc.).
- Existing and proposed underground utilities passing under wall or within wall height of the wall.
- Limits of temporary shoring for excavation, if applicable.
- Limits of wall foundation soil improvement, if applicable.
- Underdrain location. Include cleanout and outlet locations.

Elevation View

- Beginning and ending wall points by station, offset, and roadway alignment.
- Additional points as necessary to describe the relationship of wall alignment to roadway alignment(s).
- Indication of which side is the face of the wall.
- Horizontal curve information if applicable for wall alignment.
- High water and normal pool elevations, if applicable.
- Location of soil borings. Include boring name, station, offset, and top-of-hole elevation.
- Signing, lighting, etc., mounted on or passing through wall (Designate and locate the sheets that contain information for these elements.).
- Surface and subsurface drainage structures or utilities that could affect or be affected by wall construction (Designate and locate the sheets that contain information on the structure or utilities.).
- Limits of temporary shoring for excavation, if applicable.
- Limits of wall foundation soil improvement, if applicable.
- Underdrain outfall and flow direction.
- Limits and locations of wall panel types (prism, flat, and logo) (See NTTA Design Guidelines).
- Slip joints locations for MSE walls.

Typical Section

- Material limits (select backfill, retained soil, foundation replacement, etc.) required for wall construction.
- Underdrain location and related foundation grading.

- Location of existing grade.
- For cut walls, soil layering and design groundwater elevations.
- If geometry of wall changes such as slope on top of and in front of wall, indicate station range applicable for typical section.
- Limits of temporary shoring for excavation, if applicable.
- Limits of wall foundation soil improvement, if applicable.
- Estimated short-term and long-term deflections and settlements (may be shown in table on separate sheet).
- For MSE walls, show minimum length(s) of soil reinforcement (alternatively, may be shown in table on separate sheet, such as the NTTA Standard MSE-201-2014, which is intended for the use of the Design Section Engineer).
- For MSE walls, show pavement and base course, if present, above reinforcement soil mass and retained soil. See Figure 4-1 for sample details.

General Design – All Walls

- Deflection and Settlement. Limit long term lateral deflection (deflection after wall completion) at bridge abutments to 1.5 inches maximum. Limit long term vertical settlement (settlement after wall completion) within 40 feet of bridge abutments to 1.0 inches maximum. Provide short term (during construction) deflection and settlement estimates. Limit all deflections, in general, to avoid damage to wall elements or adjacent structures, or avoid unsightly long term deformations. Evaluate the effect of settlement (or heave) of proposed work on utilities, culverts and pipes (existing or proposed).
- Landscape Surcharge. Design for an additional surcharge load (100 psf unfactored) for walls supporting sod or landscaping to account for the possible future weight of landscaping. Apply uniform landscape surcharge to the active earth wedge. Do not overlap landscape surcharge with traffic surcharge, if present.
- Slip joints. Provide vertical slip joints in wall panels and coping where walls adjoin another wall type, cross a culvert, or to control differential settlement where differential wall movements are expected to open panel joints.
- Drawdown Analysis. Stability criteria apply to dry and drawdown analysis and under scoured conditions or excavation in front of wall for utility or pavement installation. Analyze walls for draw-down only if subject to inundation. Drawdown should be considered from 100 year flood elevation to normal pool (or flow) elevation but not less than 3 ft. minimum.
- Design Parameters. Provide in the plans wall and/or station range specific design parameters for applicable soils within the influence zone of the wall considering the short term and long term conditions. The design parameters shall be evaluated based on appropriate laboratory testing, which shall be selected based on soil survey information. When applicable, check wall design for saturated, fully softened or residual strength values. If the designer incorporates foundation improvements for wall stability, the designer must analyze the foundation improvements and clearly detail the performance requirements of the foundation improvement on the plans.
- Underdrains. Provide underdrains for all wall types. Underdrain pipe shall be 8-inch minimum diameter and Item 556 Type 7 or 8. Underdrain outfall shall be routed into storm sewer inlets or manholes, or channels. Provide adequate slope to ensure that pipes will drain. Consider the effect of wall foundation elevation changes when setting pipe grades. Increase depth of the underdrain as needed for walls on steep slopes (along the wall face).
- Surface drainage. Prevent runoff from flowing over the face of walls. If pavement and railing are not present adjacent on the retained side of a wall, provide a flume to collect runoff flowing toward the

face of the wall. Provide an adequate number of drain inlets along the wall and at sag curve low points. At retaining wall flume ends, provide proper collection and routing of runoff from flume. Inlets, channels, energy dissipation pads are acceptable means of routing runoff; direct outfall of concentrated flow onto grassed areas is not permissible.

- Filter fabric. Specify UV-resistant filter fabric at panel joints to prevent backfill leakage. All filter fabric shall meet DMS-6200, Type 2.
- Wall profile. Ensure wall profiles are smooth with no sharp or abrupt changes.
- Coping at approach slabs. Where retaining wall coping is attached to (or adjacent to) approach slab, provide expansion joints in coping at the start and end of the approach slab.
- Fence mounting. Use NTTA mounting details for fence on a top of walls or coping. Do not specify direct embedment of posts into walls or coping.
- Future widening. Account for the future widening of the roadway when designing walls. Locate walls to adequate clearance for future roadway. Design to minimal waste of currently proposed walls in future construction.
- Refer to NTTA Design Guidelines for aesthetic details. Also utilize NTTA standard drawings (i.e. RWD, MSE series) where appropriate.

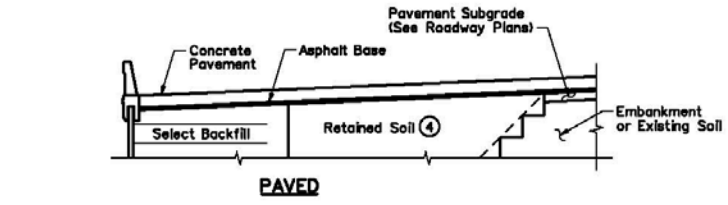
<u>Wall Design – Specific Types</u>

- MSE Walls.
  - Design Methodology. Investigate all AASHTO required potential modes of failure including, but not limited to, lateral displacement, settlement, bearing capacity, lateral sliding, overturning (eccentricity of base pressure resultant), overall (global) stability and compound stability. Comply with the methodology described in FHWA-NHI-00-043, "Mechanically Stabilized Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines", except as otherwise specified by the NTTA.
  - Standards. Comply with the design requirements of the NTTA modified TxDOT standard drawing, RW(MSE)(MOD), as published by the NTTA. Use the design parameters for the select backfill shown on this standard. Show design parameters for foundation soils and retained soils on the NTTA standard drawing, MSE-201-2014, which must be completed and sealed by the Design Engineer(s). Consider including in the plans the plasticity index of each foundation and retained soil to aid in identification of these soils during construction.
  - Retained Soil. Evaluate the use of Item 423 select backfill for retained soil between the reinforced soil mass and the embankment or cut slope. If select backfill is used for retained soil, evaluate slope stability without any select backfill in place. Slope shall not be steeper than 1:1. See "Roadway Typical Sections" in Chapter 2 and Figure 4-1 for additional guidance.
  - Embedment Depth. Provide minimum embedment depths per the following table:

