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Sequencing and Placement of Noise Walls and Retaining Walls on TxDOT Projects

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16. Abstract
The objective of this research is to provide guidance to project stakeholders for the sequencing and placement of noise walls and retaining walls. The research included examining noise and retaining wall selection, standards and specifications, preferred methods and best practices for sequencing and placement, and design and construction procedures. Meetings were conducted with TxDOT district and division officials to review existing practices, identify issues, and document recommendations. Data related to noise walls were analyzed related to noise walls and the project development process. Active TxDOT projects were selected as case studies to document issues and best practices. The research documented key challenges and developed recommendations for use. Areas of recommendation include spacing, utility coordination, earlier and wide-ranging involvement of stakeholders, right of way considerations, and alternative wall types and materials. Updates for TxDOT manuals are also presented. The research can be used by project stakeholders to assist in the sequencing and placement of noise walls and retaining walls and can be used to lessen the impact of noise walls and retaining walls on the overall project development process, including design, construction, and maintenance.

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SEQUENCING AND PLACEMENT OF NOISE WALLS AND RETAINING WALLS ON TXDOT PROJECTS

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DISCLAIMER

This research was performed in cooperation with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA). The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of FHWA or TxDOT. This report does not constitute a standard, specification, or regulation.

This report is not intended for construction, bidding, or permit purposes. The researcher in charge of the project was Kris Harbin.

The United States Government and the State of Texas do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the object of this report.

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LIST OF ACRONYMS AND ABBREVIATIONS

BCE	Blanket Categorical Exclusion
CE	Categorical Exclusion
CFR	Code of Federal Regulations
CSJ	control section job (number)
DCIS	Design and Construction Information System
DOT	department of transportation
EA	Environmental Assessment
ECOS	Environmental Compliance Oversight System
EIS	Environmental Impact Statement
ENV	TxDOT Environmental Affairs Division
FHWA	Federal Highway Administration
FM	Farm to Market
IH	Interstate Highway
KDOT	Kansas Department of Transportation
LOA	letter of authority
MSE	mechanically stabilized earth (retaining wall)
NEPA	National Environmental Protection Act
PCE	Programmatic Categorical Exclusion
PS&E	plans, specifications, and estimates
QLB	Quality Level B
QLC	Quality Level C
QLD	Quality Level D
ROWIS	Right of Way Information System
RW	retaining wall
SCE	State Categorical Exclusion
SL	State Highway Loop
SSMS	Microsoft SQL Server Management Studio
STA	station
SUE	subsurface utility engineering
TMS	Traffic Management System
TTI	Texas A&M Transportation Institute
UAR	Utility Accommodation Rules
UCL	utility conflict list
UCM	utility conflict management
UIR	Utility Installation Review (System)
VDOT	Virginia Department of Transportation
VoR	Value of Research
WPD	work plan development

CHAPTER 1. INTRODUCTION

Difficulties can arise when constructing noise walls and retaining walls due to utility conflicts, construction phasing, and inadequate access. Texas Department of Transportation (TxDOT) design manuals and design guides mention that these potential conflicts should be considered when designing noise and retaining walls.

The goal of this research was to provide guidance on the sequencing and placement of noise walls and retaining walls. The research included examining noise and retaining wall selection, standards and specifications, preferred methods and best practices for sequencing and placement, and design and construction procedures.

To accomplish the research goal, the Texas A&M Transportation Institute (TTI) research team completed seven tasks, described below:

- Task 1: Oversee Project Management. This task included the documentation of the research findings, submissions of reports, and participation in meetings held throughout the research project.
- Task 2: Conduct Literature Review. This task included identifying and summarizing available literature. The research team identified literature related to standards, specifications, manuals, and practices at other state agencies.
- Task 3: Request and Analyze Data. In this task, the research team processed and analyzed data from a variety of relevant data sources to gain a detailed understanding of the sequencing and placement of noise and retaining walls at TxDOT.
- Task 4: Conduct Preliminary Interviews. In this task, the research team conducted preliminary interviews with a selection of TxDOT districts, including districts from each district type (rural, urban, and metro).
- Task 5: Conduct Detailed Interviews. Based on preliminary interviews, the research team selected candidates for detailed interviews. The detailed interviews were more in-depth discussions with district personnel.
- Task 6: Conduct Case Studies. This task included investigating projects for case studies. The selection of projects for the case studies were based on a short list of potential projects identified during the detailed interviews.
- Task 7: Develop Guidebook. In this task, the research team developed a guidebook with a focus on providing a how-to approach to the sequencing and placement of noise and retaining walls. The guidebook was based on the lessons learned during the data analysis, interview, and case study tasks.

Completing the research tasks allowed the researchers to develop the following implementable deliverables:

- A guide for sequencing and placement of noise walls and retaining walls on complex TxDOT projects. The guidebook includes guidelines, case studies, and best practices for sequencing and placement of noise walls and retaining walls.
- Recommendations for additions to manuals and specifications. This report includes recommendations for additions and revisions to manuals and specifications regarding the placement of design features.

Following this introductory chapter, this research report includes the following subsequent chapters:

- Chapter 2: Literature Review, which provides an overview of noise and retaining walls commonly used by TxDOT, types of conflicts that often occur between noise and retaining walls and utilities, and recommended practices to resolve the conflicts.
- Chapter 3: Data Collection and Analysis, which provides a summary of the data collected and analyzed to gain an understanding of the sequencing and placement of noise and retaining walls during the TxDOT project development process.
- Chapter 4: Preliminary Interviews, which summarizes information that the research team collected during preliminary interviews with TxDOT district and division officials focusing on existing practices, identification of issues, and other recommendations for resolving issues of sequencing and placement of noise and retaining walls.
- Chapter 5: Detailed Interviews, which describes the responses from TxDOT district staff at five metro districts that provided additional information about sequencing and placement of noise and retaining walls.
- Chapter 6: Case Studies, which highlights results from five projects at metro districts that the research team reviewed
- Chapter 7: Summary and Recommendations, which provides an overview of the research team's findings and recommendations.

The report provides additional useful information in the following eleven appendices:

- Appendix A. Value of Research presents the Value of Research for this project.
- Appendix B. ECOS Data Request provides a copy of the ECOS data request that was sent to the TxDOT Environmental Division.
- Appendix C. ECOS Data Dictionary provides a copy of the ECOS data dictionary.
- Appendix D. ECOS Data Sample provides a sample of the ECOS data that the research team received.
- Appendix E. TxDOTCONNECT Data Dictionary provides a copy of the data dictionary for TxDOTCONNECT data.
- Appendix F. Interviews with TxDOT Districts provides a narrative of the interviews with TxDOT district staff.
- Appendix G. Interviews with TxDOT Divisions provides a summary of the interviews with TxDOT division staff.
- Appendix H. Preliminary Interview Guide provides a copy of the interview guide that the research team used during the preliminary interviews.
- Appendix I. District Interview Summaries provides a narrative of the preliminary interviews with TxDOT district staff.
- Appendix J. Detailed Interview Guide provides a copy of the interview guide that the research team used during the detailed interviews.
- Appendix K. Case Study Project List Submittal provides a list of the TxDOT projects that the research team considered for case study evaluations.

CHAPTER 2. LITERATURE REVIEW

INTRODUCTION

This chapter summarizes the literature review, which focused on issues regarding the sequencing and placement of noise walls and retaining walls on TxDOT projects. The chapter summarizes noise wall and retaining wall designs commonly used by TxDOT, issues regarding utility installations and the placement and sequencing of noise walls and retaining walls, and potential strategies to resolve these issues.

The researchers reviewed a variety of sources, including existing standards and specifications, manuals, reports, bidding documents, and peer-reviewed journal and conference publications. These sources identified a number of conflict types that can occur between noise and retaining walls and utilities. Most of the recommendations and best practices identified in the literature apply to the design phase. Relatively little has been published about managing utility conflicts that occur during the construction phase, or the use of alternative construction sequencing and wall placement strategies.

NOISE WALLS AND RETAINING WALLS

Noise walls and retaining walls serve different purposes on highway projects but have similarities in terms of the design and construction process. The purpose of a noise wall, also known as a sound wall or noise barrier, is to reduce the impact of traffic-related noise on nearby communities. A retaining wall is a structure designed and constructed to resist the lateral pressure of soil. This section provides an overview of different types of noise walls and retaining walls in use at TxDOT and their design and placement procedures.

Noise Walls

A noise wall is a structure designed and constructed to protect sensitive areas from noise pollution. Noise walls have reduced noise levels in nearby areas and are commonly constructed along highway projects. Noise walls are the most common traffic noise abatement measure used by TxDOT.

Types

Noise walls can be made from a variety of materials, such as precast concrete, cast-in-place concrete, concrete block, wood, metal, earth berm, and on rare occasions, transparent acrylic. Figure 1 depicts different types of noise walls. According to the Federal Highway Administration (FHWA) the majority of noise walls are precast concrete walls (*1*). These walls use a precast concrete panel as a facing element. A concrete block wall is a noise wall that uses machine-made, precast concrete block units as facing elements. Other types of noise walls used by TxDOT include metal, earth berm, and cast-in-place walls. Table 1 summarizes types of noise walls in use in the U.S. between 2014 and 2016 as reported by FHWA (*1*).

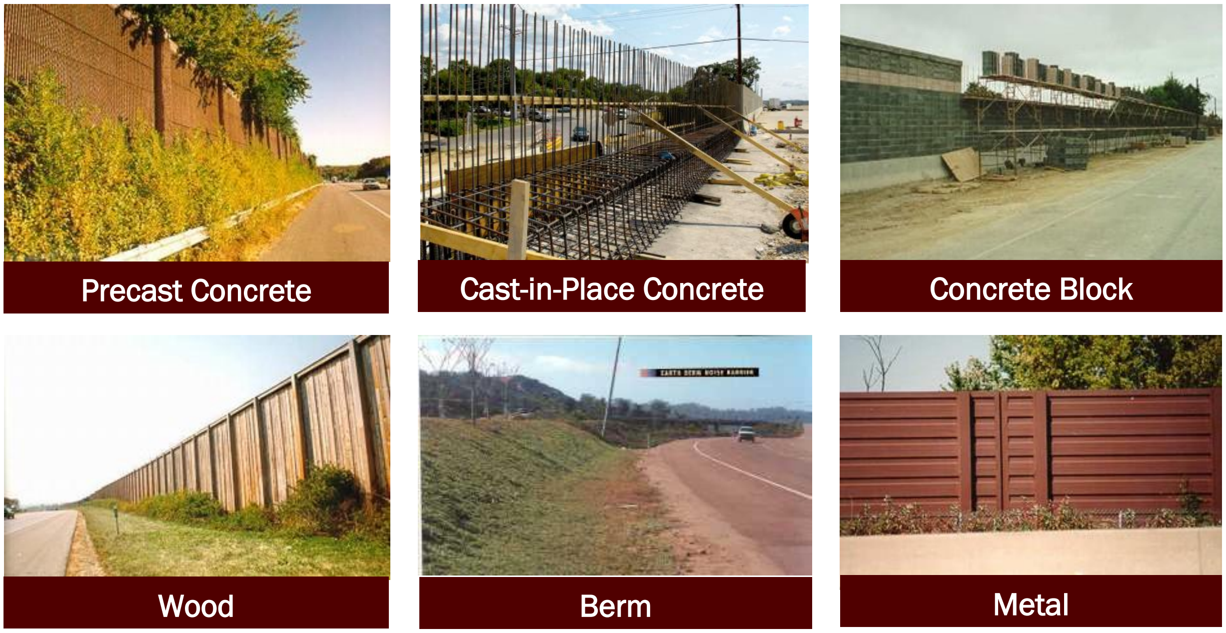


Figure 1. Types of Noise Walls (*2*, *3*).

Table 1. Noise Wall Usage in the United States, 2014–2016 (*1*).

Wall Type	Area (ft^2)	Percentage (%)
Precast Concrete	17,490,288	78
Concrete Block	2,121,946	10
Cast-in-Place Concrete	373,486	2
Berm	81,756	0
Wood	0	0
Metal	40,185	0
Combination	2,137,885	10

The *Design Guide for Highway Noise Barriers* prepared for TxDOT describes two basic categories of noise walls: walls that are required to resist vehicular impact and walls that are not. The basic structural choices of noise walls in these two categories are as follows (*4*):

- Noise wall required to resist vehicular impact:
    - Prefabricated, barrier-mounted, post-and-panel system (not recommended by TxDOT).
    - Prefabricated, sloped-face wall system.
- Noise wall not required to resist vehicular impact:
    - Prefabricated, separate post-and-panel system.
    - Prefabricated, integral post-and-panel system.
    - Constructed-in-place post-and-panel system.
    - Fan-wall system.
    - Earth berms.

Design Guidance

As roadway capacities and traffic volumes increase, so does the number of schools, residences, parks, businesses, and other areas that are impacted by unwanted noise produced from highway traffic, mainly from the tires, engines, and mufflers of cars and trucks. FHWA and state departments of transportation (DOTs) are required to consider the potential traffic noise impact of roadway projects on nearby residences and areas where human activities may occur. The current FHWA guidance on traffic noise is found in *Highway Traffic Noise: Analysis and Abatement Guidance* (*5*). This guidance document provides instructions for the implementation of the FHWA-required noise standards, codified at 23 Code of Federal Regulations (CFR) Part 772, *Procedures for Abatement of Highway Traffic Noise and Construction Noise* (*6*). These federal rules and regulations provide the framework from which DOTs set their noise abatement criteria, traffic noise analysis procedures, and traffic noise analysis guidelines that must be performed for all federal-aid projects.

The design of noise walls includes a number of factors. Some are internal factors, like the height and length of the wall, while others are external, such as input from the public. Noise wall design considerations include (*7*):

- Appearance and ability to blend in with the surrounding environment.
- Highway features and distances between the highway and impacted activity areas.
- Number and category of impacted activity areas.
- Access to activity areas from the highway for routine and emergency traffic.
- Adequate visibility around noise walls to ensure motorist and pedestrian safety.
- Ability of the noise wall (height, length, and material) to effectively reduce noise level.
- Reasonable cost of construction and maintenance.
- Avoidance of utilities and easements.
- Desires of the public.

TxDOT recently revised its traffic noise policies and guidance document, which became effective on December 31, 2019. The updated policy and guidance are provided in three separate documents that describe how TxDOT implements the requirements of FHWA's noise standard. These documents are:

- *Noise Policy: Roadway Traffic and Construction Noise*, which describes TxDOT's policies for implementing the requirements of the FHWA noise standard at 23 CFR Part 772. Effective date for this policy is December 31, 2019 (*8*).
- *Guidance: Traffic Noise Policy Implementation*, which describes the implementation and procedures for analysis and abatement of roadway traffic noise and construction noise and the requirements of the FHWA noise standard at 23 CFR Part 772 (*9*).
- Memo—Reasonable Cost Proposal for 2018 Noise Policy, which provides the FHWA-approved cost reasonableness criteria for noise abatement (*10*).

The documents are available at TxDOT's Traffic Noise Toolkit website (*11*).

Traffic Noise Analysis Process and Design Considerations

The major elements of TxDOT's traffic noise analysis process include the following:

- Identify areas where possible noise impacts may occur for each project alternative.
- Consider and evaluate abatement measures to mitigate these impacts.
- Propose implementation of feasible and reasonable abatement measures.
- Communicate the results to the public and local officials.

TxDOT recommends that traffic noise analyses are conducted early in the environmental process, which usually occurs during preliminary design, before the detailed design phase. Figure 2 shows the approximate timing of the recommended noise analysis process in reference to the overall TxDOT project development process (*12*).

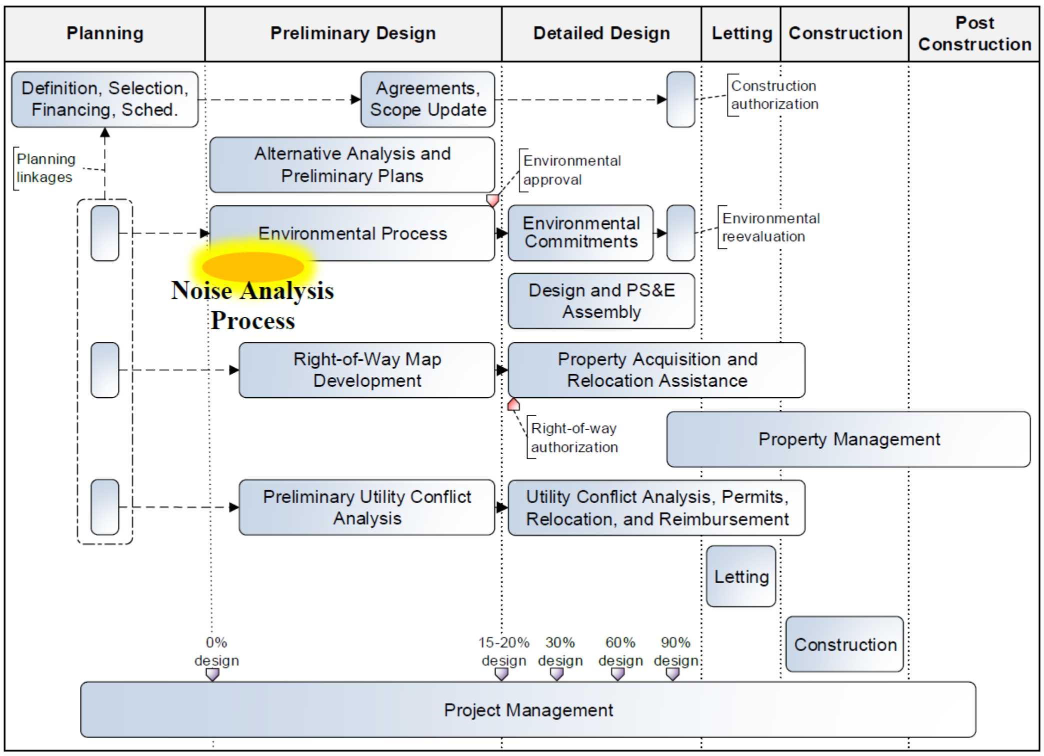


Figure 2. Noise Analysis Process in the TxDOT Project Development Process (*12*).

TxDOT's *Guidance: Traffic Noise Policy Implementation* can be used to determine noise impacts for activity area receptors and identify and implement feasible and reasonable mitigation to reduce the projected noise impacts (*9*). An activity area receptor is a discrete or representative location of a noise-sensitive area such as a residence. If noise impacts are identified for a receptor, TxDOT must consider efforts to mitigate or abate the impacts.

TxDOT's Noise Abatement Criteria

A noise abatement measure is any positive action taken to reduce the impact of noise from highway traffic on an activity area. Various types of abatement measures are available, but the most common form of abatement is the construction of noise walls. TxDOT conducts an assessment to evaluate how to mitigate the noise impacts and determines if the abatement measures are both reasonable and feasible. Noise abatement measures must be both reasonable and feasible to be proposed for construction, as follows:

- **Feasibility.** The term *feasible* is used to determine whether it is possible to build an abatement measure given site constraints and whether the abatement measure provides the minimum reduction, 5 dB(A), in noise levels. Feasibility is limited by:
  - Topography.
  - Access requirements for driveways, ramps, etc.
  - Presence of local cross streets.
  - Other noise sources in the area (e.g., aircraft, rail, commercial, and industrial noise sources).
  - Project purpose.
  - Drainage.
  - Utilities.
  - Maintenance.
  - Noise reduction.
- **Reasonableness.** In accordance with FHWA requirements, TxDOT's *Guidance: Traffic Noise Policy Implementation* states that determination of reasonableness for abatement measures considers the combination of social, economic, and environmental factors in the evaluation of a noise abatement measure (*9*). These factors are addressed with the following three criteria:
  - Cost reasonableness.
  - Meeting noise reduction design goal.
  - Views of affected receptors.

Of these criteria, cost reasonableness was of most interest for this research. TxDOT's current noise policy provides two types of evaluation methods to determine cost reasonableness for a traffic noise wall and provide a framework to address constructability issues: standard barrier cost method and alternative barrier cost method.

Standard Barrier Cost Evaluation Method

A standard barrier cost must be calculated for all abatement analyses. Under the standard barrier cost evaluation, TxDOT determines wall cost effectiveness by dividing the square footage of the surface area of a wall by the number of benefited receptors. A wall is considered reasonable if the proposed surface area of the wall does not exceed 1,500 square feet per benefited receptor, based on TxDOT's current indexed-wall-only cost criterion. For the standard barrier costs, the cost of the wall is calculated by multiplying the square footage of the proposed wall by TxDOT's current reasonable wall-only construction cost. TxDOT currently uses a construction cost of $35 per square foot of wall (*10*). This cost does not include the costs of any additional right of way, utility adjustments directly associated with construction, or additional design elements necessary to accommodate unusual topographic or drainage features directly associated with construction of the noise wall.

Alternative Barrier Cost Evaluation Method
Prior to TxDOT's revision to its traffic noise policy in December 2019, TxDOT's 2016 traffic noise guidelines stated that feasibility to construct a noise barrier is "limited by" given site restraints but did not state whether any additional constructability costs are or should be included in the cost evaluation.

Under TxDOT's current traffic noise policy, an alternative barrier cost calculation is used to address noise wall constructability issues. The alternative barrier cost calculation is optional but is needed if a proposed wall is believed to have excessive wall-related costs associated with the construction of the proposed wall. The cost is estimated using TxDOT's Alternate Barrier Cost Assessment Worksheet available at TxDOT's Traffic Noise Toolkit webpage (*11*). This cost calculation uses the standard barrier cost calculation but includes the costs of any additional right of way, utility adjustments directly associated with construction of the noise wall, or additional design elements necessary to accommodate unusual topographic or drainage features directly associated with construction of the noise wall. A wall may no longer be considered cost reasonable if the alternative wall cost is greater than two times the standard wall costs.

Traffic noise wall modeling conducted during the environmental process generally results in basic noise wall dimensions including location, length, height, and elevation. If a proposed noise wall is determined to be reasonable and feasible, and approved through public participation, the proposed noise wall dimensions are provided to design engineers for the design of the physical wall and foundation. The dimensions and location of a noise wall are determined only on the wall's noise reduction ability, which can sometimes lead to constructability issues. Since the environmental process and noise wall placement are ahead of the detailed design phase, previously unknown issues and conflicts are sometimes identified after the noise wall location is approved during detailed design.

Retaining Walls

A retaining wall is a structure designed and constructed to resist the lateral pressure of soil. TxDOT's *Standard Specifications for Construction and Maintenance* include Item 423, Retaining Walls, which divides retaining walls into permanent and temporary walls (*13*). A permanent retaining wall is designed to have a service life of 75 years, while a temporary wall has a service life of 3 years.

Types

Item 423 defines two types of retaining walls, mechanically stabilized earth (MSE) walls and concrete block walls. An MSE wall consists of select backfill with tensile earth reinforcement elements distributed throughout the wall. Permanent MSE walls use a precast concrete panel as a facing element. Temporary MSE walls use welded wire fabric with filter fabric backing as a facing element. A concrete block wall is a retaining wall that uses machine-made, precast concrete block units as facing elements. Other types of retaining walls used by TxDOT include cantilever drilled shaft, soil nailed, rock nailed, tied-back, and spread footing walls. Table 2 summarizes the wall usage by TxDOT between August 2010 and September 2011, and Figure 3 illustrates the types of retaining walls (*14*, *15*).

Table 2. Retaining Wall Usage by TxDOT, August 2010 through September 2011 (*14*).

Wall Type	Area (ft^2)	Percentage (%)
MSE	3,196,417	72
Concrete Block	47,791	1
Cantilever Drilled Shaft	72,286	2
Soil Nailed	146,793	3
Rock Nailed	197,216	5
Tied-Back	161,827	4
Spread Footing	505,019	12
Other	22,389	1

As shown in Table 2, MSE walls are the most common retaining wall type on TxDOT projects. The advantages of MSE walls include low cost, low design effort, speedy construction, and attractive appearance. MSE walls will likely continue to be used in large quantities on TxDOT projects in the coming years (*16*).

Figure 3. Types of Retaining Walls (*15*).

Design Guidance

The need for retaining walls and their approximate location is usually determined during the preliminary design phase of the project development process. The final design of retaining walls, including their final location, is conducted during the detailed design phase. Typically, some utility information is available at this stage of the project development process, and it is common for TxDOT to identify conflicts between utilities and retaining walls.

The design of retaining walls requires a thorough knowledge of structural and geotechnical engineering. A general design procedure can be outlined as follows (*17*):

- **Earth Pressure Distribution.** The pressure applied by soil on a retaining structure is determined by different methods and depending on the desired wall type. For cases with soil behind walls, such as with spread footing walls, MSE walls, or drilled shaft walls, the earth pressure is calculated based on Rankine's or Coulomb's methods. For tied-back walls, earth pressure distribution is determined by the Terzaghi and Peck method.
- **Internal Analysis.** Internal analysis refers to the design of the wall structure to resist the stresses induced by the earth pressure applied to the wall. The internal design of MSE walls involves checking the earth reinforcements for allowable stresses and checking anchorage into the mass of select fill behind the face of the wall. The internal design of tied-back walls involves the analysis of a continuous beam to determine the support reactions for an applied load diagram. The design of drilled shaft walls involves the analysis of a continuous beam on nonlinear supports.
- **External Analysis.** The external analysis of walls examines whether walls stay where they are built. For a retaining wall, factors of safety for sliding, overturning, and bearing capacity are calculated. In addition, eccentricity and rotational stability must be considered when needed.

Additional considerations when designing retaining walls are cut or fill determination, constructability, and aesthetics. The first step in the selection of a retaining wall is to determine whether a wall will be built in a cut situation, where natural ground will be removed, or a fill situation, where the natural ground is elevated by a construction material. Two common fill conditions are level ground and slopes. In a cut condition, the primary operation is removing ground with little or no fill material placed. A cut/fill condition exists where fill is placed on the upper portion of a slope and removed from the lower portion of a slope. Required vertical and horizontal clearances vary depending on the type of retaining wall selected and are an important consideration when reviewing constructability of the retaining wall. Most aesthetic treatments are accomplished independently of wall type, pattern, and panel shapes, and a variety of finishes may be considered to meet requirements (*18*). Figure 4 shows a general process for the selection of a retaining wall based on the cut or fill situation.

Local standards and codes often provide additional requirements for the design of retaining walls. For example, according to the *Transportation Criteria Manual* for the City of Austin, the design of retaining walls must include, as necessary, the effects of water or wastewater line breaks; the effects of inundation and rapid drawdown resulting from flooding or stormwater detention or retention, including hydrostatic pressures, internal erosion, and alteration of engineering characteristics; and behavior of foundation and backfill materials (*19*). Utilities, utility appurtenances, and pavements also have priority over retaining walls in street rights of way and in utility easements.

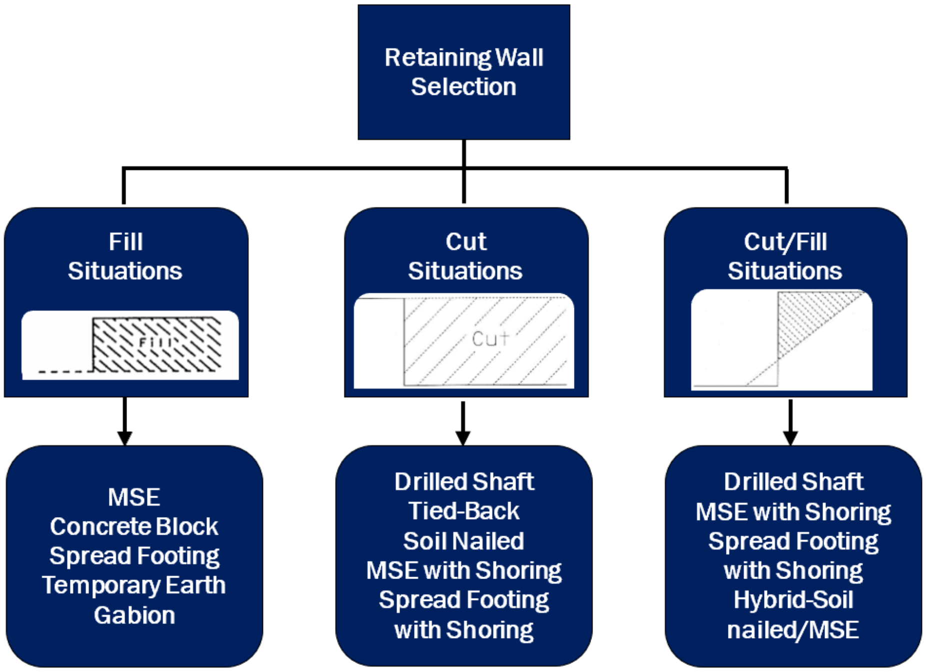


Figure 4. Selection of Retaining Walls.

DESIGN AND CONSTRUCTABILITY ISSUES

This section describes design and constructability issues for noise and retaining walls. Design issues for noise walls and retaining walls are discussed first, followed by constructability issues, which include conflicts with utilities.

Design Issues

When designing noise and retaining walls, it is crucial to have information about the type and location of utility facilities on the project. This information allows the designer to make design considerations such as type of wall and footing structure, which might avoid utility relocations under certain circumstances.

Researchers reviewed several design manuals and design guides from TxDOT and other state DOTs to identify recommendations for addressing utility conflicts with noise walls and retaining walls. The review found that these manuals mention utilities as potential conflicts when designing retaining and noise walls but fail to provide details about how to avoid or address these conflicts with existing and/or proposed utilities.

The most common conflict noted in the literature occurs between wall foundations and underground utilities (*2*, *4*, *20*). For example, the presence of utilities may prevent deep footings (e.g., piles) and require shallow spread footings or no footings in a certain area. For retaining walls, utilities should stay beyond the extent of tie-rod anchors or geogrids (*21*, *22*). In addition, the presence of underground utilities can impact the maximum tolerable settlement in a wall design (*22*).

Noise Walls

Generally, noise walls are most effective at a location between the noise source and the impacted area, adjacent to the highway. This is typically just inside the right of way, which is also the preferred location of many utility installations, and therefore the most likely location for a noise wall to conflict with utilities. Utility relocations can significantly increase cost and make the noise wall uneconomical, so it is important to select a wall design that minimizes the number of utility conflicts.

For noise walls on a grade, the weight of the wall is usually not an issue (9). Like earth berms, fan-wall systems require significant right of way, can be associated with higher mowing costs, and can provide undesirable places for concealment. If these potential drawbacks are an issue, the best structural choice usually involves a post-and-panel system. Structural costs and utility disruption can be reduced by making the wall self-supporting between posts, thereby eliminating the need for a continuous grade beam.

The prefabricated, separate post-and-panel system lends itself to a wide range of construction materials, panel heights, and aesthetic treatments. Since the choice of post material (e.g., concrete or steel) is typically a contractor option, several noise walls, such as the one shown in Figure 5, have concrete posts. If the construction site involves overhead utilities or restrictions on crane operations, the required lifting height or panel weight can be reduced by using multiple partial-height panels, rather than a single large panel. For pier-and-panel walls, restrictions on vertical clearance or lifting weight may be resolved by using smaller panels or special piers that allow placement from the side (*2*, *4*, *23*).

Figure 5. Example of Post-and-Panel System Using Concrete Posts (*4*).

Block walls can be constructed without lifting or heavy equipment (*2*). Cantilever walls have a continuous foundation (either a spread footing or a narrow trench), which makes it more difficult to run lines under the wall (*24*). Cast-in-place walls can also be constructed without lifting or use of heavy equipment and have been poured up to concrete utility poles (*2*). Pier-and-panel walls have foundations only at the piers, which allows for utility crossings between piers but typically requires vertical lifting of the panels (*2*, *24*). Another option for underground conflicts is to use special foundations that cantilever or bridge over utilities (*23*, *24*, *25*).

In some cases, utility conflicts are discovered once the noise wall design is underway. Walls proposed early in project development may change due to other revisions to the project scope or alignment. In a previous TxDOT research project, a survey of state DOTs provided insight about cases where DOTs modified the design of noise walls due to issues related to constructability (*26*). Some of the responses the DOTs reported included issues related to utilities and access (*26*):

- Noise barrier materials changed from concrete to fiberglass due to overhead utilities.
- Cost evaluation to relocate a 60-inch water main was not cost effective. The alignment of the noise barrier was shifted to avoid the water main.
- A fiber-optic line was moved a few feet to avoid conflict with a noise barrier foundation.
- A noise barrier conflict with utilities and homeowner trees required the barrier to be moved approximately 25 feet inside the right of way line. The relocated barrier was constructed although the noise reduction design goal attained by the relocated barrier was 1 to 2 dB less than the agency’s noise reduction design goal.
- Noise barrier was constructed with a door to maintain access to a utility shed.
- Noise barrier designed with holes and small wall behind to allow local drainage.
- Water utility conflict with noise barrier pilasters. A panel length of the noise barrier was adjusted to offset the pilasters and avoid the conflict.

Some conflicts can be resolved through minor design changes. Walls are often built with offsets or inserts to avoid transformers and poles, and an undulating configuration (in plan view) may be able to address longitudinal conflicts with underground utilities (*2*, *23*). In some cases, poles are relocated or raised to avoid conflicts with a noise wall (*27*, *28*, *29*).

Retaining Walls

A forensic analysis of retaining wall movement and distresses found that issues with retaining walls typically arise because of a lack of communication and flow of information in the design phase (*30*). The research project proposed designing retaining walls along with civil and structural aspects of a highway project to resolve uncertainties prior to letting projects.

A recent study for TxDOT developed guidelines for reconfiguration of MSE retaining walls to resolve conflicts with vertical and horizontal obstructions (*31*). However, guidelines included in the report that cover horizontal conflicts (i.e., utility facilities) simply state that any obstructions found within the reinforced fill must be relocated. Although a utility relocation certainly removes the conflict, there may be opportunities to avoid some utility relocations if more innovative practices are followed during design and construction.

Utility conflicts are less likely to impact project feasibility in the case of retaining walls, but relocations should be avoided if possible. Slope, curb, and retaining wall modifications are a common strategy to avoid conflicts with utilities (*20*). Relocation or encroachment may be avoided by modifying embankment slope or adding a retaining wall to the toe. Soil nails close to the surface may conflict with underground utilities (*32*). Sometimes these conflicts can be avoided by modifying the nail spacing, angle, or length. *Designing and Constructing Around Utilities* lists four strategies for avoiding utility conflicts with retaining walls (*23*):

- Change length/locations of straps for MSE walls.
- Support utilities in conflict during construction.
- Change design to use alternate wall type.
- Allow utility to pass through section of wall.

A common issue impacting retaining walls is that utility relocation design plans may not account for changes in elevation from existing grade that typically need to occur. In addition, TxDOT aims to resolve all utility conflicts and relocate, as needed, all utility facilities ahead of the letting phase. If TxDOT is proactive and utility relocation plans are created before the final design of retaining walls, additional conflicts might be created once the retaining wall design is finalized, especially when retaining walls with footers are required.

Constructability Issues

One of the first construction activities on highway projects is to relocate overhead utility poles, usually to the edge of the new right of way. This activity should ideally occur prior to construction. Relocated utility poles and the associated overhead utilities (i.e., electric and telecommunications) can interfere with the construction of noise and retaining walls. Issues arise when cranes are required to place noise wall panels and when heavy equipment is required to construct retaining walls. Utility conflicts also arise when the final grade of the project will be significantly different from the existing grade. When retaining walls are built, there may be a need for a cut or fill section behind the retaining wall. For example, if a utility pole has been relocated to the edge of the right of way prior to construction and a large amount of fill will be placed in that location, then pole attachments may not have adequate clearance above final grade. Conversely, a cut area may lead to an overexposed or unstable utility pole. In addition, quality assurance and quality control should be integral to the process to assure that construction efforts incorporate specific criteria, and that all aspects of construction are adequately documented.

Constructability issues are issues that may be encountered before or during construction of a noise wall that are beyond what is normally encountered or anticipated for wall construction, or that require extraordinary effort or costs. Noise wall and retaining wall constructability include the evaluation of all factors considered during design and construction of a structure. This includes factors such as conflicts with existing structures or utilities, existing or planned topography, soil type, geology, foundation requirements, stability, maintenance, site access, safety, and more. These considerations can affect the construction technique, construction equipment and material selection, construction sequence and timing, construction costs, and material costs.

Each TxDOT district addresses constructability issues in accordance with the professional judgment of the district engineer, with input from the TxDOT Environmental Division as needed or requested. TxDOT engineers typically address constructability issues associated with feasible and reasonable walls through utility relocation, wall modification, wall relocation, or construction technique. Some walls are determined not to be reasonable due to constructability issues or added cost associated with constructability issues and are thus removed from the project and not constructed.

In a previous research project, TxDOT districts reported that for noise wall projects affected by constructability issues, about 30 percent were affected during design and about 17 percent were affected during construction (Figure 6) (*26*).

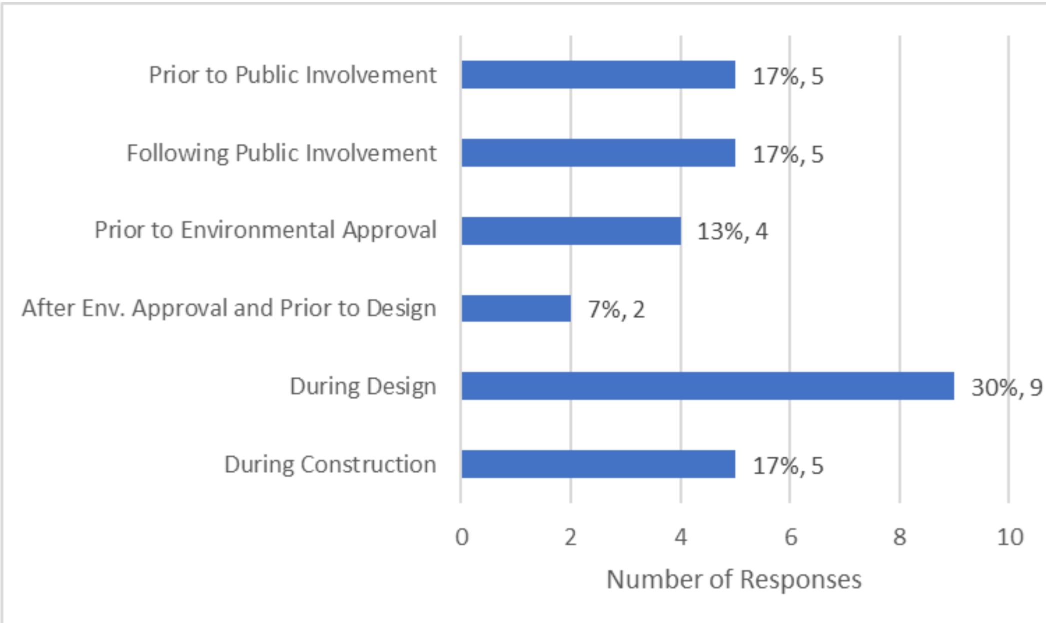


Figure 6. Noise Wall Constructability Issues Identified in Project Development Process (adapted from *26*).

Overhead utility facilities may need to be accessed for maintenance or the installation of utility attachments. If retaining walls or noise walls are placed just in front of utility poles, access to the utility may be impeded or only available on foot. This may not create a utility conflict during construction but will be a problem throughout the life of the utility and noise wall or retaining wall.

The excavation to build a retaining wall may conflict with underground utilities even if they are not in conflict with any part of the wall itself (*21*, *33*). Similarly, vibrations from the installation of sheet pile walls can damage underground utilities (*22*). Frequently, difficulties arise when constructing retaining and noise walls due to conflicts with utilities (both overhead and underground), construction phasing conflicts, and inadequate access. The following subsections summarize some of the common issues associated with noise wall placement.

Drainage and Utility Considerations

A previous research project included a survey of TxDOT district engineers. The survey asked respondents about their experience with noise wall constructability issues within the last five years (*26*). Twenty-six percent of projects in the preliminary traffic noise design stage were in conflict with utilities (direct or indirect) (*26*).

A typical method to resolve a utility conflict is to relocate the affected utility facilities. When utilities are relocated due to conflicts with highway construction features, they are often moved to the edge of the right of way, which is typically the preferred location for noise walls. As a result, it is common that additional utility conflicts arise once utility relocation plans are submitted by utility owners. Minor modifications to the horizontal alignment of noise walls might allow sufficient access for construction and maintenance activities and can be an effective tool to resolve utility conflicts and avoid utility relocations.

Noise walls may need to be constructed near lighting, sign supports, and utility poles (*2*). Another conflict noted in several sources is between overhead utilities and construction equipment (*2*, *4*, *25*, *33*). The presence of overhead utilities may limit component or crane size, or may prevent the use of cranes altogether. Similarly, a noise wall can restrict future maintenance access to overhead utilities (*4*).

The placement of noise walls or retaining walls can be affected by drainage and utility lines. Such utilities include overhead transmission lines, communication lines, traffic signal structures, light poles, high-mast illumination poles, transmission towers, and stormwater drainage. Figure 7 depicts possible interferences of noise walls and retaining walls with drainage and utilities.

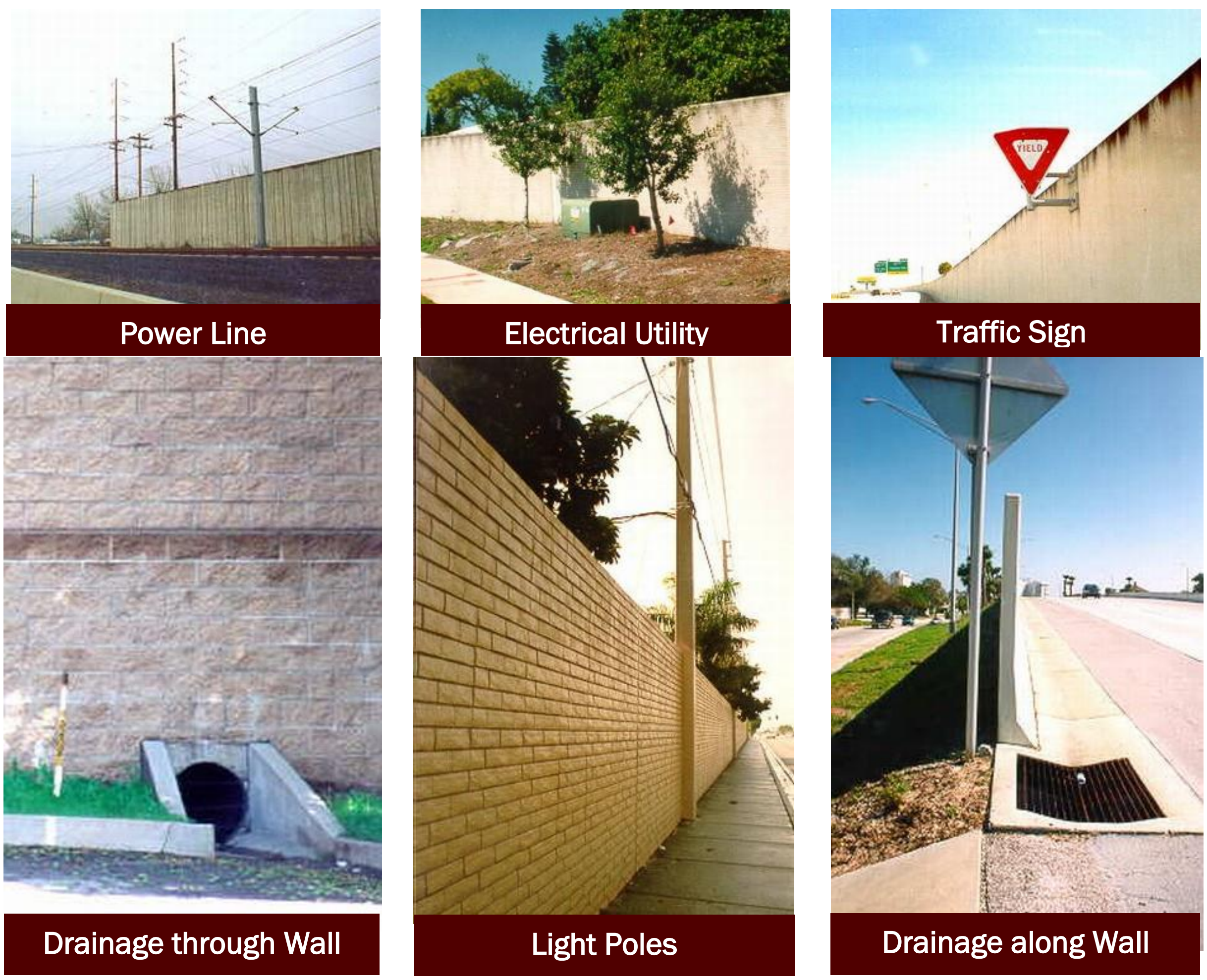


Figure 7. Interference between Walls and Drainage or Utilities (*2*).

Construction around Utilities and Drainage

For noise walls interfering with drainage and utility lines, there are several options to avoid utility relocations:

- Overlapping of noise walls to allow drainage.
- Openings to allow water drainage through walls. In this case, the opening must be large enough to allow water flow through the wall and be small enough to not violate the purpose of the wall, namely noise reduction.
- Pipes or a swale system to carry drainage water along the wall.
- Light poles installed as an integral part of the wall.
- Traffic signs attached to the noise wall.
- Use of spread footing instead of pile-type footing to not interfere with underground utilities.
- In the case of overhead transmission lines, use of a smaller precast concrete panel, a block wall, or cast-in-place concrete. Special equipment that does not interfere with the power line might be needed.

A report prepared for the Indiana Department of Transportation discusses the importance of designing and constructing around utilities. Some examples are shown in Figure 8 (*23*).

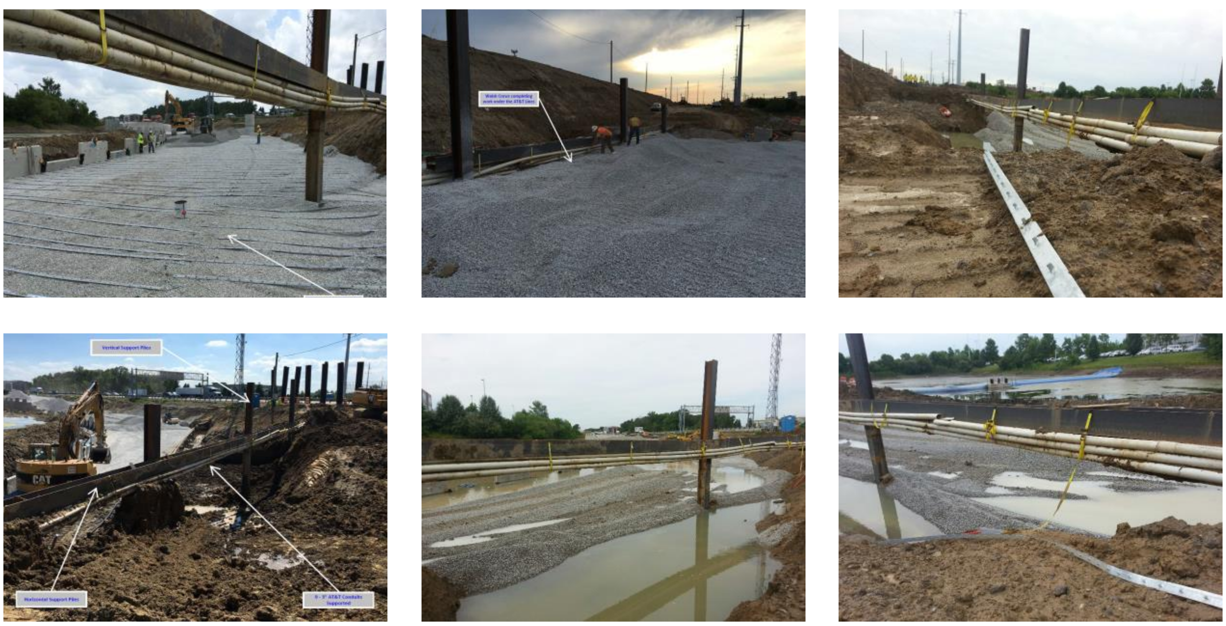


Figure 8. Construction of MSE Walls in the Presence of Utilities (*23*).

The photographs in Figure 8 show an existing telecommunications duct bank and the progression of retaining wall construction. The construction crew was able to support the duct bank and build the retaining wall without relocating the utility (*23*).

UTILITY CONFLICT RESOLUTION PRACTICES

Most of the utility conflict resolution practices identified apply to altering the design of the noise wall or retaining wall. The following subsections discuss examples from other state DOTs and TxDOT.

Examples at State DOTs

Noise Wall Conflicts

A memorandum from the Virginia Department of Transportation (VDOT), a required addendum of bidding documents for noise wall projects, advises contractors that VDOT generally does not perform subsurface investigations to locate utilities (*34*). The contractor is expected to avoid utility conflicts by adjusting foundations, shortening or lengthening wall panel lengths, or developing an alternative design if conflicts cannot be avoided. This approach simply transfers liability to the contractor but does not address the underlying issue. In effect, this practice may be costlier for the state DOT since contractors will adjust their bidding practices to take on the additional risk.

Retaining Wall Conflicts

Case studies described in *Case Study and Statistical Analysis of Utility Conflicts on Construction Roadway Projects and Best Practices for Their Avoidance* show that issues during construction are not limited to direct conflicts (*35*). In one study, a fiber-optic line was identified on project plans for a retaining wall and was expected to remain in place. The contractor realized that the line was close enough to the wall that it did not allow sufficient space to establish a safe soil slope during form work installation (*35*). The fiber-optic line was relocated to allow sufficient space to construct the retaining wall (*35*). In two other cases, utility poles, which had been identified on project plans, were relocated to allow for a safe soil slope (*35*). These relocations were not planned, even though the proximity of the utility line to the proposed retaining wall was known. These indirect conflicts were not addressed during the design phase and had an impact on the project during construction.

South Governors Avenue Project Updates, which is a project update webpage for a Delaware Department of Transportation project, describes a conflict between a utility pole and the construction of a retaining wall (*36*). The updates describe a retaining wall being placed on South Governors Avenue where construction must work around the utility pole until it is removed (*36*). The footer and the concrete retaining wall were poured before the pole was removed (*36*).

A Kansas Department of Transportation (KDOT) project identified issues encountered during construction and noted significant changes in the design of the retaining wall (*37*). The retaining wall replaced an existing embankment suffering from erosion. From preliminary to final design, there was a 30 percent increase in retaining wall length and a 60 percent increase in the amount of soil nails (*37*). There was also a utility conduit crossing under the embankment. The conduit's location differed from plans and could not be easily verified due to the embankment's instability (*37*). Because the conduit was known to be encased in 3 inches of concrete, the contractor decided to begin installing soil nails and to stop if it reached any obstructions. While drilling the soil nails, the conduit's encasement was encountered, and the contractor stopped drilling (*37*).

The location of the conduit was surveyed and sent to the design engineers for input for a redesign. The engineers redesigned the placement of the soil nails to avoid the conduit (*37*). Figure 9 shows the utility conduit, outlined in red, in relation to the construction of the retaining wall (*37*).

Figure 9. Encased Conduit Located during Construction (*37*).

Examples at TxDOT

Issues with the placement and phasing of noise walls and retaining walls are usually project specific. TxDOT is familiar with examples of issues and resolution strategies, as discussed in the following subsections.

Noise Wall Conflicts

One source of concern with noise walls is access to maintain features behind the wall. When utility poles are placed behind noise walls, occasional access may be needed for maintenance or attaching new telecommunication lines. Figure 10 shows a removable panel that has been installed in a noise wall built by the San Antonio District that allows access to the utility pole.

In a survey of TxDOT districts, participants identified that constructability issues were resolved by relocating utilities 27 percent of the time and by changing the noise wall construction material 24 percent of the time (*26*). These were the most common resolution methods. Also, the change in construction material may be due to changes in the noise wall design and may include changes in foundation types. Eliminating the noise wall was also listed as a resolution method, receiving 14 percent of the responses (*26*).

Figure 10. Utility Pole Access Panel in Noise Wall on TxDOT Project[1].

The districts also provided responses on the decision-making process regarding noise walls. Some of the responses the districts reported are encouraging because they mention working with stakeholders and utilities. A few of the district responses are as follows (*26*):

- Constructability issues and potential solutions are being worked out that include removable panels when sound walls are in front of utilities, gates for utility access, offsetting/overlapping sound wall panels for access, utility adjustments, and realignment.
- Team with utilities to relocate the utility.
- Reevaluate options for wall construction. Reengage affected stakeholders.

District personnel were asked to share specific cases where noise walls were either built or canceled, and subject to constructability issues. One of the responses regarding noise walls canceled due to constructability issues was of particular interest to this research:

> There is not much room between the proposed curb line and the right of way line, and there needs to be room for the relocation of the existing power poles and overhead utilities, the construction of the shared use path, the construction of the noise wall, and the relocation of underground utilities. Trying to put the wall behind the curb could cause potential safety issues as the users of the shared use path would be out-of-sight and secluded, due to a tunnel effect of being between the noise wall and the existing privacy fences. So, the best location for the noise wall would be at the right of way line. The construction of the noise wall would result in the removal of approximately 20 trees, including some large oaks. It would also require the relocation of approximately 2,000 feet of [the local water authority's 20-inch] water main, which is encased in steel. Although all the line is not directly under the proposed noise wall, just its proximity to the wall is an issue

[1] Rodriguez, J. (2018). Picture sent by email. TxDOT, San Antonio, TX.

and would require it to be relocated along the entire length of the noise wall. There would also be inconveniences and downtime to the water customers during the relocation process. [The local water authority] has estimated a minimum cost of $1.6 million to relocate the line. … Based on the above, we believe that these factors would serve as a basis for the construction of the noise wall to not be feasible in terms of utility construction costs, wall construction costs (due to just one impacted receiver), and impacts to trees. (*26*)

The following are a few of the responses about projects where noise walls were built and subject to constructability issues (*26*):

- [Too] many utilities were encounter[d], and [the noise wall] still was constructed.
- We have had about four or five noise walls where we have had design issues with the overhead electric and communication lines. We were able to design the noise walls with notches to accommodate the poles. The constructability issue will be that the contractor will need to provide a special drill rig and may need to request the overhead electric be de-energized, which is an inconvenience to the public and businesses.

Retaining Wall Conflicts

On one TxDOT project, a sequencing issue involved a retaining wall construction that restricted access to relocate utility poles and their associated utility lines. The electric utility company needed to relocate the poles to the new proposed right-of-way line, and the telecommunication utilities needed to attach their new lines. At the same time, the construction contractor was ready to cut the existing grade by approximately 20 feet, as shown in Figure 11. In addition, the steep grade at this location made it impossible for the utility companies to access the location with boom trucks needed to relocate the poles and construct the new electric and telecommunication lines. The proposed solution was a temporary workspace built by the construction contractor, 15 to 20 feet wide and near the edge of the proposed right of way, for construction vehicle access.

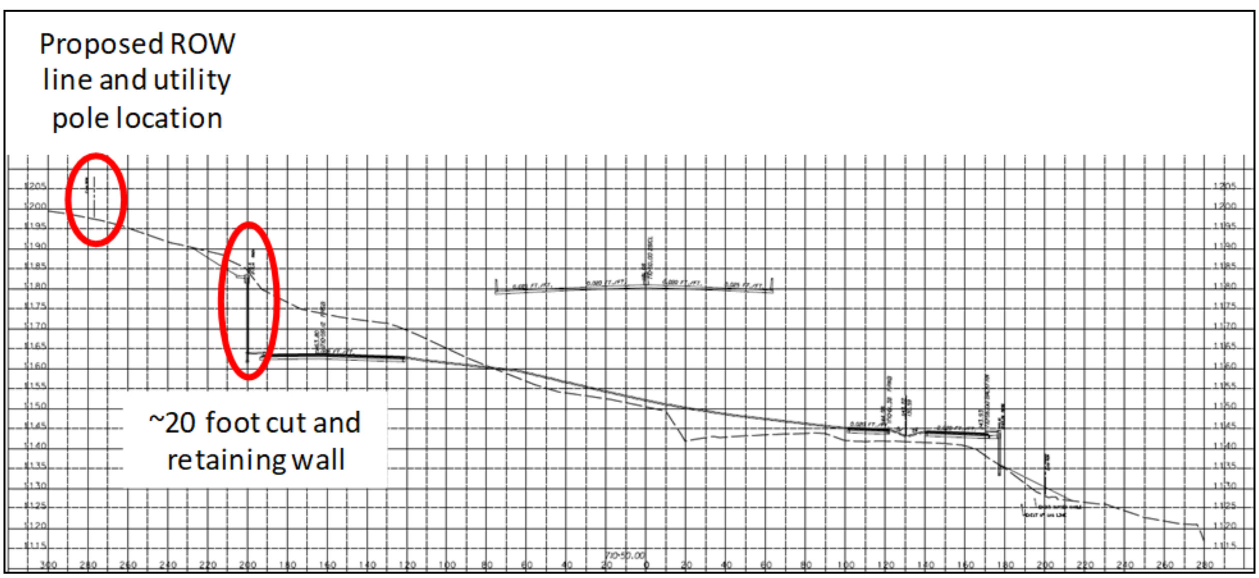


Figure 11. Overhead Utility Relocation and Retaining Wall Construction Issue (*38*).

The overhead utility companies had additional concerns about accessing this location for maintenance. Once the retaining wall was built, access to the poles would be impossible except on foot. The telecommunication companies evaluated several options, including relocating their telecommunication lines underground, crossing the roadway, and attaching on the other side of the roadway. Both options required boring in rocky soil.

GUIDELINES FOR MANAGING UTILITY CONFLICTS

Some DOTs have established thresholds for what constitutes a utility conflict. Iowa notes that a vertical clearance of 2 feet is desired for utilities crossing under a noise wall, but lower clearances may be considered on a case-by-case basis (*25*). Minnesota requires utilities within 50 feet laterally, 50 feet below, and 15 feet above the base of spread footings that support wall structures to comply with the *LRFD Bridge Design Manual* (*39*, *40*). The same section notes that overhead power and communications lines must provide adequate clearance for construction and maintenance activities but does not specify exact clearances.

North Carolina requires noise wall posts to be placed 10 feet horizontally from any underground utility, to provide 17.5 feet of vertical clearance from the lowest sag point of an overhead power line, and to provide a 50-foot clearance from a parallel power line (*41*). Wisconsin notes that a 1:1 slope is needed in many cases from the bottom of the excavation to ground level but recommends consulting the designer to determine excavation limits (*21*).

An earlier research project included a survey of state DOTs that found that, of the states that responded, only 15 percent of DOTs have formal or official guidance to address noise wall constructability issues (*26*). Conflicts with buried or overhead utilities were identified as the number one constructability issue, affecting 28 percent of projects. The survey also found that the largest number of projects identified constructability issues during design (35 percent), and 13 percent reported that issues were identified during construction (*26*). The most common resolution methods include minor location change (29 percent), relocation of utilities (24 percent), and elimination of the noise wall (18 percent) (*26*).

Regarding utilities installed after construction, KDOT requires proposed utility lines to be installed near an existing retaining wall to provide additional information to the DOT (*42*). The proposed utility installation is considered near the retaining wall if it will be within the distance of two times the height, measured from the back of the wall, or one times the height, measured from the front (*42*). Utilities must be able to install, service, and maintain their lines without interfering with the retaining wall system’s backfill. In addition, utility installations near retaining walls are generally not permitted on fully controlled access highways unless they serve highway facilities, but this may be appealed and allowed if the utility company can document adverse economic impacts (*42*). Pipelines carrying liquid petroleum, hazardous, or corrosive products are not allowed near retaining walls unless the company can show extreme hardship (*42*). These and other pipelines require casing of the section near the retaining wall.

SUMMARY

Researchers reviewed a variety of documents, including standards and specifications, manuals, reports, peer-reviewed journal articles, and conference publications. Issues with the placement and phasing of noise walls and retaining walls are often project specific. The literature identified a number of conflicts that can occur between noise walls and retaining walls and design and construction. Most of the best practices and recommendations in the literature apply to the design phase.

A previous survey of TxDOT districts revealed that for noise wall projects affected by constructability issues, 30 percent were affected during design and 17 percent were affected during construction. The most common conflict noted in the literature is between underground utilities and wall foundations. Issues are not limited to direct conflicts; some may be indirect conflicts due to proximity and phasing.

Prior to the revision of the TxDOT traffic noise policy in December 2019, constructability issues were not factored into what is reasonable for the additional cost of a noise wall. The 2019 traffic noise policy provides an optional alternative noise barrier cost calculation method to determine the cost impact the noise wall will have regarding additional right of way, utility adjustments, and additional design features. However, this alternative noise barrier cost calculation generally pertains to the environment phase of a project and is calculated prior to the design and construction phases in which many of the utility conflicts are identified.

A typical method to resolve a utility conflict is to relocate the affected utility facilities. When utilities are relocated due to conflicts, they are often moved to the edge of the right of way, and as a result, additional utility conflicts often arise. Looking for opportunities to avoid utilities rather than relocating them is recommended. This may be achieved through innovative practices during design and construction. Some recommendations for avoiding conflicts for retaining walls are choosing an alternate retaining wall type; modifying the slope; supporting utilities during construction; modifying the soil nail spacing, angle, or length; allowing utilities to pass through a section of wall; and modifying the length and location of wall straps.

For noise walls, utilities may require shallow spread footings or no footings. Overhead utilities or other height restrictions may limit component or crane size, or may prevent the use of cranes for construction altogether. The lifting height can be reduced by using multiple partial-height panels instead of large single panels. Restrictions for vertical clearances may be resolved by using special piers or smaller panels that allow for side placement on pier-and-panel walls. Some recommendations for avoiding conflicts for noise walls are choosing an alternate wall type, using spread footing, designing overlapping sections of wall, supporting utilities during construction, allowing utilities to pass through a section of wall, using special lifting equipment, incorporating utility poles into the wall’s design, and using smaller panels.

Since noise walls can restrict future maintenance access to overhead utilities, it is important to consider access during design. Occasional access may be needed for maintenance or attaching new telecommunication lines for utility poles located behind noise walls. The literature notes the use of access door or panels to allow the utility company to service its installations.

A survey of state DOTs found that only 15 percent of respondents had official or formal guidance to address noise wall constructability issues, Also, conflicts with utilities were identified as the number one constructability issue. The most common resolution methods for the conflicts were minor location change, relocation of utilities, and elimination of the noise wall. The researchers reviewed DOT manuals and guides to find recommendations for addressing conflicts with noise walls and retaining walls. Manuals mention utilities as potential conflicts when designing retaining and noise walls but do not provide many details on how to address conflicts. Some state DOTs require a minimum clearance between utilities and construction and maintenance activities. Adequate clearance with overhead utilities and a minimum distance necessary for underground utilities are required.

The literature revealed that some state DOTs do not perform utility investigations to help avoid conflicts but instead make the construction contractor responsible for any conflicts. This practice is not recommended since it does not address the underlying issue—it only transfers the problem to the contractor. This practice may be more costly for the DOT since contractors will eventually adjust their bidding practices to mitigate the additional risk.

Selecting a wall design that minimizes the number of utility conflicts is recommended since utility relocations significantly increase project cost. If utilities cannot be avoided, the project may be uneconomical.

CHAPTER 3. DATA COLLECTION AND ANALYSIS

INTRODUCTION

This chapter summarizes the information related to data collection and analysis. The researchers requested, processed, and analyzed data from a variety of relevant data sources to gain a detailed understanding of the sequencing and placement of noise and retaining walls during the TxDOT project development process. The following databases and information systems were examined to determine whether information about noise and retaining wall sequencing might be available:

- **TxDOTCONNECT**, which contains data from the Design and Construction Information System (DCIS), a TxDOT legacy system used to track project identification and evaluation data, project planning and finance data, project estimate data, and contract summary data.
- **Right of Way Information System (ROWIS)**, which contains information on tracking and reporting financial data associated with the right-of-way acquisition process.
- **Utility Installation Review (UIR) System**, which contains information on reviewing the utility construction inspection process and viewing historical installation request data from all utility installation owners.
- **AASHTOWare Project SiteManager**, which contains construction and maintenance contract data from contract award through finalization.
- **Oracle Primavera P6**, which contains information about project key dates and milestones.
- **TxDOT Lane Closure Information Databases**, which contain information about lane closures through district-managed systems, such as San Antonio TransGuide, Houston TransStar, and/or Fort Worth TransVision, including a description of the lane closure events, start and end locations, affected lanes, start and end times, and event notes.
- **Environmental Compliance Oversight System (ECOS)**, which contains information about work plans and activities to environmentally clear a transportation project.

The researchers reviewed the databases and information system content and structure, requested access to selected databases, performed a detailed analysis of the data received, and summarized the findings, as described in the following sections.

DATABASE REVIEW AND SELECTION

The researchers reviewed samples of available data from the above databases and information systems to determine which databases might be most suitable to provide information on events related to noise and retaining walls in the TxDOT project development process. Based on the review, and in concurrence with members of the project team, the researchers were able to eliminate several of the above potential database systems from a detailed review; specifically, ROWIS, UIR, SiteManager, and district lane closure databases did not provide any useful data about noise or retaining walls. Researchers reviewed a sample of project data from Primavera P6 and found that the database was potentially useful since it contained planned due dates for several key project dates, such as plans, specifications, and estimates (PS&E) design stages; right-of-way acquisition; and environmental process. However, the granularity of the available data in the projects reviewed were not sufficiently fine, with many projects only focusing on the main project development key dates, and few projects providing detailed tracking information. A review of a sample of data in the two remaining systems, TxDOTCONNECT and ECOS, showed that both systems contained data that could potentially be useful for this project. In addition, researchers reviewed available data from TxDOT's noise barrier inventory and a related FHWA database called Noise Barrier Inventory Tool (*43*).

Based on the preliminary review of available data, the researchers met with TxDOT representatives to discuss options to request access to both ECOS and TxDOTCONNECT. For the ECOS data, the researchers met with the TxDOT Environmental Affairs Division (ENV) to discuss the process to gain access. The result of the discussion was that it would be very time consuming and difficult to provide an ECOS user account to the researchers. Alternatively, ENV officials offered to download relevant data from ECOS and make the data available to the researchers. The researchers reviewed both volumes of ENV's *Environmental Guide* to determine which ECOS data fields might be of potential interest (*44*, *45*). The researchers conducted a follow-up meeting with TxDOT staff to discuss the data request and then submitted the request to TxDOT (see Appendix B. ECOS Data Request). The researchers received the ECOS data from TxDOT at the end of August 2020.

In the case of TxDOTCONNECT, the researchers discussed potential options for data access with the TxDOT research project manager. The researchers requested contractor-level account access to TxDOTCONNECT, which was approved by TxDOT on October 1, 2020.

DATA ANALYSIS

ECOS Dataset Description

TxDOT provided a sample of ECOS data using the following criteria:

- Most recent five years of data (records created in ECOS from September 1, 2014, to August 13, 2020, or fiscal year 2015 through current fiscal year 2020).
- Records with any of the following entries in the field "Action Type":
    - Determine the Need for a Traffic Noise Analysis (Type 1 Decision).
    - Prepare Traffic Noise Model.
    - Activity—Perform Noise Analysis.
    - Prepare a Noise Technical Report.
    - Activity—Perform Notification of Noise Information to Local Officials.
    - Activity—Perform Noise Workshop.
    - Activity—Perform Mitigation.

TxDOT provided to the researchers a dataset with 24 fields and 1,104 records. Appendix C. ECOS Data Dictionary presents a description of the data fields, and Appendix D. ECOS Data Sample provides sample records from the database.

ECOS Database Management

The researchers converted the raw data to a comma-delimited file and made some minor edits to improve the accessibility of the data. For example, the researchers deleted leading and trailing blank spaces in some of the data fields. The researchers also changed the month abbreviation in all data fields to the numerical equivalent to facilitate data import and analysis (e.g., “Oct” to “10”).

The researchers then set up a password-protected SQL server in Microsoft Azure, which is a cloud-based server and database provider. The researchers accessed the server through Microsoft SQL Server Management Studio (SSMS), created a database, and then created a script to import the ECOS data into the SQL server database. Data analysis of all the ECOS data was conducted using queries in Microsoft SSMS.

ECOS Dataset Analysis

The ECOS dataset provided by TxDOT contains all records over the past five years that involve one of the seven noise-related activities listed previously. The records are organized in a sequential manner, which means that new records are entered into the database whenever a project has a new noise-related activity. As a result, the records provided by TxDOT represent noise activities of projects. Since many projects have more than one noise-related activity, the database includes many more records than unique projects.

Environmental Clearance Types of Noise Projects

The first step in the analysis identified 683 unique projects based on a unique control section job (CSJ) number. The researchers then queried the database to determine which environmental clearance types are used for projects involving noise activities based on the fields ANTI_ENV_DCMNT_TYPE_CD, or anticipated environmental document type, and CLEAR_ENV_DCMNT_TYPE_CD, or final environmental document type (Table 3 and Table 4). The tables show that most anticipated environmental clearance types were categorical exclusions, followed by environmental assessments. The comparison also shows that many values were missing for the final environmental document type, either because the final document type had not yet been determined or because the project was not yet updated for other reasons.

Table 3. Anticipated Environmental Document Type.

Anticipated Environmental Document Type Code[a]	Count of Projects	Percent of Projects
Categorical Exclusion (CE)	384	56%
Environmental Assessment (EA)	185	27%
Blanket Categorical Exclusion (BCE)	70	10%
Programmatic Categorical Exclusion (PCE)	16	2%
Environmental Impact Statement (EIS)	14	2%
SEA	7	1%
SBCE	4	1%
State Categorical Exclusion (SCE)	2	0%
NULL	1	0%
Total	**683**	**100%**

[a] Some of the codes, such as BCE, PCE, and SEA, are older environmental classifications that are not in use anymore (*44*).

Table 4. Final Environmental Document Type.

Environmental Document Type Code[a]	Count of Projects	Percent of Projects
Categorical Exclusion (CE)	329	48%
Environmental Assessment (EA)	142	21%
Blanket Categorical Exclusion (BCE)	74	11%
Programmatic Categorical Exclusion (PCE)	16	2%
Environmental Impact Statement (EIS)	12	2%
SEA	6	1%
SBCE	4	1%
State Categorical Exclusion (SCE)	1	0%
NULL	99	14%
Total	**683**	**100%**

[a] Some of the codes, such as BCE, PCE, and SEA, are older environmental classifications that are not in use anymore (*44*).

ECOS Noise Activities

Since there were 1,104 noise records and 683 unique projects, over the last five years, if a project was tracked in ECOS and involved at least one noise activity, on average each project had one or two of the seven potential noise activities. Based on the ENV *Environmental Guide* and *Guidance—Traffic Noise Policy Implementation*, the typical order of noise activities in the TxDOT project development process is as follows (9, *44*):

1. Determine the Need for a Traffic Noise Analysis (Type 1 Decision).
2. Prepare Traffic Noise Model.
3. Perform Noise Analysis.
4. Prepare a Noise Technical Report.
5. Perform Notification of Noise Information to Local Officials.
6. Perform Noise Workshop.
7. Perform Mitigation.

Volume 1 of the *Environmental Guide* does not mention the traffic noise model activity. However, noise modeling is briefly mentioned as part of the activity to perform a noise analysis in both Volume 2 of the *Environmental Guide* and *Guidance—Traffic Noise Policy Implementation*. Action type and activity are used interchangeably throughout the document. They both refer to the action types referred to in ECOS and the noise activities referenced in the TxDOT policy and guide.

Based on the typical order of events, the researchers hypothesized that a count of records with noise activities in ECOS should approximately follow the above order. Specifically, all projects should have the first activity, "Determine the Need for a Traffic Noise Analysis (Type 1 Decision)," and since not all projects require mitigation, fewer projects should have the subsequent activities, with the lowest count of projects having the "Perform Mitigation" activity. The data, however, revealed a different picture, as shown in Table 5.

Table 5. Count of Projects (Identified by Unique CSJs).

Expected Order	Activity	Count	Percent of Projects
1	Determine the Need for a Traffic Noise Analysis (Type 1 Decision)	103	15%
2	Prepare Traffic Noise Model	43	6%
3	Perform Noise Analysis	634	93%
4	Prepare a Noise Technical Report	81	12%
5	Perform Notification of Noise Information to Local Officials	155	23%
6	Perform Noise Workshop	85	12%
7	Perform Mitigation	3	0%

Only 15 percent of projects tracked the "Determine the Need for a Traffic Noise Analysis" activity, while most projects (93 percent) tracked the "Perform Noise Analysis" activity. The hypothesis is that the need for a traffic noise analysis determination is often skipped and implied by the “Perform Noise Analysis” activity. In 23 percent of projects, it was necessary to notify local officials about noise analysis results, which is required when noise levels of estimated future traffic approach certain limits. Since the noise levels are outputs of traffic noise models, it is unclear why only 6 percent of projects had a record for the “Prepare Traffic Noise Model” activity. It is possible that in line with the lack of a traffic model activity in the ENV *Environmental Guide*, some TxDOT staff might track the noise model activity under the noise analysis activity. According to the count in the “Perform Mitigation” activity, the number of projects that required mitigation was small (i.e., three projects required noise mitigation over the last five years). However, TxDOT’s noise barrier inventory listed 34 projects that included noise walls for the same time span. The noise barrier inventory is discussed in more detail in a later section.

In the next step, the researchers determined how many noise-related activities were tracked for a project, as shown in Figure 12.

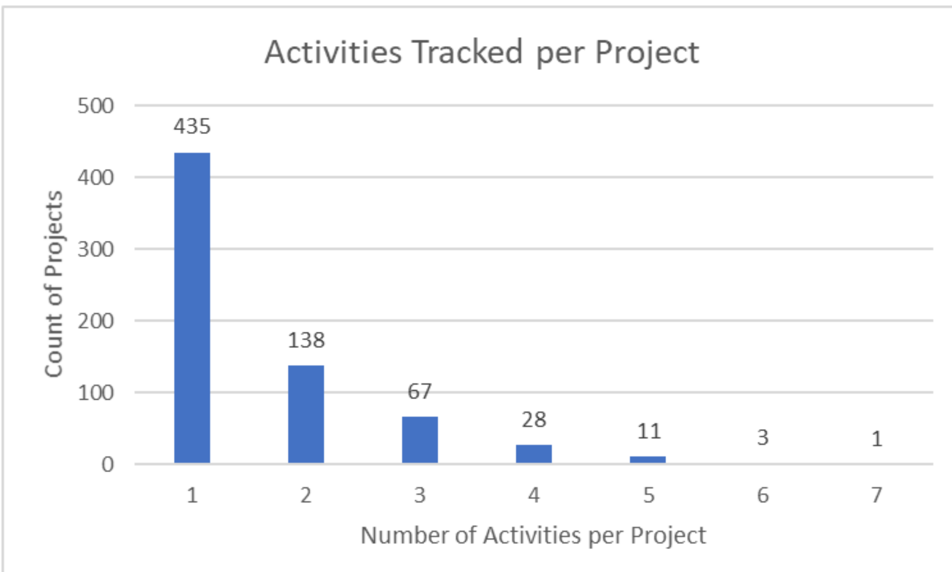


Figure 12. Number of Activities Tracked per Project.

The figure shows that of 683 unique projects, 435 (64 percent) tracked only one activity. In most cases this activity was “Perform Noise Analysis.” In addition, 138 projects (20 percent) tracked exactly two activities, and 67 projects (10 percent) tracked three activities. As a result, 94 percent of projects with a noise activity tracked three or fewer noise-related activities. This count does not mean that activities were unique (i.e., if a project had two activities, it could be that the same activity was recorded twice but with new dates).

Noise Activity Dates

In ECOS, each record has an action type that describes activities and the following 11 date fields:

- DCIS_ACTL_LET_DT (DCIS actual letting date).
- DCIS_APRV_LET_DT (DCIS approved letting date).
- DCIS_DIST_LET_DT (DCIS district letting date).

- NEPA_ENV_CLEAR_DT (National Environmental Protection Act [NEPA] environmental clearance date).
- LOA_ENV_CLEAR_DT (letter of authority [LOA] environmental clearance date).
- ACTIVITY_DUE_DATE (activity due date).
- ACTIVITY_START (activity start date).
- ACTIVITY_END (activity end date).
- ACTIVITY_CREATE (activity create date).
- WPD_SUBMIT_DATE (work plan development [WPD] submit date).
- WPD_ACCEPTANCE_DATE (WPD acceptance date).

Many of these dates do not change when a new activity occurs, and a new record is added to the database. However, four of these dates—the ones starting with the word "activity"—depend on the activity and should therefore change with each record addition. However, not all records had all activity dates populated, with the exception of the activity create date, which was available for all records. Out of 1,104 records, 869 had an activity due date, 853 had an activity start date, and 713 had an activity end date.

To get a sense of the duration of activities, the researchers ran a query to identify records that had both an anticipated start and end date, which resulted in a subset of 679 records. One of these was a test project, which reduced the workable dataset to 678 records. To analyze projects, the researchers created a pivot table with unique CSJ as the row header and start and end dates by action type as the column headers, essentially assembling one record of all action type dates for each project. Since there were seven action types with an anticipated start and end date, this effort resulted in 14 columns for 452 unique CSJs or projects. Table 6 shows a sample of that table including start and end dates for the first three noise activities.

Table 6. Sample Portion of ECOS Pivot Table of Activity Start and End Dates per Project.

CSJ	Activity Start			Activity End		
	Determine the Need for a Traffic Noise Analysis	Prepare Traffic Noise Model	Perform Noise Analysis	Determine the Need for a Traffic Noise Analysis	Prepare Traffic Noise Model	Perform Noise Analysis
…124			May/12/2017			Sep/06/2017
…234	Oct/13/2017			Oct/13/2017		
…238			Apr/14/2018			Apr/14/2018
…241			Jul/24/2017 |Jan/04/2018			Jul/24/2017 |Jan/04/2018
…179			Jun/12/2018			Jun/12/2018
…152	May/16/2018		May/02/2018	May/16/2018		Jul/18/2018
…194			Apr/28/2020			Apr/29/2020
…378		Feb/24/2016			Feb/24/2016	
…381		Jun/16/2016	Dec/01/2014		Jun/16/2016	Oct/06/2016
…152		May/27/2016 |Jul/12/2016	Sep/29/2016		May/27/2016 |Jul/12/2016	Jan/02/2017
…103		Jan/25/2016			Jan/25/2016	
…114			May/23/2017 |Feb/22/2017 |May/03/2017			May/23/2017 |Feb/22/2017 |May/03/2017
…112			Jul/16/2018			Jul/16/2018
…193	Jul/08/2015	Jul/08/2015		Jul/08/2015	Jul/09/2015	

A challenge in determining durations was how to deal with multiple instances of the same activity date types for the same project. For example, a project might have multiple instances of the "Prepare Traffic Noise Model" start date. Out of 452 projects, 403 did not have any multiple instances, and 43 projects had one or more multiple date instances for one or more activities.

The researchers then reviewed how many start and end dates were populated for each record. The researchers performed a count of how many projects had one or more start and end dates populated in the database (Table 7).

Table 7. Count of Projects with Start and End Dates.

Number of Activity Start and End Dates	Count of Projects	Percent of Projects
1	330	73%
2	93	21%
3	22	5%
4	4	1%
5	3	1%
6	0	0%
7	0	0%
Total	**452**	**100%**

Table 7 shows that 73 percent of projects had exactly one activity start and end date, and 21 percent had exactly two activity start and end dates. Only 7 percent of projects had more than two activity start and end dates, and five was the highest number of different activity start and end dates. In the next step, the researchers analyzed the subset of 452 unique records further, determining which activity dates appeared more often than others (Table 8). Activities are ordered in the typical or expected order provided by the *Environmental Guide*.

Table 8. Comparison of All Activity Start and End Dates.

Activity	Both Dates Present	Percent of Projects
Determine the Need for a Traffic Noise Analysis (Type 1 Decision)	97	21%
Prepare Traffic Noise Model	35	8%
Perform Noise Analysis	278	62%
Prepare a Noise Technical Report	70	15%
Perform Notification of Noise Information to Local Officials	84	19%
Perform Noise Workshop	47	10%
Perform Mitigation	2	0%

In many cases, a project did not have a start and end date for an activity. For example, out of 452 CSJs, only two had a start and end date for “Perform Mitigation.” The activities are listed by expected order, which is the same as the order described in Table 5.

Project and Noise Activity Durations

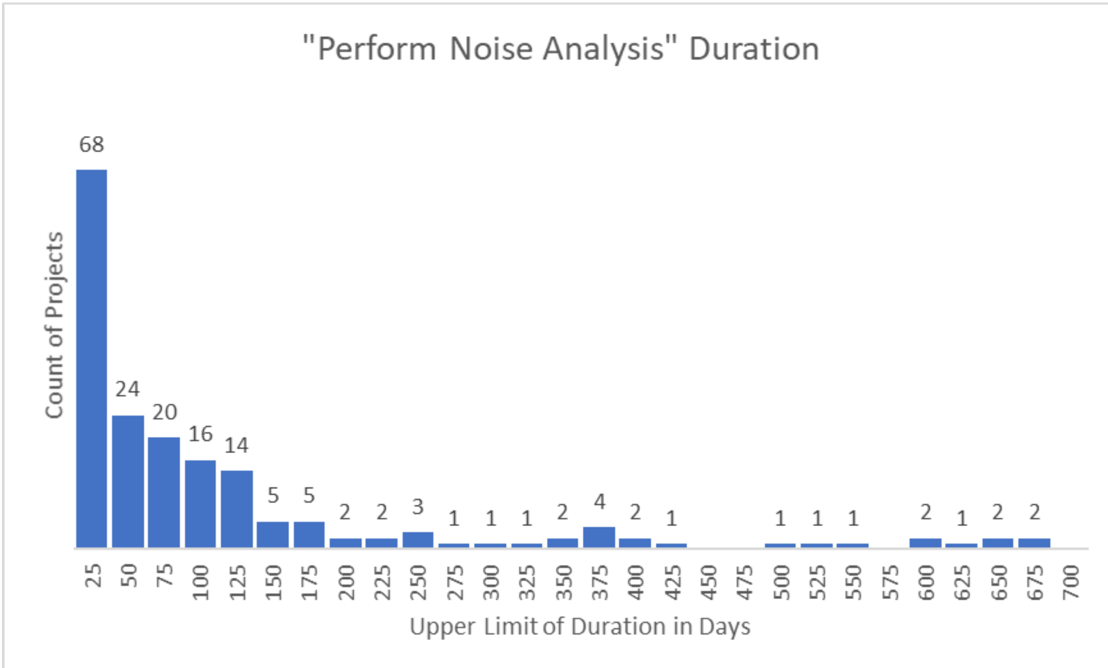
Based on the available data, the researchers calculated for each unique project the difference between the earliest estimated start date and latest estimated end date for all activities to get a sense of the overall duration of noise activities. Excluding projects with multiple start and end dates, the researchers found that out of 452 projects, start and end dates were the same for 151 projects. For the remaining 270 projects without multiple start or end dates for the same activity, the mean duration was 163 days, with a maximum duration of 1,322 days and an interquartile range of 168 days.

The researchers then calculated statistics for the duration of all action types, as shown in Table 9 and Table 10. Table 9 breaks down the number of projects with a start and end date by activity, as shown in Table 8, into the number of projects with a duration larger than 0 and the number of projects with a duration equal to 0. A project duration of 0 means that recorded start and end date of an activity was the same.

Table 9. Project Statistics by Activity Duration.

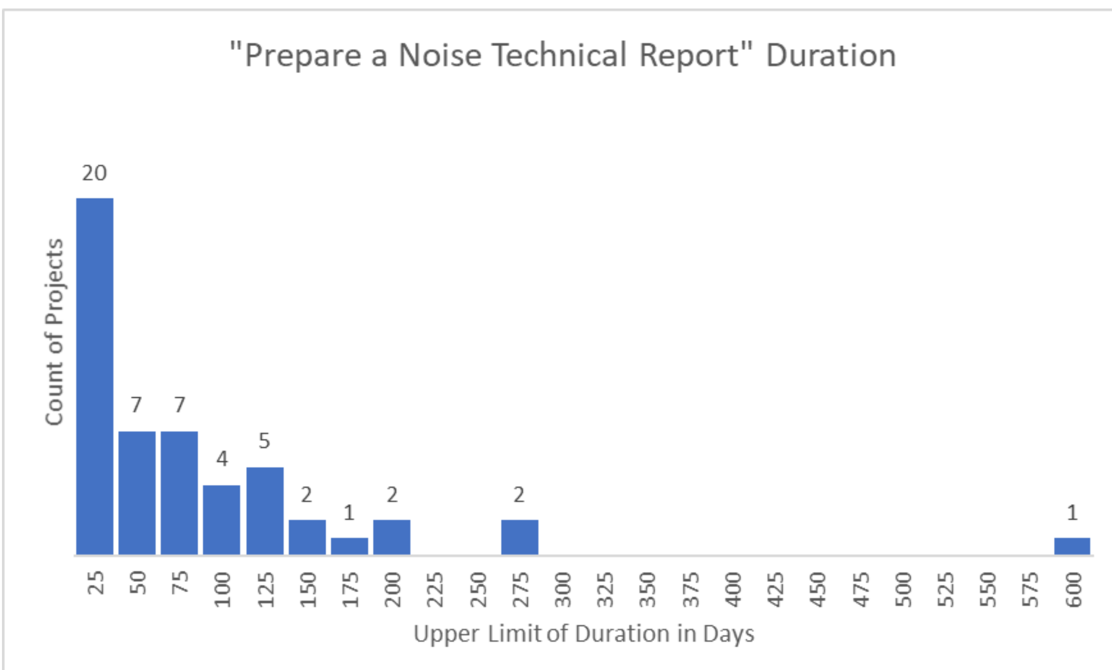
Action Type	Count of Projects with Duration > 0	Count of Projects with Duration = 0	Total
Determine the Need for a Traffic Noise Analysis	22	75	97
Prepare Traffic Noise Model	23	12	35
Perform Noise Analysis	181	97	278
Prepare a Noise Technical Report	51	19	70
Perform Notification of Noise Information to Local Officials	40	44	84
Perform Noise Workshop	31	16	47
Perform Mitigation	1	1	2

To gain a better understanding of the data distribution, researchers created histograms for the durations of each action type. As an illustration, histograms of the "Perform Noise Analysis" and "Prepare a Noise Technical Report" activities are shown in Figure 13 and Figure 14. Both figures show that the activity durations are skewed toward shorter durations. For example, Figure 13 shows that of the 181 projects with non-zero durations, the "Perform Noise Analysis" activity was 25 days or less for 68 projects.



Note: Projects with zero-day durations for the action type are not included.

Figure 13. Histogram of "Perform Noise Analysis" Duration.



Note: Projects with zero-day durations for the action type are not included.

Figure 14. Histogram of "Perform Noise Technical Report" Duration.

Table 10 shows statistics of the activity durations, which are maximum duration, minimum duration, arithmetic mean duration, median duration, interquartile range, and standard deviation. The researchers excluded projects with a zero duration from the calculation of mean, median, interquartile range, and standard deviation, reasoning that a duration of zero days is probably not realistic, and most likely the project record was not updated to reflect actual durations. If zero-duration projects would have been included in the calculation, the mean, median, interquartile range, and standard deviation would have been significantly lower.

Table 10. Activity Duration Statistics for Durations Larger than Zero.

Activity	Max Duration (days)	Min Duration (days)	Mean Duration (days)	Median Duration (days)	Interquartile Range (days)	Standard Deviation
Determine the Need for a Traffic Noise Analysis	65	1	13	9	12	14
Prepare Traffic Noise Model	106	1	29	20	30	31
Perform Noise Analysis	675	1	105	50	100	149
Prepare a Noise Technical Report	588	1	74	45	88	97
Perform Notification of Noise Information to Local Officials	862	1	43	10	24	136
Perform Noise Workshop	358	1	87	66	67	84
Perform Mitigation	29	29	29	29	0	0

Table 10 shows that for the sample of projects analyzed, the "Perform Noise Analysis" activity had a duration of up to two years, but on average had a duration of 105 days, or about three months. This activity also had the longest mean duration of all activities analyzed. The second longest mean duration was the "Perform Noise Workshop" activity, with a mean duration of 87 days. The shortest mean duration was the "Determine the Need for a Traffic Noise Analysis" activity, with 13 days, which also had the shortest maximum duration, with 65 days. The "Perform Notification of Noise Information to Local Officials" activity had the longest maximum duration, with 862 days, and a mean duration of 43 days, less than half the mean of the "Perform Noise Analysis" activity. Data for the "Perform Mitigation" activity were insufficient to draw any meaningful conclusions about duration.

Noise Activity Sequencing

To develop an understanding of noise activity sequencing based on dates, the researchers compared the start date of an activity to the start date of the other activities and calculated the difference in dates. This comparison resulted in 21 possible date combinations, and the researchers found anywhere from 0 to 44 projects for each combination. The researchers then calculated the median date difference in number of days for each of the combinations to determine the actual sequence of activities based on the data in ECOS. The results of that analysis are shown in Table 11.

Table 11. Median Duration between Start Dates of Activities in Days and Standard Error.

	Prepare Traffic Noise Model [SE]	Perform Noise Analysis [SE]	Prepare a Noise Technical Report [SE]	Perform Notification of Noise Information to Local Officials [SE]	Perform Noise Workshop [SE]	Perform Mitigation [SE]
Determine the Need for a Traffic Noise Analysis	0 [4]	13 [44]	1 [15]	69 [20]	162 [0]	n/a [n/a]
Prepare Traffic Noise Model		68 [90]	0 [61]	126 [40]	230 [122]	n/a [n/a]
Perform Noise Analysis			−43 [61]	139 [57]	162 [92]	280 [198]
Prepare a Noise Technical Report				90 [84]	415 [74]	n/a [n/a]
Perform Notification of Noise Information to Local Officials					0 [42]	n/a [n/a]
Perform Noise Workshop						n/a [n/a]

Note: n/a = not applicable.

A positive number of days in Table 11 indicates that the activity in the column header started *after* the activity in the row header, confirming the expected order provided by ENV's *Environmental Guide* and *Guidance—Traffic Noise Policy Implementation* (9, *44*). The arrows in Table 11 provide an example on how to read the table; the "Perform Noise Analysis" activity started after the "Determine the Need for a Traffic Noise Analysis" activity began, with a median difference of 13 days and a standard error of 44 days. The "Perform Noise Analysis" activity started after the "Prepare Traffic Noise Model" activity began, with a median difference of 68 days and a standard error of 90 days. Table 11 shows only the upper half of the activity sequence matrix; the lower half would show inverse values of the upper half.

Since activities in Table 11 are in the expected order provided by the *Environmental Guide*, the researchers anticipated that the median difference in start days for each row would be positive and increase from left to right, thus confirming the sequence provided by the *Environmental Guide*. The analysis confirmed that for most projects, the suggested sequence of noise activities was verified by the data. One exception was "Prepare a Noise Technical Report," which according to the data started a median of 43 days *before* the "Perform Noise Analysis" activity began.

To further illustrate this analysis, Figure 15 and Figure 16 show the distributions of two date comparisons, as indicated by the arrows in Table 11. Figure 15 shows that the start of the “Determine the Need for a Traffic Noise Analysis” activity always occurred before the “Perform Noise Analysis” activity began, and the time difference in most cases had an upper limit of 0 days or 100 days.

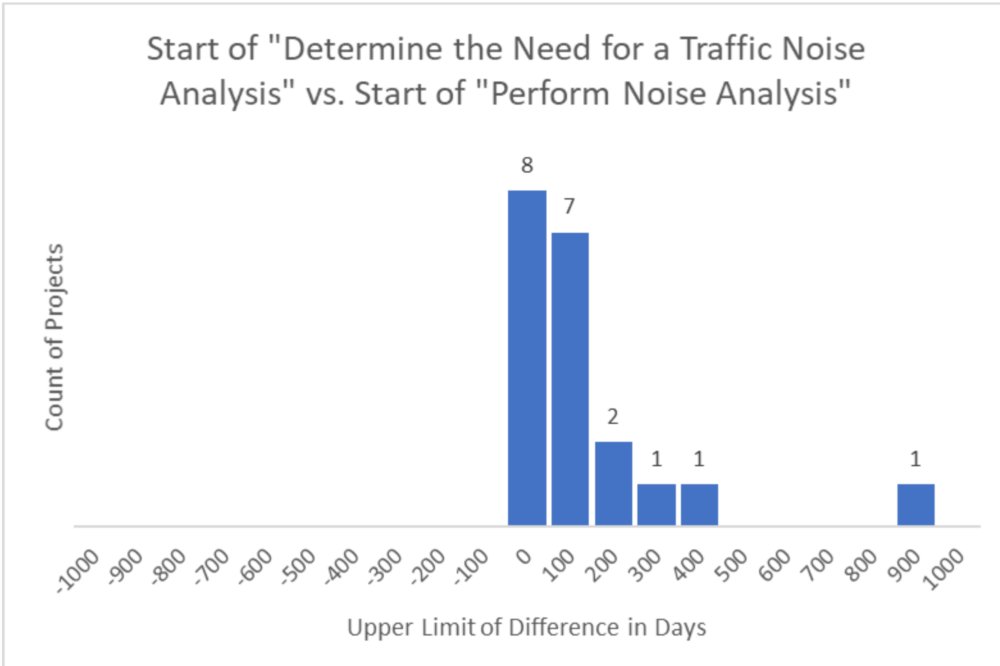


Figure 15. Distribution of Difference in Start Date between “Determine the Need for a Traffic Noise Analysis” and “Perform Noise Analysis.”

Figure 16 shows that the start of the "Prepare Traffic Noise Model" activity was mostly, but not always, before the start of the "Perform Noise Analysis" activity, and the time difference in most cases fell in the bin of −99 to 0 days, or 1 to 100 days.