Minimum Embedment Depths for MSE Walls	
Slope in Front of Wall	**Minimum Embedment Depth to Top of Leveling Pad***
All Geometries	2 feet minimum
Flat	H/20
3:1 (H:V) Slope (away from wall)	H/10

**Minimum embedment depth shall be the greater of applicable value listed, or either unprotected scour depth plus 2 feet, or future excavation plus 1 foot, whichever is deepest.*

  - Reinforcement Length. The minimum earth reinforcement length is 8 feet or 70 percent of the wall height, whichever is greater. Specify longer reinforcement lengths as needed to satisfy stability requirements.



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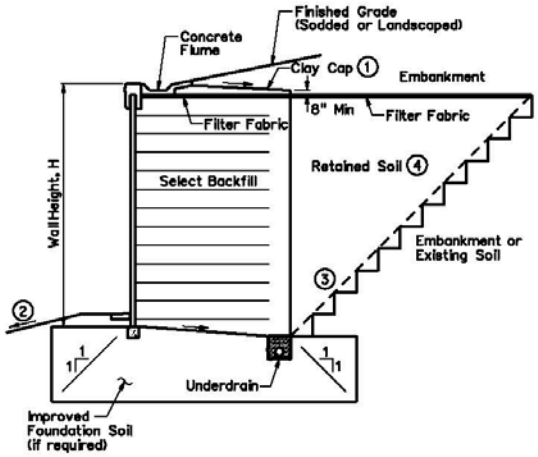

SODDED OR LANDSCAPED

MSE WALLS WITH SELECT BACKFILL RETAINED SOIL

① Place filter fabric (DMS-6200, Type 2) and clay cap over select backfill in sodded or landscaped areas. Clay cap shall consist of 8 inches minimum thickness layer of compacted clay soil backfill. The clay soil shall have a minimum plasticity index (PI) of 30 or more with at least 70% of the soil passing the no. 200 sieve size. Clay shall be free of rocks with dimensions larger than 0.75 inches and man-made materials such as concrete or asphalt.

② Slope to drain away from base of wall.

③ Match embankment lift requirements as specified for Item 132. embankment or bench in 2 feet lifts for cut slopes.

④ Place Item 423 select backfill between the mechanically stabilized earth mass and embankment or native soil.

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Figure 4.1 MSE Wall Section with Select Backfill Retained Soil.

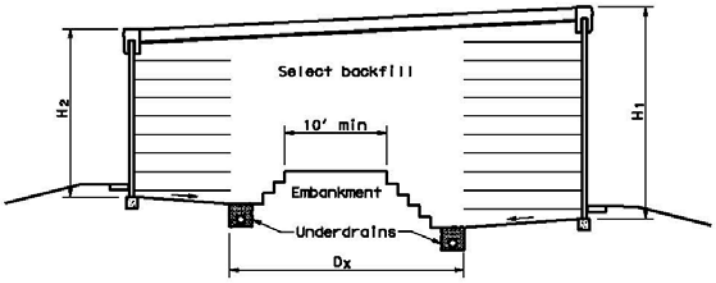
- Design Wall Height for Walls in Front of Bridge Abutments. For wall design purposes only, consider the design wall height of abutment in front of bridge abutments to be equal to the distance between the top of leveling pad and the finished grade at the abutment backwall. Show on the plans the length-to-height ratio based on wall height, measured from the top of coping.
- MSE-Supported Bridge Abutments. Bridge abutments shall not be supported shallow foundations founded on either soil or reinforced soil, such as an MSE wall. Bridge abutments shall be supported by deep foundations, such as drilled shafts, piles, or shallow foundations on rock.
- BBMSE Walls. For back-to-back MSE walls (BBMSE), such as for a ramp embankment, the base width (distance between parallel facing) shall be greater than or equal to $1.1H_1$, where H_1 is the height of the taller wall. With the exception of the transverse slope towards the underdrain, the foundation for all MSE walls shall be level. For BBMSE walls, stepping of foundation soils (2 foot maximum lifts, 1:1 maximum steepness of slope without shoring) to adjust for differences in foundation soil elevations is allowed between reinforced soil masses only. See Figure 4.2 for additional BBMSE guidance.
- SMSE Walls. Shored MSE walls (SMSE) shall not be used without permission of the NTTA and will not be allowed to support mainlane pavement. Note that SMSE walls typically have reinforcement length less than the minimum earth reinforcement lengths (See "Reinforcement Length" above for minimum permissible lengths). Figure 4.3 shows MSE walls having temporary shoring, which is a permissible design but not considered an SMSE wall.
- Project Specific Requirements. Evaluate project-specific requirements for wall backfill type, wall embedment, wall drainage, conflicts within the wall reinforced zone and other considerations as necessary.

- Drilled Shaft Walls.
  - Loading. Pressure diagrams provided shall account for and detail the movements associated with the assumed conditions. Provide wall specific soils and rock design parameters for short-term and long-term conditions. The estimation of the design parameters shall be based on appropriate laboratory testing and available project information.

Slope Stability

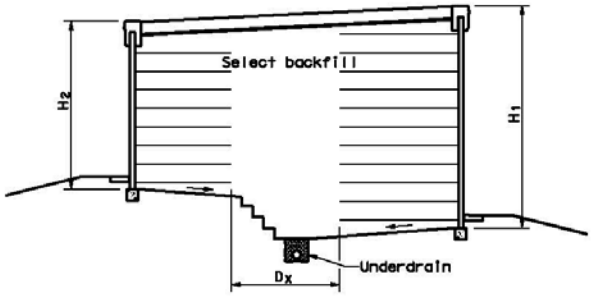
Global Stability Analysis

- Refer to the Slope Stability Chapter in the NTTA Pavement Design Manual for additional information regarding slope failure, design, and mitigation. Slopes in areas which are under the jurisdiction of other agencies, such as the USACE, also require adherence to the responsible agency's guidelines.