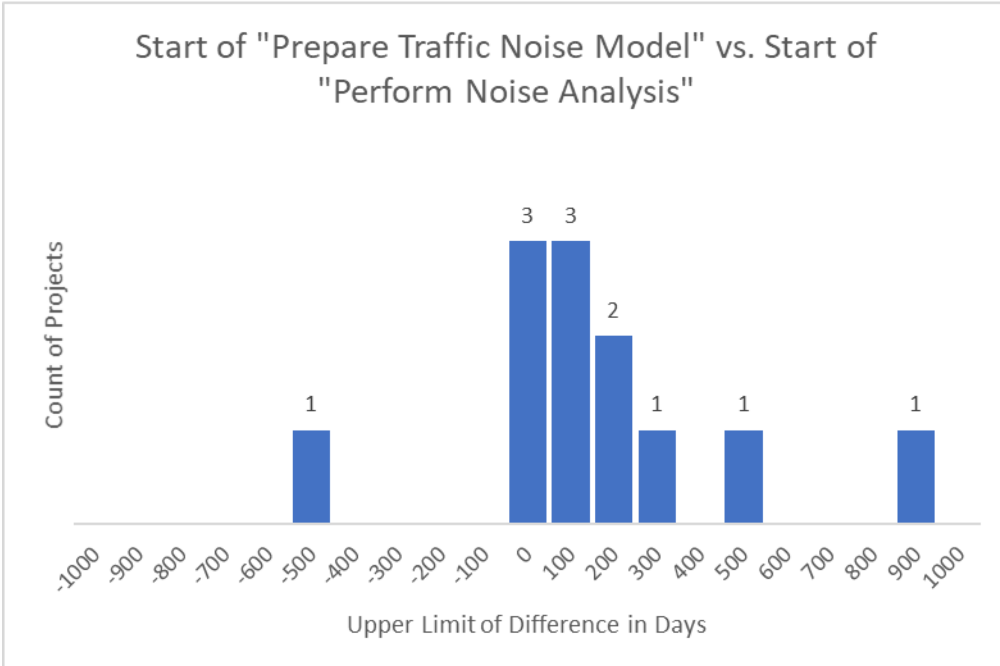


Figure 16. Distribution of Difference in Start Date between "Prepare Traffic Noise Model" and "Perform Noise Analysis."

As an alternative measure of dispersion, Table 12 shows the interquartile range and sample size (n) for each comparison of start dates.

Table 12. Interquartile Range in Days between Start Dates of Activities and Sample Size.

	Prepare Traffic Noise Model [n]	Perform Noise Analysis [n]	Prepare a Noise Technical Report [n]	Perform Notification of Noise Information to Local Officials [n]	Perform Noise Workshop [n]	Perform Mitigation [n]
Determine the Need for a Traffic Noise Analysis	5 [4]	108 [20]	8 [6]	80 [6]	0 [1]	n/a [0]
Prepare Traffic Noise Model		203 [12]	26 [13]	218 [13]	253 [3]	n/a [0]
Perform Noise Analysis			294 [25]	518 [44]	345 [21]	280 [2]
Prepare a Noise Technical Report				144 [15]	408 [9]	n/a [0]
Perform Notification of Noise Information to Local Officials					120 [18]	n/a [0]
Perform Noise Workshop						n/a [0]

Note: n/a = not applicable.

In the next step, researchers repeated the analysis of comparing activity dates, but this time with a focus on the end date of each activity. The analysis compared the end date of an activity with the end date of the other activities, grouped projects where two end dates were available, calculated the date difference in days for each project in that group, and then calculated the median date difference in days for all projects within that group. The results were comparable to those shown in Table 11 involving the comparison of start dates in that both sequence (indicated by a positive or negative number) and magnitude were similar (see Table 13).

Table 13. Median Duration between End Dates of Activities in Days and Standard Error.

	Prepare Traffic Noise Model [SE]	Perform Noise Analysis [SE]	Prepare a Noise Technical Report [SE]	Perform Notification of Noise Information to Local Officials [SE]	Perform Noise Workshop [SE]	Perform Mitigation [SE]
Determine the Need for a Traffic Noise Analysis	1 [8]	33 [51]	1 [2]	67 [24]	179 [0]	n/a [n/a]
Prepare Traffic Noise Model		63 [73]	0 [63]	69 [66]	211 [104]	n/a [n/a]
Perform Noise Analysis			−16 [61]	111 [57]	127 [89]	0 [0]
Prepare a Noise Technical Report				50 [99]	270 [88]	n/a [n/a]
Perform Notification of Noise Information to Local Officials					−3 [51]	n/a [n/a]
Perform Noise Workshop						n/a [n/a]

Note: n/a = not applicable.

Similar to Table 11, a positive number of days in Table 13 indicates that the activity in the column header ended *after* the activity in the row header. For example, the "Perform Noise Analysis" activity ended after the "Determine the Need for a Traffic Noise Analysis" activity, with a median difference of 33 days and a standard error of 51 days. Further, the "Perform Noise Analysis" activity ended after the "Prepare Traffic Noise Model" activity, with a median difference of 63 days and a standard error of 73 days.

Since the activities in Table 13 are in the expected order provided by the *Environmental Guide*, the researchers anticipated that the median difference in start days for each row would be positive and increase from left to right, thus confirming that in practice the activities end in the sequence provided by the *Environmental Guide*. The analysis confirmed that for most projects, the suggested sequence of noise activities was verified by the data. An exception again was the "Prepare a Noise Technical Report" activity, which according to the data ended with a median of 16 days *before* the "Perform Noise Analysis" activity was complete. Another exception was seen for "Perform Notification of Noise Information to Local Officials," which ended before the "Perform Noise Workshop" activity. Both activities are noted as having 0 days between start dates in Table 11, and the mean, median, and interquartile ranges, listed in Table 10, are less for

"Perform Notification of Noise Information to Local Officials" than for "Perform Noise Workshop." Thus, it seems logical that the "Perform Notification of Noise Information to Local Officials" activity would be completed before the "Perform Noise Workshop" activity.

To further illustrate the analysis shown in Table 13, Figure 17 and Figure 18 show the distributions of two date comparisons, as indicated by the arrows in the table. Figure 17 shows that the "Determine the Need for a Traffic Noise Analysis" activity always ended before the "Perform Noise Analysis" activity, and the time difference in most cases had an upper limit of 0 or 100 days.

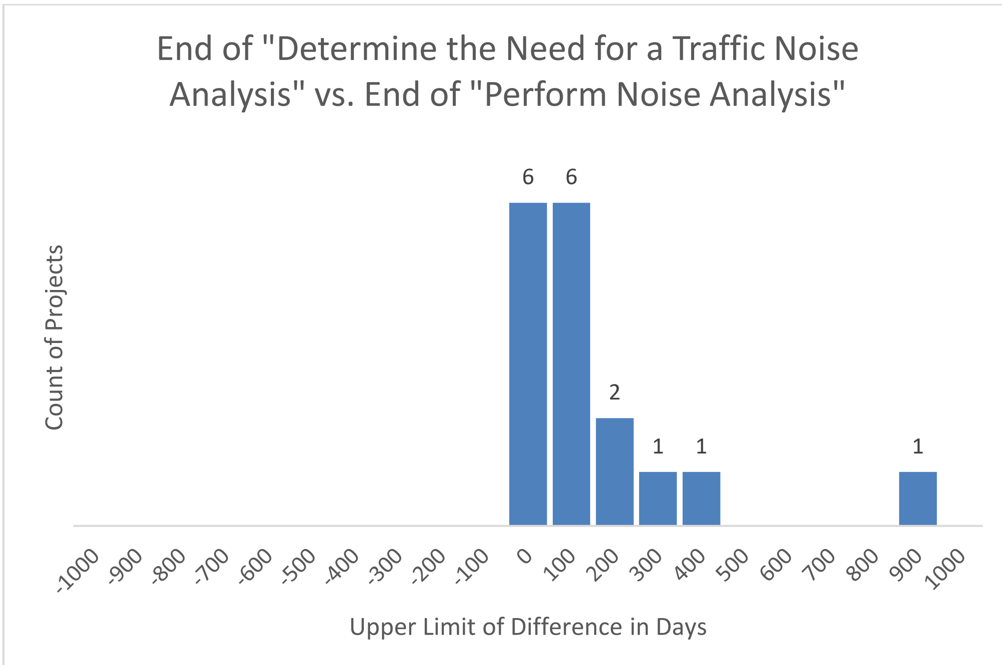


Figure 17. Distribution of Difference in End Date between "Determine the Need for a Traffic Noise Analysis" and "Perform Noise Analysis."

Figure 18 shows that the end of the "Prepare Traffic Noise Model" activity was always before the end of the "Perform Noise Analysis" activity, and the time difference in most cases had an upper limit of 0 days or 100 days. These comparisons of end dates showed similar distributions to the comparisons of start dates of the same activities shown in Figure 15 and Figure 16.

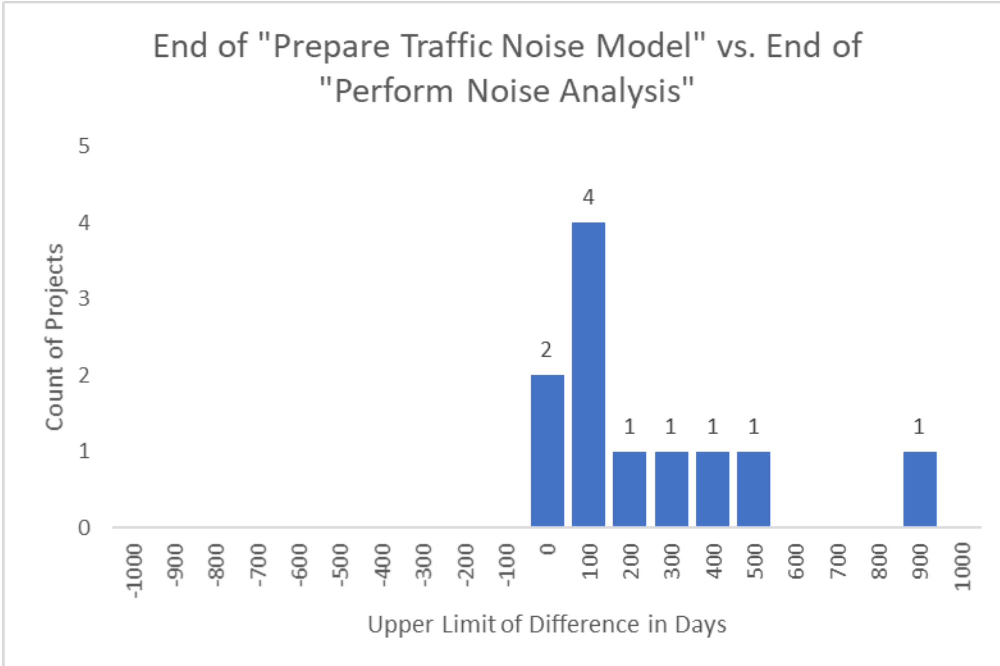


Figure 18. Distribution of Difference in End Date between "Prepare Traffic Noise Model" and "Perform Noise Analysis."

Table 14 shows the interquartile range and sample size for each comparison of end dates.

Table 14. Interquartile Range in Days between End Dates of Activities and Sample Size.

	Prepare Traffic Noise Model [n]	Perform Noise Analysis [n]	Prepare a Noise Technical Report [n]	Perform Notification of Noise Information to Local Officials [n]	Perform Noise Workshop [n]	Perform Mitigation [n]
Determine the Need for a Traffic Noise Analysis	11 [4]	103 [17]	7 [5]	106 [5]	0 [1]	n/a [n/a]
Prepare Traffic Noise Model		229 [11]	2 [12]	109 [11]	217 [3]	n/a [n/a]
Perform Noise Analysis			190 [21]	395 [33]	208 [17]	0 [1]
Prepare a Noise Technical Report				124 [12]	344 [7]	n/a [n/a]
Perform Notification of Noise Information to Local Officials					123 [14]	n/a [n/a]
Perform Noise Workshop						n/a [n/a]

Note: n/a = not applicable.

The direction (positive versus negative) and magnitude of the interquartile range values when comparing end dates was similar to the values of start dates reported in Table 12.

TxDOT Noise Barrier Inventory

23 CFR 772.13(f) requires that state DOTs maintain an inventory of all constructed noise abatement measures and report this information to FHWA on a regular basis (6). FHWA makes this information available through its Noise Barrier Inventory Tool, which has noise barrier information up to and including 2016 (*43*). TxDOT provided a current summary of that inventory for the years 2015 to 2019, based on the project letting date, which the researchers compared to the data available in ECOS. The analysis found that from 2015 to 2019, there were 34 noise wall projects based on a unique CSJ, as shown in Table 15.

Table 15. TxDOT Noise Wall Projects by Letting Year.

Letting Year	Number of Noise Wall Projects
2015	3
2016	5
2017	10
2018	11
2019	5
Total	**34**

Over the last few years, TxDOT has constructed about seven noise wall projects annually. Cost information was available for 16 of these projects, which resulted in a total expenditure of $14.9 million for the study period, with a mean of $928,000 and standard deviation of $617,000 per noise wall project. Over that period, noise walls were installed in seven districts, as shown in Table 16.

Table 16. TxDOT Noise Wall Projects by District.

District	Number of Noise Wall Projects
Austin	2
Dallas	10
Houston	10
Pharr	2
San Antonio	7
Waco	2
Yoakum	1
Total	**34**

The researchers joined the TxDOT noise barrier inventory data with the ECOS data to determine whether they were tracked in ECOS, and which activities were associated with the projects. Of the 34 projects, the researchers were able to match 15 projects in the ECOS database, resulting in 29 records, or about two noise activities per project. However, none of the 15 matched projects had a record with the "Perform Mitigation" activity. Given that these projects ultimately resulted in a noise mitigation, the researchers concluded that not all projects that result in a noise mitigation track that activity in ECOS.

TxDOTCONNECT Dataset Description

TxDOT provided access to the TxDOTCONNECT database, which contains a multitude of data reports related to TxDOT projects. The researchers reviewed available options to determine which report might provide additional project scheduling data that could be merged with the

ECOS data to provide a more complete overview of the timing and sequencing of noise activities in the TxDOT project development process. The researchers found that the letting schedule report and the portfolio data report contained fields that could potentially provide useful information and downloaded both datasets from TxDOTCONNECT.

TxDOTCONNECT Database Management

The researchers converted the raw TxDOTCONNECT data to a table and then to a comma-delimited file, and finally made significant edits to improve the accessibility of the data. For example, the researchers deleted leading and trailing blank spaces in some of the data fields. The researchers also changed the month abbreviation in all data fields to the numerical equivalent to facilitate data import and analysis (e.g., "Oct" to "10"). Most importantly, the researchers deleted recurring lines with header information.

The researchers used the password-protected SQL server in Microsoft Azure that was set up for the ECOS data to store the TxDOTCONNECT data. The researchers accessed the server through Microsoft SSMS, created a database, and then created a script to import the data into the SQL server database.

TxDOTCONNECT Dataset Analysis

After reviewing both TxDOTCONNECT datasets, the researchers found that the fields of interest in the portfolio data report were largely blank, and the report was therefore not useful for further analysis. The letting schedule, however, was complete. As a result, the researchers focused on the letting schedule. Appendix E. TxDOTCONNECT Data Dictionary provides an overview of the data elements in this dataset.

The researchers joined the TxDOTCONNECT letting schedule data to the ECOS data using CSJ fields in both tables. To facilitate the merge, the researchers created a CSJ field in the TxDOTCONNECT table, with a data type and format matching the CSJ field in the ECOS table. The researchers then exported the joined table to RapidMiner Studio, which is software used to facilitate data analysis.

In RapidMiner, the researchers created a pivot table similar to the pivot table created previously for the ECOS data. The pivot data consisted of a row grouping that involved the CSJ field and several date fields, a header grouping involving the ECOS action type, and the activity start and end dates as the aggregate using the concatenate function. The result was a table with 441 records that showed the activity start and end dates for each CSJ by action type, along with the NEPA clearance date and the actual letting date.

Using the pivot table, the researchers calculated the difference in days between the final (or most recent) noise activity end date and environmental clearance date, and the difference in days between final noise activity end date and actual letting date. The idea was to get a sense of when the noise wall development process concluded with respect to the environmental clearance date and the actual letting date. Comparing the final noise activity date with the environmental clearance date resulted in 308 records with exactly one date to compare; and comparing the final noise activity date with the actual letting date resulted in 152 records with exactly one date to compare (Table 17). Table 17 further shows the number of records where the final noise wall activity concluded before the NEPA clearance date or letting date (differences larger than 0), when the final noise wall activity concluded after the NEPA clearance or letting date (differences smaller than 0), and when activities concluded on the same day (differences equal to 0).

Table 17. Count of Record Comparison of Final Noise Wall Activity Date with Environmental Clearance and Letting Dates.

	Final Noise Wall Date vs.	
	NEPA Clearance Date	**Actual Letting Date**
Count of records with both dates	308	152
Count of records with difference larger than 0	195	137
Count of records with difference smaller than 0	88	15
Count of records with difference equal to 0	25	0

In Table 17, negative differences in days are problematic given that all noise wall activities should be concluded with the environmental clearance date, and definitely by the time of letting. For example, of 308 projects, 88 had ongoing noise activities after the environmental clearance date, and 25 had the same date. Some of the records with negative day differences were clearly problematic. For example, one project had an environmental clearance date of April 1991, and the final noise activity was completed in May of 2018, with no recorded letting date. For the letting date analysis, which involved 152 projects, 137 concluded noise activities before letting, and 15 projects had noise activities after the actual letting date.

In reality, records that produce a negative day difference might be a result of changes to the letting date or environmental clearance date that were not recorded in either ECOS or TxDOTCONNECT. As a result, the researchers decided to develop mean, median, interquartile range, and standard deviation of day difference using only positive values. The results of that analysis are shown in Table 18. For example, the final noise wall process activity concluded with a mean of 147 days before the environmental clearance date, with an interquartile range of 188 days. Noise wall activities further concluded about 270 days before the letting date, with an interquartile range of 376 days.

Table 18. Comparison of Final Noise Wall Activity Date with Environmental Clearance and Letting Dates.

	Final Noise Wall Date vs.	
	NEPA Clearance Date	Actual Letting Date
Maximum number of days difference	753	1,384
Minimum number of days difference	−9,894	−3,504
Mean[a]	147	270
Median[a]	87	157
Standard deviation[a]	163	266
Interquartile range[a]	188	376

[a] Considering only positive day differences, or records where final noise wall was completed before NEPA clearance date or actual letting date.

To further illustrate this analysis, Figure 19 shows the distribution of projects that fell within a range of day differences when comparing the final noise wall activity with the NEPA environmental clearance date. For example, 185 projects had a final noise wall activity between 1 and 500 days before the NEPA clearance date.

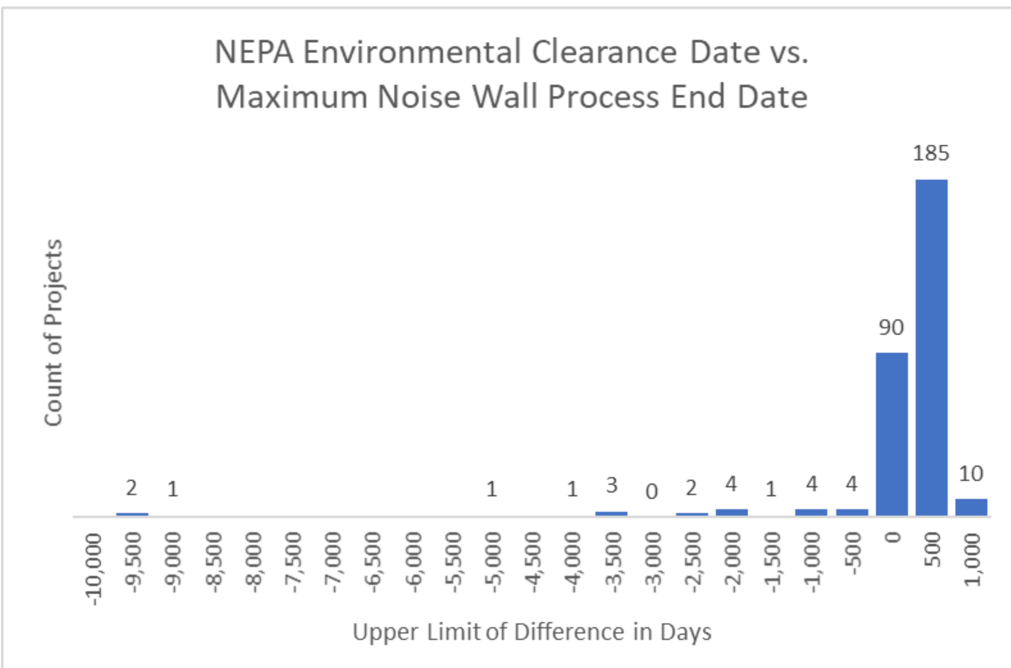


Figure 19. NEPA Environmental Clearance Date vs. Maximum Noise Wall Activity Date: Count of Projects within Range of Day Differences.

Figure 20 shows a similar diagram, focusing only on 195 projects with a positive day difference. As the figure shows, 69 projects ended their final noise wall activity between 1 and 50 days of the NEPA clearance date.

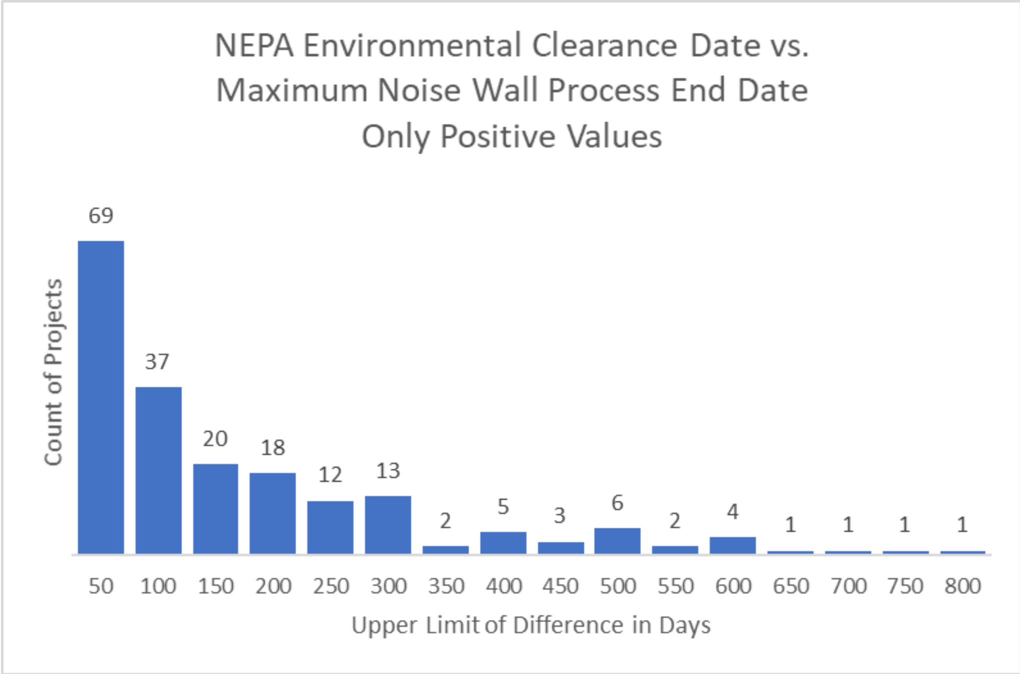


Figure 20. NEPA Environmental Clearance Date vs. Maximum Noise Wall Activity Date: Count of Projects within Range of Day Differences (Positive Day Differences Only).

Figure 21 shows the distribution of projects that fell within a range of day differences when comparing the final noise wall activity with the actual letting date. For example, 86 projects had a final noise wall activity between 1 and 250 days before the actual letting date.

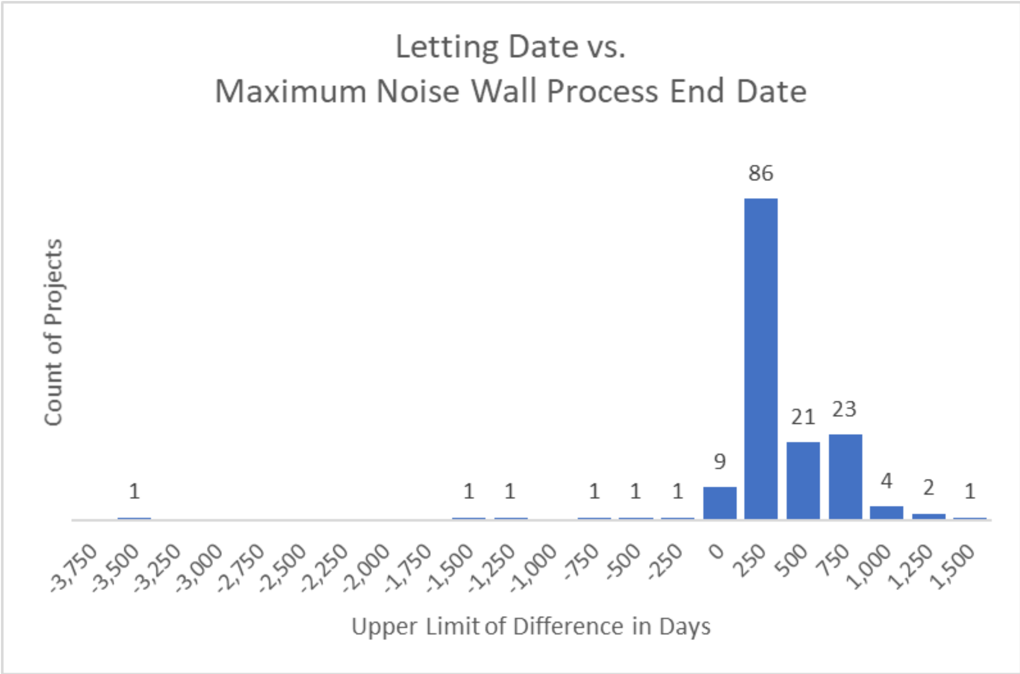


Figure 21. Actual Letting Date vs. Maximum Noise Wall Activity Date: Count of Projects within Range of Day Differences.

Figure 22 shows a similar diagram, focusing only on 137 projects with a positive day difference. The figure shows that 47 projects ended their final noise wall activity between 1 and 100 days of the actual letting date.

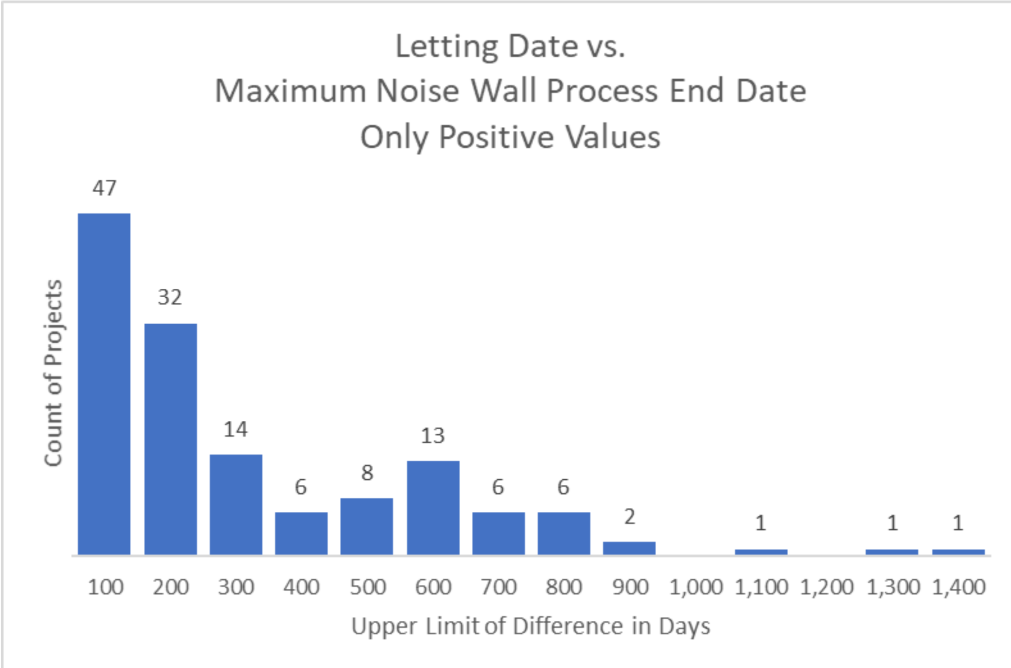


Figure 22. Actual Letting Date vs. Maximum Noise Wall Activity Date: Count of Projects within Range of Day Differences (Positive Day Differences Only).

CHAPTER 4. PRELIMINARY INTERVIEWS

INTRODUCTION

This chapter summarizes the information related to interviews with TxDOT district and division officials. Meetings were conducted to review existing practices, identify issues, and document recommendations for resolving issues regarding sequencing and placement of noise walls and retaining walls. Appendix F. Interviews with TxDOT Districts and Appendix G. Interviews with TxDOT Divisions provide detailed information collected during the interviews.

MEETING LOCATIONS AND STAKEHOLDERS INVOLVED

TTI coordinated with the project team and selected 15 districts representing different regions (north, south, east, and west) and types (rural, urban, and metro) and five divisions. TTI completed interviews with 13 of the 15 districts and all 5 divisions. Two of the districts were not available or did not respond to requests for interviews. Figure 23 shows the 13 districts interviewed.

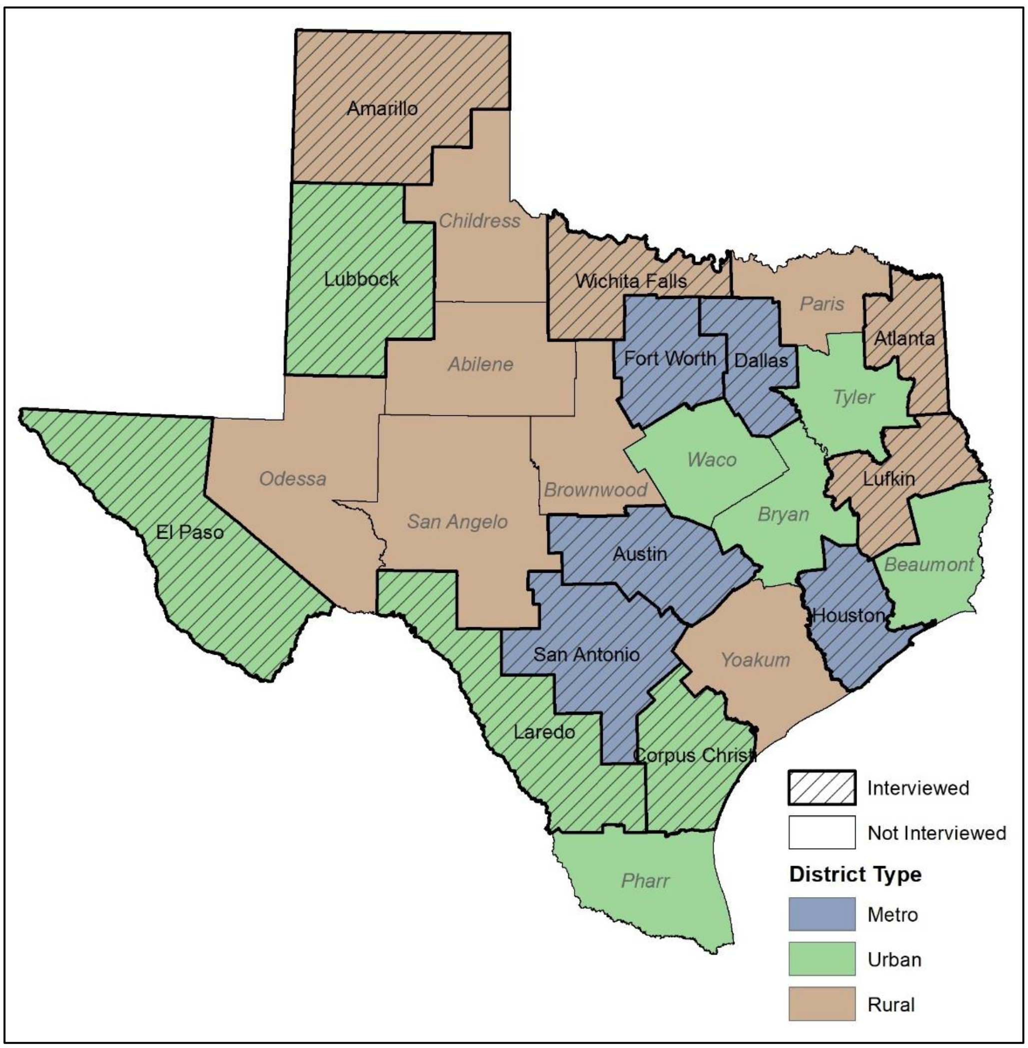


Figure 23. Interviewed Districts.

TTI provided a preliminary interview guide to interviewees when setting up meetings and encouraged the inclusion of additional attendees. Appendix H. Preliminary Interview Guide presents a copy of the preliminary interview guide.

Metro Districts

TTI interviewed representatives from the Austin, Dallas, Fort Worth, Houston, and San Antonio districts. Meetings were held by district and conducted in March 2020. The first meeting was held in-person and the remaining meetings were held via web-based format due to the COVID-19 travel restrictions. A total of 28 personnel, representing the metro districts, were interviewed. Participation included persons with the following general titles: design director, design project manager, design team lead, project delivery supervisor, engineer supervisor, roadway designer, structural engineer, engineering consultant, utility manager, utility engineer, utility section supervisor, utility project manager, utility coordinator, assistant area engineer, maintenance engineer, construction engineer assistant, construction project manager, and construction inspector.

Urban Districts

Preliminary interviews were held with Corpus Christi, El Paso, Laredo, and Lubbock districts. Interviewees included personnel with the following titles: planning and development director, planning supervisor, design director, design project manager, transportation engineer, engineering consultant, utility coordinator, environmental specialist, area engineer, construction director, maintenance engineer, construction engineer, and construction inspector. Meeting was held in March and April 2020 by phone or web-based format. A total of four meetings were held, separated by district. A total of 17 personnel representing urban districts were included in the interviews.

Rural Districts

TTI held four interview meetings with rural districts, Amarillo, Atlanta, Lufkin, and Wichita Falls district. A total of 17 persons were interviewed. Meetings were held in March and April of 2020 via web-based format. General titles for interviewed personnel include planning and development director, operations director, design project manager, design engineer, utility coordinator, environmental coordinator, area engineer, construction director, and maintenance director.

Divisions

TTI held meetings with the following five TxDOT divisions: Bridge, Construction, Right of Way, Environmental Affairs, and Design. Meetings were held by division via WebEx and phone between March and April 2020.

SUMMARY OF PRELIMINARY INTERVIEWS

As noted previously, the preliminary interviews were conducted to review existing practices, identify issues, and document recommendations pertinent to retaining walls and noise walls. This section is a summary of the related information collected during the preliminary interviews. The following subsections are organized according to the variety of topics covered.

Sequencing

Design

A main concern raised during the interview process was the identification of noise walls late in the design process, after schematic design. Many districts stated that proposed noise walls were not known until after right-of-way acquisition and utility coordination had begun. Sometimes this led to additional design features being placed in the same amount of right of way and utility relocations needing to be redesigned. In a few cases, additional relocation of previously relocated utilities was required.

In some instances, noise workshops may be conducted prior to the preparation of detailed noise wall design plans or before utility coordinators are informed about the need for a noise wall. This can lead to additional utility conflicts and more complex installations during construction. This issue can be addressed by providing as much detail as possible to the utility coordinators prior the noise workshop so that they can identify and consider potential utility conflicts.

As of December 2019, TxDOT's Environmental Affairs Division released updated guidance for implementation of traffic noise policy that specifies that noise barrier constructability assessments must be performed by the project's engineering or design team prior to the noise barrier workshop (9). The interview responses herein are likely based on district experiences prior to implementation of the updated guidance. These requirements were not in the formal noise policy prior to this update and may not reflect the new policy.

Implementing TxDOT's updated noise policy as well as engaging the engineering or design team and providing detailed plans to the utility contractors prior to the public noise workshop may help in determining if a noise wall is feasible and reasonable and allow utility coordinators to consider the noise wall placement when working with utility companies to resolve conflicts.

Utility coordinators should have access to noise wall designs early since the wall type, footing, and location affect the coordination process. More design and placement information earlier in the process will have a positive impact on utility coordination.

It was noted that some designers may be reluctant to include noise walls in detail until they know they are wanted by the affected receptors. This means designers may wait until after the noise workshop to include noise walls in their design.

The reasons why noise walls are included late in the design phase is not fully clear at this point. Additional investigation is needed to determine the reasons and possible resolutions to the issue. Some of the recommendations collected during the interviews include having effective communication and coordination between the environmental team and the design team. This is recommended as a best practice and should take place regardless of the need for a noise wall.

Construction

Construction sequencing of noise walls and retaining walls varies and is project specific. Unless the plans specify, construction sequencing is left up to the contractor. This usually means that noise walls are constructed near the end of the project. However, a good practice is to construct noise walls at the beginning of construction since doing so helps alleviate noise impacts to affected receptors during construction.

Early noise wall installation is not always possible, partially due to the need to perform utility relocations. In certain areas, it may be possible to install noise walls before utilities relocate. This requires additional coordination and early notification of noise walls in project design. Another method used to sequence the construction of noise walls is to let noise walls separately from the highway contract. Interviewees noted that this practice can be useful if a noise wall construction ahead of the highway construction is desirable.

Placement

Noise Walls

Existing utilities need to be considered when placing a noise wall; otherwise, the placement is likely to lead to conflicts with utilities. As a result, it is important to develop noise wall parameters such as height and alignment early in the project development process and ensure those data are reviewed along with utility data.

Noise walls are more effective when they are placed near affected receptors or the noise source. Since affected receptors are located off the right of way, noise walls are usually located near the edge of the right of way (Figure 24). Since the edge of the right of way is the most common location for utilities, placement in that area not only blocks or limits maintenance access to utilities but also makes the installation of the noise wall more difficult. Sufficient room should be left between the noise wall and the edge of the right of way for the contractor to properly construct the noise wall. If sufficient room is not available, then a temporary construction easement may need to be acquired to construct the noise wall. Thoughts on the amount of room that should be left between the back of the noise wall and the right-of-way line vary, but a rule of thumb would be to design the noise wall to include sufficient room to allow access for construction and maintenance. An example of sufficient room for utility maintenance access can be seen in Figure 25.

Figure 24. Plastic Noise Wall Installed near Right-of-Way Line (Source: Google Street View).

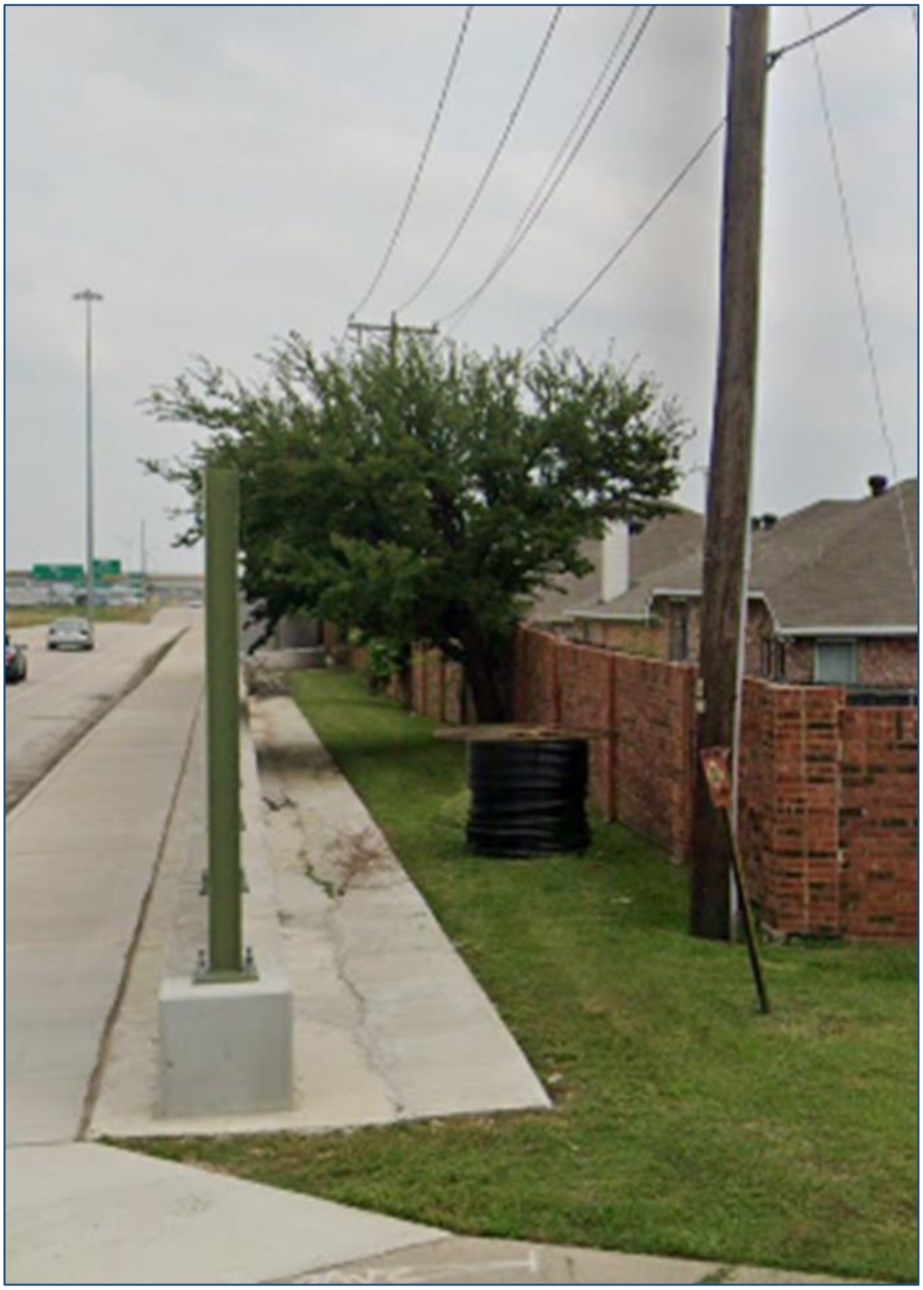


Figure 25. Room for Access behind Plastic Noise Wall (Source: Google Street View).

In some areas, noise walls have been placed off the right of way to serve affected receptors located behind commercial properties adjacent to the right of way. The commercial properties wanted to keep their visibility from the highway, and the residential areas behind wanted a noise wall. Since these noise walls are not on the TxDOT right of way, the local municipality is responsible for wall maintenance once construction is complete.

Another instance where a noise wall may be constructed off the right of way is where a local municipality's easement is adjacent to TxDOT's right of way. This might create a large area between the back of the noise wall and affected receptors. If all parties agree, the noise wall can be located next to the affected receptors, off the right of way, to improve the effectiveness of the noise wall.

As mentioned earlier, noise walls may be effective when they are located near the noise source. Because of this, some noise walls may be located adjacent to the travel lanes. Some districts have reported placing noise walls between the frontage road and the main lanes, as seen on the left in Figure 26. This placement reduces only noise from the mainlanes for residents adjacent to the frontage road. In terms of constructability, this placement has great potential to alleviate conflicts between noise walls and utilities. On projects with many known utilities close to the right of way edge, this placement could result in tangible benefits. Some concerns with placing noise walls near the main lanes include aesthetics, the need for crash protection, and limitations to future lane widening.

The proximity of noise walls and retaining walls should be considered. Installing a retaining wall and a noise wall in the same area raises the level of complexity for construction. This should be avoided when possible.

Figure 26. Transparent Noise Wall Located between Frontage Road and Main Lanes (Source: Google Street View).

Retaining Walls

Retaining walls are usually located away from the right-of-way line. Sometimes retaining walls are placed near existing travel lanes, which makes construction difficult. When retaining walls are placed near the right-of-way line, constructability should be considered with respect to space. Sufficient space should be left to accommodate construction activities. Otherwise, a temporary construction easement may be necessary.

Retaining walls constructed between the frontage road and the main lanes can help mitigate access issues for driveways connected to the frontage road. This placement can be achieved by designing the frontage road at a similar elevation as the right of way.

In some situations, TxDOT has been asked to consider a perched retaining wall design. A perched retaining wall is a retaining wall placed on top of a slope or a high edge. Perched retaining walls are not recommended due to stability issues. Walls should be at the bottom of a slope, or a different design should be considered.

Utilities

Utilities can have a significant impact on projects, including the installation of noise walls and retaining walls. It is important to identify utility conflicts early in the design phase of a project since it is critical to have utility information available for designers and other team members to make informed decisions. Quality subsurface utility engineering (SUE) information early in the design process is crucial in identifying utility conflicts early. SUE information also helps designers make informed decisions regarding placement and design of noise walls and retaining walls. Test holes may be warranted to get accurate utility location information to aid in design and coordination. Major conflicts and delays may be avoided when the project team is informed about utilities.

It is also important to have good internal communication between the various parts of the project team. Informing utility coordinators earlier in the design process about design features can mitigate some of these issues. The earlier utility coordinators know about noise walls and retaining walls, the sooner they can start coordinating with utility owners and planning any necessary relocations.

Communicating early and often with utility companies is recommended. Impacts to utilities, which include conflicts as well as limited access, should be considered during project design. Once the project moves into construction, impacts to the schedule and changes to the design may lead to noise walls not being able to be built.

Overhead Utilities

Overhead utilities present a challenge to the installation of noise walls if located near the proposed installation location. This issue is mainly due to clearance requirements of construction equipment when installing drilled shafts and placing noise wall panels.

Overhead utilities might need to relocate before noise wall construction. Districts have dealt with overhead utility relocations in several ways. Some relocate overhead lines before the noise wall is installed, while others do so after installation is complete. This decision usually depends on the situation. When overhead lines are to be placed next to noise walls, they are normally relocated after the noise wall is installed. There have also been times where overhead lines were temporarily relocated to facilitate the installation of the noise wall and were relocated back after construction.

Methods to deal with existing overhead utilities that avoid relocation include using low-profile equipment, using half-sized panels, selecting front-installing panels, and sleeving or deenergizing electrical lines. Electric companies typically prefer to deenergize rather than sleeve, or insulate, their overhead electrical lines. Deenergizing is the preferred method since it provides a safer working environment and sourcing low-profile equipment may be difficult. Deenergizing might also allow the temporary pulling of the electrical line away from the work area. Deenergizing may not be possible in all areas, and the fees and scheduling requirements should be considered when planning to deenergize for construction.

The use of half-sized panels reduces the lift height necessary to install the panels. Selecting front-installing panels instead of the traditional top-install panels reduces the impact to overhead utilities even more. However, top-installing panels are still used much more frequently than front-installing panels. Additional investigation is needed to see why front-installing panels are not used more frequently on projects.

In cases where installation and access to utility poles will be limited once the noise wall is constructed, overhead utilities are likely to relocate before the noise wall is installed. Other requirements, such as using taller poles and raising utility lines, have been used to make constructing noise walls easier once the overhead lines are relocated. The effectiveness of some of these requirements may be affected by other factors. In the instance of raising utility lines, the top utilities may be placed higher, but the height of the lowest utility may not be affected. This may be due to the presence of neutral line switches and required spacing between utility lines.

As seen on the pole to the left in Figure 27, the height of the neutral line switch affects the maximum height of the telecommunication lines. The neutral line can be seen between the three electrical lines at the top of the poles and the three telecommunication lines at the bottom of the poles. The height of the neutral line is less for the pole on the left and is the limiting factor for the telecommunication line to locate higher. This leaves the telecommunication lines much lower than the primary electrical line. In understanding these requirements, raising the primary electrical line will not necessarily resolve conflicts with overhead utilities during construction. The location of switches and spacing requirements should be considered as well.