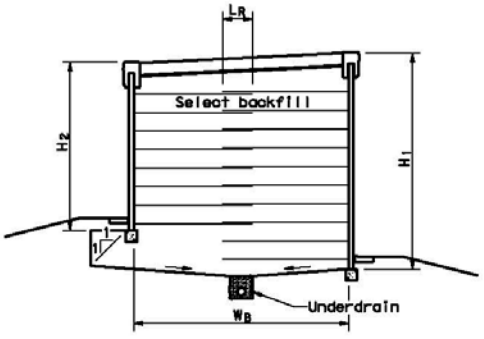
CASE 1A - WIDELY SEPARATED REINFORCEMENT

Applies where the distance between wall soil reinforcement, D_X , is more than the greater of 10 feet or $0.5H_1$ where H_1 is the taller wall height.



CASE 1B - NARROWLY SEPARATED REINFORCEMENT

Applies where the distance between wall soil reinforcement, D_X , is less than or equal to the greater of 10 feet or $0.5H_1$ where H_1 is the taller wall height.



CASE 2 - OVERLAPPING REINFORCEMENT

If soil reinforcement overlap, L_R , is more than $0.3H_2$, the base width, W_B , shall not be less than $1.1H_1$. H_1 and H_2 are the taller and shorter wall heights, respectively.

BACK-TO-BACK MSE WALLS (BBMSE)

Figure 4.2 BBMSE Wall Sections

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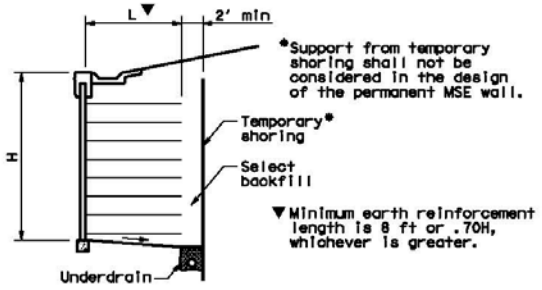

MSE WALLS WITH TEMPORARY SHORING

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Figure 4.3 MSE Wall Section with Temporary Shoring

Chapter 5 – Structures

Overview

This chapter provides NTTA supplementary criteria for NTTA bridges and noise barrier (sound) walls. To the extent practical, select bridge types, component details and finishing treatments that reduce long-term maintenance commitments

Application

Guiding Documents:

TxDOT Bridge Design Manual - LRFD
TxDOT Bridge Detailing Manual
TxDOT Bridge Railing Manual
TxDOT Geotechnical Manual
NTTA Design Guidelines

Supplementary NTTA Criteria to Guiding Documents:

Bridges

Superstructure

- Bridge Deck Contour Plan. For all bridge plan sets, provide a bridge deck contour plan showing planned finished grade of bridge deck surface. Draw contour lines at 0.1 ft. increments. Show stations, bents, and deck drains, if applicable; label whole foot contour lines. Eliminate depressions ("duck ponds") in the bridge deck.
- Concrete Surface Treatment. Specify Class I concrete surface treatment (linseed oil) for all new bridge decks.
- Conduit. Coordinate conduit system design with bridge design at abutment backwall, bridge under deck, bridge drainage system location, and column/bent structures. Show piping and conduit penetrations in backwall on abutment drawings and conduit location on slab drawings, typical transverse sections, and bent drawings. Do not place conduit under the bridge deck overhang. Place conduit for deck illumination in the traffic rail, not the bridge deck.
- Deck Concrete. Use Class S, f'c = 4000 psi air entrained concrete in bridge deck. The underside of the overhang and outside (visible portion only) vertical edge shall comply with "off-the-form" finish requirements in Item 427.
- Deck Reinforcement. Specify epoxy coated reinforcing steel for top and bottom mats of all new bridge decks. Also specify epoxy coated reinforcing steel for connecting the concrete traffic barriers and rails to the deck. Provide 2.5 inches of clear cover for top mat of deck reinforcement. TxDOT design recommendations shall take precedence over AASHTO.
- Deck Drainage. See "Drainage" section in Chapter 2.
- Deck Sensors. Provide road weather information system (RWIS) sensors in the bridge decks as directed by the NTTA Maintenance Department.
- Deck Thickness. All concrete deck shall be 8.5 inches thick minimum.
- Girder/Beam Ends. Align outside girder/beam lines on bent caps.
- Illumination Poles. Poles shall be placed within 15 feet of a support (bent or abutment) to minimize vibration which reduces bulb life. Barrier mounted poles should be avoided due to higher exposure to traffic impacts. Mounting poles behind traffic rail on a deck bracket (see TxDOT BL, Bridge Lighting standard) is preferred.

- Steel Girders. All steel girders shall be uncoated, weathering steel meeting the requirements of ASTM A709 Gr 50W, HPS 50W or HPS 70W. Provide stain protection for concrete bent caps and abutment caps including drip pans and drip plates on outside girder lines, and anti-graffiti coating of cap (top and sides).
- Traffic Rail Expansion Joints. Align traffic rail expansion joints with expansion joints in bridge decks and approach slabs. Provide expansion joints in the traffic rail where the rail transitions from one support to another, such as from the bridge deck to wingwalls or MSE wall copings, from wingwalls to TRF or pavement, etc. Callout expansion joint locations on the plans.

Substructure

- Abutment Embankments. Avoid full height retaining walls at abutments, if possible, to reduce lateral movement of the abutment. Full height end slopes or a combination of partial height retaining walls and end slopes are preferred.
- Abutment End Slopes. Abutment end slopes (under the bridge) shall be 3H:1V or flatter and covered by concrete riprap. Isolate the lateral or downhill movement of sloped riprap and retaining walls from fixed structures such as columns or pavement curbs. Riprap and walls tend to slide downhill or move laterally over time and can cause damage to pavement curbs if riprap is in direct contact sloped riprap or retaining wall and to columns or the riprap Use ¾ inch fiberboard against curbs and retaining walls. Provide a block-out in riprap around columns (on a slope) and fill with asphalt. The block-out dimension(s) shall be 6 inches larger than column.
- Approach Slab. Provide supplemental expansion joint as shown on NTTA BAS-201, Bridge Approach Slab Supplement standard, if CRCP pavement adjacent to bridge approach slab is over 1000 feet long. The supplemental expansion joint is designed to accommodate pavement growth typical in CRCP pavements. Also see Wingwall requirements.
- Column Design. The NTTA aesthetic bent details require column sizes which in some cases are larger than minimum requirements. Do not model a smaller “core” column and reinforce accordingly. Instead, reinforce the entire column cross section minus reveals. This includes the design of capitals as well. If designing columns for bending, do not count reinforcement further than 6” from tension face as effective.
- Column Drain Pipes. For drain pipes within columns, do not reduce the size of drain pipe coming into or within columns. Provide accessible cleanouts at bends.
- Drilled Shaft Reinforcement. The clear distance between drilled shaft reinforcing bars (both longitudinal and transverse) shall not be less than 4.5 inches to ensure concrete flows freely from within the reinforcing cage to the edge of the excavation.
- Foundation Type. Use drilled shafts for all bridge bent and abutment foundations.
- Retaining Wall Coping. Where retaining wall coping is attached to approach slab, provide expansion joints in coping at the start and end of the approach slab.
- Scour Considerations. Minimize the number of columns located inside the 100 year floodplain. If within the floodplain, use gabions mattresses or rock riprap to reduce scour. However, when designing new foundations for bridges or new walls, ignore erosion protection measures and assume fully scoured conditions. Support columns with single drilled shaft foundations when located within the 100-year floodplain; lower tops of shafts to predicted scoured stream bed if near an eroding bank or a meandering channel.
- Underbridge Riprap. Areas beneath bridges shall have a surface that resists soil erosion such as brick pavement, rock riprap, concrete riprap, gabion mattress treatment, etc. Refer to NTTA URD-201, Underbridge Riprap Detail Standard for underpass and overpass details. Also see “Drainage” section in Chapter 2.