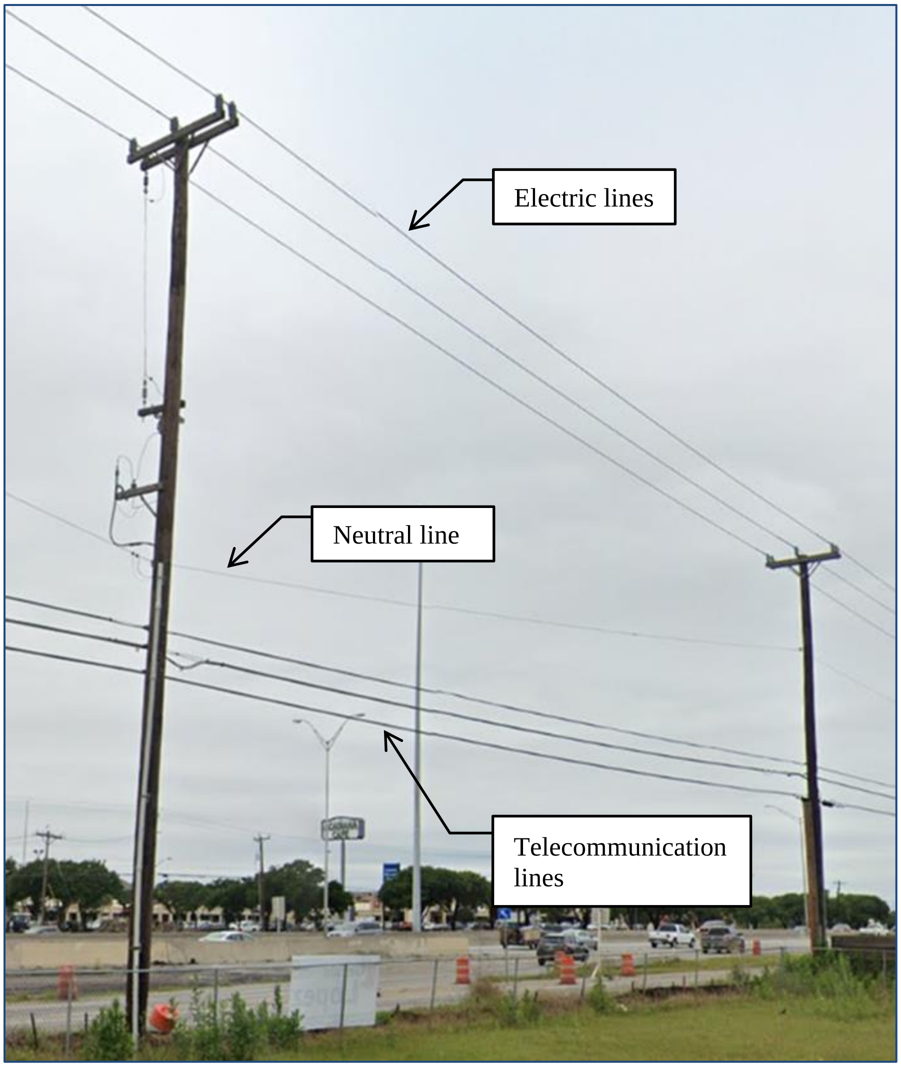


Figure 27. Location of Neutral and Telecommunication Lines Lower Due to Switch Height (Source: Google Street View).

Retaining Walls

Conflicts between utilities and retaining walls are not as common as with noise walls. This is partially due to the location of retaining walls, which are mainly located away from the edge of the right of way. Utilities that are in conflict are mostly relocated, but there are instances where accommodations are made. Some examples include notching or working a retaining wall around an existing utility pole, casing underground lines, and designing the foundation to straddle underground utilities.

Noise Walls

The main issues that districts encounter with noise walls are existing utilities. This challenge is due to utilities being in direct conflict or constructability issues. Noise walls placed near the edge of the right of way are more likely to impact utilities since most utility facilities are located near the edge of the right of way. This means utilities and noise walls are competing for the same space. This is especially true for areas where the space between the back of the curb to the right-of-way line is minimal. It was noted that utility conflicts are a common reason noise walls are not constructed. This may be due to the added construction complexity as well as the additional cost of utility relocations. Conflicts may be minimized by placing the noise wall away from the utility corridor.

Utility Coordination

Having good communication with utility owners is recommended since coordination with utilities is required when conflicts are discovered. It is also helpful if the district has a good working relationship with utility owners. In addition, it is important to consider the clearance requirements of the utility since they may impact design. Internal communication at the district between design, environmental, and utility sections is also important.

The cost of utility relocations and the impact to the project schedule should be considered during the design process, regardless of whether a utility is reimbursable or not. Some methods used to accommodate utilities include the use of spread footing, notch outs, and slip joints. Another method to mitigate the impact of utility relocations is to include relocations in the construction contract. Doing so reduces some of the complexity and sequencing issues when dealing with multiple utility relocations.

Ideally, utility relocations take place before construction begins, but there are times when utilities need to relocate during or after construction. There are instances where utilities are temporarily relocated for construction and then are relocated back once construction is complete.

There have been times where utilities have been relocated more than once due to a late change in the design process, such as the addition of a noise wall. This practice can have a negative effect on the district's relationship with utility companies and make the utility company hesitant to relocate early on future projects.

Some districts have sequenced the utility relocation with the installation of the noise wall. Sequencing the utility relocation together with the noise wall installation requires a lot of coordination but may lead to the easiest installation for both parties. This sequencing is normally accomplished by installing the noise wall foundation, usually drilled shafts, then the utility poles followed by the noise wall panels, and finally the overhead utility lines.

In some cases, noise wall design requirements can limit utility access for maintenance activities. Some districts have worked with utility companies to ensure that maintenance access to the utility facilities is available after construction of the noise wall. Different means of access noted by the districts include doors, gates, gaps in noise walls, and removable noise wall panels.

Right of Way

The need for right of way depends on the needs of a highway project, such as clear zone requirements, but not the needs of utilities. If right of way is sufficient to accommodate utilities without negatively impacting the highway, utilities have a right to use the right of way for their facilities, with permission from TxDOT, and typically on a first come, first served basis. As a result, right of way for utility purposes is typically limited and the lack of sufficient right of way for utilities is an issue on many projects. It affects the location of utilities, noise walls, and retaining walls. It is important to understand what is required for the project and to ensure that everything required will fit in the right of way. If not, additional right of way may need to be acquired. Project requirements should be addressed early since the right-of-way acquisition process takes time. Getting input from the right-of-way project manager early in the schematic phase is critical. Right-of-way agents should be included in early project meetings for utilities and design.

Noise Walls

With respect to utility coordination, it is preferable to acquire additional right of way to accommodate noise walls. Currently, this is not a common practice, partially due to the timing of the related right-of-way acquisition process. The right-of-way acquisition area should be reviewed very early, with noise walls and utilities considered. If the need for a noise wall has not been determined, it is safe to assume a noise wall may be included near neighborhoods. The use of temporary construction easements may make installation of noise walls near the right-of-way line easier in instances where additional right of way is not being acquired.

Retaining Walls

In certain areas, retaining walls may not be required if sufficient right of way is available. Some districts look at acquiring additional right of way instead of installing a retaining wall. Depending on the area, acquiring additional right of way may be less costly than constructing a retaining wall. Bridge designs may also include elements that minimize the use of retaining walls. Moreover, temporary construction easements may be necessary to construct retaining walls near the right-of-way line. This should be considered during project design and the right-of-way acquisition process.

Other Issues

Wall Types

MSE retaining walls are the most common type used, followed by soil nailed walls. The use depends on the cut or fill situation. Other retaining wall types may be used but depend on project specifics and area.

Precast and cast-in-place concrete panel noise walls are most commonly installed. Alternate noise wall types and materials should be considered. Besides concrete, other materials that have been used by TxDOT for noise walls include transparent plastic, fiberglass, and opaque plastic panels. The type of noise wall depends on the location and specific project requirements. For example, transparent noise wall panels may be used to minimize the obstruction of views for the traveling public and can be seen in Figure 28. Fiberglass (Figure 29) and Plastic panels (Figure 30) have been used to reduce the weight of the noise wall.

Figure 28. Transparent Noise Wall (Source: Google Street View).

Figure 29. Fiberglass Noise Wall Panels (Source: Google Street View).

Figure 30. Plastic Noise Wall with Access Gate (Source: Google Street View).

Survey

It is important to have the existing ground elevation accurately shown in design plans. When detailed survey information is not available, the design will not properly account for the actual elevation. This translates into additional time spent designing and planning that could be avoided with detailed survey data. Some of the problems seen from incomplete survey data include gaps at the base of the noise wall and drainage issues.

Geological

Geological features may be an issue when placing noise walls and retaining walls. Karst features, fault lines, and voids can cause problems with foundations. It is important to be aware that geological issues are a problem in some areas of Texas. Performing testing in karst areas and creating test bores every 200 feet is recommended.

Maintenance

Depending on the location, maintenance behind noise walls may be an issue. This is seen when noise walls are installed close to the right-of-way line. It is recommended to design for maintenance in mind by leaving sufficient space between the noise wall and the right-of-way line for access. Gates and access panels, as seen in Figure 30, may be included to allow access behind the noise wall.

If adequate space is not left between the noise wall and adjacent fences for proper maintenance, the area may become a safety issue. Some homeowners may complain about maintenance and safety concerns. In some areas, adjacent property owners may extend privacy fences to the noise wall. This allows property owners to maintain the area behind the noise wall.

Other Items of Note

A few items not directly related to the research topic that have an impact on noise walls and retaining walls were mentioned during the interviews and are documented in this subsection. The following issues may need to be addressed in future research.

Underdrains

Underdrains in retaining walls are an issue during construction. This issue may be attributed to underdrains being included in the standard detail instead of the design plans, which may lead to the installation of underdrains being overlooked in construction. Outflows are often not accounted for either. It is important to understand where the water will go. Otherwise, there is a risk that water will impact the stability of the retaining wall. There may be a need to clarify the location of the underdrains in the design plans. Also, if underdrains are shown in the design plans, they become a pay item. Currently, underdrains are a subsidiary item and are not tied to payment. Making them a pay item is a way to ensure underdrains are installed.

Backfill Material

Another issue for retaining walls is backfill material. The selected backfill material needs to allow drainage of water without washing the material through the wall. The use of proper backfill material is required. It is important to have good testing and inspection to ensure the material meets design specifications.

The Dallas District noted a successful method of placing backfill for retaining walls. The district recommended the contractor use a conveyor belt system to place the backfill material. This method was implemented due to issues placing backfill material. The use of the conveyor system allowed the contractor to place material faster and without contamination. It was also noted that the contractor continued to use the method on other retaining wall projects.

Graffiti

Graffiti is an issue with noise walls and retaining walls. It was noted that anti-graffiti coatings seem to only work once in helping with removal. Some districts have begun to use a sealer, which does not allow the paint to absorb into the wall. This makes graffiti easier to remove. This method is preferred versus painting over the graffiti since color-matching the existing paint is difficult and makes the coverup noticeable.

Aesthetics

It is important to work with the local municipality to gain support for the aesthetics. Selecting simple generic themes for use in the aesthetics of noise walls and retaining walls is recommended to reduce the chances of controversy. Also, more detailed designs may be difficult to portray and lead to an installation that does not reflect the design.

SUMMARY OF MAIN ISSUES AND RECOMMENDATIONS

Based on the information collected during the preliminary interviews, the research team created the following list of the most important issues and recommendations.

Main Issues

The most important issues noted during the preliminary interviews were as follows:

- The need for noise walls is often identified late in the design process (after schematic design, during detailed design).
- Noise walls are usually located near the edge of the right of way, which blocks or limits access to utilities in the future and makes the installation of the noise walls more difficult since the edge of the right of way is the most common location for utilities.
- Utilities and noise walls compete for the same space, often resulting in direct conflicts or constructability issues. Overhead utilities present a challenge to the installation of noise walls near the edge of the right of way due to clearance requirements.
- Most projects deal with a lack of sufficient right of way for utilities, which affects the location of utilities, noise walls, and retaining walls.

Recommendations

The notable recommendations from the preliminary interviewers were as follows:

- Sequencing:
  - Assume a noise wall will be included in the design.
  - Ensure that utility coordinators have access to noise wall designs early.
  - Alleviate noise impacts during construction by installing noise walls at the beginning of construction.
  - If practical, let noise walls separately from the main construction project.
- Placement:
  - Avoid installing a retaining wall and a noise wall in the same area.
  - Consider existing utilities when placing noise walls and retaining walls.
  - Leave sufficient room between the noise or retaining wall and the edge of the right of way for the contractor to properly construct the wall.
  - Place noise walls between the frontage road and the main lanes to alleviate conflicts between noise walls and utilities.
  - Place retaining walls between the frontage road and the main lanes to help resolve issues with driveways.
  - Consider proximity to travel lanes when placing retaining walls. Leave sufficient space to accommodate construction activities.
  - Avoid perched retaining walls due to stability issues.
- Utilities:
  - Identify utility conflicts early in the design phase.
  - Consider the cost of utility relocations and the impact to the project schedule during the design process.
  - Communicate early and often with utility companies.

    - Collect quality SUE information early in design.
    - Work with utility companies to provide access to the utility facilities.
    - Consider the location of switches and spacing requirements for overhead utilities.
    - Place the noise wall away from the utility corridor.

- Right of Way:

    - Understand what is required for the project and confirm that everything required will fit in the right of way.
    - Get input from the right-of-way project manager early in the schematic phase.
    - Include right-of-way agents in early project meetings for utilities and design.
    - Examine the right-of-way acquisition area very early, with particular consideration of noise walls and utilities.
    - If the need for a noise wall has not been determined, assume that a noise wall will be included near neighborhoods.

- Other:

    - Consider use of alternate noise wall types and materials.
    - Ensure that surveys show existing ground elevation accurately in design plans.
    - Consider geological features that may be an issue when placing noise walls and retaining walls, such as karst features, fault lines, and voids.
    - Leave sufficient space between a noise wall and the right-of-way line for maintenance access.

CHAPTER 5. DETAILED INTERVIEWS

INTRODUCTION

This chapter summarizes information related the details and organization of the detailed interviews held with TxDOT districts. Detailed interviews were conducted to collect additional information regarding existing practices, issues, and recommendations for noise walls and retaining walls based on the experience at each district. The detailed interviews allowed for more in-depth discussions with district personnel as well as one-on-one conversations. Appendix I. District Interview Summaries provides detailed information from the interviews.

To conduct efficient interviews, the researchers used an interview guide based on lessons learned from the preliminary interviews. Since some of the methods for the sequencing and placement of noise walls and retaining walls vary by district, summaries are provided at a district level in this chapter, along with a summary of the information learned for all districts.

STAKEHOLDERS

TTI coordinated with the project team and selected five metro districts and seven functional areas (planning and design, construction, environmental, bridge, utilities, right of way, and maintenance) for detailed interviews. TTI completed interviews with representatives of 27 of the 35 total functional areas. Representatives from the remaining areas were not available or did not respond to requests for interviews. Table 19 shows the functional areas, by district, that took part in the detailed interviews.

Table 19. Functional Area by District.

Functional Area	Austin	Dallas	Fort Worth	Houston	San Antonio
Bridge	X		X	X	
Construction		X	X	X	X
Environmental	X	X	X	X	
Maintenance	X	X		X	X
Planning and Design	X	X		X	X
Right of Way			X	X	X
Utilities	X	X	X	X	X

TTI provided a detailed interview guide when setting up meetings with interviewees. Some of the detailed interview questions were specific to certain functional areas; thus, not all the questions provided in the detailed interview guide were asked of all functional area representatives. For ease of use during the interviews, only questions related to the specific functional area were provided to the interviewees. The complete detailed interview guide can be found in Appendix J. Detailed Interview Guide.

The following is organized by district and provides a brief overview of the interview process. All interviews were conducted by virtual meeting or phone due to safety precautions arising from COVID-19.

TTI met with eight TxDOT personnel and one consultant for the Austin District. Interviews were held by functional area. Five interviews were conducted for the Austin District between August and October 2020. TTI held five interviews for the Dallas District. Interviews were conducted between July and October 2020. Six total personnel representing the Dallas District were interviewed.

Interviews for the Fort Worth District were held between July and October 2020. A total of five interviews were conducted during four scheduled times. The interviews for the right of way and utilities functional areas were conducted at the same time. Seven district personnel were interviewed during the meetings.

TTI met with TxDOT personnel from the Houston District, Galveston County Area Office, and a representative from CenterPoint Energy (Electric). Between July and October 2020, seven interviews took place concerning functional areas. Houston was the only district where all seven functional areas were represented in interviews. A total of 13 people participated in the Houston's Districts detailed interview process.

The San Antonio District interviews were held between August and October 2020. Five interviews were conducted during that time and included a total of six personnel. The interviews for the planning and design and right-of-way functional areas were held together.

AUSTIN DETAILED INTERVIEW SUMMARY

This section is a summary of the information collected during the detailed interviews held with the different functional areas at the Austin District.

Planning and Design

Noise Walls

The need for a noise wall is identified during the schematic phase after the development of the noise technical report. The technical report is prepared after the traffic data are approved and the noise model is run. The height, length, and placement of a noise wall are typically determined during this time. After the completion of the noise technical report, the environmental team sits with the project manager on the design side to convey information on the warranted noise walls. Then, they begin to look at what is on the ground.

The Austin District plans for and integrates noise wall placement early in the design process. The placement of a wall should typically occur between 30 and 60 percent schematic design to allow for adequate planning for budget, utilities, construction and maintenance spacing, and other related needs.

The evaluation of the feasibility and reasonableness of a noise wall takes place during the schematic design phase. If a wall is planned for early in the project delivery timeline, it is easier to adjust to the different circumstances of each project and stay on a proper timeline and budget.

Noise walls are not fully designed until after the noise workshop. The noise workshops are held after environmental clearance has been finalized. In the past, the district conducted workshops before the NEPA decision, but due to design changes, this timeline was not efficient. Now the district waits for the NEPA decision to hold noise workshops. Noise workshops may be held from the beginning of the PS&E phase up to 100 percent PS&E, with the average noise workshop being held at about 60 percent PS&E.

Project managers are involved in the noise workshop process. The project manager can also answer questions from the public regarding the project as a whole. Utility coordinators are not involved in the workshop except for the planning of the wall and the evaluation of its feasibility.

After the noise workshop is held and the public votes, the detailed design team is notified whether the noise wall will be included in the detailed design. The detailed design for the noise wall is not started until after the noise workshop is completed and the noise wall is voted on by the public.

The project delivery method does not affect the noise wall process during schematic design since the district typically manages the NEPA process. For design-build projects, the contractor takes on the responsibility for utility coordination.

Retaining Walls

For retaining walls, although need and location are determined early during the schematic phase, there could be further refining of the design plans, which can result in new retaining walls added and previously planned retaining walls removed. The retaining wall layouts are turned in at the same time as the bridge layouts, which is between 30 and 60 percent detailed design.

Placement

The Austin Planning and Design group focuses on many traditional considerations when placing a noise wall or retaining wall, such as location of utilities, design needs, and safety. Many factors exist surrounding the installation of a noise wall or retaining wall, such as the cost to the contractor, soil evaluation, utility locations, and wall placement, all of which require a wall to be planned for and located early.

Determining where to place a noise or retaining wall is largely contingent upon a number of factors, including maintenance requirements, design of wall (height, etc.), type of footing needed, availability of a construction easement, proximity to travel lanes, utilities, and other issues. It is always important to consider how placement impacts travel lanes. It is a best practice to think about how placement impacts risk for a vehicle striking the wall and other safety considerations, such as maintenance spacing around the wall and spacing between the wall and adjacent properties.

Noise Walls

Decision-Making Process to Place Wall
After completion of the technical report, the district reviews utility information, right-of-way information, other constraints (like large trees), and public feedback given through public meetings.

Determining placement for a noise wall is largely contingent on the location of utilities within a project. The design team tries to avoid all utility conflicts on a project and relocate utilities when the conflict is unavoidable, and the detailed design is mostly complete.

Providing Quality Level B (QLB) SUE information may help inform environmental personnel who are placing the noise wall for the noise analysis of where existing utilities are located. This process may help reduce conflicts between noise walls and existing utilities later in the project.

Spacing Requirement
For spacing, it is helpful for the design team to have standards and requirements across projects, such as a required 2-foot spacing from a water line. A rule of thumb for spacing may help reduce issues related to the placement of noise walls. Utilities have location assignments within the right of way. For example, two feet from the right-of-way line is the alignment for overhead electric lines.

The design team adjusts as feasible, and in some situations, spacing very close to the right-of-way line may be adequate. In other situations, having a noise wall 2 feet from the right-of-way line is not sufficient due to maintenance needs. A minimum of 5 feet between the back of the noise wall and the edge of the right of way is recommended for work behind the noise wall, which includes construction and maintenance.

A tiered approach may be considered when placing noise walls, which may include location of utilities, amount of right of way available, and other concerns, such as presence of creeks and trees. The placement can change when considering utility conflicts, environmental concerns, or safety challenges.

The need for space between the noise wall and the edge of the right of way may be reduced if TxDOT can get a permanent easement adjacent to the right of way. The need for the permanent easement can be included in the right-of-way acquisition when a noise wall is planned within 5 feet of the edge of the right of way.

Off TxDOT Right of Way
Typically, the district will not place noise walls outside of the TxDOT right of way. Access and maintenance of noise walls off the right of way can be difficult. If noise walls are planned off the right of way, then the area must be environmentally cleared.

Although placing a noise wall on TxDOT right of way is a standard across districts, opportunities may arise in which a structure might be better suited off TxDOT right of way. Locating the noise wall off the right of way may lessen the impact to utilities in the right of way. Thus, depending on the location of utilities and available space, it may be beneficial to consider placing a noise wall off the right of way. If the noise wall is being placed to benefit adjacent commercial properties (economic impact) or if another entity is willing to acquire the land and take responsibility for future maintenance, placing a structure off TxDOT right of way can be beneficial for all stakeholders. In this situation, TxDOT can pass the responsibility for future maintenance, such as mowing and upkeep, to another willing party, which decreases future cost and obligations. It is extremely important to properly document these agreements. This setup might become problematic if there is not a formal agreement with attached documents or if a new property owner moves into the area. Situations like this can often become more challenging in the long run as turnover within TxDOT and adjacent properties occurs, but if this setup can be executed effectively, it can be useful. Thus, a primary takeaway is that constructing projects off TxDOT right of way can be beneficial for multiple entities if an agreement is in place and comprehensive documentation has been completed to ensure that responsibility is clearly outlined in the near and long term.

The Austin District cited two examples related to placing noise walls off the TxDOT right of way. In one case, a commercial business did not want a proposed noise wall blocking the view of the business. The commercial business bought land adjacent to the right of way for the noise wall. The commercial business then deeded the purchased property back to TxDOT. TxDOT built and maintains this noise wall since it is within the TxDOT right of way. In the second case, traffic noise impacts were identified within a residential area where a railroad runs parallel to and between the highway and the impacted residential area. Working with the City of Austin, TxDOT constructed a noise wall on the city property along the opposite side of the railroad to mitigate the residential traffic noise impacts. The City of Austin maintains the noise wall.

It is not preferable to place a noise wall off the right of way if TxDOT must maintain it or if placement creates access issues. Also, the location of existing utilities outside of the right of way is a concern if placing a noise wall off the right of way. If no significant economic impact to nearby properties or need to adjust to other circumstances exists, it is typically most reasonable and consistent to place TxDOT projects on TxDOT right of way.

Between the Frontage Road and Main Lanes

Typically, the Austin District places a noise wall close to the edge of the right of way near affected receivers. Noise walls are primarily geared toward decreasing noise generated from the main travel lanes. If a noise wall can be placed between the main lanes and the frontage road, that setup may be preferable. With this spacing, the wall is closer to the noise source and can have more continuity with fewer breaks, thus increasing its effectiveness, especially in areas with many side streets feeding onto the frontage road. Sight distance when pulling out of side streets onto the frontage road might be less impacted, and it is also far easier to avoid utility conflicts and provide more room near the right-of-way line.

Placement of noise walls close to the travel lanes may be preferable when there are utilities along the right of way, large trees, or other obstructions, or when there is a large grade separation between a depressed frontage road and the elevated main lanes. Elevation differences between the location of a noise wall and receptors may affect the height of the wall.

When placing a noise wall near a travel lane, the project team should pay special attention to barriers and crash protection for the wall. Regarding vehicle impact risk, the Austin District prefers to have a shoulder or barrier, or both, between the travel lanes and the noise wall. The requirements for a shoulder or railing barrier vary for different types of roads but adding this buffer can reduce potential damage to the structure as well as risk to travelers.

Adequate space should be available for the traveling public to pull onto the shoulder. No less than 10 feet of space should be available for maintenance between the back of the noise wall and the frontage road.

Other considerations for wall placement related to the main lanes and the frontage road include the right of way and access to adjacent properties. Drainage should also be considered since it may be impacted by the placement of the wall. Locating a noise wall between the frontage road and the main lane should be considered when there is limited space near the right-of-way line or when the noise wall blocks visibility to commercial businesses. Such placement can allow for easier access for maintenance and utilities because fewer challenges in accessing limited space available in the right of way will exist. Moreover, the space between the main lanes and the frontage road may be a good area to implement transparent noise walls.

Away from the Edge of the Right of Way

For situations in which the district is evaluating placing a noise wall close to the travel lanes and farther from the edge of the right of way, it is important to consider safety, maintenance needs, future development, and utilities. Shifting the noise wall away from the edge of the right of way can lessen the impact to utilities This placement may be preferable when there are utilities along the right of way, large trees, or other obstructions. Moving a wall closer to the travel lanes can bring additional risks to the traveling public and the construction and maintenance crews and increase the barrier needs for the wall. When placing a noise wall near a travel lane, the noise wall should be crash rated or crash tested.

Shifting the noise wall away from the edge of the right of way seems to be happening more often in the district. This shift lessens the impact to utilities, partly because overhead utilities are required to be installed within 3 feet of the right of way line. In addition, gas companies are responsible for surveying and probing their gas lines to verify that there are no leaks. Gas companies have informed the district that the farther the gas line is away from asphalt, the fewer false readings they get. Gas companies prefer their lines to be farther away from the travel lanes and closer to the right-of-way line to reduce the number of false readings. In the district's experience, utilities in general prefer to be farther away from the travel lanes and closer to the edge of the right of way.

Placing a noise wall away from the right-of-way line can create additional right-of-way space on the residential side of the noise wall, which might lead to encroachments from property owners. This result may create future conflicts in which property owners begin to treat this space as their own. They may begin to store items on the property, like travel trailers, and potentially disrupt maintenance responsibilities or access. Unless there is an opportunity to do something with this space, such as installing a hike and bike trail, it is best to leave just enough space for maintenance and utility access without leaving an excess of space between the right-of-way line and the back of the noise wall.

Retaining Walls

Spacing Requirement

The placement and spacing of retaining walls are primarily dependent on the type of wall being constructed. In deciding how much spacing is needed, it is crucial to know what type of retaining wall is being placed in a certain location since different walls will have different requirements for the support and space needed. For example, a fill wall will likely require more space than a cut wall.

Typically, a minimum of 5 feet of space is needed between the retaining wall and the edge of the right of way. The necessary spacing increases with the height of the wall and may possibly be as much as 20 feet for proper construction and maintenance. It is typically preferable to have 10 to 20 feet of space from the right-of-way line. This distance leaves enough space to prevent any footing from going onto adjacent property and leaves space for maintenance activities.

A tiered approach to spacing requirements may be considered where a minimum of 5 feet is required that increases as the height of the retaining wall increases. This process may be accomplished by considering height in 5-foot increments, in which up to a 5-foot wall will require a certain amount of space and a wall between 5 and 10 feet will require a greater amount of space behind the retaining wall.

Between the Frontage Road and Main Lanes

In evaluating the placement of retaining walls between the frontage road and main lanes, a primary concern is spacing. When placing an obstruction, such as a retaining wall, the design team looks at the crash risk. Minimizing this risk usually means placing the wall outside of the clear zone. This task can be difficult to accomplish when placing a retaining wall between the main lanes and frontage road. Consequently, it is typically easier to put it near the main lanes and put a crash barrier up, but the considerations should always be crash worthiness, clear zone spacing, available right of way, access to adjacent property, utilities, drainage, and future expansion.

Locating a retaining wall between the frontage road and main lanes allows for a constant grade with adjacent properties and helps maintain access, which can be highly useful. Placing retaining walls between the frontage road and main lanes will lessen the impact to utilities in comparison to placing a retaining wall near the right-of-way line. It is not always possible to shift a retaining wall. Utility crossings should be considered whenever placing a retaining wall.

If possible, it is preferable to have enough of a buffer to avoid a retaining wall altogether because retaining walls are costly, require longer periods of time for construction, and sometimes have maintenance issues.

Noise Walls and Retaining Walls in the Same Area

In instances in which a noise wall and retaining wall are proposed in the same area, these walls should each be designed with the other in mind, early in project design. Some of the considerations for this situation are spacing, providing an opening wide enough to allow for ramps, proximity of the two structures, and potential need for a taller noise wall. Noise walls and retaining walls are typically designed together, with the noise wall placed on top of the retaining wall. If the need for both walls is known early, constructing both structures in close proximity is much easier to do. This procedure can be an effective use of the same space.

Maintenance access between the two structures should be considered during design. Adequate spacing and access should be included. The amount of right of way should be considered to ensure that there is sufficient room for both with spacing for maintenance needs.

Construction Sequencing

Noise Walls

Sequencing during Construction
For noise walls, the timeline of construction varies. Districts should consider installing noise walls later in construction, after the final grade has been achieved for the area. This recommendation varies depending on the area, with respect to existing grade and neighborhood preference. In some instances, no change to the existing grade may be needed. Moreover, the Austin District has had requests during noise workshops to construct the noise wall as soon as possible to help mitigate noise from construction.

The Austin District environmental team would prefer to construct the noise walls first to cut down on public complaints and help secure the worksite. However, the existing construction process allows the contractor to schedule the work. Unless the district adds notes in the plans that the noise walls must be built first, they typically will not get built until near the end of the project.

Let Noise Wall Separately
It is more common to let noise walls within the same construction project. Although a separate letting could allow for a contractor to give full attention to a wall, two letting schedules could create scheduling conflicts and create additional construction costs if one construction schedule is delayed. The Austin District does not recommend letting the noise walls separate from the main highway project.

Retaining Walls

For retaining walls, the timeline of construction varies and is often related to grading. Retaining walls are essential to achieving the desired cross-section. For this reason, it is typical to construct retaining walls early in the project, along with the earthwork. An additional recommendation is to build a retaining wall all at once instead of building it in sections.

Utilities

Project designers are responsible for identifying utility conflicts. Designers are responsible for trying to work around utility conflicts early in the design phase. Utility coordinators in the district handle utility agreements and requests for exceptions to policy. Typically, utility coordinators get involved between 30 and 60 percent PS&E. The bridge team at the Austin District does not connect directly with utilities or the project engineer to discuss exact utility conflicts. The bridge team finds out about utility conflict during design.

Noise Wall Design and Utility Coordinator

The schematic project manager typically provides the utility coordinator a copy of the noise wall plans after the noise workshop is completed and the public has voted on the noise wall proposal.

Coordination with Utility Companies

During the project delivery phase, design engineers meet with every utility company for every project once a month. This coordination begins when the team learns of the project and has sufficient information to share with the utility companies. The team typically has sufficient information to begin conversations with utility owners between 30 to 60 percent design. This process can allow for proactive adjustments on utility conflicts if a company is willing to work with the project team. However, if the project team initiates meetings with utility companies too early without adequate information, the company might lose interest in meeting. It is important to keep the lines of communication open.

SUE Information

The Austin District requires SUE and a preliminary utility conflict list (UCL) sheet to be complete by the end of the schematic phase for design-bid-build projects. The design is scoped out with special attention to utility conflicts. The design team receives all the information for utilities, as well as SUE and topographic survey information, during schematic design. The design team tries to integrate this information into design as early as possible to avoid conflicts. Additional SUE information, including test holes, may be collected at around 30 percent PS&E to help with the design and confirm the location of utilities. Some utility information may be collected during the schematic phase for design-build projects, but most of the utility coordination is built into the design contract.

Utility Relocation Timing

The Austin District likes to see utility companies begin their relocations after 60 percent detailed design, which helps ensure utilities have sufficient time to relocate without impacting the let date. The actual relocation start date depends on the utility company and may not happen until later—at around 90 percent PS&E.

Right of Way

Temporary Construction Easements

The district prefers to construct noise walls and retaining walls without acquiring temporary construction easements. Sometimes easements are needed and cannot be avoided. The process of obtaining a temporary construction easement and purchasing additional right of way is similar. If additional space is needed, it is usually more effective to purchase it rather than use a temporary construction easement.

Considered in Right-of-Way Development

Noise walls should be considered during the right-of-way development process. The right-of-way and environmental program areas should always be in communication about the amount of right of way needed. This communication allows for full disclosure of information, such as land needed for noise walls and retaining walls, early in the project. This disclosure can curb later needs, such as purchasing additional right of way later in the project. If a project team realizes additional space is needed, the Austin District prefers to purchase additional right of way rather than request a temporary construction easement since the cost between the two is similar.

Amount of Right of Way Considered When Planning for Noise Wall

Noise Walls
The project team tries to acquire additional right of way as needed if it is able. If right of way is very limited, then adjustments are made, such as removing all grass from behind the noise wall when it would not be feasible to mow. Five to 15 feet is usually required to accommodate mowing and other maintenance activities.

Retaining Walls
Right of way is a significant factor in the construction of retaining walls and is considered when planning for and designing projects. It is important to consider spacing needs when determining placement.

Alternative Designs

Noise Walls

The Austin District typically uses concrete noise walls for maintenance and aesthetic reasons. The district tries to match the noise wall with roadway elements. However, alternative noise wall types and materials may be considered on projects in the district to lessen the impact on utilities and help with the installation of the noise wall.

Alternative noise wall types have been used to mitigate utility conflicts through the addition of gates to access utilities or through hand-built sections to address constructability issues. Transparent noise walls have also been used in the district.

Retaining Walls

Different retaining wall types and alternative designs are considered for retaining walls, which include acquiring additional right of way to mitigate the need for a retaining wall. Cost and schedule have an impact on which alternative is selected. Other factors that go into the decision-making process include availability of sloping and impact to utilities.

On one project, the Austin District was able to eliminate a costly retaining wall from a project design due to right-of-way availability. The team was able to buy slightly more property and add a grade slope rather than construct an entire wall, which reduced project costs.

Surveys

Detailed survey information is collected in areas where noise walls and retaining walls are planned. However, the district has experienced issues in the past with inaccuracies in the topographic survey.

Geological Information

Geological information is collected in areas where retaining walls and noise walls are to be installed. Soil bores are collected every 200 feet per the TxDOT geotechnical manual. Additional soil bores may be collected every 100 feet if the samples have a lot of variation within a short distance.

The district has experienced issues with underground voids regarding the placement of noise walls and retaining walls. If the proposed noise wall is in Karst Zone 1 or 2, test bores will be drilled in wall locations to look for karst voids. The district has had to move some noise wall columns around to avoid the voids found in the drilled shafts. Test bores are collected at every noise wall column location for walls located within Karst Zones 1 or 2; otherwise, the standard spacing is used.

The Austin District has some unique challenges with regard to soil conditions. Some projects might be constructed on ground composed of hard limestone, while other projects might require modifications to improve in-situ soil. When facing changing soil conditions, it becomes increasingly important to prioritize noise walls and retaining walls early in the design. The geotechnical process and the potential need for additional soil borings may be a lengthy process that requires additional time.

Other

Noise Wall Aesthetic

The Austin District has a standard aesthetic for noise walls that is presented to the public at the noise workshop. This standard alleviates issues with choosing an aesthetic for the noise wall. The placement, height, and aesthetic are provided during the noise workshop.

DALLAS DETAILED INTERVIEW SUMMARY

This section is a summary of the information collected during the detailed interviews held with the different functional areas at the Dallas District.

Planning and Design

Noise Walls

The need for a noise wall is typically identified at around 60 percent schematic design, after the roadway geometry is set. The traffic noise technical report can begin once the Dallas District has the project footprint and approved traffic. Early communication is needed in the schematic phase so decisions can be made.

Evaluations for feasibility and reasonableness usually take place at around 90 percent schematic design. The design section is involved in the feasibility evaluation.

Feasibility and Reasonableness
The Environmental Division is involved with the NEPA documents and conducts reviews to ensure that the traffic noise technical reports and models are accurate and correct. Environmental also addresses design and constructability issues. It makes sure any changes are documented and, if a noise wall is affected, that the noise wall is still effective. High-profile projects are also reviewed by the Environmental Division.

Utility coordinators are not involved in the feasibility and reasonableness evaluations. Constructability issues should be identified before the noise workshop to avoid changes after the public has been engaged. The Environmental Division should work hand in hand with PS&E designers.

Noise Workshops
Often, the noise workshop is held after the schematic plans have been approved, which is shortly after the public meeting for the project. Workshops are usually held after environmental clearance, and preferably after determining if there are constructability issues.

Noise workshops are attended by design personnel who answer general questions about the project. Utility coordinators are not involved in the noise workshop process. Typically, most of the noise wall design is completed after the workshop. The degree of completion of the noise wall designs at the noise workshop depends on the project. At the time of the noise workshop, the noise wall design consists of location, height, and possibly aesthetics.

Included in Design
Detailed design of the noise wall is usually complete at around 60 percent PS&E. Designers know about noise walls during the schematic phase, but the design of noise walls does not start until after the noise workshop. Once the noise wall and the workshop summary are approved, the district works one on one with the design team to include noise walls in the plans. The workshop summary is approved once the noise workshop is held and the public votes on the wall.

Type of Project Delivery Method
Since the schematic design phase is the same regardless of the project delivery method, the process to identify noise walls does not change.

Retaining Walls

The majority of retaining walls are identified at around 60 percent schematic design.

Placement

Noise Walls

Decision-Making Process to Place Wall
In the Dallas District, project designers place the noise walls. The environmental and design teams work with each other to determine the best placement of the noise wall. The environmental team determines the length and height of the noise wall. The need for a noise wall and feasibility are important factors when deciding where to place a noise wall.

It may be a good recommendation for districts to have environmental personnel run the noise analysis a few times while varying the placement of the noise wall and provide a few locations to project designers for them to see which placement works best with the project's design. It is helpful during project design to view the placement of the noise wall as having some degree of flexibility. This element can help designers when conflicts arise with the current placement of the wall and other project features.

Noise wall designers should consider the impact to utilities when placing noise walls in the right of way. Several times, utilities have been relocated for a project only to have a noise wall constructed on top of the relocated line. This discrepancy is an issue when drilling for the noise wall foundation. Designers need to know where utilities are and where they are planned. Unfortunately, many noise walls go where utilities are supposed to go.

Conflict between noise walls and utilities is one of the biggest reasons for delay claims when dealing with noise walls. As little impact as possible should be made to the utility corridor. The way to achieve this result is to place the noise wall away from the edge of the right of way, which can be accomplished by placing the noise wall closer to the roadway or between the frontage road and main lanes.

Spacing Requirement

The Utility Accommodation Rules (UAR), which govern where utilities are accommodated in the right of way, require placement of electrical lines within 3 feet from the right of way line. Several times the location of the relocated overhead electrical lines have conflicted with the placement of the rig installing the drill shafts for the noise wall. The conflict is a vertical conflict with the construction method, not a horizontal conflict with the noise wall. Guidance to help with this issue would be useful, such as an if/then guide to help when placing noise walls. Having a checklist of items and different options for various scenarios may also help.

The UAR may need to be updated to consider the placement of utilities at the noise wall location. Updating TxDOT's *Roadway Design Manual* may also be helpful. Currently, the *Roadway Design Manual* calls for a 15-foot border width that could be updated to 18 feet to include 3 feet from the edge of the right of way to place a noise wall if one is required. If a noise wall is not required, the additional 3 feet could be used to further accommodate utilities. Increasing the minimum border width in the *Roadway Design Manual* to accommodate noise walls would help prevent issues with the placement of utilities.

Feedback from the district about whether placement near the right-of-way line or away from the right of way is best was mixed. Placing a noise wall at or near the edge of the right of way creates issues during construction and, depending on how much space is behind the wall, can either eliminate the need for mowing or make it very difficult. To provide sufficient room for construction, leaving 8 to 10 feet between the back of the noise wall and the right-of-way line is recommended. This margin includes spacing to help reconcile vertical conflicts with overhead utilities. Making as little of an impact to the utility corridor as possible is recommended and may be accomplished by placing the noise wall closer to the roadway or between the frontage road and main lanes.

Off TxDOT Right of Way
Placing a noise wall off TxDOT right of way will reduce the impact to utilities located in the right of way. TxDOT would need to ensure the area considered for placement has been environmentally cleared, which may be an issue if the location is outside the project's footprint. Early planning may help lessen this issue.

If the noise wall is placed off TxDOT right of way, then TxDOT should not be responsible for maintenance. This factor reduces the overall maintenance cost for TxDOT, which reduces the cost to taxpayers. If an opportunity exists in which a developer or local municipality is willing to take on the responsibility of maintaining the noise wall, then TxDOT should be open to the possibility.

As a rule of thumb, utility coordinators recommend that design features, including noise walls, be located within the right-of-way footprint. However, utility coordinators also realize that locating a noise wall off the TxDOT right of way may alleviate conflicts with utilities, including large transmission lines. If this is the case, then locating off TxDOT right of way should be considered.

The Dallas District has placed noise walls off TxDOT right of way. In the past, this placement has caused issues with utilities located off TxDOT right of way because TxDOT does not have any control of utilities. In a particular instance, the noise wall had to be shifted to accommodate existing utilities during construction, which caused a delay in the project, and additional funds had to be paid due to delay claims. Attention should be given to how TxDOT will reimburse a utility if a noise wall placed off TxDOT right of way requires the utility to relocate.

Between the Frontage Road and Main Lanes
Placing a noise wall between the frontage road and main lanes can reduce issues with utilities since such placement removes the impact of the noise wall from the utility corridor. It is preferable to place the noise wall by the main lanes if there is not a lot of space adjacent to the right of way for the utility corridor and noise wall. Considerations when placing noise walls between the frontage road and main lanes instead of next to the right-of-way line include location, amount of right of way available, and number of utilities near the edge of the right of way.

If the noise wall meets the noise reduction requirements, this type of placement can be beneficial for the project. It can also be a benefit in areas where the main lanes are elevated with respect to receivers. The opportunity also exists to place the noise wall on top of barriers, as was the case for a transparent noise wall that was placed between the frontage road and main lanes on top of an existing concrete barrier.

Depending on the actual placement between the frontage road and main lanes, maintenance activities may be hindered and require a lane closure for major activities. This placement is not preferable where safety issues impede clear zone and line of sight. It would also not dampen noise from frontage roads. This element may be an issue where frontage roads are multilane and have a lot of traffic.

Away from the Edge of the Right of Way
Placing noise walls closer to the frontage road might be more effective in reducing noise; however, ramps, utilities, driveways, line of sight, and other features must be considered along the frontage road. When shifting a noise wall away from the edge of the right of way, designers will have to address clear zone requirements. They cannot place noise walls within a clear zone regardless of preference. If the wall is not in the clear zone, then the installation of the noise wall will be easier. If the wall is in the clear zone, more issues with safety countermeasures will arise.

The location of utilities should be considered when placing a noise wall. If shifting the noise wall closer to the travel lanes can reduce the impact to utilities and still be functional, then it should be considered as an option. Shifting the noise wall away from the right of way will also provide access for utility companies to maintain their facilities, which should be taken into consideration. Utilities do not want their facilities to be on both sides of the noise wall: they want to be on one side or the other. Depending on the location, shifting a noise wall away from the edge of the right of way may impact utilities more than placing it near the right of way line.

Retaining Walls

Spacing Requirement
A minimum of 5 feet should be left between the retaining wall and the edge of the right of way to provide access for construction and maintenance activities. Utility crossings, including overhead lines, should be considered whenever placing a retaining wall.

Between the Frontage Road and Main Lanes
Placing a retaining wall between the frontage road and main lanes is preferable compared to placing it next to the right-of-way line. Such placement will reduce the impact to utilities since they are mostly located near the right-of-way line. Moreover, shifting the retaining wall next to the main lanes from the edge of the right of way can help with roadway access issues for adjacent property. Further, a retaining wall impacting access from adjacent property can cost more in terms of right-of-way acquisition since TxDOT has to purchase the right of access for areas where access is impacted.

Noise Walls and Retaining Walls in the Same Area

If a noise wall and retaining wall are required within the same area, it is preferable to place the noise wall on top of the retaining wall to limit the impact of the structures to the utility corridor and other design features. The retaining wall and noise wall need to each be designed with the other in mind. They should be designed at the same time so that the retaining wall can be included in the traffic noise model.

Construction Sequencing

Noise Walls

Sequencing during Construction
Scheduling noise walls early in the construction phase is preferred. If noise walls are scheduled early in construction and an issue arises, such as an unknown utility, more time is available to resolve the conflict. In addition, the earlier noise walls are installed, the sooner they will mitigate

noise from construction. There may be instances, due to grading or other project features, where noise walls cannot be done early in construction. One recommendation is to construct noise walls in the last phase of construction so any changes to the noise wall will not affect the roadway project.

Let Noise Wall Separately
Noise walls have sometimes been constructed before the main construction project, perhaps to mitigate construction noise in surrounding areas. Generally, it is preferred to let noise walls with the main construction project, but some district personnel prefer to let noise walls before the main construction project.

Retaining Walls

Sequencing of retaining walls is usually dictated by the project's critical path, traffic control plan, and sequence of other design features. The district has a phasing sequence in plans, but the contractor has the option to propose a new traffic control plan.

Utilities

SUE information is considered when designing the project. Project designers receive SUE information between 30 and 60 percent schematic design. Additional SUE information, including QLA, may be requested at around 30 percent PS&E.

Utility Conflicts

A detailed conflict analysis is developed when plans are adequate and SUE QLB information is received. The utility conflict analysis is done by the design project manager. A copy of the analysis is given to the district utility coordinator and the area office utility coordinator.

The environmental team is notified of utility conflicts typically at between 30 to 60 percent PS&E when noise walls are included in the PS&E plans. All construction issues have preferably been identified so that revisions can be made before the noise workshop.

New utility installations done between the original SUE study and the final design of the noise wall can have an impact. The Dallas District has many requests for new utility installations and, depending on the project, it might be years between the original SUE study and detailed design. These additional installations need to be considered during the conflict analysis.

Noise Wall Design and Utility Coordinator

During preliminary design, utility coordinators are aware that noise walls may be needed on a project, but they do not know the wall design, permanent placement, or even if they are wanted by the public.

The utility coordinator is typically provided a copy of the noise wall design plans after the noise workshop and after the environmental team receives the approved noise workshop summary. Utility coordinators usually get detailed noise wall information when plans are deemed adequate— at about 60 percent PS&E—from the PS&E project manager. Plans are also sent to utility companies around this time.