- Wingwalls. Provide constant height wingwalls. Align traffic rail expansion joints with approach slab expansion joints by extending wingwall lengths up to 10 feet beyond the length required by the TxDOT Bridge Detailing Manual. If the approach slab extends 10 feet or more beyond the end of the wingwall, support traffic rail on the approach slab, widened to support the rail. See NTTA BAS-201, Bridge Approach Slab Supplement standard for standard details.

Noise Walls

This section provides design criteria for noise walls.

- Drainage. Drainage shall be diverted away from noise walls.
- Galvanizing. All exposed steel structural elements shall be galvanized.
- Location. Noise walls shall be within three (3) feet of ROW line. If noise walls are within the clear zone, protect the wall from traffic impacts by placing a traffic rail in front of the wall. Offset noise wall a minimum of 5 feet clear behind traffic rail.
- Minimum Height. No point along the length of a noise wall shall be less than the established criteria height.
- Mow Strips. Mow strips shall be installed adjacent to the noise wall level pad or foundation cap.
- Expansive Soils. Consider the effect of seasonal expansive soil movement on wall design.

Chapter 6 – Traffic

Overview

This chapter provides NTTA supplementary criteria on roadway signs and pavement markings. Comply with all applicable NTTA, TxDOT, and Texas MUTCD requirements.

Application

Guiding Documents:

NTTA Sign Policy
NTTA Sign and Traffic Control Device Guidelines
TxDOT Signs and Marking Manual
TxDOT Pavement Marking Handbook
Texas MUTCD

Supplementary NTTA Criteria to Guiding Documents:

Pavement Markings

- Striping type shall conform to NTTA Pavement Marking Standards.
- Thermoplastic Type I pavement workings shall be used unless otherwise specified by the NTTA.
- Provide striping pay item numbers per TxDOT specifications.
- Ensure delineators on pavement sections are of the self-correcting type.

Signs

Location

- Sign supports are to be properly located and clear of the roadway per TxDOT standards.
- Avoid placing signs in a ditch; this could impede drainage, make mowing difficult and result in erosion or siltation around the sign support.
- Coordinate overhead sign structure location with ITS system.
- Station Markers shall be mounted on median rail at five-hundred (500) foot spacing and at station equations.
- To the extent possible, avoid excessive signing which not only contributes to visual clutter that impacts visual quality in the roadway environment, but increases maintenance commitments and safety.

Large signs

- Large signs are defined as signs having an area greater than 64 SF.
- Large signs shall be constructed of extruded aluminum.
- Large signs shall use Type IX or XI sheeting.
- Screen printing will not be permitted.

Small signs

- Small signs are defined as signs having an area equal to or less than 64 SF.
- Small signs shall be constructed of plate or sheet metal.
- Small signs shall be mounted on approved breakaway sign supports.
- Screen printing will not be permitted.
- Small signs shall be installed on triangular slip-bases.

Cantilever Overhead Sign Structure (COSS)

- Provide square concrete riprap/apron (a minimum of two-feet from the structure) around all COSS supports.
- Leave no vegetation between a COSS support and MBGF unless these items are more than eight (8) feet apart clear. Refer to "Riprap" subsection under "Plan and Profile" section in Chapter 2, Roadway.

Concrete Barrier/Rail Delineation

- Specify Linear Delineation Panels (LDS) to be installed on the concave face of either concrete barrier or rail that is in a curve with a 1,500 foot radius or less.
- Follow TxDOT Barricade and Construction (BC) standards for temporary barriers used for traffic control.
- Follow TxDOT Delineator & Object Marker standards for permanent barriers used to divide opposing direction of traffic or for cross-over protection in wide medians.
- Require station markers. Provide quantities and a separate pay item for station markers.

Signals

- Signals shall be in compliance with TxDOT standards.
- Coordinate with TxDOT and/or the adjacent municipality during the design phase.
- All signal controllers shall comply with National ITS standards; proprietary software will not be permitted.
- Appearance characteristics must be coordinated with NTTA Design Guidelines Manager.

Chapter 7 – Electrical & Lighting

Overview

This chapter provides design criteria for primarily for electrical and illumination requirements on NTTA projects. See Chapter 8 for ITS specific requirements.

The Design Engineer shall coordinate with the Corridor sections/segments adjacent to the design for which they are responsible. When the design of multiple roadway sections are apportioned to different design firms, all electrical work specified herein shall be coordinated with the work of the other Section Engineer's working on the Project and completed so that all installations shall operate as a single unified design.

Guiding Documents:
NTTA Roadway Electrical System Manual (RESM)
TxDOT Highway Illumination Manual

Supplementary NTTA Criteria to Guiding Document:

Illumination

- Minimize the use of roadway lighting except as noted or where necessary to improve user safety.
- Provide lighting at along ramps and under bridges.
- Avoid barrier mounted light poles if possible.
- Design lighting systems to avoid direct views from adjacent residential properties and other sensitive receptors.
- To extent practical, specify consistent lighting standards; illumination structures (poles), mountings, fixtures and lamps for all segments and phases of the roadway corridor.
- Locate lighting poles along outside roadway shoulders to improve maintenance accessibility and minimize lane closures; where possible, align fixture heads to the center of any shoulders.
- Ensure ground junction boxes reference the NTTA as the owner per NTTA standard drawings and related manuals.
- Ensure all high mast illumination poles (HMIP) have base sleeves.

Chapter 8 – ETC, Gantries & ITS

Overview

This chapter provides design criteria associated with the electronic toll collection (ETC) system and intelligent transportation systems (ITS).