Coordination with Utility Companies

Detailed utility coordination begins at around 60 percent PS&E (plans adequate). The district meets with utility companies monthly and may meet weekly depending on the level of coordination needed. Earlier coordination may begin in preliminary design if there is a major utility that requires additional coordination or a long lead time. Large utility transmission facilities, including overhead and underground, usually need a lot of time to relocate their facilities. Utility coordinators at the local area office oversee utility coordination, but the PS&E project manager is included in the meetings.

Utility Relocation Timing

Ideally, utilities are ready to begin utility relocations when TxDOT has acquired all the right of way on the project, which may be one year after 60 percent PS&E is complete.

Right of Way

Temporary Construction Easements

The district has moved away from using temporary construction easements since they have similar time and cost requirements as acquiring additional right of way. If access is needed to construct a wall, then a right of entry document is used during construction instead.

Noise Walls

Considered in Right-of-Way Development
Noise walls should be considered during the right-of-way development process. For areas where neighborhoods are adjacent to the right of way, it may be beneficial to assume that a noise wall will be required during right of way development.

Amount of Right of Way Considered When Planning for Noise Wall
The amount of available right of way is considered when planning for and designing noise walls, which may be the reason a noise wall is shifted near the main lane and away from the right of way line.

Retaining Walls

The amount of available right of way may dictate the need for retaining walls. Acquiring additional right of way may be considered a design alternative to mitigate the need for a retaining wall. Cost and impact to utilities are considered when comparing design alternatives.

Sometimes soil nails are designed beyond the right-of-way line. In this situation, the retaining wall is redesigned to keep all elements within the right of way.

Alternative Designs

A few alternative noise wall types have been constructed in the district to assess their functionality. District personnel are not aware of alternative noise wall types being approved for widespread use but think that the more options that are available regarding noise wall types and materials, the better it is for projects since designers can be more flexible when needed. Moreover, alternative noise wall types and materials would be considered if they lessen the impact to utilities. Gates have been installed in a noise wall in the Dallas District to provide access for utility companies to maintain their facilities. Local Dallas area cities may provide funds to upgrade TxDOT's standard noise walls.

Surveys

Detailed survey information is usually collected on a project that includes areas where noise walls and retaining walls are located. In one instance, a detailed survey was omitted, and the district had an issue where the ground elevation varied significantly from design plans. Deeper (and more expensive) shafts had to be created to mitigate the elevation difference.

Occasionally, issues result from inaccuracies of the existing ground elevation surveys. The Dallas District experienced such an issue when a noise wall was constructed in the wrong location after the drilled shafts were first placed in the wrong location. An instance also occurred in which drainage was coming off the city's right of way onto TxDOT's right of way. The drainage was running into a ditch that was blocked by the noise wall, which should have been revealed by the survey. Drainage is always a constraint for noise walls.

Geological Information

Geological information is typically not collected for areas where noise walls are placed. The Dallas District has not experienced any noteworthy geological issues with noise walls except for a few cases of subsidence or settling under noise walls that may have caused minor movement or cracks.

For retaining walls, geological information is collected every 200 feet, as stipulated in the TxDOT geotechnical manual. Retaining walls have experienced a few geological issues in the past. For instance, spread footing retaining walls have encountered a lot of groundwater in combination with geological and elevation issues. The issue was addressed by performing a three-month LIDAR survey to monitor movement of the retaining walls. The same issues may be encountered for noise walls.

Other

Purpose of Noise Wall

The purpose of a noise wall is often misunderstood by the public. Sometimes neighborhoods want a noise wall because an adjacent neighborhood has one, or the need may be due more to aesthetics than noise reduction.

Additional Wall Height

For noise walls, the environmental team recommends modeling an additional 2 feet on top of the noise walls. The difference in noise reduction may be 1 or 2 decibels. This process provides an additional factor of safety since the noise validation procedure—based on the 2019 noise rules—has a potential error of plus or minus 3 decibels. This recommendation is based on experience in traffic noise modeling and the validation of noise models.

FORT WORTH DETAILED INTERVIEW SUMMARY

This section is a summary of the information collected during the detailed interviews held with the different functional areas at the Fort Worth District.

Planning and Design

Noise Walls

Typically, the need for a noise wall is identified at between 60 to 90 percent schematic design, including placement, height, and length. The design team is informed that a noise wall is needed on a project during the schematic design phase. The timing of when utility coordinators are informed of the need for a noise wall varies. It may be during the schematic phase or right before the project is let.

The evaluation for feasibility and reasonableness takes place during the environmental and schematic design phases. This includes an initial constructability review for design and utilities. The district's environmental supervisor coordinates the process. Utility coordinators are not too involved in the feasibility and reasonableness evaluations for noise walls but are asked for their opinion on what the utility impacts will be. Recently, coordination between utility and environmental sections regarding noise wall evaluations has improved.

Typically, noise workshops are conducted right after NEPA clearance. In some situations, the noise workshops can be conducted between the public hearing and the NEPA clearance, but the district usually waits until after the NEPA clearance to start developing and scheduling the noise workshops.

Project designers are usually involved with developing part of the presentation and providing project design files and displays. The project manager typically gives part of the presentation to describe more of the design and project development and possibly project sequencing. Utility coordinators are not too involved in the noise workshop process. Coordinators may be invited to attend the workshop but would rather discuss the noise wall separately with the environmental team rather than attend the workshop.

At the time of the noise workshop, the noise wall designs include the height, length, location, and possibly aesthetics. The noise wall designs are not near 100 percent complete. The noise wall foundation and other design features are not included in design until the wall is approved after the noise workshop. Designers are hesitant to complete the design of noise walls until they are approved by the public. Detailed noise wall design plans are usually produced during PS&E.

Noise walls should be better integrated into the preliminary design phase of project development to allow them to be better incorporated into projects. Having a more detailed noise wall design before the public meeting may reduce the chance for a wall to be canceled later in design or construction since the detailed design can be compared with available SUE information to identify utility conflicts earlier.

The Fort Worth District has more of a hands-on role for design-bid-build projects and more of a management role for design-build projects. Generally, the type of project delivery method should not affect when noise walls are identified since they are identified during schematic design. However, noise walls may be identified later for design-build projects since the projects can be more fluid.

The district performs SUE during the schematic phase no matter the project delivery method. The district's environmental team is notified of utility conflicts as part of the noise wall constructability review. The process can differ based on project delivery method since there may be changes later in the process in design-build projects.

Retaining Walls

Typically, the district aims to include retaining walls in the design as early as possible. This process may happen during schematic design but sometimes happens during PS&E. Good communication and coordination is recommended to help ensure retaining walls are included in designs sooner rather than later. Stakeholders such as bridge design, right of way, and utility coordinators should be included in meetings at the beginning of the project because these subject matter experts can provide information to help make better decisions.

Early coordination between all the disciplines, especially the noise wall and retaining wall designers, is the key to success in every project. Many times, retaining wall designers are different than the project designer. The district needs to ensure that designers for all aspects of the project are effectively communicating on the project.

Placement

Noise Walls

Decision-Making Process to Place Wall

The topography, drainage features, and locations of other design features are considered in the decision-making process of where to place a noise wall. Considerations include the general characteristics of the roadway areas between the existing road, elevations of the proposed roads and the adjacent property, access points, cross streets, driveways, utility requirements (existing or relocations), and the most effective location of the wall.

Utilities are considered in the placement of noise walls, including the location of utility crossings. Integrating utilities earlier in the project design phase will help avoid some of the utility conflicts. The placement of noise walls should be identified early in the schematic phase or early in PS&E if the schematic phase is skipped so that the location of noise walls can be considered when planning to relocate utilities.

On a recent large project that required noise walls, the district coordinated with the designers and the consultant noise modeler to select possible locations for modeling walls to make sure all the potential locations were considered. Utility coordinators and designers were then asked if they had any issues with each location. The idea was to address noise location at the front end of the project to cut down the amount of remodeling needed later.

Spacing Requirement

Knowing the exact design criteria for traffic noise wall placement—needed offsets, spacing requirements for overhead utilities, distance from sidewalks, sight distance, and so forth—is helpful to the environmental team. District personnel aim to have conversations early in the placement process to identify what those limitations might be.

Off TxDOT Right of Way

The Fort Worth District has not placed any noise walls outside of the TxDOT right of way. Noise walls are placed within the right of way as a standard practice. However, one of the reasons to consider placing a noise wall off the right of way may be due to a lack of available space in the right of way.

It may be a good option to place the noise wall between retail properties adjacent to right of way and residential areas. This placement would provide a noise reduction to the residential areas while not impacting the visibility for the retail businesses. This placement may also be an option to limit the visibility/aesthetic impact to parks and other green spaces adjacent to the right of way.

Responsibility for maintaining the noise wall should be considered. If a local municipality or other entity is willing to maintain the wall, that option should be considered. If the noise wall is placed in a dedicated utility easement, the rights of the utility within the easement must also be considered.

Although the district prefers to keep design features on the right of way, placing noise walls elsewhere should be considered depending on the need to accommodate adjacent property and with the appropriate maintenance agreement in place.

Between the Frontage Road and Main Lanes

The district might consider placing a noise wall between the frontage road and main lanes in certain situations, such as the frontage road being at a lower elevation than the main lanes. The district appreciates the fact that the noise wall may not be as effective if noise walls were placed at the edge of the right of way because the wall would not shield any of the frontage road traffic. For placement of a noise wall between the frontage road and main lanes, the district considers ground elevations, sight distance for ramps, frontage roads, and gores. Moreover, the district determines if there are any utilities, retaining walls, drainage, and illumination considerations.

Locating a noise wall between the frontage road and main lanes should be considered when it can safely be placed there because it alleviates conflicts between the noise wall and other features in the right of way, including utilities. Locating a noise wall between the frontage road and main lanes will reduce the number of conflicts with utilities since they are usually located near the right-of-way line. This process will especially benefit projects in which the right-of-way corridor is tight on the project.

In instances where adjacent property owners are concerned about access, locating the noise wall between the frontage road and main lanes should also be considered. In one instance, a homeowner's association was concerned that a noise wall placed near the right-of-way line would limit access for maintaining the privacy wall and other features near the right of way.

Placement of a noise wall between the frontage road and the main lanes is preferable if a narrow right of way between the frontage road and the edge of the right of way exists and there is a need to fit utilities, illumination, bus stops, pedestrian elements, or other elements that may cause a wall along the right of way to be eliminated.

Away from the Edge of the Right of Way
Shifting a noise wall away from the edge of the right of way can provide additional room between the back of the noise wall and the right-of-way line for utilities to access their facilities and for TxDOT to perform maintenance. Placing a noise wall closer to the travel lane may avoid issues that occur closer to the edge of the right of way, such as extreme elevation changes or grading issues that could potentially affect noise wall placement.

Placing a noise wall closer to the travel lanes may limit sight distance for people on side streets accessing the frontage road. District personnel consider overall clearance widths between the edge of the pavement or curb line, whether the barrier design is crash tested, bus stops, pedestrian elements, utilities, maintenance, and security when determining placement.

The preferable spacing is usually 6 feet from the edge of the right of way. It is better to provide this space for construction because it could be challenging to get a construction easement if the wall is placed closer to the right-of-way line. Leaving additional space behind noise walls can create challenges in allowing use for transient persons or storage. The district typically does not object to residents utilizing the space behind noise walls as long as they maintain the space and allow access as needed.

Retaining Walls

Spacing Requirement
For retaining walls, the amount of space needed may vary depending on the type of retaining wall and ground elevation. Space is needed to properly access the area with equipment for construction and maintenance. As much space as possible is recommended between retaining walls and the edge of the right of way, but 10 to 12 feet should be the minimum for proper construction and maintenance.

Between the Frontage Road and Main Lanes
It is preferable to shift the retaining wall between the frontage road and the main lanes instead of having the wall near the right-of-way line if there is sufficient room between the frontage road and the main lanes and if it lessens the impact to utilities. The district might prefer to construct all its retaining walls in this location to manage grade change and avoid utility conflicts. The cost of placing the retaining wall should be considered, as well as the impact to utilities and drainage.

Shifting the placement of a retaining wall from the edge of the right of way to the area between the frontage road and main lanes allows better access to the frontage road from driveways and side streets. Placing retaining walls between the frontage road and the main lanes is preferable from a utility coordination standpoint. It is important to note that there may be older non-TxDOT utilities that were installed between the frontage road and main lanes. If this is the case, then the location of these utilities should be considered as well when designing retaining walls.

Noise Walls and Retaining Walls in the Same Area

When considering placing noise walls and retaining walls in the same area, it is good to discuss potential issues with representatives from different disciplines, such as right of way, utilities, and drainage. Designers should look for a way to incorporate the two walls together. Designers should consider drainage and pedestrian issues in the area as well. Unfortunately, the environmental process is usually not complete when retaining wall design begins. Thus, designers do not know for sure if a noise wall is going to be placed in the area. Incorporating noise walls and retaining walls together in preliminary design can eliminate the need for two separate foundations, may reduce conflicts with utilities, and reduces the need for additional right of way.

Construction Sequencing

Noise Walls

Sequencing during Construction

Beyond the design phase, noise walls should also be constructed early if possible, but for most projects, the contractor determines the project timeline. Contractors can leverage resources as they prefer on the schedule, which often leads to noise walls being completed later in the delivery process when the project has completed all its grading and the rest of the construction. Installing the noise walls early rarely happens, even though the public almost always wants the noise wall installed at the beginning of the project rather than the end.

Let Noise Wall Separately

Letting a noise wall separately might cause issues since there may be too many moving parts with respect to separate construction contracts and schedules. In addition, communication may not be as effective if multiple contracts exist.

On the other hand, if there is some flexibility, building a noise wall early in the construction process can provide benefits in preventing delayed conflicts with utilities. If the district does a specific contract to relocate utilities for a construction project, it can be useful to include the construction of noise walls in the same project. Doing so will ensure that noise walls and utilities are considered at the same time in project design, which will minimize conflicts and help with coordination instead of unanticipated issues arising further into the construction process.

The district only considers letting noise walls separately from the project if they are let sooner than the main construction project. The district's concern is that if the main construction project is completed first, a chance exists that the wall project may not move forward and be implemented like it should be to meet the project commitments for NEPA.

Retaining Walls

Retaining walls should also be constructed early if possible. For most projects, the contractor determines the timeline of the project. Coordination during construction is important to ensure proper installation. The contractor can leverage resources in a way that is most beneficial for the contractor to complete the work. The contractor should have a well-thought-out plan for how the construction of all the design features is considered to ensure the construction of the retaining wall happens in the proper sequence for the project.

Utilities

Designers consider SUE information when designing the structural elements of the project, including retaining walls. Most of the time, the district receives utility information early in the process. If SUE is not part of the design contract, then district utility coordinators will develop their own SUE work authorization. Sometimes, the utility survey contract or SUE consultant will not get initiated until later in the decision process. It is helpful to have this information early in the process. Additional SUE information, including test holes, has been requested when more information is needed regarding utility conflicts.

Utility conflicts are identified during schematic design and PS&E. Utility coordinators try to get involved in the project early to help mitigate the impact of utilities and are usually brought in during the schematic phase. The district's environmental team is notified of utility conflicts as part of the noise wall constructability review. The process can differ based on project delivery type (design-build versus design-bid-build) since there may be changes later in the process in design-build projects.

For retaining walls, structural designers are informed of utility conflicts but would like to be informed earlier. The structural design process includes a question regarding utilities. It is at this time that the structural designers get a copy of the SUE plans. Including SUE information as a layer in the design would be helpful for structural designers. Structural design may begin during schematic design or PS&E and depends on the project. District structural designers seem to find out about utility conflicts earlier for design-build projects, even though their role is in more of an oversight capacity.

The TxDOT project manager typically provides a copy of the noise wall design plans to the utility coordinator before the noise workshop. Early coordination with utility coordinators is recommended when placing and designing noise walls. Identifying which utility accommodation methods, including utility relocation, are going to be used on which utilities is helpful in designing retaining walls because designers may need to design around utilities.

Utility coordinators initially meet and communicate with utility owners about four times a month. Fewer meetings may be held when the utility is closer to being clear of the project. Utility relocations typically begin after 60 percent PS&E.

Right of Way

Involvement in Project Meetings

The right-of-way team is getting involved earlier in the project development process, usually during the schematic phase but sometimes in the planning phase. For larger utility conflicts, such as a lengthy longitudinal utility relocation, utility coordinators may coordinate with district right-of-way personnel on how to best handle the situation, which may include parcel acquisition priority.

Right of Way Set on Project

Determining right of way needs varies by project. During the planning stage project personnel are trying to refine the right of way. However, changes to the footprint may occur as late as 90 to 100 percent PS&E. The Fort Worth District tries to get a head start on making offers for parcels by performing some front-end activities, such as title work and appraisals for areas where the project footprint is not expected to change. If additional right of way is requested late in the project development, it may be out of the area in which environmental approval has been granted. In this case, a reevaluation will need to be completed to include the additional parcel in the project, which may take time to perform.

Temporary Construction Easements

For right of way, the district will request temporary construction easements if it does not have the proper space for construction. The district must go through a similar process to secure a temporary construction easement as it does to acquire right of way, which is time consuming and, if started late in the project, might potentially delay a project. The need for temporary construction easements must be identified early in the project to be able to secure the easement without affecting the project. It is usually too late to obtain a temporary construction easement once the project goes to construction. It may also be too late to pursue a construction easement for areas where a parcel has already been acquired from the property owner.

If possible, the Fort Worth District will try to get a letter from the adjacent property owner for a right of entry to access the property. This process is quicker and is a way to avoid the lengthy acquisition process for an easement.

It may be a good practice to assume temporary construction easements will be needed to help construct noise walls when placed near the right-of-way line. This practice ensures sufficient time to obtain an easement rather than waiting until construction starts and ensures that the area is considered in the environmental approval. It is also important to note that if access is needed to construct the wall, access will probably be needed after construction for maintenance.

Noise Walls

Noise walls should be considered during the right-of-way development process. The district looks at the available right of way prior to the start of modeling to decide where to locate noise walls. The Fort Worth District has not acquired any right of way specifically for noise walls;

however, right-of-way personnel should be more involved in discussion about the placement of noise walls.

Retaining Walls

The district considers the amount of necessary right of way when planning for noise walls. Purchasing additional right of way is considered when placing retaining walls. Cost is considered when reviewing details of constructing a retaining wall versus omitting the need for a retaining wall by acquiring additional right of way for sloping.

Alternative Designs

The Fort Worth District has considered the use of other alternative types and materials for noise walls. The district is interested in considering alternative noise wall types and materials to lessen the impact on utilities and help with constructability. Most of the noise walls are concrete. Concrete is considered an old highway custom and has become the default material for these walls. Although the district considers other materials, these materials may not be as forgiving as traditional concrete.

When alternative noise wall types and materials are used, it is important to ensure that the proper specifications are included in the project documents. Moreover, local requirements may exist for noise walls, such as wind loads, and need to be taken into account when considering alternative noise walls.

Surveys

From time to time, issues with survey information have been encountered for retaining walls. More detailed topographic survey information for adjacent areas outside TxDOT right of way would be helpful in the noise wall location decision process. Using topographic maps or other sources to find elevation data outside the right of way can be a challenge.

Geological Information

Geological information is collected in areas where retaining walls are planned. The TxDOT geotechnical manual provides good information for project designers regarding soil borings. The ground is unique in some areas of Fort Worth, and geological issues cannot always be prevented. However, it is important to keep in mind that projects have faced ground material challenges before. One example that was mentioned was the failure of an MSE wall that was about 75 percent complete. The wall slid down due to a slipping plane about 40 feet under the wall and had to be completely redesigned. Although it is unclear whether additional borings could have detected the issue, some areas are prone to challenges with slope and soil, so geological information should always be incorporated into planning.

HOUSTON DETAILED INTERVIEW SUMMARY

This section is a summary of the information collected during the detailed interviews held with the different functional areas at the Houston District.

When dealing with noise walls and retaining walls, the district follows many of the typical formal and informal standards mentioned by other districts, including managing utilities, considering safety of construction/maintenance teams, and balancing relationships with adjacent property owners. The district faces unique challenges in planning due to the frequency of severe weather incidents and soil characteristics.

Planning and Design

Noise Walls

Although noise walls are generally identified during the schematic phase, the timing can fluctuate because it is contingent upon the noise analysis. The environmental team needs at least 30 percent of the schematic plans to perform a traffic noise model, which will determine if a noise wall is needed on the project. With this in mind, the analysis may be completed at any point during the schematic phase. The environmental team reviews the volume of traffic on a roadway and the proximity of residential properties, which are good indicators for whether a noise wall might be needed in the area. The difference between the 30 percent and 90 percent schematics may be a shift in the project alignment by a few feet. That factor does not change a noise model very much.

The point in time at which the design team is informed that a noise wall is needed depends on whether the schematic design is being developed through a consultant contractor or through TxDOT's Advanced Project Development Section, but it usually happens during the schematic phase. In project development, the district works with the Advanced Project Development Section during the schematic phase. Thus, when the schematics are complete, the recommended noise wall locations are included on the schematic plans. This ensures that once schematics advance to PS&E, the design group is aware of the proposed noise wall. The process is similar when working with design consultants. Typically, by the time the 30 percent schematic is complete, consultant contractors should know where the district recommends placing the noise walls so they can make any accommodations.

Feasibility and Reasonableness

The evaluation for feasibility is used to determine if a noise wall will be recommended at a specific location. It is completed before the noise wall is added to the schematics. The district uses cost averaging for noise walls across individual subdivisions and neighborhoods. This benefits as many residences as possible within a common neighborhood or subdivision by allowing noise walls to be built that individually would not have been feasible.

This process is based on the district's experience of hearing from the excluded residents during public noise workshops. Although the minimum noise wall height is determined during the noise analysis, the district has been leaning toward using uniform wall heights across individual residential subdivisions and neighborhoods within a corridor. This uniformity reduces public complaints and simplifies construction.

Noise Workshops

Most of the time, noise workshops are held after the project has cleared the environmental process, although they may be held in the schematic design phase or later. Project designers and utility coordinators are involved before and after noise workshops but not during the noise workshop process. Noise workshops can involve personnel from the following sections: advanced project development, district environmental, area office, and schematics.

Another issue with planning for noise walls is community involvement. The limits of the noise wall, placement, and height are available during the noise workshop. However, Houston has faced situations where a wall has come in and out of favor with the local community and may be voted on multiple times. To address noise wall aesthetics, the Houston District established a green ribbon program regarding wall aesthetics.

Included in Design

Proposed noise walls are included in the schematic design but only provide length, height, and placement. During public involvement of the schematic design, the district prefers to have recommended noise walls included in the exhibits showing the recommended roadway alignment because it helps the district receive feedback from the public. It also alerts the public to the proposed design and prepares them for the noise workshops after the project has been approved.

The district does not want to waste time designing noise walls that the public may not want, so the detailed noise wall design is not completed until after the noise workshop. Designers of the noise wall need to know what noise wall texture or design was selected by the public vote resulting from the noise workshop. Detailed noise walls may be included in plans between 30 and 90 percent PS&E. Occasionally, a noise wall is added later, even during the construction phase. Identifying these noise walls earlier would make life easier for utility coordination activities.

Type of Project Delivery Method

The project delivery method does not affect when the noise walls are identified but rather the coordination effort. By the time a design-build project receives a design package, the package has been approved and typically includes the proposed locations of noise walls. For design-build projects, PS&E is bundled with construction.

The project delivery method is a factor in the timeline for communicating utility issues between the project team and the right of way team. The process of right-of-way acquisition and early phases of work may begin earlier in a design-bid-build project since the district has the opportunity to begin purchasing right of way while the contract is still being settled. The right-of-way team can work off preliminary plans to get a start on the early phases of project delivery, and they are more likely to be made aware of utility conflicts due to the timeline. A design-build contract may provide fewer opportunities to be made aware of utility conflicts due to the pace of the project. One of the right-of-way agents is responsible for acquiring right of way in the early phases of this project, so information sharing might be more limited.

Retaining Walls

Retaining wall placement is usually determined early in the schematic design.

Placement

Noise Walls

Decision-Making Process to Place Wall

The environmental team generally determines the physical placement of the noise wall. The design team has less involvement in determining the placement of noise walls. To place a noise wall, the district needs to know how much space exists between the back of the curb and the edge of the right of way. The environmental team tries to model noise walls at the edge of the right of way. The environmental team sees this as the preferred location because the wall is closer to the affected receivers and provides adjacent owners with a better security situation since there is no access between the noise wall and adjacent properties.

The Houston District focuses on the following aspects when deciding where to place a noise wall: adjacent land use, security, utility conflicts, and drainage. Regarding residential landscape easements adjacent to the right of way, if the noise wall is kept in the right of way, the buffer zone created by the easement lessens some of the noise reduction seen by receptors.

If there is a residential landscape easement, it might prevent the placement of the noise wall closer to the affected receptor. In that case, the placement in the ROW will lessen some of the noise reduction seen by the receptors.

A noise wall might also create security issues such as creating a blind spot for people to enter adjacent properties. Noise walls placed in or near drainage features may affect hydrology, which might prevent the extension of the wall across certain areas of the project. The location of transverse utilities should be considered when placing a noise wall since a wall cannot be placed on top of a gas pipeline crossing. A break in the noise wall may be used to resolve the issue.

After a noise wall is placed in the schematic, it is sent to designers for review. Designers look at the placement of the noise wall with respect to other design features. If too many issues with placement exist, designers send the schematic back to the environmental team to see if another location for the noise wall might be feasible. Providing the location of utility easements and right-of-way maps to environmental planners may help in determining the placement of noise walls.

Regarding construction, the Houston District tries to find a balance between the spacing of a project, maintenance needs, and adjacent property owners. Placing a wall can be challenging because the team has to ensure that there is an appropriate amount of space behind a noise or retaining wall for necessary future maintenance. This can create issues because the property line between TxDOT right of way and adjacent property owners can become less clear over time. The district may have to work around existing utilities. Overhead utilities affect the ability to place wall sections during construction due to the possibility of lifting equipment causing electrical hazards.

Spacing Requirement

The district usually uses a 4-foot spacing from the edge of the right of way and centers the noise wall on it, which leaves 2 feet between the noise wall and right of way line. Occasional issues have arisen with overhead utility lines due to this spacing. Sometimes the wall is shifted to allow for more room behind the noise wall for utilities.

Currently, the district places concrete rip rap behind the noise wall to reduce maintenance activities. It is best to consider what the minimum and desired width should be with respect to access for maintenance. A minimal amount of space needed for maintenance is 3 to 4 feet between the back of the noise wall and the right-of-way line. A 5-foot spacing behind the noise wall would be more beneficial. The Houston District does not object to residents using the back of the noise wall as an extension of their privacy fence, which reduces the amount of maintenance the district performs behind the noise wall.

For construction, it is typically ideal for there to be a 5 to 10-foot buffer between a TxDOT structure and adjacent property to minimize any potential conflicts during construction. This buffer allows access for construction contractors and maintenance crews.

Off TxDOT Right of Way

Houston faces some unique situations regarding noise wall placement. Sometimes noise walls are located off the right of way. The Houston District works with the local municipality and property owners and is more flexible in potentially placing a project off the TxDOT right of way or cost sharing with another entity. These noise walls often occur at the request of a stakeholder, such as the city.

The district is permitted to have a maintenance agreement with a local municipality but not with a homeowner’s association. A municipality may clear the land and relocate utilities if TxDOT will construct the noise wall. The noise wall can be built by TxDOT and then transferred to the municipality for maintenance. The district usually requires a 5-foot easement for the wall and a 20-foot easement for access. TxDOT prefers placing a noise wall off the right of way for areas that have large landscape easements between the right of way and the residences when a wall in the right of way may not be reasonable and feasible.

It is difficult to place walls off the right of way. The district prefers to place all project features, including noise walls, on TxDOT rights of way because it prevents confusion about who is responsible for future maintenance. If significant utility conflicts that caused the need to shift the location off the TxDOT right of way ever arose, a noise wall might potentially be placed on property owned by another entity.

Between the Frontage Road and Main Lanes

Locating a noise wall between the frontage road and main lanes is uncommon. However, the Houston District will sometimes place a noise wall in this area, though it prefers to avoid doing so. Placement considerations include maintenance, construction, drainage, and utilities. Locating a noise wall near the main lane might be preferable if the right of way is limited.

From the public’s perspective, placement between the frontage road and main lanes is usually desirable. Much of the public feels that frontage roads are community roads, and the public wants them separated from the main lanes. Placing a noise wall between the roadways provides this separation.

Noise walls located between the frontage road and main lanes can be a useful option as long as safety—such as maintaining sufficient space for traffic to be able to pull over, adequate drainage from the main lanes, or no visibility issues at ramps—is not impacted. When locating a noise wall between the frontage road and main lanes, damage to walls from vehicle impacts needs to be considered. However, noise from the frontage road would not be abated, which may contribute to the need for another noise wall near the right of way, which would not be a practical option. Moreover, noise walls placed on concrete traffic barriers along the road are limited to a maximum height of 10 feet, which may not be sufficient to abate all noise sources.

In cases where multiple driveways, alleyways, or businesses located between the frontage road and right-of-way line would create too many separations in the noise wall for it to be effective, a noise wall located between the frontage road and main lane is preferable. This will further benefit businesses adjacent to the right of way in that noise walls near the right of way edge can block visibility and access.

Away from the Edge of the Right of Way

When placing a noise wall closer to travel lanes and away from the edge of the right of way, many of the same items—safety, utilities, right of way, end, maintenance, and constructability—should be considered. There must be sufficient room behind the wall for maintenance and construction activities. Depending on the space there may not be sufficient room for maintenance equipment to access the area behind the noise wall. The noise wall cannot create a significant crash risk for travel lanes, and end treatments for walls need to be considered. Keeping a wall farther from travel lanes is preferable for safety but shifting a noise wall can be a useful tool to alleviate utility conflicts. The location of utilities must also be considered since utilities run along highway corridors.

It is usually preferable to place walls closer to the edge of the right of way and away from travel lanes to provide adequate spacing for other needs. However, depending on the orientation of the wall, this placement can cause issues, such as casting too much shade and hindering plant growth on adjacent properties. The public usually prefers noise walls placed closer to the travel lanes instead of next to the right-of-way line. However, excess spacing behind the noise wall might create a risk for adjacent property owners. In addition, placing the noise wall too close to the frontage road could limit future road widening.

A wall closer to travel lanes could also reduce the space needed for a sidewalk or shared use path. Wherever the noise wall is placed, sufficient room should be provided for projects with sidewalks. An alternative use for the area behind the noise wall would be a shared use path, which could be beneficial, although it depends on how it is designed. If the area is extremely narrow, then it may not be an inviting place for pedestrian use. However, if the area is wide enough, it could work very well as a shared use path. Sight distance for users needs to be considered as well.

Retaining Walls

Retaining walls have different challenges in the Houston District. The district has its own design standards for retaining walls due to local soil conditions. The need for retaining walls is usually determined during the schematic phase. It is up to designers to determine the length, height, foundation, and other characteristics of the wall. Location of utilities is always a concern. Additional considerations can include safety and signage.

Spacing Requirement
The designer should determine the proper spacing between the retaining wall and the edge of the right of way to ensure proper construction. The amount of space needed for construction varies based on the type of wall (cut or fill), height, and surrounding conditions. The specifics of the retaining wall will determine the type of equipment needed to construct the wall, and space requirements will vary based on equipment needed. A minimum of 2 to 5 feet is recommended between the retaining wall and right-of-way line, but 15 to 20 feet may be needed depending on the equipment required for proper construction and maintenance.

Between the Frontage Road and Main Lanes
Some items to consider when determining whether to place a retaining wall between the frontage road and main lanes or next to the edge of the right of way include amount of cut or fill, cost to construct, drainage/flooding, access to and from the main lanes, and access to the frontage road from adjacent property. Since the Houston District is relatively flat, there is not much need for retaining walls near the edge of the right of way.

Noise Walls and Retaining Walls in the Same Area

The district usually tries to place noise walls and retaining walls in separate locations. When retaining walls and noise walls are placed in the same area, the noise wall and retaining wall designs should account for one another. Noise wall foundations are substantial and can impact retaining walls if not properly considered. How the area will be accessed needs to be discussed, which may include equipment access to maintain the retaining wall and the noise wall. For construction, the district would like to see more separation between these noise walls and retaining walls to provide additional space to bring in cranes and other needed supplies.

Construction Sequencing

Noise Walls

Sequencing during Construction
Regarding construction sequencing, the Houston District prefers that noise walls are constructed first. This sequence is usually expected from residents. Although the district may recommend this sequence, the contractor does not always follow this guidance because construction is typically related to challenges with right-of-way acquisition, utility relocations, and waiting for panels to be manufactured.

From a construction standpoint, it is recommended to acquire all the right of way and relocate any overhead and underground utilities in conflict before construction begins. It is also recommended to leave sufficient room to access the area during construction with heavy equipment. It may also be helpful to install the drilled shaft foundation for noise walls before overhead utilities relocate. This step will help alleviate the need for overhead electric lines to be deenergized for drilled shaft installation.

Let Noise Wall Separately
As far as letting, the Houston District lets noise walls in the same contract as the rest of the project. The district does not see significant benefit in letting noise walls separately. Although the district likes to see walls placed first, noise wall letting should not be separate from the rest of the project unless there is an extenuating circumstance. For example, in a recent project, a noise wall was let after the main construction project. The noise wall was added to the project during construction, but the contractor finished the main construction project by the time the local municipality acquired the easement and relocated utilities for the noise wall to be built.

Retaining Walls

The district likes to see retaining walls built and backfill placed quickly due to the ground characteristics of the region. If a retaining wall is placed and constructed early, the backfill can be added and the wall can sit for a while and consolidate. After settling, a little additional backfill can be added to the retaining wall prior to the remainder of the project features being added on top. Phased construction like this method is difficult due to project timelines, but it is an ideal strategy for the region.

Utilities

Utilities are evaluated in advance, but usually, some utility details remain unknown. If utility conflicts affect the noise wall, the utility coordinator will discuss the issue with the project team. When the district is developing the noise wall during modeling, it specifically looks for and avoids pipelines, since pipeline easements result in breaks in the noise wall. The district is increasingly looking for small local-distribution pipelines and other utilities are in the area, such as telephone poles, power lines, storm sewers, and sanitary sewers.

The planning and design team in Houston is informed of utility conflicts on projects. Team members generally find out about conflicts between 60 and 90 percent PS&E. By then, they usually have a preliminary storm sewer design. Right-of-way and utility coordination teams work together. Although the right-of-way team stays active in much of the design portion of project delivery, it is less active in the early stages of utility coordination. The right-of-way team usually gets a copy of the utility conflict list once it is developed by the utility coordination team.

Noise Wall Design and Utility Coordinator

The utility coordinator is usually provided a copy of the noise wall design plans after the noise workshop, which occurs at around 30 to 60 percent PS&E. The PS&E team provides the utility coordinator with the noise wall plans. The PS&E team coordinates with utility coordinators about the wall in the process of developing the plans. Utility coordinators will discover issues that the designers did not know about. A noise wall does not go through the typical 30, 60, 90 type of utility accommodation process. Rather, a noise wall may come in late in the project development process. Usually, no lengthy utility coordination process occurs for noise walls.

In a current district project, a noise wall was added late. The project is in construction, and the utility coordinator just found out about the noise wall. An additional SUE investigation is being performed for the noise wall because several longitudinal utilities appear to be where the noise wall is planned. Some of these upcoming issues could have been mitigated if the noise wall had been known about in design.

Coordination with Utility Companies

The project design team works with utility companies throughout the project, and sometimes hires a utility coordination consultant to maintain communication channels between TxDOT and utilities.

Depending on the type of utility, communication may vary. A transmission utility or pipeline company may be notified early on that a project is being developed, and other utility companies may be informed later in PS&E.

Communication with utilities typically begins with a kickoff meeting. Meetings also occur at the completion of 30, 60, and 90 percent PS&E. These meetings keep utility owners informed about the development of the project. Utility companies become more involved at around 60 to 90 percent PS&E, which is when utility conflicts begin to appear on the design plans.

While the right-of-way team may attend some of the utility coordination meetings, these meetings seem to be less beneficial for the team because they are more complex and cover detailed utility issues. The right-of-way team may attend if a question about right of way arises. With numerous ongoing meetings to attend, attending all meetings can be excessive. Right-of-way acquisition takes time and may be complete around letting.

SUE Information

SUE information is usually received at around 30 percent PS&E. Additional SUE information, including test holes, may be requested in areas where more clarification is needed regarding the location or depth of a utility. When the SUE investigation is conducted, there are usually no detailed noise wall designs available. SUE sometimes has been conducted specifically for noise walls since they can come in late in the process. SUE information is considered when performing the detailed design of retaining walls in PS&E. All the existing utilities should be identified by 30 percent PS&E.

Utility Relocation Timing

It is ideal for traditional utilities to begin relocating at around 90 percent PS&E for the sake of the project timeline, but it often does not work this way. Most often, these companies begin relocating about a month prior to letting.

Right of Way

In recent years, there has been a push to get the right-of-way team at the Houston District involved earlier in project design because the team is better able to anticipate some of the potential design issues and right of way needs. The right-of-way team found that project designers were coming across issues at a later stage in project delivery that called for the opinions of right-of-way specialists. Once design has significantly advanced, it is more difficult to adjust and change projects. The Houston District right-of-way team now gets involved early in the project, at between 0 to 30 percent schematic design, and stays active in the process. The team attends meetings monthly and may meet biweekly depending on project complexity.

Right of Way Set on Project

The right of way limits for a project are set early in design, by at least 30 percent schematic design. The limits must be set before the right-of-way map can be drawn.

Temporary Construction Easements

Temporary construction easements are usually not considered for noise walls and retaining walls. If necessary, however, the Houston District will request temporary construction easements to help construct noise walls and retaining walls.

Sometimes temporary construction easements are required to help construct retaining walls if additional right of way cannot be acquired. This condition mainly occurs in urban areas. Temporary construction easements need to be identified early since the acquisition process is lengthy. During construction, requesting permission from owners is often easier than going back to request an easement because it would have to go back to the environmental team for clearance.

A concern with using temporary construction easements is that if an easement to construct a noise wall or retaining wall is needed, access will probably be required later to repair or maintain the wall. By then, access will no longer exist since the easement was temporary, thereby creating an access issue with respect to maintenance.

Noise Walls

Considered in Right-of-Way Development
When the placement of noise walls is determined in the early phases of design, the walls are considered in the development of the right-of-way map. The district should know about the noise walls before the right-of-way development process. If the right-of-way team is more informed on the exact location of noise walls earlier, it will have a greater understanding of how adjacent landowners are affected and where access to constructed facilities is limited, which impacts how right of way compensates for acquired property.

Amount of Right of Way Considered When Planning for Noise Wall
The amount of available right of way is considered when planning for and designing noise walls. Acquiring additional right of way to accommodate a noise wall should be considered, and the district has often done so. However, the cost of acquiring right of way in the Houston District has increased greatly over the years and continues to increase. Thus, the Houston District is more flexible in placing noise walls if an opportunity presents itself to share costs with another entity.

Since right-of-way acquisition is contingent upon environmental clearance, the clearance process must be repeated if a project requires further right of way. It might be possible that the environmental team provide some flexibility on project spacing by making the area included in the environmental study larger than the project footprint.

Municipal entities working with the district have provided right of way or easements for the construction of noise walls. In these cases, the district is not acquiring the right of way. Instead, the district is constructing the noise wall for the municipal entity to benefit residential properties. The municipal entity will maintain these noise walls.

Retaining Walls

Project designers may request additional right of way to accommodate the retaining wall. Additional right of way needs to be identified early since the acquisition process is lengthy.

Alternative Designs

Noise Walls

The Houston District is beginning to incorporate removable fiberglass panels around utility poles to mitigate relocating poles similar to the San Antonio District. The district is also considering different methods of constructing noise walls to reduce utility impacts, including the use of low-profile drill rigs to keep away from power lines when installing drill shafts. The district has further considered alternative noise wall types when it could not get drill shaft equipment into a location. In one such case, the district considered an absorptive plastic since it is installed using small equipment.

The district has considered acrylic panels, but the panels are more expensive and have to be mounted on a concrete traffic barrier. The district prefers traditional concrete and has avoided acrylic panels. Other material types may be able to absorb more noise, and they may be more aesthetically pleasing. The district has one experimental noise wall that is semi-absorptive made from a mixture of concrete and Styrofoam beads. Alternative noise wall types will still have to meet the safety requirements of the noise wall. In the past, noise walls have been struck and broken in the district.

Opportunities may exist for designers to be more creative in the placement of noise walls. For example, a noise wall was placed adjacent to a floodway. The flood control district was concerned with the wall blocking flow. Thus, designers had the drilled shafts for the noise wall extend up to the 100-year floodplain level, while the mow strip was designed at ground level. The section of the noise wall over the floodway was elevated on the drilled shafts, allowing a flow of high water within the floodway. These elevated noise walls do not attenuate as much noise as a traditional ground-mounted wall but are feasible and reasonable and provide some mitigation. This technique is being applied in other locations and districts.

Retaining Walls

The district mainly uses MSE retaining walls. Alternatives may be considered for retaining walls, including acquiring additional right of way to mitigate the need for a retaining wall. Cost, schedule, and impact to utilities are considered when weighing design alternatives.

Surveys

Issues have arisen with the existing ground elevation, which can affect design. When this happens, retaining walls seem to be more affected than noise walls. Typically, the district does not collect detailed survey information for the noise walls. The district relies on the elevations obtained from schematic design or from Google Earth. Elevation data inside the right of way are generally good. Outside of the right of way, the data are less reliable. The environmental team does not typically have access to good elevation data when performing the noise analysis. Sometimes, the environmental team will assume that the back of the ditch will be the same elevation as the roadway, but it could be a foot or two different.

The district has experienced issues with flooding. Sometimes drainage is missed in the survey. It is normally adjusted in the field, but sometimes designers need to be involved to resolve the issue. Verification of survey data helps reduce issues with the accuracy of existing ground elevation.

Geological Information

Geological information in the area where noise walls are placed is collected by the designers, who schedule the soil borings for retaining walls. The Houston District has experienced geological issues when dealing with retaining walls. Poor soil conditions, fault lines, and saturated soils are some of the geological issues encountered when dealing with noise walls and retaining walls.

Other

The district noted that it would probably be beneficial to have statewide guidance on noise walls, including the types and materials that can be used. Further, some homeowners have expressed a need for a noise wall installed as a security fence. The district recommends emphasizing the reason for a noise wall in public meetings and noise workshops and why TxDOT is placing them in certain locations.

Political

A significant portion of noise wall installations are politically generated. For example, a homeowner's association or attorney may reach out to a state representative who contacts the district engineer because a community wants a noise wall. In such instances, a noise wall may be placed late in design or in construction.

Bike and Pedestrian

Bike and pedestrian access are a big concern. Sight issues are also a big concern, especially for roadway crossings. This element is particularly an issue when bike paths are separated from the roadway. The district would like to include room for bikes and pedestrians in the right of way. Including access in retrofitting and roadway widening projects can be difficult, so it is good to include room for the bikes and pedestrians early in design.

SAN ANTONIO DETAILED INTERVIEW SUMMARY

This section is a summary of the information collected during the detailed interviews held with the different functional areas at the San Antonio District.

Engineers and designers from various teams, such as environmental, planning and design, right of way, and utilities, are engaged early and often in the project delivery process to improve communication and proactive adjustments on projects.

Planning and Design

The need for a noise wall is typically identified at final schematic, near the end of the NEPA process. If noise walls are identified earlier, 30 to 60 percent schematic design, the noise analysis may be inaccurate. This could be a result of changes in alignment, final grades, and other design aspects. The environmental team will conduct the required noise analyses for an area to determine the need for a noise wall and the very basic physical characteristics of a wall. The environmental team conducts a noise analysis and evaluates different heights, lengths, and wall types. During the early phases of a project, the environmental team handles much of the work related to the need for noise walls.

Once the length of a noise wall is set, the design team handles the placement of the wall based on consideration of utilities, safety, pedestrian facilities, adjacent property, drainage, and other factors. The project team also notifies district utility coordinators about the wall.

Designers begin working the noise wall into the design plans at between 60 and 90 percent PS&E. Designers specifically strive to integrate the noise wall alongside existing structures and shift the wall, as necessary. The project team works closely in this phase to determine the cost of moving various utilities, how to best integrate the wall into the design, and what changes need to be made to the noise wall based on these adjustments.

The feasibility and reasonableness assessments are performed at the end of the NEPA process, usually around 90 percent schematic. Designers validate the noise model by going through the cross sections and ensuring details of the topography are considered. There can be an issue with noise models especially when developed by consultants. The cost of utility relocations is considered during the feasibility and reasonableness process. Utility coordinators participate in that process.

The design of the noise wall needs to be complete to perform the constructability analysis. This includes the size and spacing of the foundation but maybe not the depth of drilled shafts. Noise wall designs are reasonably complete by the time the noise workshop is held since the constructability analysis is performed before the workshop.

The process to determine if a noise wall is feasible, reasonable, and wanted by the public can be a lengthy process. Utility coordinators can make assumptions about the foundation type and typical design features, but it is critical to know whether the wall is going to be constructed or not. Utilities can be hesitant to relocate if it is not known whether a noise wall will be constructed in the area. It would be helpful if the decision whether to build the noise wall could be accelerated. Decisions about noise walls are not made until after 30 percent detailed design and sometimes later, between 60 and 90 percent design. The noise workshop is held at around 60 percent PS&E. Noise wall characteristics, such as height and material, are used in conversations with the public.

Placement

Noise Walls

Decision-Making Process to Place Wall

The primary goal when placing a noise wall is determining a location that minimizes the impact of the noise wall. Some of the considerations are utilities, spacing, pedestrian facilities, and vegetation. The environmental team typically determines the basic characteristics of a noise wall, and the planning and design team will take this information and determine where the wall will fit. The design team is usually responsible for figuring out the spacing and moving a wall within the right of way. The environmental team will go back and adjust wall characteristics, such as height, accordingly.

Spacing Requirement

The amount of space needed between the back of the noise wall and the edge of the right of way to ensure proper construction and maintenance depends on the situation. Noise walls are usually associated with neighborhoods. The more room behind the noise wall, the easier it is to access utilities.

For the placement of a noise wall, San Antonio typically considers 5 feet of spacing behind the wall adequate for construction. This distance may increase depending on the type of foundation. Design features, including the foundation, make a difference when placing a noise wall. If the foundation requires a drill rig or a crane to hang panels, then the noise wall cannot be placed too close to overhead utility lines due to vertical clearance issues. Overhead electric lines have a safety radius. For a spread footing, the distance may need to be adjusted to a minimum of 10 feet. Spacing is often project specific and can be influenced by particular factors associated with the different types of foundations.

For areas with level grade, the closer the wall is to the right-of-way line, the better it is for maintenance. Concrete rip rap or a similar product can be installed behind the noise wall to mitigate mowing. If vegetation is left behind the noise wall, then having more room is better for mowing. Behind some noise walls, weed eating is the only mowing option available. If additional room is needed to access utility poles, then the distance behind the noise wall may be 15 to 20 feet.

Off TxDOT Right of Way

Placing a noise wall off the right of way may be considered if there is an easement or agreement with the property owner to do so. Those agreements need to include expectations of maintenance requirements. One possible maintenance scenario is for TxDOT to address graffiti and structural issues, while the homeowner’s association addresses landscaping and mowing.