Guiding Documents:
NTTA Design Guidelines
NTTA Roadway Electrical System Manual (RESM)
TxDOT Highway Illumination Manual

Supplementary NTTA Criteria to Guiding Documents:

Roadway Design

- Gantries shall be located within a horizontal tangent section with vertical grade between 0.3% minimum to 5.0% maximum with 1% desirable grade. Cross slopes shall range from 0.5% minimum to 4% maximum with 2% desirable. Gantries shall not be located within vertical curves.
- Provide a ten (10) foot minimum width service access measured from edge of shoulder and downstream of gantry as shown on NTTA Gantry Standards.
- Avoid gantry site locations with space limitations that preclude safe and proper design for regular user access.
- Locate ramp gantries adjacent to the mainlane gore as design permits.
- Pavement typical section and joint design shall be coordinated with ETC loop layout. Longitudinal and transverse joints shall not be permitted through a loop.
- CCTV shall be coordinated with large overhead signs. CCTV location be designed downstream of sign structure.
- Ponding is not permitted in the tolling zone.
- See Chapter 2 Roadway, “Drainage” Section, “Pipes, “Inlets”, and “Manholes” subsections for drainage structures requirements near gantries.

Electrical Design

- Ensure interdisciplinary design coordination of ITS and ETS systems.
- Supply adequate electrical and communication infrastructure per NTTA Gantry standards.
- Provide electrical and communication conduit runs to adjacent ETC signage.
- Multi-duct conduit shall not be designed under or through retaining wall.

Chapter 9 – Landscape

Overview
This chapter provides design criteria for landscape, including sod, and irrigation elements. All landscape designs must meet all requirements outlined in the latest edition of the NTTA Design Guidelines.

Guiding Document:
NTTA Design Guidelines

Supplementary NTTA Criteria to Guiding Document:

Pre-Landscape Design
Roadway
- Riprap. See Chapter 2 Roadway, "Plan and Profile" Section, "Riprap" Subsection for riprap requirements.
- Ditches. See Chapter 2 Roadway, "Drainage" Section, "Ditches and Sodded Slopes" Subsection for drainage ditch design requirements.
- Mow Strips & Surface Treatments. See Chapter 2 Roadway, "Roadway Typical Sections" Section, "Mow Strips" Subsection for mow strip design requirements.
- Maintenance Access. See Chapter 2 Roadway, "Maintenance Access" Section, for maintenance access design requirements.
- Under Bridge Areas. Follow current NTTA Standards on how to address areas under bridges where vegetation will not grow due to lack of sunlight and/or water.
- Erosion Control. Specify silt fence, compost sock or Best Management Practices (BMP). Hay bales are not permitted for temporary or permanent erosion control.
- Environmental Protection. To the extent practical and/or required by law (and approved by the Authority), preserve and protect unusual vegetation features and special habitat environments. Mitigate vegetation requiring preservation and protection when disturbed consistent with project requirements and compliance with 1998 TxDOT-TWPD MOU.
- Soil Cover. Provide adequate soil cover (minimum six (6) inches) above rock layer or impervious soil to resist erosion and provide suitable depth for vegetation establishment.

Irrigation Electrical and Plumbing
- Provide 120v AC receptacles at each irrigation controller location for the operation of the irrigation system.
- Where an open cut trench is feasible, provide one six (6) inch and one four (4) inch schedule 80 PVC sleeve with tracing wire attached four (4) feet below grade and extending five (5) feet beyond outside edge of pavement for irrigation water and control wires.
- Where open cut trench installation is not possible, provide one six(6) inch and one four (4) inch HDPE sleeve with SDR-11 rating with tracing wire inside conduit four (4) feet below grade and extending five (5) feet beyond outside edge of pavement for irrigation water and control wires.
- Coordinate locations of receptacles, pipes, and conduits with NTTA's Design Guidelines Manager and follow NTTA irrigation standards.

Sodding
- Use Bermuda sod only; neither temporary (except for SW3P purposes) nor permanent seeding is permitted unless approved by the NTTA Design Guidelines Manager.
- Four (4) inches of compost manufactured topsoil (CMT) is required for soil preparation for all Bermuda sod.

- Properly label all vegetation items, soil improvements, etc., in a legend and follow NTTA policy.
- Sod all areas that are not covered by pavement or riprap nor planted with landscape vegetation.

Landscape Design

Roadway

- Nose and/or gore areas should be reviewed for potential integrally colored stamped concrete due to impacts from vehicles, difficult growing location, maintainability and site visibility.
- Ensure planting design will follow TxDOT's design standards for horizontal clearance.
- Ensure sight distances are never compromised.
- Planting locations should consider construction and maintenance accessibility.
- Planting will not be allowed in any swales and only permitted on the "back slope" of the median; swales shall have turf installed.

Vegetation

- Planting design should reflect a mix of ornamental grasses, shrubs and trees.
- A minimum of twenty (20) canopy or understory trees per landscape bed acre is required (includes evergreens) for design scale and air quality issues.
- Plant selection will consider low or minimal life cycle maintenance requirements.
- Plant descriptions shall include height and spread requirements in addition to root condition (in ball & burlap or container grown), container size and/or caliper.

Bed Preparation

- All existing vegetation shall be eradicated in all planting bed locations prior to irrigation and plant installation.
- Soil tests are required for each focus area to determine soil amendment requirements.
- Compost (4 inches) will be incorporated into the top six (8) inches of the existing soil mixed to a depth of 12" as part of bed preparation for landscape areas
- Hardwood mulch (3 inch applied, 2 inch settled) will be used as top dressing after irrigation and plants are installed.

Irrigation

- Irrigation design shall incorporate the latest water conservation principles and practices.
- Sub-surface drip irrigation is the preferred method of irrigation. If rotors or spray heads are required the design will eliminate the possibility of water spraying onto pavement in all circumstances.

Warranty

Specify the following items:

- Maintenance and plant replacement provisions during the construction phase are required.
- For construction acceptance, the landscape and irrigation system must be as designed and in proper operating condition.
- A two (2) year maintenance/warranty period following landscape construction acceptance is required.

Chapter 10 – Sand Stockpiles

Overview

This chapter provides design criteria for sand stockpiles. Evaluate sand stockpiles for location and design that supports the successful execution of the NTTA's snow and ice mitigation plan.

The sand stockpile design criteria addresses the location, spacing, placement and functionality parameters that include: sizing, accessibility, aesthetics, capacity and maneuverability associated with the NTTA system. Additionally, each stockpile location must adhere to the latest concrete finishes requirements per direction by the NTTA.

Guiding Documents:
NTTA Design Guidelines
NTTA Roadway Electrical System Manual

Supplementary NTTA Criteria to Guiding Documents:

Design Features

Size and geometry

- Size stockpile bins based on required "sand" quantities specified by NTTA for snow and ice mitigation plan. See Standard Drawings for Sand Stockpile details.
- Provide proper drain of the stockpile area.
- Size sand stockpile facility to be accessible for a WB-50 design vehicle.
- If precast concrete walls are specified, ensure that adequate vertical clearance is available.

Concrete finishes on bin wall exteriors

- Specify, as a minimum, Item 428 "Off-the-form" finish for exterior surfaces. If concrete is to be left under coated (which is the default), include NTTA Special Specification SS-850, "Natural Grey or Integrally Colored Concrete."
- Coordinate finish with local entities when required.

Location

- Space sand stockpiles along the corridor approximately six (6) miles apart, desirable, ten (10) mile maximum, and within a half (0.5) mile each way of a turnaround.
- Site locations shall be evaluated for visual compatibility with adjacent property uses, including NTTA roadway corridors, and preference for permanent dry cover over sand storage bins (such as beneath mainlane bridges). If stockpile bins are not located under bridges, fabric on steel frames (i.e. covers) is required. Covers shall be in compliance with the latest edition of the NTTA Design Guidelines.
- Ensure that all utilities, including NTTA's, are properly identified and located during design.

Right-of-Way Fence and Gates

- Ensure fence panel clearance from finished grade to prevent blockage by debris and drainage problems.
- Ensure finished slab elevation will not impede the function of the gate.
- Ensure fences and gates comply with the latest edition of the NTTA Design Guidelines.

Ground Cover

- In disturbed areas under the shade of the bridge, refer to the NTTA Groundcover Standard and coordinate with the NTTA's Design Guidelines Manager regarding groundcover type (i.e. riprap, pavers, etc.).

Restrooms

- Permanent restroom facility is required at each location.
- Require electrical, water, and sanitary sewer service.

Lighting and Conduit

- Maintain a minimum of 25 foot-candles at the pavement level throughout the site.
- Locate lighting fixtures in such a manner that they are serviceable while the bins are full and in service.
- Provide multi-duct communication connection to sand stockpile equipment wall.
- Coordinate with NTTA SIM's department for external security.

Chapter 11 – Utilities

Overview

This chapter provides design criteria for existing and/or or proposed utilities. Consideration should be given to location, alignment, encasement requirements, future expansion and all federal, state, local and NTTA requirements. See the NTTA QMS Manual UC-Series for sample utility agreement forms.

Guiding Document:
NTTA Utility Relocation Manual
TxDOT ROW Utility Manual

Supplementary NTTA Criteria to Guiding Document:

Plan Preparation

- List all utility contact information in the General Notes.
- Show all existing and proposed utilities in plan and profile view. Clearly mark encasement dimensions and type of material, directly or with legend. Identify beginning/termination points with station and offset.
- Verify that proposed items of work, such as utilities, drainage system, walls, or roadway profile are not in direct conflict with existing utilities and will not cause damage to the existing utilities. See Chapter 4 for soil settlement/surcharge requirements.
- Include irrigation conduit sleeves under the proposed pavement at all gantry and interchange locations for future irrigation lines. See Chapter 9, Landscaping, for additional irrigation electrical and plumbing requirements.

Coordination with NTTA

- Evaluate proposed utility relocations for their impact on existing NTTA fiber optic network. Coordinate with the NTTA IT Department.
- Evaluate proposed utility relocations for their impact on existing and future landscaping. Coordinate this work with the NTTA Project Delivery staff.
- Provide all Subsurface Utility Engineering (SUE) data to the Construction Manager.
- Utilities seeking to cross NTTA facilities will be granted permanent access without an easement.

Chapter 12 – Right of Way

Overview

This chapter provides design criteria for right of way acquisition requirements. Consideration should be given to design roadway elements for access, location, alignment, future expansion, and all federal, state, local and NTTA requirements. For information pertaining to the ROW acquisition process, please see the NTTA QMS Manual ROW-Series.

Guiding Documents:

NTTA QMS Manual, ROW Series Procedure Definitions
TxDOT Right of Way Manual Vol. 2 - Right of Way Acquisition
TxDOT Right of Way Manual Vol. 4 – Eminent Domain

Supplementary NTTA Criteria to Guiding Document:

Size Requirements

- On all new corridors, a minimum 400' right of way width is required.
- Minimize the need to acquire ROW during the design process.
- Identify and recommend any necessary drainage, utility or slope easements early in the design phase for maintenance access or ROW constraints.
- Provide adequate access (twelve (12) foot minimum) adjacent to culvert aprons and wing walls.

Parcel Numbering Conventions

- For parcels on projects that are 100% funded by NTTA, or for projects that have donated right of way parcels, number each parcel by project, section and parcel number. For example, Parcel 2 on PGBT-EE, Section 28 would be labeled: PGBT-EE 28-02.
- For jointly funded projects, or previously acquired by TxDOT, retain the previously assigned TxDOT numbering system.

Miscellaneous

- For situations where excess ROW is identified, please refer to the NTTA Policy Regarding Sale of Surplus Real Property by NTTA, which may be found in the Appendix B of this document.
- Refer to any relevant executed Agreements within the design corridor for compliance on commitments for ROW acquisitions and transfers with the affected corridor cities.