This placement requires considerations such as the impact to off-site drainage, landscape features, and utilities. It is preferable to place a noise wall off TxDOT right of way if utility conflicts exist and cannot be properly accommodated. If there are no issues with placing a noise wall in the right of way, such as utilities, drainage, or landscape, then placing the noise wall in the TxDOT right of way is typically preferred.

Between the Frontage Road and Main Lanes

The San Antonio District does not usually place any noise walls between the frontage road and main lanes due to the inability of this placement to satisfy the requirements of the reasonable and feasible evaluation. Although this placement is typically not ideal, it might be considered in a situation where the entrances and exits to main lanes are permanent. However, this placement may constrain future roadway widening since the noise wall would need to be removed and relocated.

The San Antonio District noted that the Dallas District placed transparent acrylic noise wall panels on top of a barrier between the frontage road and main lanes. The district started evaluating the placement of a noise wall between the frontage road and main lanes on a project that had a lot of utility conflicts. Drainage should also be considered when placing a noise wall between the frontage road and main lane.

Although this placement can alleviate utility issues because utilities are typically closer to the edge of the right of way, it creates a new set of challenges, including raising the risk of the noise wall being hit during construction and operation and impact to sight lines. Placing a noise wall between the frontage road and main lanes could be a strategy when faced with major utility conflicts but keeping noise walls away from the traveling public is preferable for safety.

The district installed a noise wall on a parkway where it wanted to move the noise wall from the right of way to an overpass. The noise wall consists of acrylic panels between sections of chain link fencing.

Away from the Edge of the Right of Way

For noise wall placement with respect to roadways, the San Antonio District considers factors such as utilities, drainage during and after construction, location of sidewalk, security, and vegetation in determining the impact of the noise wall. The San Antonio District has found it less preferable to place a noise wall closer to travel lanes and away from the edge of the right of way. Aside from the typical safety considerations that arise when a wall is placed closer to the traveling public, such as a vehicle striking the wall, additional safety considerations exist behind the noise wall as well.

For example, the noise wall might potentially impede visibility and create access to the back of adjacent properties, creating safety challenges for those owners. Although it is not ideal to have a sidewalk between the frontage road and noise wall, a sidewalk on the back side of the wall has issues as well. The San Antonio District typically prefers to maintain a 5-foot buffer between the noise wall and adjacent properties for construction and maintenance without providing a path and access to adjacent properties.

In the case of a major conflict with utilities or other features, shifting the noise wall closer to the travel lanes and away from the edge of the right of way may be useful. This procedure may also shift the wall away from overhead utility lines and provide additional room for equipment behind the noise wall for maintenance needs.

Retaining Walls

The need for retaining walls is determined in schematic design. At 30 percent detailed design, an understanding exists of where retaining walls will be placed and what type of wall will be constructed. At 60 percent detailed design, retaining walls have been designed and incorporated into plans. Some slight adjustments may be made later in the project when additional geotechnical information is received.

Spacing Requirement

When placing a retaining wall, a general rule of spacing is a minimum of 5 feet from the back of the wall to the edge of the right of way. This space may increase to provide additional access for maintenance. Sufficient space should be left to get equipment in for maintenance. The space needed may be 10 to 15 feet. The space will also require access points that do not infringe on adjacent property.

The type of retaining wall will affect the spacing required for proper construction and maintenance. For retaining walls in cut sections, sufficient room should exist so soil nails fall within the right of way. Sometimes soil nails extend beyond the right of way, which can be a problem if land is developed and excavated.

When a retaining wall is a fill wall, panels need to be braced during construction. Some walls are close to the right-of-way line, and there is not enough room for braces during construction. Moreover, sometimes a temporary construction easement is needed to brace walls, especially taller walls with longer braces. Construction methods should be planned for during design.

Between the Frontage Road and Main Lanes

When evaluating retaining wall placement with respect to roadways, the proximity to travel lanes is always considered, in addition to other considerations, such as slope and utilities. Much of the placement with respect to main lanes, frontage road, and right of way is more focused on ramps. Driveways do not dictate the need for retaining walls, but roadway characteristics are ranked based on importance, beginning with ramps. Space for construction may also be a consideration. If there is not sufficient room, a lane may need to be closed, which can create additional traffic control costs.

The main issues that prevent placing a retaining wall between the frontage road and main lanes instead of next to the edge of the right of way are drainage issues and future roadway needs. Future efforts to widen the roadway may be hindered by placing the retaining wall between the frontage road and main lanes.

Noise Walls and Retaining Walls in the Same Area

The San Antonio District has not experienced a noise wall and retaining wall in the same area. There is concern that the design of the two walls would be complex and not easy to install.

Construction Sequencing

Noise Walls

Sequencing during Construction
For construction sequencing, the San Antonio District typically recommends constructing noise walls early, which is often ideal from the public's perspective. The timing for constructing noise walls depends on a variety of factors, including how the contractor implements resources, spacing of the project, congestion in the area, and utility clearance. If the construction schedule is left up to contractors, they may phase the project differently to leverage resources. In addition, structures by the right-of-way line are more difficult to construct early because these are the structures most in conflict with utilities, which may be completing relocations at the beginning of construction.

Let Noise Wall Separately
An interesting consideration for construction is to let a noise wall project after constructing the roadway project. Because some roadway materials reduce noise more than others, a delay could allow for a noise evaluation to determine whether a noise wall is still necessary after construction. It could also allow for additional time to clear utility conflicts since noise wall placement and design is not tied to the highway design schedule. Once a noise wall is approved by the public, it can be a challenge to remove from the project. Thus, letting the noise wall project after the highway project could allow for additional time needed to evaluate necessity.

Retaining Walls

The timing for constructing retaining walls within a project depends on a variety of factors, such as how the contractor leverages resources, congestion, drainage during construction, utility clearance, and spacing of the project. Importantly, these structures are tied to other elements that create a less uniform approach to sequencing. Some of these structures may need to be started early to allow for settling of the foundation before placing other structures on top or to address grade changes early, but these factors vary greatly from project to project.

Utilities

Utility Conflicts

The San Antonio design team stays active in utility meetings during the project delivery process. Utilities are considered on all projects. They are often relocated or deenergized to avoid conflicts. For major utility conflicts, the district will look for alternative options for noise walls and retaining walls, which may include alternative placement or wall types.

Having a better understanding of the construction process for retaining walls would help utility engineers better identify conflicts with construction activities, which is an important aspect since construction methods and sequence for walls might create additional utility conflicts.

Coordination with Utility Companies

Communication with utility companies begins early in schematic design. Major utility conflicts are known by about 60 percent schematic design. Once utility conflicts are reasonably defined based on schematics, the team will begin working with utility companies on ways to mitigate utility conflicts, which includes relocation plans. Beyond communicating on active projects, engineers also meet with utility companies quarterly to share information on their list of projects for the upcoming years.

SUE Information

SUE is typically started in schematic development and will progress from QLD to QLC and QLB during PS&E. Additional SUE information such as QLA test holes is requested as needed.

Right of Way

Involvement in Project Meetings

The right-of-way team becomes involved in a project very early. The right-of-way team is invited to every meeting throughout the project. Meetings occur monthly, and the right-of-way team attends to stay up to date on what is going on with the project to help mitigate any issues that could arise and need team input.

Right of Way Set on Project

The right-of-way team is tasked with acquiring parcels set out in the right-of-way map. The team is tasked with meeting with adjacent property owners at around 60 percent schematic design, so it is typically around this time that the team has more detail on what the right of way will look like for the project. The San Antonio District usually needs to have all the right of way identified by 30 percent PS&E. Thus, if additional right of way is required, the process should begin early to prevent delays on the project.

Although right-of-way acquisition begins right after environmental clearance is received, sometimes permission will be requested for advanced acquisition of right-of-way. This process may occur if there are parcels that will require a lengthier acquisition process.

Temporary Construction Easements

Noise walls are usually placed far enough away from the edge of the right of way to not require a temporary construction easement.

Alternative Designs

Noise Walls

The San Antonio District has used alternative noise wall types to alleviate issues with utilities and is open to continuing to use alternate noise wall types and materials. Using a lighter material for the noise wall panels, including fiberglass, may reduce the amount of foundation needed.

The district has used two types of alternative designs to mitigate conflicts and lack of access to utility poles: removable fiberglass panels and notch outs. Notch outs are no longer used because it is difficult to coordinate their exact location with relocated utility poles. Utilities companies may shift poles from design when relocating. Removable fiberglass panels should be light enough for a bucket truck to move.

Surveys

The San Antonio District has experienced issues with design and elevations being incorrect. Retaining wall alignments are usually developed by one designer, the roadway by another, and drainage by a third. It can be difficult for these designers to communicate with each other. For one retaining wall, issues arose with drainage outfalls and final grade. The outfalls were below final grade and were not draining into the outfall ponds.

Geological Information

The district follows a strict environmental process when it discovers karst features. The Edwards Aquifer has unique features found only in the San Antonio District. Changing geological conditions can be an issue in San Antonio. Therefore, when needed, the project team collects additional geological information before placing noise walls and retaining walls.

Geological issues were noted in an area where a soil nailed retaining wall was planned. The material was not conducive to the installation of a soil nailed wall and differed from what the geotechnical sample showed. Additional geotechnical investigations may help resolve some of these issues.

Other

A study from a concrete conference showed that concrete is quieter when texturing is done longitudinally with traffic. The San Antonio District noted that the Houston District was able to mitigate some noise walls by doing community outreach and showing that longitudinal texturing is quieter. The San Antonio District usually paves with asphalt but is starting to use more concrete. Typical modeling does not capture differences in pavement types or texturing.

One of the biggest complaints the district receives from the public is about noise. Having local municipalities share in the cost of noise walls may help incentivize municipalities to enforce the noise mitigation notes and rules that already exist. This may get cities interested in ensuring developers take noise mitigation steps when constructing new developments.

In the incorporated areas of San Antonio, the district reviews the plats for any developments that is adjacent to a TxDOT roadway. Homes in a new development will be build adjacent to a highway with only a 6-foot privacy fence. The plat notes include a note saying that the developer is responsible for noise mitigation. But many times, developers do not take any steps to mitigate noise. The district might then receive calls from new homeowners complaining about noise and requesting a noise wall.

There is one suburban city within the San Antonio District that ensures developers follow the noise mitigation note. The City of Schertz requires developers to construct an 8-foot masonry wall and have a minimum setback of 150 feet from TxDOT facilities. The district is currently working on similar expansion projects through the Cities of Schertz and Converse. No noise walls are required for the expansion project through Schertz, but eight or nine noise walls are required through the City of Converse. This exemplifies how municipal requirements can help mitigate noise.

SUMMARY OF DETAILED INTERVIEWS

This section is a summary of the information collected during the detailed interviews with the five metro districts. Based on the information collected during the detailed interviews, the research team created a list of the processes, issues, and recommendations. This information will help contribute to the compilation of best practices and lessons learned for the final guidance.

Planning and Design

Noise Walls

In terms of identifying the need for a noise wall, districts interviewed provided the following:

- The need for a noise wall is typically identified around 60 percent schematic design.
- Final roadway geometry, which should be complete around 30 percent schematic design, is required for the environmental team to develop the traffic noise model.
- The traffic noise model should provide information about noise wall placement, height, and length.

Districts identified the following issues and recommendations:

- Timing to identify the need for a noise wall can fluctuate and is contingent upon the completion of the noise analysis.
- For various reasons, noise walls may be added later in the project development process and have been added during construction.
- A recommendation would be to identify noise walls earlier, which would make utility coordination activities easier.

Regarding informing the design team of the need for a noise wall, districts interviewed provided the following:

- The design team is informed during schematic design that a noise wall is needed.
- The timing of when utility coordinators are informed of the need for a noise wall varies. Utility coordinators may be informed during the schematic phase or right before project letting.

Districts identified the following issues and recommendations:

- Utility coordinators may not be informed of noise walls until later in project development, after utility accommodate activities have begun.
- Recommendations:

  - Utility coordinators and other stakeholders need to be informed of the need for a noise wall as early as possible.
  - Include noise walls in the schematic design plans.
  - Project stakeholders, including engineers, designers, environmental, right of way, and utility coordination, should be engaged with each other in the project development process early and often to improve communication and make proactive adjustments to the project.
  - Environmental should involve the design team and utility coordinators to set the placement of the noise wall based on utilities, safety, pedestrian facilities, adjacent property, drainage, and other factors.

Concerning noise wall feasibility and reasonableness, districts interviewed provided the following:

- The evaluation of the feasibility and reasonableness usually take place at around 90 percent schematic design.
- Completed before the noise wall is added to the schematics.
- The cost of utility relocations may be considered. Utility coordinators can be involved in the feasibility and reasonableness process.

Districts identified the following issues and recommendations:

- Issues:
  - The design of the noise wall needs to be complete to perform the constructability analysis.
  - Utility coordinators are not much involved in the feasibility and reasonableness evaluations, but coordination between utilities and environmental regarding the evaluations is beginning to happen more often.

- Recommendations:
  - Perform the feasibility and reasonableness review early in the project delivery process.
  - Ensure that utility coordinators are included in the constructability review.
  - Use noise wall cost averaging across individual subdivisions and neighborhoods. This helps benefit as many residences as possible within a common neighborhood or subdivision.

Concerning noise workshops, districts interviewed provided the following:

- The responses varied for when noise workshops are held and included:
  - The noise workshop is held after the schematic plans have been approved.
  - Workshops are usually held after environmental clearance, and preferably after determining if there are constructability issues.

    - Noise workshops may be held from the beginning of the PS&E phase to 100 percent design, with the average being about 60 percent PS&E.

- Project designers are usually involved with developing part of the presentation and providing project design files and displays.
- The project manager typically gives part of the presentation to describe more of the design and project development and possibly project sequencing.
- Utility coordinators are not involved in the noise workshop process.
- Typically, most of the noise wall design is completed after the workshop. At the time of the noise workshop, the noise wall design consists of location, limits, height, and possibly aesthetics.
- After the noise workshop is held and the public votes, the detailed design team is notified whether it will have to include the noise wall in the detailed design.

Districts identified the following issues and recommendations:

- Issues:

    - In the past, workshops may have been conducted before the NEPA decision, but due to design changes, this timeline was not efficient. Some districts wait for the NEPA decision to hold noise workshops.
    - Some districts have faced situations where a noise wall has come in and out of favor with the local community and was voted on multiple times.

- A recommendation was to have a district standard for the aesthetics of a noise wall.

In terms of what wall design elements should be included in design districts interviewed provided the following:

- The detailed design for the noise wall is not started until after the noise workshop is completed, the workshop summary is approved, and the noise wall is voted on by the public.
- Detailed noise wall design plans are usually produced during PS&E.

Districts identified the following issues and recommendations:

- It is inefficient to design a noise wall that the public may not want. Designers know about noise walls during the schematic phase, but designers are hesitant to complete the design of noise walls until the wall is approved by the public after the noise workshop. As a result, noise wall foundation and other detailed design features are typically not included in the project design until the PS&E phase.
- A recommendation was to better integrate noise walls into the preliminary design phase so that noise walls can be better incorporated into project designs. Having a more detailed noise wall design before the public meeting may reduce the chance that a wall is canceled later in design or construction since the detailed noise wall design can be compared with available SUE information to identify utility conflicts earlier.

Regarding the type of project delivery method for noise walls, districts interviewed provided the following:

- The project delivery method does not affect the noise wall process during schematic design since the district typically manages the NEPA process.
- Noise walls identified after schematic design may be affected by the delivery method.

Retaining Walls

Regarding planning of retaining walls, districts interviewed provided the following:

- The majority of retaining walls are identified at around 60 percent schematic design.
- Good communication and coordination is recommended as a way to help ensure retaining walls are included in designs sooner rather than later.
- Districts need to ensure that designers for all aspects of the project are effectively communicating since the retaining wall designer may be different than the project designer.
- Stakeholders such as bridge design, right of way, and utility coordinators should be included in meetings at the beginning of the project because these subject matter experts can provide information to help make better decisions regarding retaining walls.

Placement

Noise Walls

Regarding the decision-making process to place a wall, districts interviewed provided the following:

- Determining where to place a noise can be determined by a number of factors, including topography, drainage, maintenance requirements, vegetation, right of way, adjacent land use, security, wall height, type of footing needed, availability of a construction easement, public feedback, proximity to travel lanes, utilities, and pedestrian facilities.
- In some districts, project designers place the noise walls. The environmental and design teams work with each other to determine the best placement of the noise wall. The environmental team determines the length and height of the noise wall.
- For some districts, the environmental team typically determines the basic characteristics of a noise wall. Designers look at the placement of the noise wall with respect to other design features. If too many issues with placement exist, designers send the schematic back to the environmental team to see if another location for the noise wall might be feasible.

Districts identified the following issues and recommendations:

- Issues:
    - Conflicts between noise walls and utilities are one of the biggest reasons for delay claims when dealing with noise walls.

  - The physical placement of the noise wall is generally determined by the environmental team. The design team has less involvement in determining the placement of noise walls.

- Recommendations:

  - Addressing noise mitigation at the beginning of the project may reduce the amount of redesign later.
  - Besides noise mitigation, the primary goal when determining the placement of a noise wall should be minimizing the impact of the noise wall.
  - Environmental personnel should consider impacts to utilities when placing noise walls.
  - Providing SUE information, location of utility easements, and right-of-way maps to environmental personnel will help inform them where existing utilities are located when placing a noise wall for the noise analysis.
  - As little impact as possible should be made to the utility corridor. One way to achieve this is to place the noise wall away from the edge of the right of way, which can be accomplished by placing the noise wall closer to the roadway or between the frontage road and main lanes.
  - It is helpful during project design to view the placement of the noise wall with some degree of flexibility. This can help designers when conflicts arise with the placement of the wall and other project features.
  - It may be a good recommendation for districts to have environmental personnel run the noise analysis a few times with varying placements of the noise wall and provide multiple locations to project designers, so they can determine which placement works best with the project's design.

In terms of spacing requirements, districts interviewed provided the following:

- The environmental team tries to model noise walls at the edge of the right of way. This is usually the preferred location since the noise wall would be closer to the affected receivers.
- A particular district usually uses a 4-foot spacing from the edge of the right of way and centers the noise wall on it, which leaves 2 feet between the noise wall and right of way line. Currently, the district places concrete rip rap behind the noise wall to reduce maintenance activities.
- Some districts typically consider 5 feet of spacing behind the wall adequate for construction. This distance may increase depending on the type of foundation.

Districts identified the following issues and recommendations:

- Issues:

  - In some situations, 2 feet spacing from the back of the noise wall to the right-of-way line is not sufficient for maintenance activities.
  - The UAR places electrical lines within the first 3 feet from the right-of-way line, which might conflict with the placement of the noise wall. Overhead electric lines also have a safety radius that needs to be considered during noise wall construction.

- Feedback was mixed regarding the best placement of noise walls in terms of proximity from the right-of-way line.
- Placing a noise wall at or near the edge of the right of way often creates issues during construction.
- Depending on the amount of room behind the noise wall, the spacing can either eliminate the need for mowing or make maintenance very difficult.
- Design features, such as foundation type, can make a difference when placing a noise wall. Spacing is often project specific and can be influenced by particular factors associated with different types of foundations.

- Recommendations:
  - Considerations should be given to location assignments for utilities installing within the right of way.
  - It is helpful for the design team to have some kind of standards and requirements across projects for spacing from existing features, such as a required 2-foot spacing from waterlines. A rule of thumb for spacing may help reduce issues related to the placement of noise walls.
  - The UAR may need to be updated to consider the placement of utilities at the noise wall location. Guidance to help with utilities and noise wall placement would be useful, such as an if/then guide to help when placing noise walls. A checklist of items and different options for various scenarios may also help.
  - The amount of space needed between the back of the noise wall and the edge of the right of way to ensure proper construction and maintenance depends on the situation.
  - A minimum of 5 feet between the back of the noise wall and the edge of the right of way is recommended to accommodate work behind the noise wall, including construction and maintenance.
  - 8 to 10 feet between the back of the noise wall and the right-of-way line is recommended to provide sufficient room for construction.
  - The need for space between the noise wall and edge of the right of way may be omitted if TxDOT can get a permanent easement adjacent to the right of way. The need for the permanent easement can be included in right-of-way acquisition when a noise wall is planned near the edge of the right-of-way.
  - If additional room is needed to access utility poles, then the distance behind the noise wall may be 15 to 20 feet.
  - A tiered approach may be considered when placing noise walls, which may include location of utilities, amount of right of way available, and other concerns, such as presence of creeks and trees. The placement can change when considering utility conflicts, environmental concerns, or safety challenges.
  - Updating the minimum border width in TxDOT's *Roadway Design Manual* may be helpful. The *Roadway Design Manual* calls for a 15-foot border width that could be updated to 18 feet to include 3 feet from the edge of the right of way to place a noise wall.

Regarding placement of noise walls outside the TxDOT right of way, districts interviewed provided the following:

- Noise walls are placed within the right of way as a standard practice. It can be difficult to place noise walls outside TxDOT right of way.
- If noise walls are planned off the right of way, then the area must be environmentally cleared.
- The location of a noise wall off TxDOT right of way requires considerations such as the impact to off-site drainage, landscape features, utilities, economic impact to nearby properties, and the need to adjust to due to other circumstances.
- If noise walls are placed off TxDOT right of way, then TxDOT should not be responsible for maintenance. Placing noise walls on TxDOT right of way avoids confusion about who is responsible for future maintenance. If a local municipality or other entity is willing to maintain the noise wall off TxDOT right of way, then it should be considered by the district. It is extremely important to properly document these agreements.
- Some districts have placed noise walls off TxDOT right of way and is flexible in placing a wall off TxDOT right of way and cost sharing with another entity. The district works with the local municipality and property owners since these noise walls often occur at the request of a stakeholder, such as the city. In the past, this placement has caused issues with utilities located off TxDOT right of way because TxDOT does not have any control over these utilities.
- If the noise wall is placed in a dedicated utility easement, the rights of the utility within the easement must also be considered. Attention should be given to how TxDOT will reimburse a utility if a noise wall placed off TxDOT right of way requires the utility to relocate.
- Placing a noise wall off TxDOT right of way may be preferred in the following circumstances:

    - In areas where large landscape easements exist between the right-of-way line and receivers.
    - When a wall within the right of way may not be reasonable and feasible.
    - When a maintenance agreement is in place, which reduces the overall maintenance cost for TxDOT and the cost to taxpayers.
    - When it lessens the impact to utilities in the right of way.
    - When there is a lack of available space in the right of way.
    - When it provides a benefit to adjacent properties.
        - By locating the noise wall between retail properties adjacent to right of way and residential areas, this placement would provide a noise reduction to the residential areas while not impacting the visibility for the retail businesses.
        - Limit the visibility/aesthetic impact to parks and other green spaces adjacent to the right of way.

- Placing a noise wall off TxDOT right of way may not be preferred in the following circumstances:

    - There are no issues, such as utilities, drainage, or landscape in the right of way.
    - If TxDOT must maintain the noise wall off the right of way.
    - If the placement off right of way creates access issues for construction and maintenance.
    - If there are conflicts with existing utilities off TxDOT right of way.

- The area off TxDOT right of way is not environmentally cleared. Early planning may help lessen this issue.

For placement of walls between the frontage road and main lanes, districts interviewed provided the following:

- Locating a noise wall between the frontage road and main lanes is uncommon. Typically, noise walls are located near the edge of the right of way close to affected receivers.
- Noise walls are primarily needed to decrease noise from the main travel lanes. But in certain instances, noise from frontage roads may be a significant contributor. In this case, noise from the frontage road would not be abated by placing a noise wall between the frontage road and main lanes.
- This placement may constrain future roadway widening since the noise wall would need to be removed and relocated.
- Considerations when placing a noise wall should include retaining walls, right of way, access to adjacent properties, location of on/off ramps, safety, visibility for on/off ramps, damage from vehicle impacts, utilities, drainage, construction activities, and illumination poles.
- If placing a noise wall between the frontage road and main lanes special attention should be paid to barriers and crash protection for the wall. It is preferable to have a shoulder, barrier, or both between the noise wall and travel lanes since the buffer can minimize potential damage to the structure as well as risk to travelers. Keeping the noise wall away from the traveling lanes is preferable for safety.
- Transparent acrylic noise wall panels may be used on top of barriers.
- Noise walls placed on concrete traffic barriers along the roadway are limited to a maximum height of 10 feet. This may not be a sufficient height to abate the noise source.
- Adequate space should be available for the traveling public to pull onto the shoulder.
- No less than 10 feet of space should be available for maintenance between the back of the noise wall and the frontage road. Otherwise, a lane closure may be needed for major maintenance activities.
- From the public's perspective, placing a noise wall between the frontage road and main lanes is usually desirable. Much of the public feels that frontage roads are community roads, and the public wants them separated from the main lanes. Placing a noise wall between the roadways provides this separation.
- Placing a noise wall between the frontage road and main lanes may be preferred in the following circumstances:

    - In areas where the main lanes are elevated with respect to receivers.
    - In situation where the district is able to place the noise wall on top of barriers. This also allows for the use of transparent noise walls.
    - In areas with limited space between the right-of-way line and frontage road.
    - When a noise wall between the frontage road and right-of-way line would block visibility or access to commercial businesses.
    - In areas with limited access for maintenance and utilities near the right-of-way line.
    - In areas with many side streets, alleyways, and driveways feed onto the frontage road. There would be fewer breaks in the noise wall and less of an impact to sight distance when pulling out of side streets.

- To avoid utility conflicts since most utilities are located near the right-of-way line.
- If there is a large grade separation where the frontage road is lower than the main lanes. The elevation difference between the location of a noise wall and receptors may affect the wall height.
- When property owners are concerned about accessing their property adjacent to the right-of-way line.

- Placing a noise wall between the frontage road and main lanes may not be preferred when:

    - Line of sight and the clear zone is obstructed.
    - Widening of the main lanes is expected in the near future.
    - Noise from the frontage road is a significant contributing factor for the need of a noise wall. This may be the case for multilane frontage roads that have a significant amount of traffic.

Regarding wall placement away from the edge of the right of way, districts interviewed provided the following:

- The public usually prefers noise walls placed closer to the travel lanes instead of next to the right-of-way line.
- Considerations should include utilities, driveways, safety, line of sight, future development, maintenance needs, constructability, drainage during and after construction, vegetation, location of sidewalks, bus stops, and other features near the frontage road.
- Moving a wall closer to the travel lanes can bring additional risks to the traveling public, construction and maintenance crews.
- Placing the noise wall too close to the frontage road could limit future roadway widening.
- Wherever the noise wall is placed, sufficient room should be provided for projects with sidewalks.
- When placing a noise wall near a travel lane, the noise wall should be crash rated or crash tested. Noise wall designers must address clear zone requirements. If the wall is in the clear zone, more issues with safety countermeasures will arise.
- Shifting the noise wall away from the edge of the right of way lessens the impact to utilities, partly because overhead utilities are required to be installed within 3 feet of the right of way line.
- Shifting a noise wall away from the edge of the right of way can provide additional room between the back of the noise wall and the right of way line. This can be used for:

    - Utility companies to access their facilities.
    - TxDOT to perform maintenance.
    - A shared use path.

- Excess of space between the right-of-way line and the back of the noise wall can lead to:

    - Encroachment by property owners.
    - Use by transient persons.

- There must be sufficient room behind the wall for maintenance and construction activities including for maintenance equipment to access the area behind the noise wall.
- Depending on wall orientation placement near the edge of the right of way can create shading issues and hinder plant growth on adjacent properties.
- Placing a noise wall away from the edge of the right of way may be preferred in the following circumstances:

    - When it will lessen the impact to utilities, large trees, or other obstructions near the right-of-way line.
    - When it provides access for utility companies to maintain their facilities.
    - When it provides room for construction and maintenance activities.
    - When the wall will create shading issues for adjacent landowners if placed near the right-of-way line.

- Placing a noise wall away from the edge of the right of way may not be preferred when:

    - A roadway widening project is expected in the near future.
    - Excess space will be left behind the noise wall which may encourage use by adjacent property owners or transient persons.

Retaining Walls

For placement of retaining walls, districts interviewed provided the following:

- The need for retaining walls is usually determined during the schematic phase.
- At 30 percent detailed design, an understanding exists of where retaining walls will be placed and what type of wall will be constructed.
- At 60 percent detailed design, retaining walls have been designed and incorporated into plans.
- Adjustments may be made later in the project when additional geotechnical information is received.
- Location of utilities, safety, and signage are considerations when placing a retaining wall.

In terms of spacing requirements, districts interviewed provided the following:

- The amount of space needed for construction varies based on the type of retaining wall (cut or fill), height, and surrounding conditions. The specifics of the retaining wall will determine the type of equipment needed to construct the wall, and space requirements will vary based on equipment needed.
- A fill wall will likely require more space than a cut wall since panels need to be braced during construction.
- A temporary construction easement may be needed to brace fill walls, especially taller walls with longer braces.
- For cut walls, sufficient room should be planned for so soil nails fall within the right of way.
- Construction methods should be planned for during design.

- A minimum of 5 feet of space is needed between the retaining wall and the edge of the right of way. The necessary spacing increases with the height of the wall and may possibly be as much as 20 feet for proper construction and maintenance.
- It is typically preferable to have 10 to 20 feet of space from the right-of-way line. This distance leaves sufficient space to prevent any footing from going onto adjacent property and leaves space for maintenance activities.
- The space will require access points that do not infringe on adjacent property.
- A tiered approach to spacing requirements may be considered where a minimum of 5 feet is required and will increase as the height of the retaining wall increases.
- Utility crossings, including overhead lines, should be considered whenever placing a retaining wall.

For placement of the wall between the frontage road and main lanes, districts interviewed provided the following:

- It is preferable to shift the retaining wall between the frontage road and the main lanes.
- Locating a retaining wall between the frontage road and main lanes allows for a constant grade with adjacent properties and helps maintain access to the frontage road from driveways and side streets.
- When considering placing the retaining walls between the frontage road and main lanes instead of near the right-of-way line some items to consider include slope, utilities, cost, drainage, spacing, future roadway needs, crash worthiness, clear zone spacing, available right of way, proximity to travel lanes, access to adjacent property, and access to and from the main lanes.
- The district might prefer to construct retaining walls between the frontage road and the main lanes to manage grade change and avoid utility conflicts if there is sufficient room.
- A retaining wall impacting access from adjacent property can cost more in terms of right-of-way acquisition since TxDOT has to purchase the right of access for areas where access is impacted.
- Space for construction may also be a consideration. If there is not sufficient room, a lane may need to be closed, which can create additional traffic control costs.
- Utility crossings should be considered whenever placing a retaining wall.

Noise Walls and Retaining Walls in the Same Area

Considerations for placement of noise walls and retaining walls in the same area include the following:

- For instances where a noise wall and retaining wall are proposed in the same area, these walls should each be designed with the other in mind early in project design.
- Noise wall foundations are substantial and can impact retaining walls if not properly considered.
- Noise walls and retaining walls should be designed at the same time so that the retaining wall can be included in the traffic noise model.
- Environmental process is usually not complete when retaining wall design begins. Retaining wall designers may not know if a noise wall is going to be placed in the area.

- Some of the considerations are spacing, providing an opening wide enough to allow for ramps, proximity of the two structures, drainage, pedestrian issues, and potential need for a taller noise wall.
- Designing noise walls and retaining walls in the same area can be an effective use of the same space.
- Maintenance between the two should be considered during design. Adequate spacing and access should be included which may include equipment access to maintain the retaining wall and the noise wall.
- The amount of right of way should be considered to ensure that there is sufficient room for both with spacing for maintenance needs.
- Some districts prefer more separation between noise walls and retaining walls to provide additional space during construction.
- There is a concern that the design of the two walls together may be complex and not easy to construct.

Construction Sequencing

Noise Walls

In terms of sequencing during construction, districts interviewed provided the following:

- For noise walls, the timeline of construction varies. The existing construction process allows the contractor to determine the project timeline.
- Delays in noise wall construction may be due to delays in right-of-way acquisition, utility relocations, and manufacture of noise wall panels.
- Unless the district adds notes in the plans that the noise walls must be built first, they typically will not get built until near the end of the project.
- Scheduling noise walls early in the construction phase is preferred.
- Acquiring all the right of way and relocating any overhead and underground utilities in conflict before construction begins is recommended.
- It may also be helpful to install the drilled shaft foundation for noise walls before overhead utilities relocate. This step will help alleviate the need for overhead electric lines to be deenergized for drilled shaft installation.

Districts offered differing recommendations based on circumstances:

- Consider installing noise walls later in construction, after the final grade has been achieved for the area.

    - Due to grading, utility relocations, or other project features there may be instances where noise walls cannot be done early in construction.
    - Changes to the noise wall design will not affect the roadway project if constructing the wall in the last construction phase.

- Construct the noise walls first.
    - This will cut down on public complaints since it will help mitigate noise due to construction.
    - If an issue arises, such as an unknown utility, more time is available to resolve the conflict.
    - It will help secure the construction worksite.

For letting the noise wall separately, districts interviewed provided the following:

- It is more common to let noise walls within the same construction project.
- It is not usually recommended to have let a noise wall separately from the main construction project unless there is an extenuating circumstance.
- A separate letting could allow for a contractor to give full attention to a noise wall.
- Separate letting schedules could create scheduling conflicts and create additional construction costs if one construction schedule is delayed. Communication may not be as effective if multiple contracts exist.

When sequencing before main construction project, districts interviewed provided the following:

- Noise walls have been constructed before the main construction project to mitigate noise from construction.
- If the district does a specific contract to relocate utilities for a construction project, it can be useful to include the construction of noise walls in the same project since it would prevent delayed conflicts with utilities. This would ensure that noise walls and utilities are considered at the same time in project design, which would minimize conflicts and help with coordination.

When sequencing after main construction project, districts interviewed provided the following:

- For a particular district, a noise wall was let after the main construction project since the wall was added to the project during construction. The contractor finished the main construction project by the time the local municipality acquired the easement and relocated utilities for the noise wall to be built. So, this let the district to let a separate project to construct the noise wall.
- It could also allow for additional time to clear utility conflicts since noise wall placement and design is not necessarily tied to the highway design schedule.
- Delaying a noise wall and preforming a noise evaluation after completion of the main construction project may be beneficial. It may help determine if a noise wall is still needed since some roadway materials reduce noise more than others.
- There is a concern that a noise wall may not be constructed if let after the main construction project. This is an issue if the noise wall is needed to satisfy NEPA requirements.

Retaining Walls

In terms of sequencing during construction, districts interviewed provided the following:

- The timeline for construction of retaining walls varies.
- Sequencing of retaining walls is usually dictated by the project's critical path, traffic control plan, grading, drainage during construction, congestion, utility clearance, project spacing, and sequence of other design features.
- Retaining walls should also be constructed early if possible. For most projects, the contractor determines the timeline of the project.
- It is recommended is to build a retaining wall all at once instead of building it in sections.
- The district likes for retaining walls to be built and backfill placed quickly due to the ground characteristics of the region. Also, if a retaining wall is constructed early, backfill can be added and can consolidate. Additional backfill can be added to the retaining wall prior to the remainder of the project features being added on top. This can be difficult due to project timelines.

Utilities

In regard to SUE information, districts interviewed provided the following:

- The Austin District requires SUE and a preliminary utility conflict list to be complete by the end of the schematic phase for design-bid-build projects. The design team receives all the information for utilities, as well as SUE and topographic survey information, during schematic design. The design team tries to integrate this information into design as early as possible to avoid conflicts.
- At the Dallas District, SUE collection (QLB) begins when the project begins. Project designers receive SUE information at between 30 and 60 percent schematic design.
- Most of the time, the Fort Worth District receives utility information early in the process. If SUE is not part of the design contract, then district utility coordinators will develop their own SUE work authorization.
- SUE is typically started in schematic development, in San Antonio, and will progress from QLD to QLC to QLB until PS&E.
- SUE information is usually received at around 30 percent PS&E in the Houston District. When the SUE investigation is conducted, there are usually no detailed noise wall designs available.
- Additional SUE has been conducted, at the Houston District, for noise walls since they can come in late in the process.
- Additional SUE information, including test holes, has been requested when more information is needed regarding utility conflicts. Depending on the project and district this may happen as early as 30 percent PS&E.

In terms of utility conflicts, districts interviewed provided the following:

- Project designers are responsible for identifying utility conflicts in the Austin District. Designers are responsible for trying to work around utility conflicts early in the design phase.

- A utility conflict list is developed at the Dallas District when plans are adequate and QLB SUE information is received. The utility conflict analysis is done by the design project manager. A copy of the analysis is given to the district utility coordinator and the area office utility coordinator. The environmental team is notified of utility conflicts typically at between 30 to 60 percent PS&E when noise walls are included in the PS&E plans.
- The Fort Worth District's environmental team is notified of utility conflicts as part of the noise wall constructability review. For retaining walls, structural designers are informed of utility conflicts but would like to be notified earlier.
- Including SUE information as a layer in the design would be helpful for structural designers.
- The planning and design team in Houston find out about conflicts at between 60 and 90 percent PS&E. By then, the storm sewer design is included in design. The right-of-way team usually gets a copy of the utility conflict list once it is developed by the utility coordination team.
- For major utility conflicts, the San Antonio District will look for alternative options for noise walls and retaining walls, which may include alternative placement or wall types.
- It was noted that having a better understanding of the construction process for retaining walls would help utility engineers better identify conflicts with construction activities, which is an important aspect since construction and sequence for walls might create additional utility conflicts.

Regarding noise wall design and utility coordination, districts interviewed provided the following:

- Utility coordinators are typically provided a copy of the noise wall design plans after the workshop is completed and the noise walls are voted on.
- Utility coordinators are aware that noise walls may be needed on a project, during preliminary design, but they do not know the wall design, permanent placement, or even if they are wanted by the public.
- Early coordination with utility coordinators is recommended when placing and designing noise walls.

For coordination with utility companies, districts interviewed provided the following:

- During the project delivery phase, design engineers in Austin meet with every utility company for every project once a month. This coordination begins when the team learns of the project and has sufficient information to share with the utility companies. The team typically has sufficient information to begin conversations with utility owners between 30 to 60 percent design.
- At the Dallas District, detailed utility coordination begins at around 60 percent PS&E. The district meets with utility companies monthly and may meet weekly depending on the level of coordination needed.
- Utility coordinators in Fort Worth initially meet and communicate with utility owners about four times a month. Fewer meetings may be held when the utility is closer to being clear of the project.
- Communication with utilities at the Houston District typically begins with a kickoff meeting and occur at the completion of 30, 60, and 90 percent PS&E. These meetings keep utility

owners informed about the development of the project. Utility companies become more involved at around 60 to 90 percent PS&E, which is when utility conflicts begin to appear on the design plans.

- Communication with utility companies at the San Antonio District begins early in schematic design. Major utility conflicts are known by about 60 percent schematic design. Once utility conflicts are reasonably clear based on schematics, the team will begin working with utility companies on ways to mitigate utility conflicts, which includes relocation plans.
- It is important to keep the lines of communication open.
- Earlier coordination may if there is a major utility that requires additional coordination or a long lead time, such as a transmission line.
- Utility companies can be hesitant to relocate if it is not known whether a noise wall will be constructed in the area. It would be helpful if the decision could be accelerated.

In terms of utility relocation timing, districts interviewed provided the following:

- The Dallas District likes utilities to be ready to begin relocations when TxDOT acquires all the right of way on the project, which may be one year after 60 percent PS&E is complete.
- Utility relocations at the Fort Worth and Austin District typically begin after 60 percent PS&E. But the actual relocation start date depends on the utility company.
- At the Houston District utility companies begin relocating about a month before letting.

Right of Way

Regarding project meeting involvement, districts interviewed provided the following:

- The right-of-way team is getting involved earlier in the project development process, during schematic design.
- There has been a push to get the right-of-way team involved earlier in project design because the team is better able to anticipate some of the potential design issues and right of way needs.
- It is more difficult to adjust and change projects when issues are identified later in project development.
- The right-of-way team attends meetings monthly and may meet biweekly depending on project complexity.

In relation to right of way being set on a project, districts interviewed provided the following:

- Determining right of way needs varies by project.
- By the 60 percent planning stage, project personnel in the Fort Worth District are narrowing down the right of way. Changes to the footprint may occur as late as 90 to 100 percent of completion.
- At the Houston District right of way for a project is set early in design, by at least 30 percent schematic design. It must be set before the right-of-way map can be drawn.
- The San Antonio District usually needs to have all the right of way identified by 30 percent PS&E.

- If additional right of way is requested late in the project development, it may be out of the area in which environmental approval has been granted. A reevaluation will need to be done to include the additional parcel in the project, which may take time to perform.

For temporary construction easements, districts interviewed provided the following:

- Districts prefer to construct noise walls and retaining walls without acquiring temporary construction easements.
- The process of obtaining a temporary construction easement and purchasing additional right of way is similar.
- If additional space is needed, it is usually more effective to purchase it rather than use a temporary construction easement.
- The need for temporary construction easements must be identified early in the project to be able to secure the easement without affecting the project.
- It is usually too late to obtain a temporary construction easement once the project goes to construction.
- It may also be too late to pursue a construction easement for areas where a parcel has already been acquired from the property owner.
- It may be a good practice to assume temporary construction easements will be needed to help construct noise walls when placed near the right-of-way line. This practice ensures sufficient time to obtain an easement rather than waiting until construction and ensures that the area is considered in the environmental approval.
- A concern with using temporary construction easements is that if an easement to construct a noise wall or retaining wall is needed, access will probably be required later to repair or maintain the wall. By then, access will no longer exist since the easement was temporary, thereby creating an access issue with respect to maintenance.
- Some district haves moved away from temporary construction easements and use a right of entry document during construction instead. The process is quicker than acquiring an easement.

Regarding consideration during right-of-way development, districts interviewed provided the following:

- Noise walls should be considered during the right-of-way development process.
- For areas where neighborhoods are adjacent to the right of way, it may be good to assume that a noise wall will be required during right of way development.
- The district should know about the noise walls before the right-of-way development process. If the right-of-way team is more informed on the exact location of noise walls earlier, it will have a greater understanding of how adjacent landowners are affected and where access to constructed facilities is limited, which impacts how right of way compensates for acquired property.
- The right of way and environmental program areas should always be in communication about the amount of right of way needed. This allows for full disclosure of information, such as land needed for noise walls and retaining walls, early in the project.

Related to the amount of right of way considered when planning for noise walls, districts interviewed provided the following:

- Some districts try to acquire additional right of way as needed if able. If right of way is very limited, then adjustments are made, such as removing all grass from behind the noise wall when it would not be feasible to mow.
- If possible, it would be beneficial to make the area included in the environmental study larger than the project footprint. This would provide more flexibility in case additional right of way is needed.
- The amount of available right of way is considered when planning for and designing noise walls at some districts. Which may be the reason a noise wall is shifted near the main lane and away from the right-of-way line.
- The cost of acquiring right of way in the Houston District has increased greatly over the years and continues to increase. So, the district is more flexible in placing noise walls if an opportunity presents itself to cost share with another entity.
- Municipal entities working with the Houston District have provided right of way or easements for the construction of noise walls. In these cases, the district is not acquiring the right of way. Instead, the district is constructing the noise wall for the municipal entity to benefit residential properties. The municipal entity will maintain these noise walls.

Related to the amount of right of way considered when planning for retaining walls, districts interviewed provided the following:

- It is important to consider spacing needs when determining placement.
- The amount of available right of way may dictate the need for retaining walls. Acquiring additional right of way may be considered a design alternative to mitigate the need for a retaining wall.
- Additional right of way needs to be identified early since the acquisition process is lengthy.

Wall Designs

For current noise wall designs, districts interviewed provided the following:

- The Austin District typically uses concrete noise walls for maintenance and aesthetic reasons. The district tries to match the noise wall with roadway elements.
- Most of the noise walls are concrete within the Fort Worth District. Concrete is considered an old highway custom and has become the default material for these walls.
- The Houston District prefers traditional concrete and has stayed away from acrylic panels. Alternative noise wall types will still have to stand up to the safety aspect of the noise wall. In the past, noise walls have been struck and broken in the district.

For alternative noise wall designs, districts interviewed provided the following:

- Alternative noise wall types have been used by the Austin District to mitigate utility conflicts through the addition of gates to access utilities or through hand-built sections to address constructability issues. Transparent noise walls have also been used.
- The Fort Worth District has considered the use of other alternative types and materials for noise walls. The district is interested in considering alternative noise wall types and materials to lessen the impact on utilities and help with constructability.
- A few alternative noise walls have been constructed in the Dallas District to assess their functionality. District personnel are not aware that alternative noise wall types have been approved for widespread use but think that the more options that are available regarding noise wall types and materials, the better it is for projects since designers can be more flexible when needed. Alternative noise wall types and materials would be considered at the district if they lessen the impact to utilities. Gates have been installed in a noise wall in the Dallas District to provide access for utility companies to maintain their facilities. It was mentioned that local Dallas area cities may provide funds to upgrade TxDOT’s standard noise walls.
- The San Antonio District has used alternative noise wall types to alleviate issues with utilities and is open to continuing to use alternate noise wall types and materials. Using a lighter material for the noise wall panels, including fiberglass, may reduce the amount of foundation needed.
- The San Antonio District has used two types of alternative designs to mitigate conflicts and lack of access to utility poles: removable fiberglass panels and notch outs. Notch outs are no longer used because it is difficult to coordinate their exact location with relocated utility poles. Utilities companies may shift poles from design when relocating. Removable fiberglass panels should be light enough for a bucket truck to move.
- The Houston District is beginning to incorporate removable fiberglass panels around utility poles to mitigate relocating poles, similar to the San Antonio District. The district also looks at different methods of constructing noise walls to reduce utility impacts, including the use of low-profile drill rigs to keep away from power lines when installing drill shafts. The district has also considered alternative noise wall types when it could not get drill shaft equipment into a location.
- Opportunities may exist for designers to be more creative in the placement of noise walls. At the Houston District, a noise wall was placed adjacent to a floodway. The flood control district was concerned with the wall blocking flow. So, the designers had the drilled shafts for the noise wall extend up to the 100-year floodplain level, while the mow strip was designed at ground level. The section of the noise wall over the floodway was elevated on the drilled shafts, allowing a flow of high water within the floodway.
- When alternative noise wall types and materials are used, it is important to ensure that the proper specifications are included in the project documents. Moreover, local requirements may exist for noise walls, such as wind loads, and need to be taken into account when considering alternative noise walls.

In terms of retaining wall design, districts interviewed provided the following:

- Different retaining wall types and alternative designs are considered for retaining walls, which include acquiring additional right of way to mitigate the need for a retaining wall.
- Cost, schedule, availability of sloping, and impact to utilities are considered when weighing design alternatives.

Survey and Geological Information

In terms of surveys, districts interviewed provided the following:

- Detailed survey information is collected in areas where retaining walls are planned.
- The majority of districts collect detailed survey information in areas where noise walls are placed. If detailed survey information is not available elevations obtained from schematic design or from Google Earth are used.
- Some districts have experienced issues in the past with inaccuracies in the topographic survey for noise walls and retaining walls.
- Issues with drainage was noted as being affected by survey inaccuracies.
- More detailed topographic survey information for adjacent areas off TxDOT rights of way would be helpful in the noise wall location decision process. Using topographic maps or other sources to find off-right-of-way elevation data can be a challenge.
- Verification of survey data helps reduce issues with inaccuracies of existing ground elevation.