Appendix A

NTTA Maintenance Access Design Details

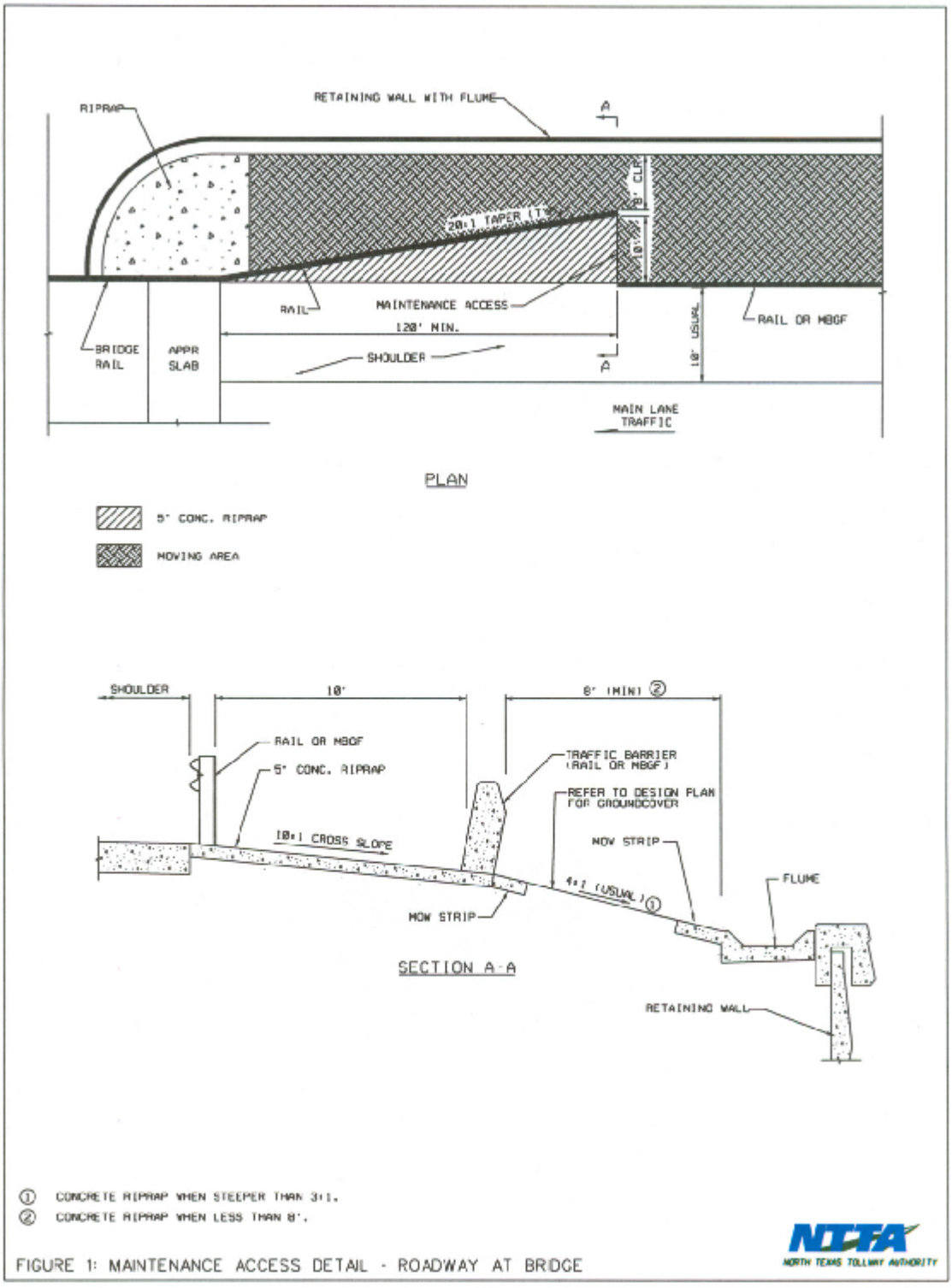

FIGURE 1: MAINTENANCE ACCESS DETAIL - ROADWAY AT BRIDGE

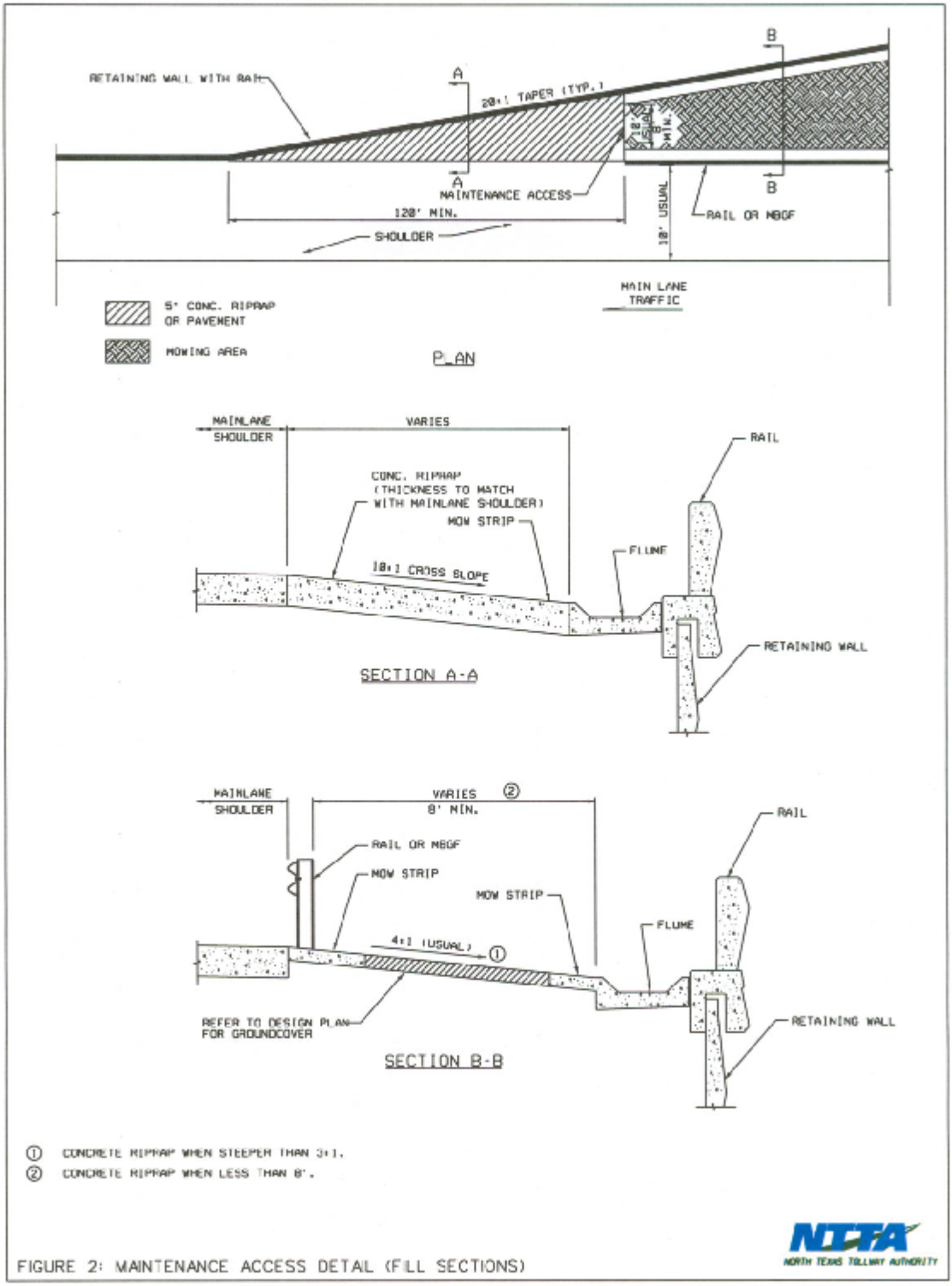

FIGURE 2: MAINTENANCE ACCESS DETAL (FILL SECTIONS)