For geological information, districts interviewed provided the following:

- Most districts collect geological information in areas where noise walls are to be installed.
- Soil bores are collected every 200 feet per the TxDOT geotechnical manual in areas where retaining walls are planned.
- Additional soil bores may be collected every 100 feet if the samples have a lot of variation within a short distance.
- Most district have experienced issues with retaining walls during construction. Additional soil bores would probably not have helped due to the variations in the soil.
- When facing changing soil conditions, it becomes increasingly important to prioritize noise walls and retaining walls early in the design. The geotechnical process and the potential need for additional soil borings may be a lengthy process that requires additional time.

Other

Other pertinent information includes the following:

- It would be beneficial to have statewide guidance on noise walls, including the types and materials that can be used.
- The purpose of a noise wall is often misunderstood by the public. Some homeowners have expressed a need for a noise wall installed as a security fence. Sometimes neighborhoods want a noise wall because an adjacent neighborhood has one. Emphasizing the reason for a

noise wall during public meetings and noise workshops and why TxDOT is placing them in certain locations may help educate homeowners to the purpose of noise walls.

- Some noise mitigation may be achieved through longitudinal texturing of concrete pavement. Typical noise modeling does not capture differences in pavement types or texturing.
- It was mentioned that adding an additional 2 feet on top of the modeled noise wall height would provide an additional factor of safety.
- One district is leaning toward using uniform wall heights across individual residential subdivisions and neighborhoods within a corridor. Uniformity reduces public complaints and also makes it easier for contractors during construction.
- Bike and pedestrian access and sight issues are a concern when placing noise walls. Sight issues can be especially tricky at roadway crossings where bike and shared use paths are separated from the roadway. It is helpful to include bikes and pedestrians use early when placing noise walls.

CHAPTER 6. CASE STUDIES

INTRODUCTION

This chapter summarizes information related to case studies selected from TxDOT districts. The purpose of the case studies was to collect and review information pertaining to selected projects and summarize the data related to noise walls and retaining walls. The TTI team performed site visits, discussions with TxDOT personnel and contractors, and reviews of documents received from TxDOT personnel. The chapter provides information on each of the selected case studies.

PROJECT SELECTION

TTI coordinated with the project team and selected a case study project from each of the five metro districts. Appendix K. Case Study Project List Submittal includes a copy of the case study list submittal. The preliminary selection of the case study projects was based on recommendations during the interviews and through information available in TxDOTCONNECT. Table 20 lists the case study projects.

Table 20. List of Case Study Projects.

Project Name	Highway	Let Date	District	CSJ	County	Project Stage	Project Classification
FM 2304 from Ravenscroft to FM 1626	FM 2304	08/2019	Austin	2689-01-023	Travis	Construction	Widen Non-freeway
IH 30 from Bass Pro Drive to Dalrock Rd	IH 30	03/2021	Dallas	0009-11-241	Dallas	PS&E	Widen Non-freeway
IH 30, 1 mile West of SH 360 to Great SW Pkwy	IH 30	11/2015	Fort Worth	1068-02-076	Tarrant	Construction	Interchange (New or Reconstructed)
IH 45, South of FM 1764 to North of FM 519	IH 45	08/2019	Houston	0500-04-105	Galveston	Construction	Widen Freeway
SL 1604: 2452-03-112; Convert Non-freeway to Freeway	SL 1604	06/2018	San Antonio	2452-03-112	Bexar	Construction	Convert Non-freeway to Freeway

The projects were selected based on a combination of recommendations. Preference was also given to projects recommended by TxDOT personnel. Projects considered for selection were either in the PS&E stage or construction. TTI also looked for projects that included both noise walls and retaining walls. To confirm these criteria, TTI reviewed the project specification list in TxDOTCONNECT. Also, TTI considered a variety of project classification types to allow for more variation in the potential issues seen with noise walls and retaining walls.

AUSTIN DISTRICT—FM 2304 FROM RAVENSCROFT TO FM 1626

The selected case study project for the Austin District was a project on FM 2304 from Ravenscroft Drive to FM 1626. Figure 31 and Figure 32 depict the project location. The project is being constructed to help improve the mobility and connectivity to meet future traffic demands. The project is in Travis County and includes the widening of FM 2304, also known as Manchaca Road, to a four-lane road with a center turn lane. The project also includes drainage improvements. All the construction is taking place in the existing right-of-way footprint.

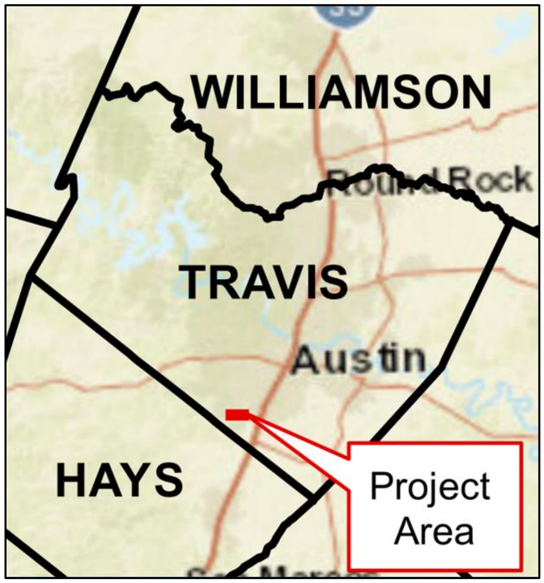


Figure 31. FM 2304 Project Location within Travis County (*46*).

The CSJ number for the project is 2689-01-023. The cost of the project is $12,151,983.78, with 288 contract working days. The project let in August of 2019, and construction began December 17, 2019. The project site visit took place on Friday, March 19, 2021. TxDOT personnel was in the field to help guide TTI while on site.

A project schedule was estimated from dates located on documents received from the district and publicly available on TxDOT websites. Figure 33 shows the project schedule. Schematic design was complete before the traffic noise technical report was produced and NEPA clearance was achieved. The final noise wall design plans were completed seven months after the public votes were counted for the proposed noise walls. There was a redesign for some of the noise walls during construction, which was related to the foundation type.

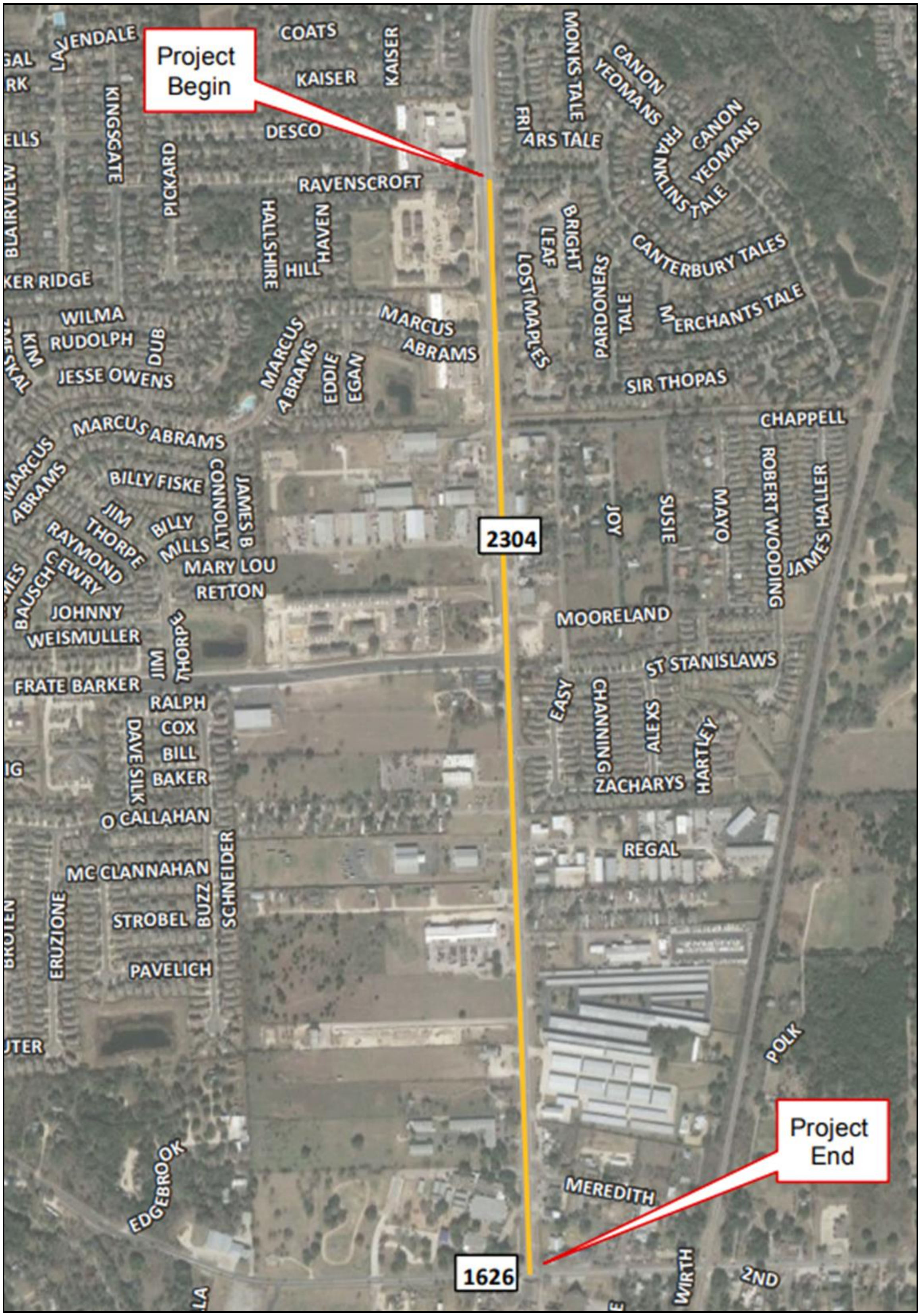


Figure 32. FM 2304 Project Location (*46*).

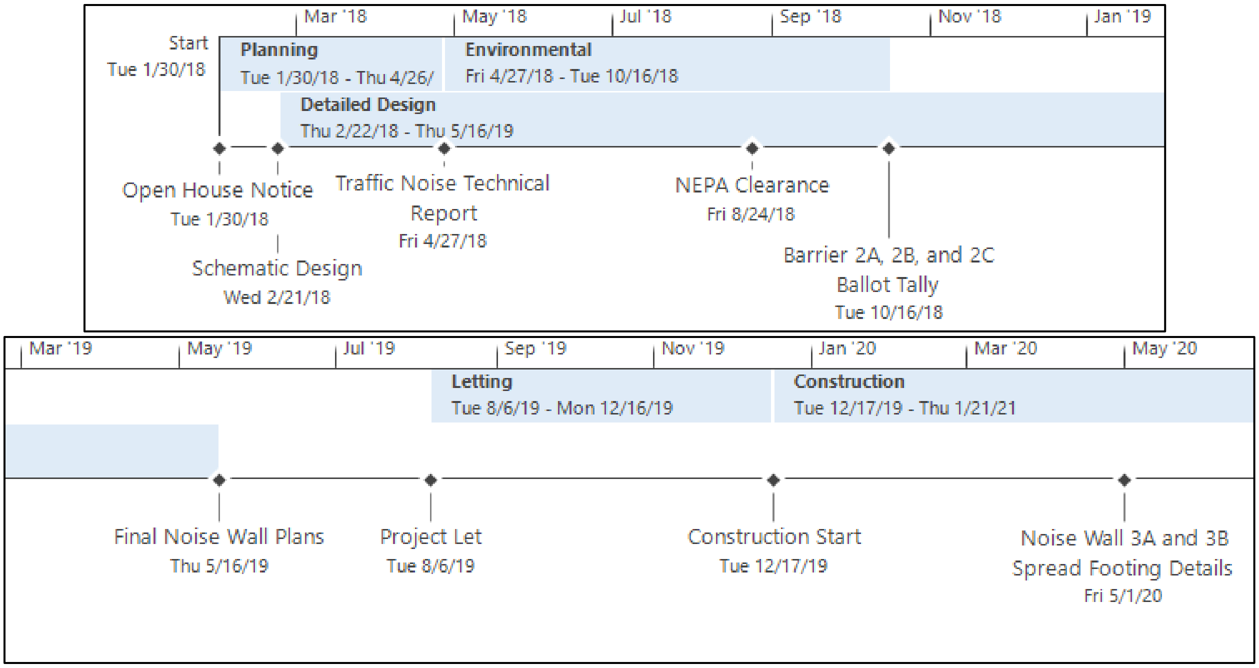


Figure 33. Estimated Project Schedule, FM 2304.

Utility coordination was performed for the project, and other than Austin Water, which was joint-bid, utilities were complete with their relocations before construction began. Spectrum was the last to complete, which was three months after letting. There have been utility conflicts and utility strikes that have affected the project. The effects on the project include changing the design for some of the noise walls due to utility conflicts. Design changes are discussed for each of the walls, wherever pertinent, in the following sections.

Noise Walls

Twenty-six representative receivers were considered for the traffic noise technical report. Of those representative receivers, 11 had a noise impact, and five noise walls were proposed to mitigate noise for 10 representative receivers. The remaining receiver, which represented a soccer field for a local school, was modeled with a break in the noise wall to provide access to the site and was not able to achieve the minimum feasible noise reduction (*46*).

Table 21 provides a comparison of four design process milestones when five noise walls (1 through 5) divided into multiple segments (A, B, and C) were included in the project plans. The five proposed noise walls included in the noise technical report were voted on by the affected public. The first two noise walls were in areas adjacent to neighborhoods and were voted on in the affirmative. The remaining three noise walls all had single landowners. The landowner for the third noise wall wanted a wall. The landowners for wall four and five opted not to have a wall. The final design included three noise walls separated into a total of seven separate walls. The walls are all located on the east side of the project.

Table 21. FM 2304, Noise Wall Listing by Plan.

Schematic (2/21/18)	Noise Technical Report (4/27/18)	Final Plans (5/16/19)	Shop Drawings (5/5/20)
—	1A	1A	1A
—	1B	1B	1B
—	2A	2A	2A
—	2B	2B	2B
—	2C	2C	2C
—	3A	3A	3A
—	3B	3B	3B
—	4A	—	—
—	4B	—	—
—	5	—	—

Note: — means not applicable.

During the site visit, a contractor representative recommended using a spread footing foundation instead of a drilled shaft foundation on future projects. This recommendation was due to the impact that drilled shaft foundations have on underground utilities and also due to issues with the design depth of the drilled shaft foundations. The representative also recommended the use of cast-in-place noise walls instead of precast noise wall panels. The contractor felt that cast-in-place walls could be constructed faster and would need less lead time since the walls would not be affected by the manufacture or delivery of precast panels. The contractor also stated that temporary supports for the cast-in-place noise wall would not need to extend beyond the back of the spread footing foundation.

FHWA, in conjunction with the Texas Commission on Environmental Quality, performed an audit of the noise walls on the project. The reason for the audit was not clear, but it seemed the auditors were interested in knowing how many of the noise walls had been completed. Some of the questions asked were related to the letting and utility coordination procedures for the project. The TxDOT construction inspector provided information to the representative and answered questions about the noise walls.

Noise Wall 1A and 1B

Noise wall 1A is adjacent to overhead utilities, which include electric lines (see Figure 34, Figure 35, and Figure 36). The electric utility company deenergized the overhead electric line so the contractor could perform the installation of the noise wall drilled shaft foundations. The power disconnection was performed in two separate phases. Power was rerouted so the adjacent areas did not experience an outage. The electric utility was paid for the deenergizing. Due to the short height of the noise wall panels, a shutdown is not expected for the placement of the panels.

Figure 34. South End of Noise Wall 1A.

Figure 35. South-Facing View of 1A.


Figure 36. South-Facing View at 1A, North End of Spread Footing.

Potential utility conflicts with a Texas Gas line and a telecommunications line are shown on the final design plans at the north end of noise wall 1A. A Texas Gas line crossing was also highlighted as a potential conflict. The gas line crossing ended up being a conflict during construction (see Figure 36 and Figure 37). TxDOT and the construction contractor asked Texas Gas to shift the gas valve and place a riser on it during construction to help mitigate the conflict with the noise wall foundation. Also, 194 feet of proposed drilled shaft foundation was replaced by 199 feet of spread footing at the south end of 1A. The transition from drilled shaft to spread footing is visible in Figure 36 and Figure 37.

Another conflict experienced during construction was with a Google Fiber line. Google Fiber has an existing 120-foot run of fiber underground within noise wall 1A's footprint. The contractor was unaware of this line until Google Fiber began locating its line during construction of the drilled shafts. Google Fiber stated to the TxDOT field representative that TX811 does not know the location of the Google Fiber line. It is unknown whether Google Fiber is receiving TX811 locate requests. It is also not known if Google received a permit for the installation.

Potential future issues with the placement of the wall include displaced persons using the area between the noise wall and privacy fence, and access to fire hydrants and other utilities in an emergency. A shopping cart (Figure 38) with belongings was present in the bushes next to the privacy fence. The shopping cart with belongings raises the concern of the area being occupied or used by unauthorized individuals, which may raise concerns from adjacent residents. Fire hydrants and other utility appurtenances (see Figure 39) are present in the easement behind the proposed noise wall. Visibility and access to the fire hydrant will be affected since the fire hydrant will be blocked from the traveling public and adjacent properties.

Figure 37. Relocated Gas Valve and Appurtenances at 1A Spread Footing.

Figure 38. Shopping Cart and Possessions behind 1A.

Figure 39. Existing Fire Hydrant behind 1A.

Noise wall 1B, which can be seen in Figure 40, Figure 41, and Figure 42, is located to the south of 1A and is adjacent to the right of way. Potential conflicts with a Texas Gas line crossing and a wastewater crossing were called out in the design plans. Another shopping cart was present (right side of Figure 41) behind noise wall 1B. It is not clear if this shopping cart indicates use or just the presence of debris collection behind the noise wall.

Due to utility conflicts, the north end of noise wall 1B is being constructed at less of an angle called for in the plans, with one less noise wall panel, and with a spread footing (see Figure 42). Thirty feet of proposed drilled shaft foundation were revised to a spread footing foundation. The utility conflicts in this area are from the location of a previously relocated gas line and an existing telecommunication line. The gas line was relocated, by directional bore, years before construction began. During construction, the gas company was unable to confirm the depth of the relocated line. Yellow paint marks in Figure 41 and Figure 42 show the horizontal location of the gas line with respect to the location of the noise wall foundation.

Figure 40. North-Facing View at South End of 1B.

Figure 41. South-Facing View of 1B.

Figure 42. South-Facing View at North End of 1B.

Noise Wall 2A and 2B

For noise walls 2A (Figure 43 through Figure 45) and 2B (Figure 46 and Figure 47), a potential conflict with an underground electric line was called out in the final design plans. Also, the existing water main was shown closer to the right of way and was not noted as being in conflict. The actual location of the existing water main shifts in the area of noise wall 2A and 2B can be seen from the blue marking flags in Figure 43 and Figure 44.

While performing the drilled shafts for noise wall 2B, the water main was struck, which flooded the adjacent property and home. TxDOT and the contractor worked to divert the water away from the residence until the water line was repaired. The local water authority sent an evening crew later to repair the strike.

The entire foundation for 2A and the northern part of 2B was revised to spread footing due to the conflict with the existing waterline. This revision pushed the proposed noise wall 2A farther south, which impacted an existing circular drive and will block the northern driveway entrance. The change in foundation from drilled shaft to spread footing shifted the space between 2A and 2B from 29 feet to 19 feet, which provided access to the homeowner's property.

The homeowner also has a residential propane tank that is refilled by a service delivery truck. It was mentioned during the site visit that the homeowner has expressed concern about access to her driveway for truck deliveries since the delivery location will be between a break in the two noise walls.

The property owner would rather have a shortened noise wall than lose partial access to her property. Issues related to flooding, usage of both driveways, and access for propane deliveries were raised by the homeowner during the public hearing in June 2018. The public hearing comments addressed the flooding through the proposed improvements. The response regarding the usage of both gates was that "within the project limits along FM2304 access to private property would be maintained" (*47*). This comment is general but implies that access to both gates would be maintained.

Figure 43. Proposed Location for North End of 2A.

Figure 44. South-Facing View at Proposed Location of 2A.

Figure 45. North-Facing View at Proposed Location for South End of 2A.

Figure 46. North End of 2B.

Figure 47. North-Facing View at South End of 2B.

Noise Wall 2C

No issues of note were seen during the installation of the drilled shaft foundation for noise wall 2C. Figure 48 and Figure 49 show the drilled shaft foundations for the wall. Since there are no overhead utilities in the area, construction for the remaining portion of the wall should be straight forward.

Figure 48. South-Facing View at North End of 2C.

Figure 49. North-Facing View at South End of 2C.

Noise Wall 3A and 3B

From the beginning of construction, it was recognized that based on the foundation, the noise walls could not be constructed the way they were designed. The foundations for noise wall 3A and 3B (see Figure 50 through Figure 53) were redesigned to a spread footing due to a conflict with a gas line. The final design plans called out potential conflicts with the water line and storm sewer inlet but not the gas line. Due to the change in foundation type, the space between 3A and 3B went from 40 feet to 20 feet. This space change may impact access and create line-of-sight issues.

Figure 50. South-Facing View at North End of 3A.

Figure 51. North-Facing View at South End of 3A.

Figure 52. South-Facing View at North End of 3B.

Figure 53. North-Facing View at South End of 3B.

Retaining Walls

As part of the project selection process, TxDOTCONNECT was reviewed to confirm that noise and retaining walls were included as part of the project. During the review it was noted that specifications related to retaining walls were listed under the project in TxDOTCONNECT. During the case study collection and review process, it was determined that there were no retaining walls on the FM 2304 project. However, the project does include two headwalls to support drainage on the project. The headwalls were documented and included in this section.

The headwall on the southbound side of the project (see Figure 54) is 66 feet in length. Existing utilities in the area of the southbound side of the headwall (see Figure 55 and Figure 56) made construction more complex. The local water authority had issues locating its existing water lines during the construction project, which made excavation tedious. The utility pole shown in Figure 56 conflicted with the back of the concrete slope. Thus, the base of the utility pole was blocked and cased with concrete to mitigate the conflict.

Construction for the northbound side headwall (Figure 57 and Figure 58) did not encounter as many conflicts with utilities. The reduced conflicts may be partly due to some of the utilities being in the easement adjacent to the right of way, which can be seen in Figure 57 between the existing utility poles and fence.

Figure 54. Headwall on Southbound Side.

Figure 55. Water and Electrical Appurtenances near Southbound Headwall.

Figure 56. Close-Up of Utility Pole Adjacent to Southbound Headwall.

Figure 57. North-Facing View of Northbound Headwall.

Figure 58. Headwall on Northbound Side.

DALLAS DISTRICT—IH 30 FROM BASS PRO DRIVE TO DALROCK RD

The Dallas District case study project was on IH 30 from Bass Pro Shop Drive to Dalrock Road (Figure 59 and Figure 60). The project includes the reconstruction of the Dalrock interchange, and the modification to the ramping layout to provide better access and reduce weaving along the IH 30 main lanes. The project is in Dallas County and is being constructed to improve operations and safety along the corridor.

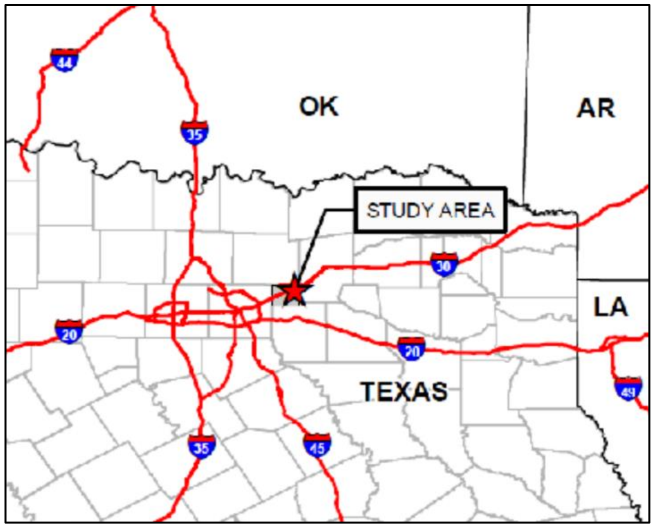


Figure 59. IH 30 from Bass Pro Drive General Location[2].

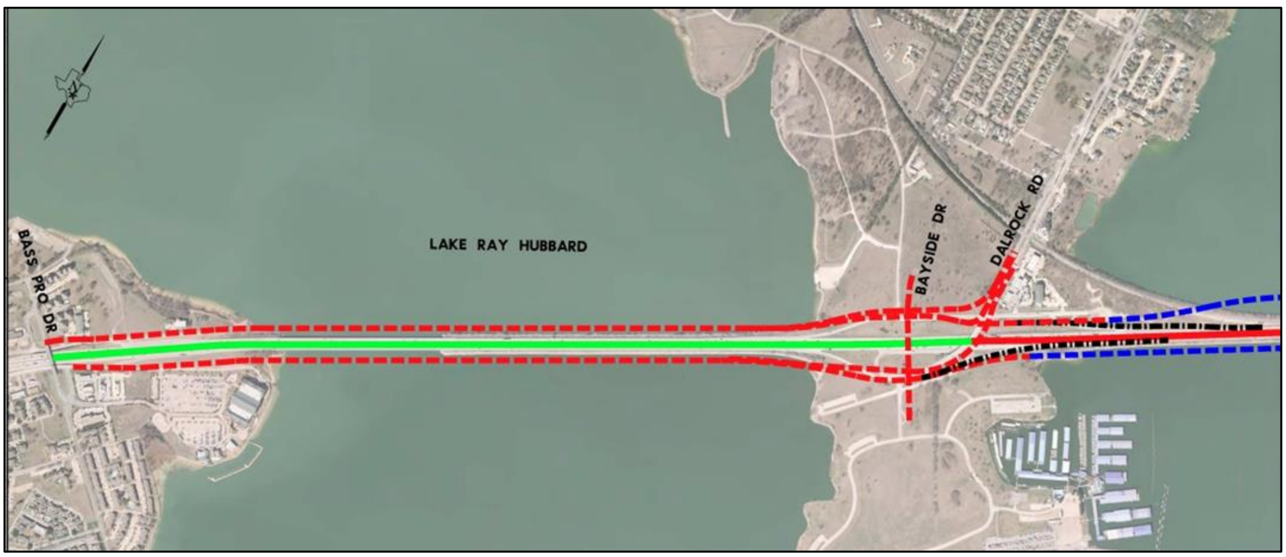


Figure 60. IH 30 from Bass Pro Drive Project Location (*48*).

The project's CSJ number is 0009-11-241, with a cost of $142,404,495.37. The contract working days for the project are 938 days. The project site visit took place on Monday, March 22, 2021, and Tuesday, March 23, 2021, due to weather delays. The project let on March 4, 2021, and SEMA Construction Inc. was selected as the construction contractor.

The project schedule, shown in Figure 61, was estimated from dates located on documents received from the district and available online. Schematic design was completed March 21, 2018. Detailed design was completed on January 26, 2021, about seven months before utilities are

[2] BGE Inc. (2017). Interstate Access Justification Report: IH 30 from Bass Pro Drive to FM 2642. Texas Department of Transportation. Frisco, TX.

expected to be clear of the project. The AT&T expected clearance date is September 2021, over a month after construction is scheduled to begin.

Three separate start dates were listed in Texas ECOS for the perform noise analysis step of environmental design. It is assumed these separate start dates are due to design or location changes to the proposed noise walls that required a repeat of the noise model. The latest noise analysis began on August 10, 2020, after NEPA clearance, right-of-way acquisition, and noise workshop completion. Right-of-way acquisition was completed about a year before project letting.

Noise Walls

The two proposed noise walls, 1A and 1B, are listed in the 95 and 100 percent PS&E plans (Table 22). The walls were not included in schematic design. Figure 62 and Figure 63 show the proposed location for noise wall 1A. Figure 64 and Figure 65 show the planned location of noise wall 1B. (Some of the retaining walls, which are discussed in the next section, are included in these figures as well.)

During discussions with the TxDOT designer, it was mentioned that noise wall 1A and 1B were originally included in the detailed design as a single noise wall. The wall was located east of Sapphire Bay Boulevard and adjacent to the right-of-way line near the westbound bypass road. The westbound bypass is in a depressed section and runs under Sapphire Bay Boulevard.

The westbound bypass at Sapphire Bay Boulevard is located close to the edge of the right of way. The designers attempted to shift the noise wall closer to the edge of the right of way due to the location of the bypass but encountered a number of existing utilities near Sapphire Bay Boulevard.

To mitigate any potential utility conflicts with the proposed noise wall, the noise wall was split into two walls (see Figure 66), with noise wall 1B, the closest wall to Sapphire Bay Boulevard, shifting closer to the main lanes and moving to between the frontage road westbound bypass. Noise wall 1A is still near the right-of-way line.

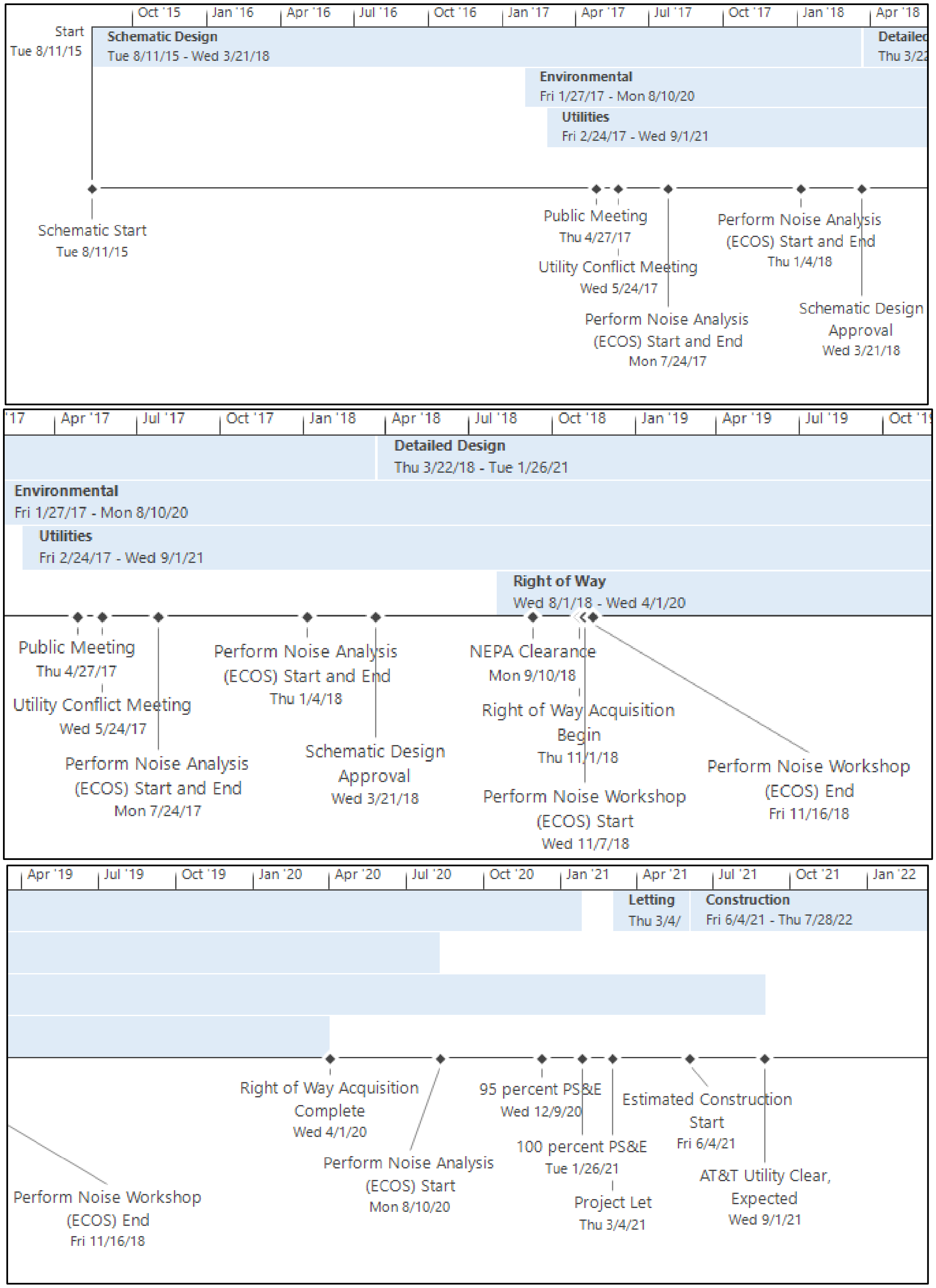


Figure 61. Estimated Project Schedule, IH 30 from Bass Pro Drive.

Figure 62. West View of Proposed 1A and AD Locations.

Figure 63. North View of Proposed 1A and AD Locations.

Figure 64. West View of Proposed 1B, AE, and AF Locations.

Figure 65. North View of Proposed 1B, AE, and AF Locations.

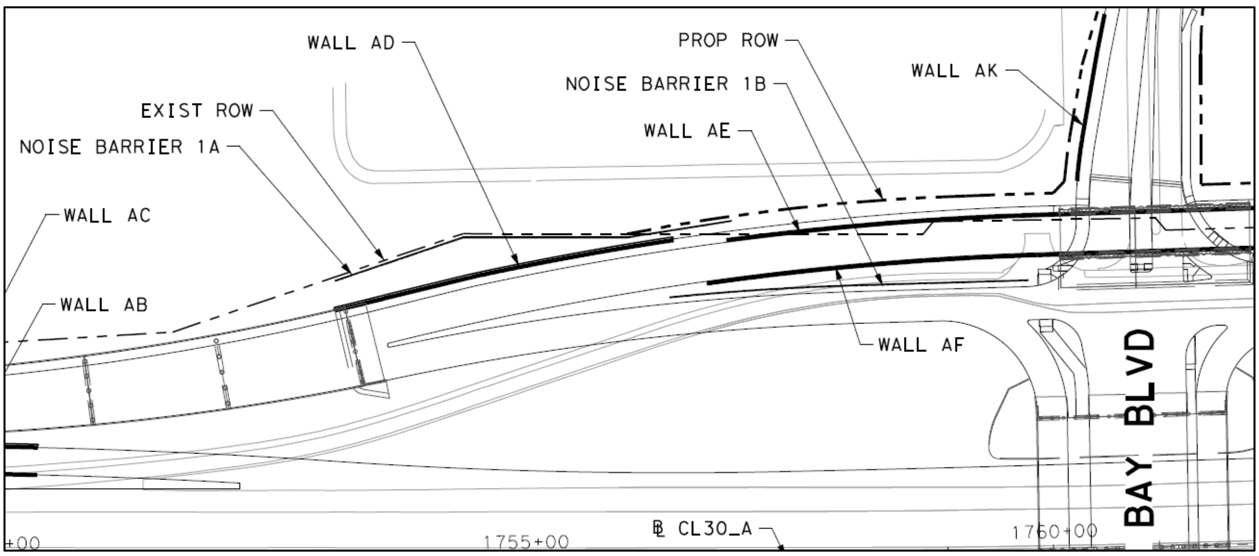


Figure 66. Location of Proposed Noise Wall 1A and 1B.

One noise wall that did not make it into detailed design was listed in the schematic plans (see Table 22). The wall was located east of Dalrock Drive on the north side of IH 30. The public did not want the noise wall, so the wall was removed from design.

Table 22. IH 30 from Bass Pro Drive, Noise Wall Listing by Plan.

Schematic (3/21/18)	95% PS&E (12/9/20)	100% PS&E (1/26/21)
—	1A	1A
—	1B	1B
Unnamed (begin WB30FR STA 6+00)	—	—

Note: — means not applicable.

Retaining Walls

Near Bass Pro Shop Drive (AA, AM, BE, and BF)

Retaining wall AA (Figure 67) was originally included in the schematic plans as WBFR-1. Retaining wall BF was listed as EBML-1 in the schematic design. Figure 67 and Figure 68 show the general location for retaining wall BF.

Table 23 shows when retaining walls were included in the design plans. Copies of the schematic, the 95 percent design plan, and the 100 percent design plan were reviewed. A number of retaining walls were added between the schematic and the 95 percent PS&E. Two retaining walls, DALROCK-1 and DALROCK-2, were included in the schematic but were removed during detailed design.

Figure 67. North View of Proposed AA, AM, BE, and BF Locations.

Figure 68. North View of Proposed BF Location.

Table 23. IH 30 from Bass Pro Drive, Retaining Wall Listing by Plan.

Schematic (3/21/18)	95% PS&E (12/9/20)	100% PS&E (1/26/21)
WBFR-1	AA	AA
—	AB	AB
RWXBASS-1	AC	AC
—	AD	AD
DALROCK-4	AE	AE
DALROCK-3	AF	AF
—	AH	AH
—	AJ	AJ
—	AK	AK
—	AL	AL
—	AM	AM
—	AN	AN
—	AP	AP
—	AQ	AQ
—	AR	AR
—	AS	AS
—	AT	AT
BAYSIDE-1	BA	BA
	BD	BD
BAYSIDE-2	BB	BB
—	BC	BC
—	BE	BE
EBML-1	BF	BF
EBML-2	BG	BG
DALROCK-1	—	—
DALROCK-2	—	—

Note: — means not applicable.

East of IH 30 Bridge (AB, AC, AJ, AL, AN, AQ, AR, AS, AT, BC, and BG)

Figure 69 shows the area of the proposed locations for retaining walls AB, AC, AJ, AL, and AQ. Retaining walls AL and AQ are split due to the location of the bridge bent. The general location for construction of retaining wall AC, also known as RWXBASS-1 in the schematic plans, is shown in Figure 69. Figure 70 shows the proposed location for retaining wall BC. Retaining wall BG was renamed during detailed design from EBML-2. The wall was also shortened from its original length shown in the schematic plans. Figure 70 and Figure 71 portray the location for wall BG.

Figure 69. West View of Proposed AB, AC, AJ, AL, and AQ Locations.

Figure 70. Southwest View of Proposed BC and BG Locations.

Figure 71. West View of Proposed BG Location.

North Sapphire Bay Boulevard (AD, AE, AF, and AK)

Retaining wall AD, which is near noise wall 1A, was needed due to the cross slope. The space available to the right-of-way line was not sufficient to allow for sloping. Figure 62 and Figure 63 show the general location for the installation of wall AD. During schematic design, retaining wall AE and AF were named DALROCK-4 and DALROCK-3, respectively. Figure 64, Figure 65, and Figure 72 show the planned location for the retaining walls. Retaining wall AK's proposed location is shown in Figure 73 and Figure 74.

Figure 72. East View of Proposed AE and AF Locations.

Figure 73. West View of Proposed AK Location.

Figure 74. North View of Proposed AK Location.

South Sapphire Bay Boulevard (BA, BB, and BD)

Retaining wall BAYSIDE-1 from the schematic plans was split into two retaining walls (BA and BD) during detailed design. Figure 75 presents the proposed location for retaining wall BA. Retaining wall BB's planned location in the field can be seen in Figure 76. During the schematic, retaining wall BB was labeled as BAYSIDE-2. The name was revised during detailed design. Figure 77 shows a view of the proposed location for retaining wall BD.

Figure 75. West View of Proposed BA Location.

Figure 76. Southeast View of Proposed BB Location.

Figure 77. South View of Proposed BD Location.

East Dalrock Drive (AH and AP)

Figure 78 and Figure 79 present the location for retaining walls AH and AP.

Figure 78. West View of Proposed AH and AP Locations.

Figure 79. East View of Proposed AH and AP Locations.

FORT WORTH DISTRICT—IH 30, 1 MILE WEST OF SH 360 TO GREAT SW PKWY

The IH 30 and SH 360 interchange project, CSJ number 1068-02-076, was selected as the case study for the Fort Worth District. The project is located in Tarrant County (see Figure 80). The project let in November 2015 and is still in construction. Figure 81 provides a map of the project's location with respect to the surrounding area. The project includes the construction of a direct connector at SH 360 and the installation of a traffic management system.

Williams Brothers Construction Company Inc. was selected as the construction contractor. The adjusted bid days and projected cost for the project are 1,806 days and $251,036,950.71, respectively. The project site visit was originally planned for Monday, March 22, 2021, but was delayed to Tuesday, March 23, 2021, due to inclement weather.

The selected project was just one of many in the package of design projects. This inclusion of the selected project in the design projects made reviewing the documents more tedious since some documents were partly relevant to the project and some were not. Relevant material was not always clear at first since earlier documents did not show all the related CSJs. As the designs progressed, it became clearer which documents were relevant to which sections of the design package. Also, due to the age of the design project, some of the documents may have been submitted to TxDOT and kept as hard copies.

The project schedule, shown in Figure 82, was estimated from documents received from TxDOT, contractors, and information available online. Schematic design was completed by Halff Associates, and the detailed design was done by AECOM (formerly URS Corporation). The schematic and detailed designs were done concurrently, with the schematic design being completed on August 12, 2015, which was about two months before the 100 percent design plans were completed.

Environmental clearance was granted shortly after the design schematics were completed and about two months before the project let in November 2015. Construction began on the project in January 2019, about two and a half months after letting. Design revisions were submitted during construction, with the latest being published on November 25, 2019. As of this report's writing, it is estimated that there is another year and a half of construction left on the project.

Utilities have been a major issue on the project, especially issues that were not fully known during design. There have been redesigns for retaining walls due to utility conflicts, and there has also been a noise wall redesign that was affected by utilities.

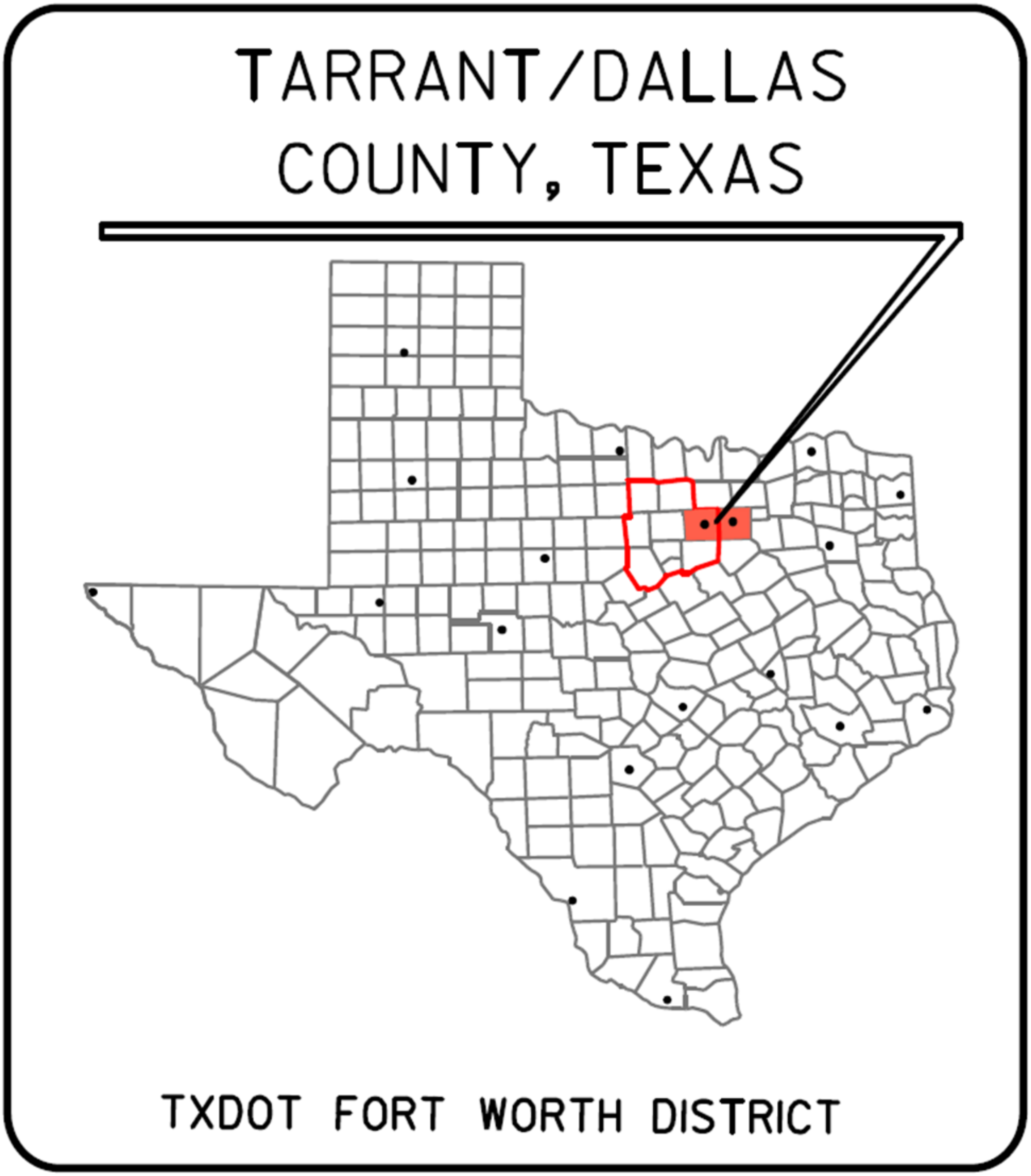


Figure 80. IH 30, 1 Mile West of SH 360 General Location[3].

[3] Halff Associates Inc. (2015). IH 30 from Cooper Street to SH 161 including SH 360 Interchange. Design Schematic. Texas Department of Transportation. Fort Worth, TX.

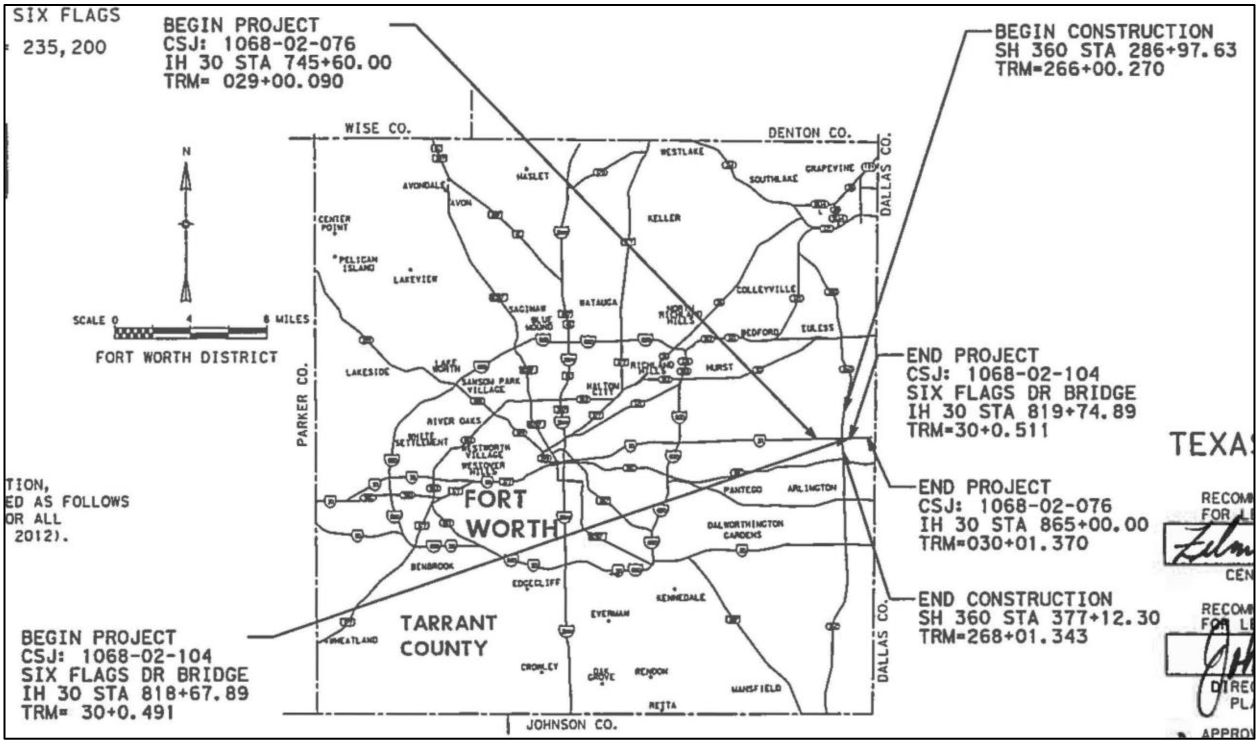


Figure 81. IH 30 Project Location[4].