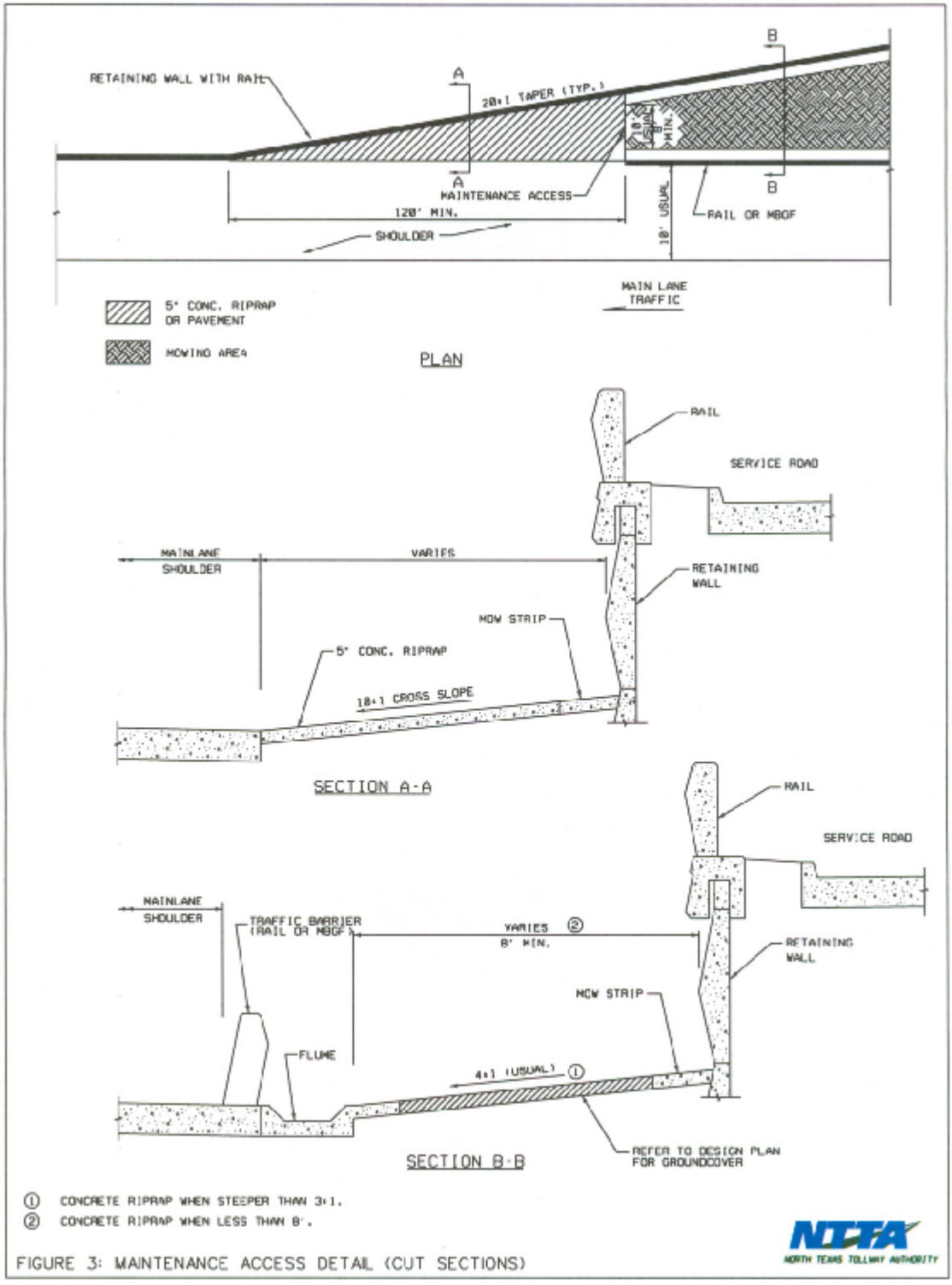

FIGURE 3: MAINTENANCE ACCESS DETAIL (CUT SECTIONS)

Appendix B

NTTA Policy Regarding Sale of Surplus Real Property by NTTA

NORTH TEXAS TOLLWAY AUTHORITY

BD 6.12	**POLICY REGARDING SALE OF SURPLUS REAL PROPERTY BY NTTA**	Resolution Number	11-92
		Resolution Date	06/15/2011
		Effective Date	06/15/2011
		Revision Date	
		Procedure Number	BD 6.12 A

PURPOSE	The purpose of this policy is to ensure that the sale of surplus real property by NTTA: (i) complies with the Texas statutory mandates and requirements, (ii) does not jeopardize or negatively impact the safe and efficient operation or maintenance of NTTA facilities, and (iii) does not impair the preservation of NTTA real property for existing or future transportation-related uses planned or identified by the NTTA or other transportation or governmental entities.
POLICY STATEMENT	The NTTA shall review and evaluate all proposed sales of surplus real property owned by the NTTA based on criteria and requirements that (1) are intended to ensure that a proposed sale does not jeopardize or negatively impact the safe and efficient operation of NTTA toll roads or facilities, or impair the preservation of NTTA real property for existing or future transportation-related uses planned or identified by the NTTA or other transportation or governmental entities, and (2) seek to ensure that the NTTA obtains proper compensation for the sale of surplus real property. The sale of surplus real property will be documented in written agreements acceptable to the NTTA. The NTTA shall follow all applicable statutory requirements in the sale of surplus real property. The NTTA shall impose deed restrictions on surplus real property sold by the NTTA as necessary, in the sole opinion of the NTTA, to prevent the placement of billboards within view of the traveling public on any NTTA turnpike project.
RESPONSIBILITIES	The NTTA Maintenance Department will execute this policy. The Board shall approve all sales of surplus real property as permitted under this policy.

SCOPE	Except as specified below, this policy applies to initiatives by NTTA to sell surplus real property which is not required in connection with NTTA operated or maintained toll roads or other NTTA facilities. Without limiting the generality of the foregoing, this policy applies also to the sale of NTTA-owned real property to other governmental entities; however, NTTA staff shall evaluate another governmental entity's request to purchase NTTA-owned real property by applying only the criteria and analyses set forth in this policy and its associated procedures that are appropriate for the particular request. In all events, staff shall ensure that the proposed purchase by the government entity does not materially and adversely affect the safe and efficient operation or maintenance of NTTA facilities. This policy does not govern the sale or lease of mineral rights. This policy does not apply to the sale of surplus or salvage personal property. This policy does not apply to the use of NTTA-owned real property by public utilities, as defined by Section 11.004 of the Texas Utilities Code, which uses typically shall be documented in a utility adjustment agreement or utility permit. This policy does not apply to agreements to allow uses of NTTA rights-of-way for limited amounts of time; such uses are governed by the "Policy Regarding Use of NTTA Rights-of-Way By Individuals or Other Entities."