Noise Walls

According to the Draft Environmental Assessment (*49*), which was performed with other projects within the corridor, there were 16 representative receivers related to the project. Of those representative receivers, nine had noise impacts. Two of them did not meet the minimum feasible reduction design goal, and another two exceeded the cost-effectiveness amount. A noise wall serving the Castillian Condominiums was proposed. The remaining four representative receivers that had noise impacts were not covered in detail in the Draft Environmental Assessment. However, a general note in the public hearing stated that noise walls for receivers with noise impacts, other than for the condominiums, were not proposed because the walls either exceeded reasonable cost effectiveness or did not achieve the minimum required reduction (*50*).

Issues regarding noise and vibration near the Castillian Condominiums were commented on during the public hearing. The response noted that TxDOT has proposed including a noise wall to serve the condominium into project design (*50*).

Noise wall BN01 (see Figure 83 and Figure 84 for the proposed location) underwent a redesign from 2017 to 2018 due to conflicts with utilities. On April 18, 2017, Jacobs Engineering Group sent a memorandum to the project designer laying out potential design changes. The memorandum also described the issue with the current design as follows:

[4] URS. (2015). *Plans of Proposed State Highway Improvement: CSJ: 1068-02-076, etc*. Design Plans. Texas Department of Transportation. Fort Worth, TX.

At the time the layouts were prepared, the design team was aware of various utilities that were potentially in conflict with the noise wall, however it was understood at the time that all the utilities would be relocated. After the project had let, the design team was advised that the utilities would not be relocated and that changes to the location and geometry would be required[5].

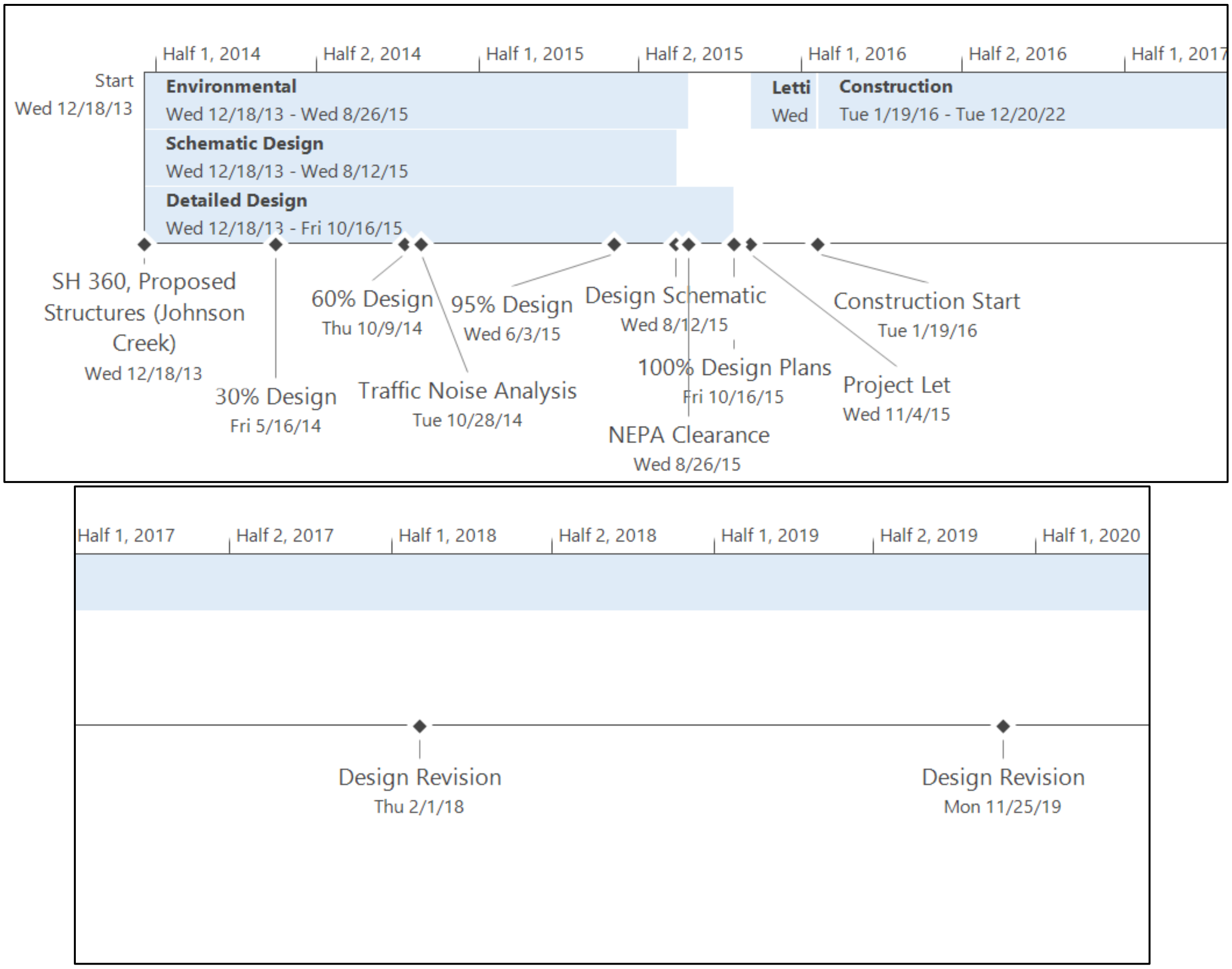


Figure 82. Estimated Project Schedule, IH 30, 1 Mile West of SH 360.

The two options were to move the noise wall to the same grade as the existing right of way or add a retaining wall to the foundation of the noise wall, creating a perched noise wall. The second option, a perched noise wall, was selected for the redesign. The revised noise wall design was added to the plans in February 2018.

Table 24 provides a listing of the noise walls from the design files. The schematic design is located between 95 and 100 percent PS&E. This location is based on the date shown on the plans. The same is true for the Draft Environmental Assessment.

[5] Beaird, J. D. (2017). Noise Wall BN01. Memorandum. Jacobs Engineering Group Inc., Dallas, TX.

Table 24. IH 30, 1 Mile West of SH 360, Noise Wall Listing by Plan.

30% PS&E (5/16/14)	60% PS&E (10/9/14)	Draft Environmental Assessment (5/1/15)	95% PS&E (6/3/15)	Schematic (8/12/15)	100% PS&E (10/16/15)	Design Revision (2/1/18)
—	—	R12	—	—	—	—
—	—	R13	—	—	—	—
—	—	R14	—	—	—	—
—	—	R19	—	—	—	—
Unnamed	BN01	R20	BN01	Unnamed (begin PNBFR STA 306+55)	BN01	BN01

Note: — means not applicable.

Figure 83. North-Facing View at Proposed Location of BN01.

Figure 84. South-Facing View at Proposed Location of BN01.

Retaining Walls

During the public hearing, a commenter voiced a concern about accessing their property adjacent to the frontage road. TxDOT commented that it will need a temporary construction easement from the property owner to construct the retaining wall and that TxDOT will provide allowances for a driveway but that the owner will have to apply for a driveway permit (*50*). This example highlights the concerns that some property owners have about access limitation due to retaining walls adjacent to the edge of the right of way. Table 25 provides a list of the retaining walls shown in the design files. The placement within the table is based on the date shown on the design plans and as such the column for the schematic design is shown between 95 and 100 percent PS&E. This corresponds to the schematic and detailed designs being done in parallel.

Table 25. IH 30, 1 Mile West of SH 360, Retaining Wall Listing by Plan.

30% PS&E (5/16/14)	**60% PS&E (10/9/14)**	**95% PS&E (6/3/15)**	**Schematic (8/12/15)**	**100% PS&E (10/16/15)**	**Retaining Wall List (3/23/21)**
B01A	B01	B01	Unnamed (begin IH30 STA 752+00)	B01	B01
B01B					
B02	B02A	B02A	Unnamed (begin PWBCDBP SAT 761+83)	B02A	
	B02B	B02B		B02B	B02B
B03	B03	B03	Unnamed (begin PLRBPS STA 12+95)	B03	B03
—	—	—	—	B04	
B05	B05	B05A (Retrofit rail)	Unnamed (begin PBRPW STA 20+50)	B05A (Retrofit rail)	
		B05B		B05B	B05B
B06	B06A	B06A	Unnamed (begin PSBWB STA 57+04)	B06A	B06A
B06B	B06B	B06B		B06B	B06B
B07	B06C	B06C		B06C	B06C
—	—	B07	Unnamed (begin PWBCD STA 768+49)	B07A	B07A
—	—		Unnamed (begin PWBCD STA 775+50)	B07B	B07B
B08	B08A	B08A	Unnamed (begin PEBSB STA 15+61)	B08A	B08A
B09B	B08B	B08B		B08B	B08B
B09	B08C	B08C		B08C	B08C
—	—	B09	Unnamed (begin PWBCD STA 784+74)	B09	
B10	B10	—	Unnamed (begin PCOPE STA 786+90)	—	—
—	B11	B10		B10A	B10A
—	—	—	—	B10B	B10B
B11	B11	B11	Unnamed (begin PWBCD STA 790+76)	B11A	B11A
—	—	—	—	B11B	B11B
B12	B12	B12	Unnamed (begin PEBCD STA 791+95)	B12	B12
B13	B13	B13	Unnamed (begin PWBCD STA 795+62)	B13A	B13A
—	—	—	—	B13B	B13B

Table 25. IH 30, 1 Mile West of SH 360, Retaining Wall Listing by Plan (continued).

30% PS&E (5/16/14)	60% PS&E (10/9/14)	95% PS&E (6/3/15)	Schematic (8/12/15)	100% PS&E (10/16/15)	Retaining Wall List (3/23/21)
B14A	B14A	—	—	—	—
B14B	B14B	—	—	—	—
B15	—	—	—	—	—
B15B	—	—	—	—	—
B16	B16	B16	Unnamed (begin PWBNB STA 23+00)	B16	B16
B17	B17	B17	Unnamed (begin PSBEB STA 47+55)	B17	B17
B17B	—	—	—	—	—
B18	B18A	B18A	Unnamed (begin PNBEB STA 40+81)	B18A	B18A
A2	B18B	—		—	—
B18	B18C	B18B		B18B	B18B
B19A	B19A	B19	Unnamed (begin PWBNB STA 20+24)	B19	B19
A1	B19B				
B19B	B19C				
B20	B20	B20	Unnamed (begin PWBCD STA 822+42)	B20	B20
B21	B21A	B21A	Unnamed (begin PWBSB STA 17+90)	B21A	B21A
B21B	B21B	B21B		B21B	B21B
B22	B21C	B21C		B21C	B21C
B23	B23	B23	Unnamed (begin PEBCD STA 826+23)	B23	B23
B24	B24A	—	—	—	—
—	B24B	—	Unnamed (begin PRO360-1 STA 298+37)	—	—
B25	B25A	B25	Unnamed (begin PR299R STA 12+03)	B25	B25
	B25B				
B27	B27	B27	Unnamed (begin PR303L STA 17+72)	B27	B27
B28	B28	B28	Unnamed (begin PRO303L STA 20+21)	B29A	B29A

Table 25. IH 30, 1 Mile West of SH 360, Retaining Wall Listing by Plan (continued).

30% PS&E (5/16/14)	60% PS&E (10/9/14)	95% PS&E (6/3/15)	Schematic (8/12/15)	100% PS&E (10/16/15)	Retaining Wall List (3/23/21)
B29A	B29A	B29A	Unnamed (begin PRO303L STA 20+21)	B29A	B29A
B29B	B29B	B29B	—	B29B (Clad existing)	
B29C	B29C	B29C	Unnamed (begin PRO360-1 STA 318+20)	B29C	B29C
B29C	B29D	B29C	Unnamed (begin PRO360-1 STA 318+20)	B29C	B29C
B30A	B30A	B30A	—	B30A	B30A
B30B	B30B	B30B	—	B30B (Clad existing)	
B30C	B30C	B30C	Unnamed (begin PRO360-1 STA 321-55)	B30C	B30C
B30C	B30D	B30C	Unnamed (begin PRO360-1 STA 321-55)	B30C	B30C
B31A	B31	B31	Unnamed (begin PSBWB STA 17+57)	B31A	B31A
—	—	—	—	B31B	B31B
B32A	B32A	B32A	Unnamed (begin PEBNB STA 64+65)	B32A	B32A
B32B	B32B	B32B	Unnamed (begin PEBNB STA 64+65)	B32B	B32B
B32C	B32C	B32C		B32C	B32C
B33	B33	B33	Unnamed (begin PSBFR STA 326+15)	B33	B33
B34	B34	B34	Unnamed (begin PSBFR STA 332+26)	B34	B34
B35	B35	—	—	—	—
—	—	B35	—	B35	B35

Table 25. IH 30, 1 Mile West of SH 360, Retaining Wall Listing by Plan (continued).

30% PS&E (5/16/14)	60% PS&E (10/9/14)	95% PS&E (6/3/15)	Schematic (8/12/15)	100% PS&E (10/16/15)	Retaining Wall List (3/23/21)
B36	B36	B36A	Unnamed (begin PRO360-2 STA 346+77)	B36A	B36A
—	—	B36B	Unnamed (begin PRO360-2 STA 346+77)	B36B	B36B
—	—	B36C		B36C	B36C
B37	B37	—	—	—	—
—	—	—	—	B37	B37
—	B38	B38	Unnamed (begin PSBFR STA 354+90)	B38	
—	—	—	Unnamed (begin PNBFR STA 329+25)	B39A	B39A
—	—	—	—	B39B	B39B
B39	B40A	B40A	Unnamed (begin PNBEB STA 18+21)	B40A	B40A
B39B	B40B	B40B	Unnamed (begin PNBEB STA 18+21)	B40B	B40B
B40	B40C	B40C		B40C	B40C
B41	B42A	B42A	Unnamed (begin PEBSB STA 49+36)	B42A	B42A
B42B	B42B	B42B	Unnamed (begin PEBSB STA 49+36)	B42B	B42B
B42	B42C	B42C		B42C	B42C
B14A	B14A	—	—	—	—
B14B	B14B	—	—	—	—
Unnamed	—	—	Unnamed (begin PLRBPN STA 13+53)	—	—
—	—	—	Unnamed (begin PNBFR STA 358.25)	—	—
—	—	—	Unnamed (begin PNBFR STA 360+75)	—	—

Note: — means not applicable.

West of SH 360, North of IH 30

Retaining wall B01 (Figure 85), B02B (Figure 86), B03 (Figure 87), B06A, B06B and C (Figure 88), B07B, B11A, and B13A have been completed. Retaining wall B07A has not been constructed. Also, construction for retaining wall B11B and B13B is not complete.

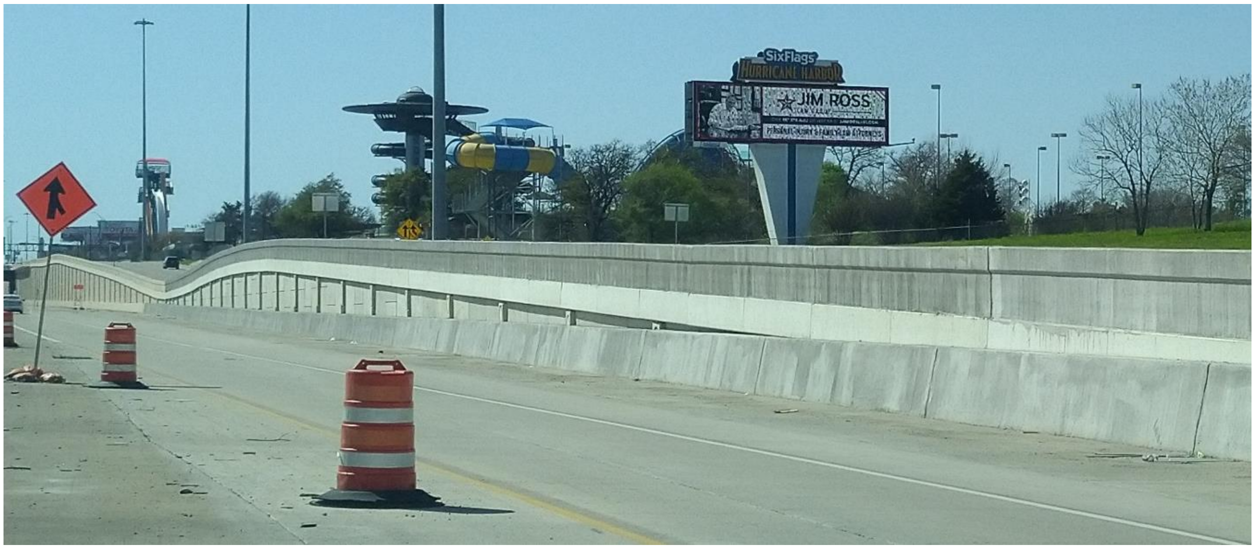


Figure 85. Retaining Wall B01.

Figure 86. Retaining Wall B02B.

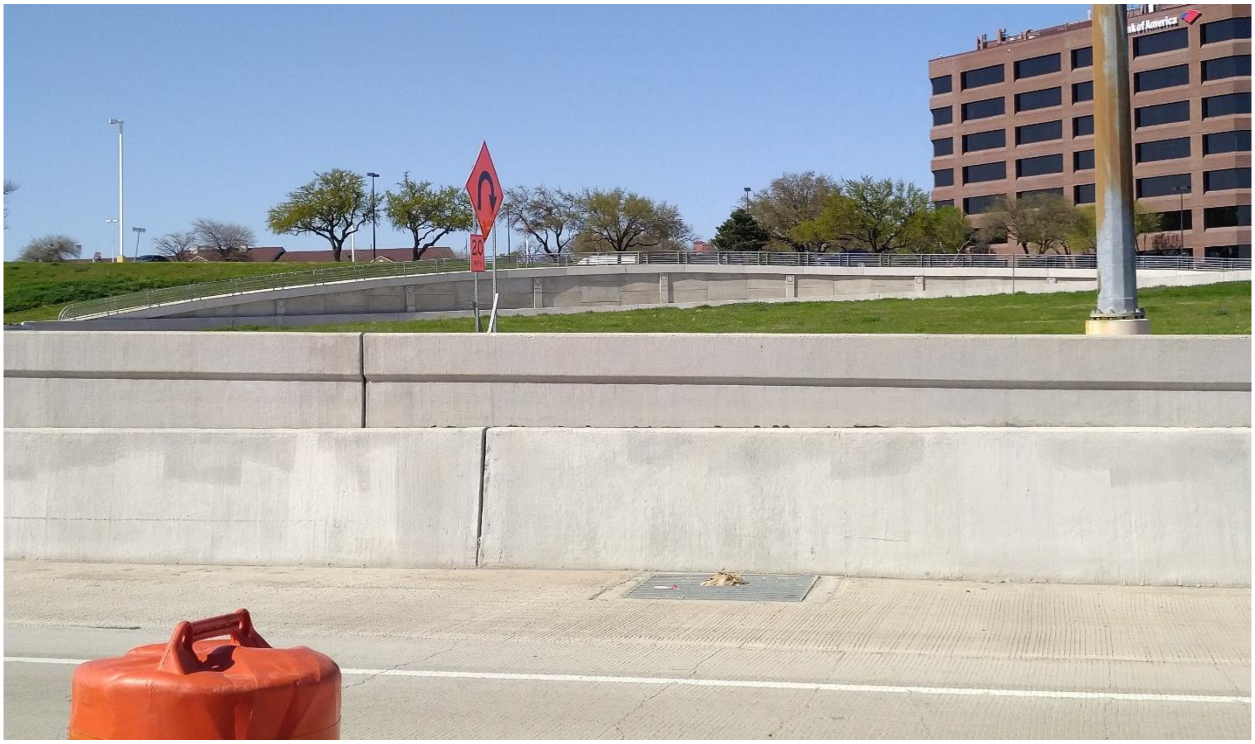


Figure 87. Retaining Wall B03.

Figure 88. Retaining Wall B06B and B06C.

West of SH 360, South of IH 30

Construction has been completed for all of the following retaining walls: B05B (Figure 89), B08A (Figure 90 and Figure 91), B08B (Figure 92), B08C (Figure 93), B10A (Figure 94), B10B, and B12.

Figure 89. Retaining Wall B05B.

Figure 90. Retaining Wall B08A.

Figure 91. West-Facing View at East Side of B08A.

Figure 92. Retaining Wall B08B.

Figure 93. Retaining Wall B08C.

Figure 94. Retaining Wall B10A.

East of SH 360

Retaining walls B16, B17, B18A, B18B, and B23 are not complete. Construction is complete for B19 (Figure 95), B20, B21A, and B21B and C (Figure 96).

Figure 95. Retaining Wall B19.

Figure 96. North-Facing View of Retaining Wall B21B and B21C.

North of Avenue J

Retaining walls B25 (Figure 97) and B30A (Figure 98) are complete. Retaining walls B27, B29A, and B26 are not complete. B26 was listed on some of the roadway plan and profile sheets in the area of the proposed noise wall, but it was not listed in the retaining wall layout sheets. B26 is related to the proposed noise wall foundation.

Figure 97. Retaining Wall B25.

Figure 98. Retaining Wall B30A.

North of IH 30, South of Avenue J

B30C (Figure 99 and Figure 100), B31A, B33, B34, and B35 (Figure 101) have been constructed. Retaining walls B29C, B32A, B32B, B32C, B39A, and B39B have not been completed.

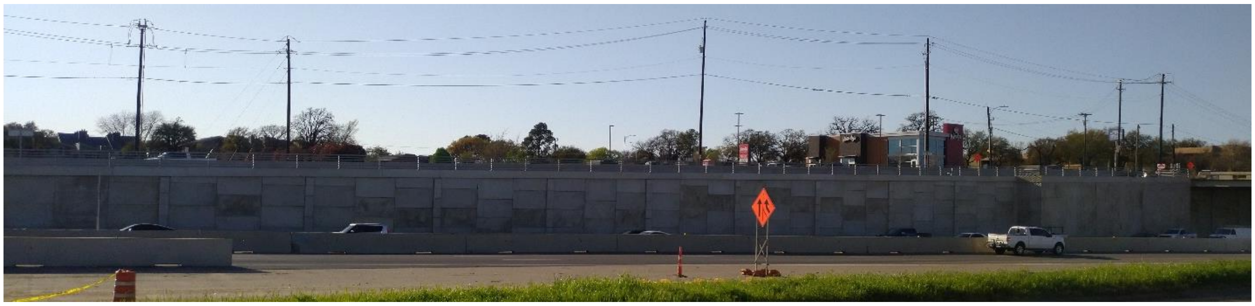


Figure 99. Retaining Wall B30C.

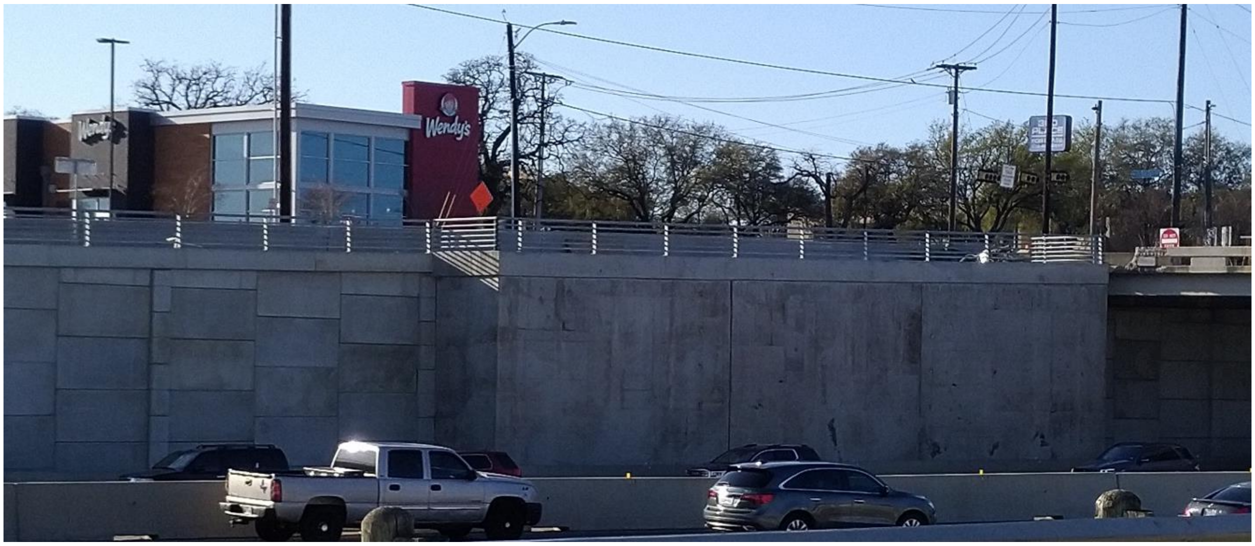


Figure 100. Retaining Wall B30C, Drilled Shaft Portion.

Figure 101. Retaining Wall B35.

AT&T has a large duct bank crossing in the area of retaining wall B29C and B30C. The contractor began excavating the existing retaining wall for the installation of B30C and uncovered the AT&T duct bank. The line was a lot shallower than AT&T's as-builts showed. AT&T estimated that relocating the duct bank would take about two years and $2 million dollars. It was determined that waiting for AT&T to relocate would take too long. Thus, a section of retaining wall B30C was redesigned in November 2019 due to the existing 18-inch AT&T duct bank crossing. The foundation for a section was revised from a standard MSE wall to a drilled shaft wall. TxDOT is currently redesigning B29C to mitigate the AT&T duct bank in the same way as B30C.

Before construction, an Atmos Gas line was identified and determined to be in conflict with retaining wall B33. The gas line was relocated but was later found to be within the foundation improvement zone of the wall. Due to time constraints, the designers assessed the global stability of the wall and determined that the select fill below the wall could be reduced by 2 feet to accommodate the relocated gas line rather than relocate the gas line a second time.

South of IH 30

Construction is complete for B36A and B36C (Figure 102), B36B, B42A, B42B, and B42C (Figure 103). Retaining wall B37, B40A, B40B, and B40C are not complete.

Figure 102. Retaining Wall B36A and B36C.

Figure 103. Retaining Wall B42B and B42C.

HOUSTON DISTRICT—IH 45, SOUTH OF FM 1764 TO NORTH OF FM 519

For the Houston District, a project on IH 45 was selected for the case study (see Figure 104). The project spans from south of FM 1764 to north of FM 519. The project location is shown in Figure 105. The project is located in Galveston and was let in August of 2019. The CSJ number for the project is 0500-04-105. The purpose of the project is to reconstruct eight main lanes and two frontage roads. Williams Brothers Construction Company Inc. was selected to construct the project. The adjusted cost for the project is $167,584,633.26. The project consists of 1,500 contract working days. The project site visit took place on Friday, March 26, 2021. Construction project management consultants were in the field to help guide TTI personnel.

An estimated project schedule, shown in Figure 106, was created to better understand the project development process. The information for the project schedule is based on information received from the Houston District, contractors, and information available online. From the project schedule information, the notification for the proposed noise wall was produced about eight months after the completion of the schematic design plans. The noise workshop documentation was completed about three months before the final design plans were submitted. The project was let about two months after the final design plans were completed. Construction also began less than two months after the project was let. Requests for information were released regarding drainage design details and retaining walls in August 2020 and February 2021, respectively.

Information for intermediate design milestone dates (30, 60, and 90 percent) was not readily available. The project was designed in house, and the Houston District does not usually apply intermediate design milestones to in-house projects.

Noise Walls

The public meetings, held on June 13, 2017, and February 6, 2018, involved multiple projects for the corridor. There were a number of comments regarding the need for noise walls or a way to reduce noise. Most of these comments were from property owners in neighborhoods within the project south of the case study project. There was a request to have noise walls installed to block noise before construction begins. All adjacent property owners would probably prefer this action to mitigate noise from the construction process.

According to the traffic noise technical report, of the 10 representative receivers listed, six of the receivers had a noise impact[6]. Out of the six with noise impacts, two noise walls were planned. Of the remaining four receivers, three would not meet the minimum noise reduction goal with a proposed 20-foot-high noise wall and the other was not adjacent to the project. The two walls were adjacent and were around a mobile home park. The noise workshop was performed over the phone and via email. These methods were used since there was only one affected property owner.

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[6] TxDOT. (2018). *IH 45 (from FM 1764 to North of the Galveston Causeway Bridge)*. Traffic Noise Technical Report. Texas Department of Transportation. Houston, TX.

The two noise walls have been included in the plans since schematic design (see Table 26). Noise wall No. 1 (Figure 107 and Figure 108) is the northernmost noise wall on the project. A triangular-shaped parcel was acquired just north of noise wall No. 1 and south of Cedar Drive. The remaining noise wall, No. 2, is located just south of No. 1. The proposed location for noise wall No. 2 can be seen in Figure 109 and Figure 110.

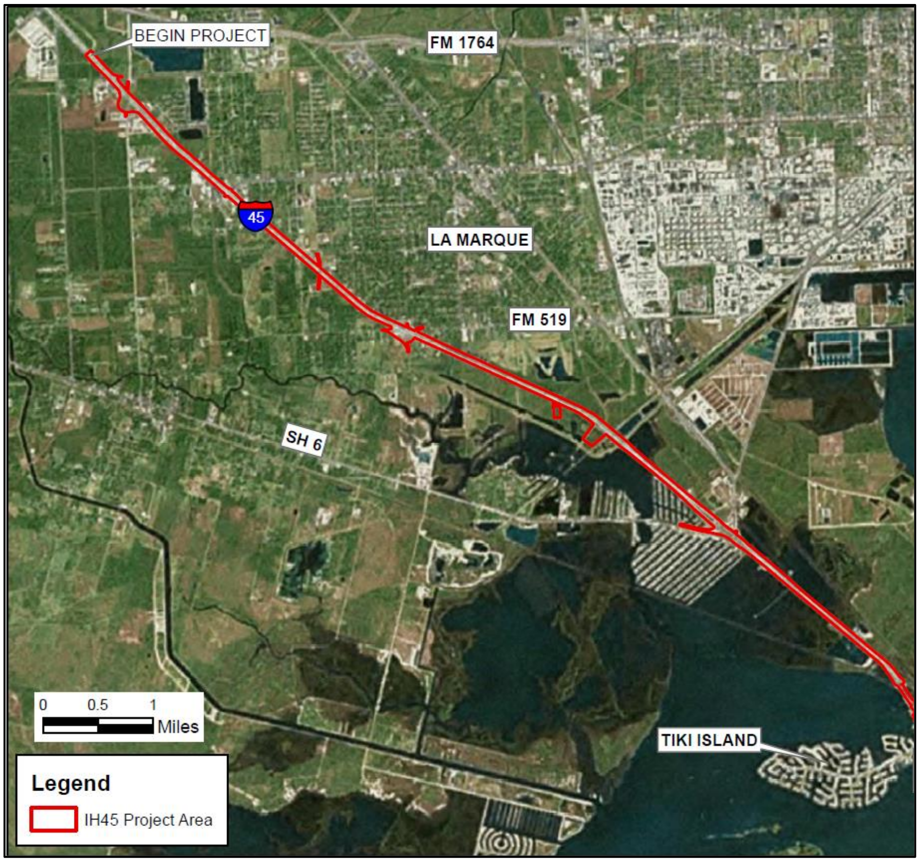

Figure 104. IH 45 General Project Location (*51*).

The planned noise wall, No. 1, is rather short, at 104.16 feet. This shorter length is due to an existing driveway that services the adjacent property. Noise wall No. 2 has a total length of 533.73 feet and spans from the south end of the existing driveway to the south end of the adjacent mobile home park.

As the figures show, construction has not begun on the noise walls. Utility relocations are complete in the area, and the contractor is working to finish the installation of the storm sewer. In conversations with TxDOT, it was mentioned that it is preferable to mitigate any utility conflicts before constructing the noise walls.

The centerline of the proposed noise walls is located 2 feet from the edge of the right of way. No temporary construction easements have been acquired to help construct the noise walls. Along part of the right of way (see Figure 109 and Figure 110), there is not much room behind the edge of the right of way to help with construction due to the location of mobile homes.

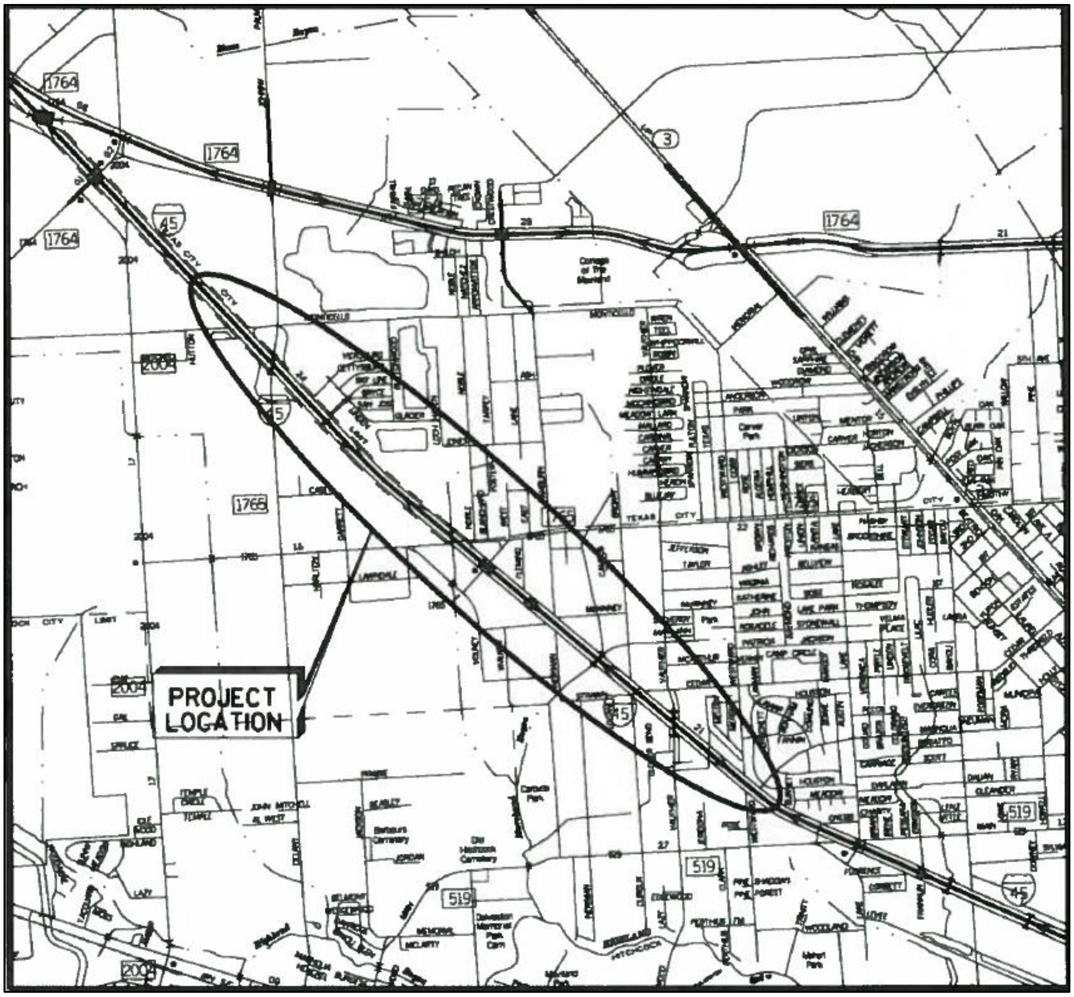

Figure 105. IH 45 Project Location[7].

Existing overhead utilities, which are private, are located off the right of way in this area. The utility poles that are visible in the figures related to noise wall No. 1 and 2 are for a temporary overhead installation for TxDOT's Traffic Management System (TMS). Originally, the design plans called for the TMS line to be temporarily installed underground. However, due to concerns for existing underground utilities, since no offsets were given for the placement of the line, the line was installed overhead. The installation was less expensive and reduced the potential impact to utilities. The permanent location for the TMS line is between the main lanes and the frontage road. The poles are to be removed and the TMS line installed in its permanent location before construction for the noise walls begins.

[7] TxDOT. (2019). *Plans of Proposed State Highway Improvement: CSJ 0500-04-105*. Design Plans. Texas Department of Transportation, Houston, TX.

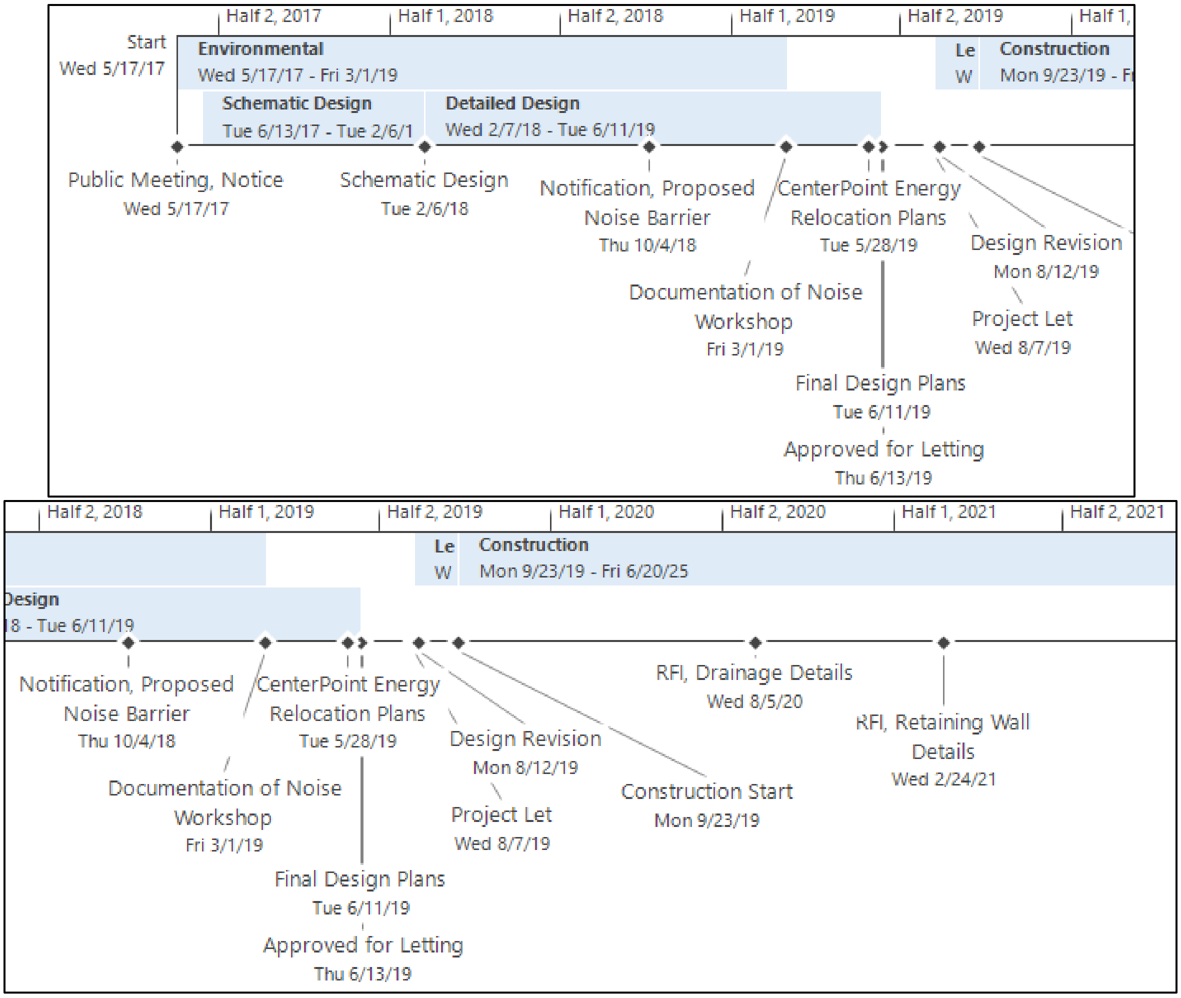

Figure 106. Estimated Project Schedule, IH 45.

Table 26. IH 45, Noise Wall Listing by Plan.

Schematic (2/6/18)	Final Design (6/11/19)
Present on plans	No 1
Present on plans	No 2

Figure 107. South-Facing View at Proposed Location of Noise Wall No 1.

Figure 108. North-Facing View at Proposed Location of Noise Wall No 1.

Figure 109. South-Facing View at Proposed Location of Noise Wall No 2.

Figure 110. North-Facing View at Proposed Location of Noise Wall No 2.

Retaining Walls

All the retaining walls except RW 19 were present in the schematic plans. Table 27 lists the retaining walls by plan. For ease of review, retaining walls have been grouped into subsections based on the related cross street intersecting IH 45.

Table 27. IH 45, Retaining Wall Listing by Plan.

Schematic (2/6/18)	Final Design (6/11/19)
Present on plans	RW 1
Present on plans	RW 2
Present on plans	RW 3
Present on plans	RW 4
Present on plans	RW 5
Present on plans	RW 6
Present on plans	RW 7
Present on plans	RW 8
Present on plans	RW 9
Present on plans	RW 10
Present on plans	RW 11
Present on plans	RW 12
Present on plans	RW 13
Present on plans	RW 14
Present on plans	RW 15
Present on plans	RW 16
Present on plans	RW 17
Present on plans	RW 18
—	RW 19

Note: — means not applicable.

Construction has begun for two of the retaining walls, RW 8 and RW 12. The contractor is also excavating at wall RW 7 and 11 to begin temporary special shoring. These retaining walls are discussed in more detail in the Texas Avenue subsection. The subsection also includes further detail for the retaining walls on the project.

Delany Road Crossing (RW 1, RW 2, RW 3, RW 4, RW 5, and RW 6)

The existing Delany Road overpass is planned to be removed and replaced by an overpass for IH 45. The overpasses are being swapped due to a clear lane initiative. TxDOT wants to make a clear path from Galveston to Houston so that evacuations, heavy haul, and military mobilizations can happen without any obstructions.

The planned overpass will be supported by six retaining walls. Figure 111 depicts the location of the proposed RW 1 and 2. Figure 112 shows the proposed location for RW 4 and 5. The proposed location for RW 3 and 6 is not shown.

Figure 111. Proposed Location for RW 1 and 2.

Figure 112. Proposed Location for RW 4 and 5.

Texas Avenue (FM 1765) Crossing (RW 7, RW 8, RW 9, RW 10, RW 11, and RW 12)

As part of the case study project, the IH 45 overpass at FM 1765, Texas Avenue, is being raised and widened. To accommodate traffic and widen the bridge, a temporary bridge widening is being performed on the southbound lanes (RW 8 and 12). The vertical clearance of the bridge is also being raised from 16 feet to 16 feet 6 inches.

The project used partially constructed permanent retaining walls instead of temporary retaining walls to assist with project phasing for the bridge widening. The use of partial permanent retaining walls has complicated construction for the contractor, who has asked TxDOT for clarification on the project. The contractor has opted to construct temporary earth walls to help in the construction of the phased permanent retaining walls.

The construction contractor would prefer to use all temporary earth walls to accommodate the temporary bridge widening. The use of temporary earth walls is planned for the next project on IH 45, which is south of the case study project. The Additional Project subsection provides more information.

Retaining Wall RW 7 through RW 10

Excavation for the construction of temporary special shoring at RW 7 can be seen in Figure 113. RW 8 is being constructed in two stages. The first stage has been constructed and can be seen in

Figure 114. About 75 percent of RW 8 has been constructed. A temporary retaining wall (Temp RW 7) was added in February 2021 adjacent to RW 8.

Figure 113. Proposed Location for RW 7.

Figure 114. North-Facing View of RW 8.

Figure 115 and Figure 116 show the location of RW 9. Plans for RW 9 were redesigned in February 2020. Temporary special shoring was added for RW 9 in February 2021. Temporary special shoring and a temporary retaining wall were added in February 2021 adjacent to RW 9.

RW 10 is located between RW 11 and 12. RW 10 can be seen in Figure 117 and Figure 118. Temporary special shoring and a temporary retaining wall were added for RW 10 in February 2021. A temporary retaining wall, Temp RW 4, was added in February 2021. The temporary retaining wall is located at the centerline of the proposed main lanes and runs parallel to RW 11 and RW 12.

Retaining Wall RW 11 and RW 12

The construction contractor has begun excavating for the installation of temporary special shoring at RW 11 (see Figure 119).

Figure 115. Northbound Side of RW 9.

Figure 116. Southbound Side of RW 9.

Figure 117. Southbound Side of RW 10.

Figure 118. Northbound Side of RW 10.

Figure 119. South-Facing View of RW 11.

RW 12 is being constructed in two stages. Figure 120 and Figure 121 present the construction for the first part of the retaining wall. Issues have been encountered regarding the stages on the retaining wall construction. Since only about 75 percent of the retaining wall was constructed in the first stage, the contractor wanted clarification on items related to how to fill in the gaps behind the partially built retaining wall (Figure 121) and how to brace panels that do not have full reinforcement in the first stage. A temporary retaining wall (Temp RW 8) was also added in February 2021 adjacent to RW 12.

The contractor experienced issues when dealing with the storm sewer culvert relocation and the temporary condition of RW 12. Temporary special shoring to hold the embankment under the active lanes was planned to tie into the existing storm sewer. Collars were also going to be used to tie the new and old storm sewer lines together under the embankment.

Figure 120. South-Facing View of RW 12.

Figure 121. North-Facing View at Back of RW 12.

Due to the complex nature of the new storm sewer installation, a design change was made to relocate the replacement storm sewer line to the turnaround lane. Figure 122 shows the existing and proposed culvert locations in the revised version of the design plans. Figure 123 shows the existing culvert crossing under IH 45 during the construction of RW 12. The old storm sewer line was grouted and abandoned in place.

The existing drainage culvert crosses at a skew, as shown in Figure 122 and Figure 124. Figure 124 was taken in general alignment with the culvert crossing. The abandoned storm sewer line was probably installed before IH 45 was constructed, which would help explain the cumbersome placement under the existing embankment and why it was at a skew.

The use of temporary retaining walls instead of permanent walls for the temporary widening would provide additional time to resolve any utility relocations or installations (such as the culvert installation).

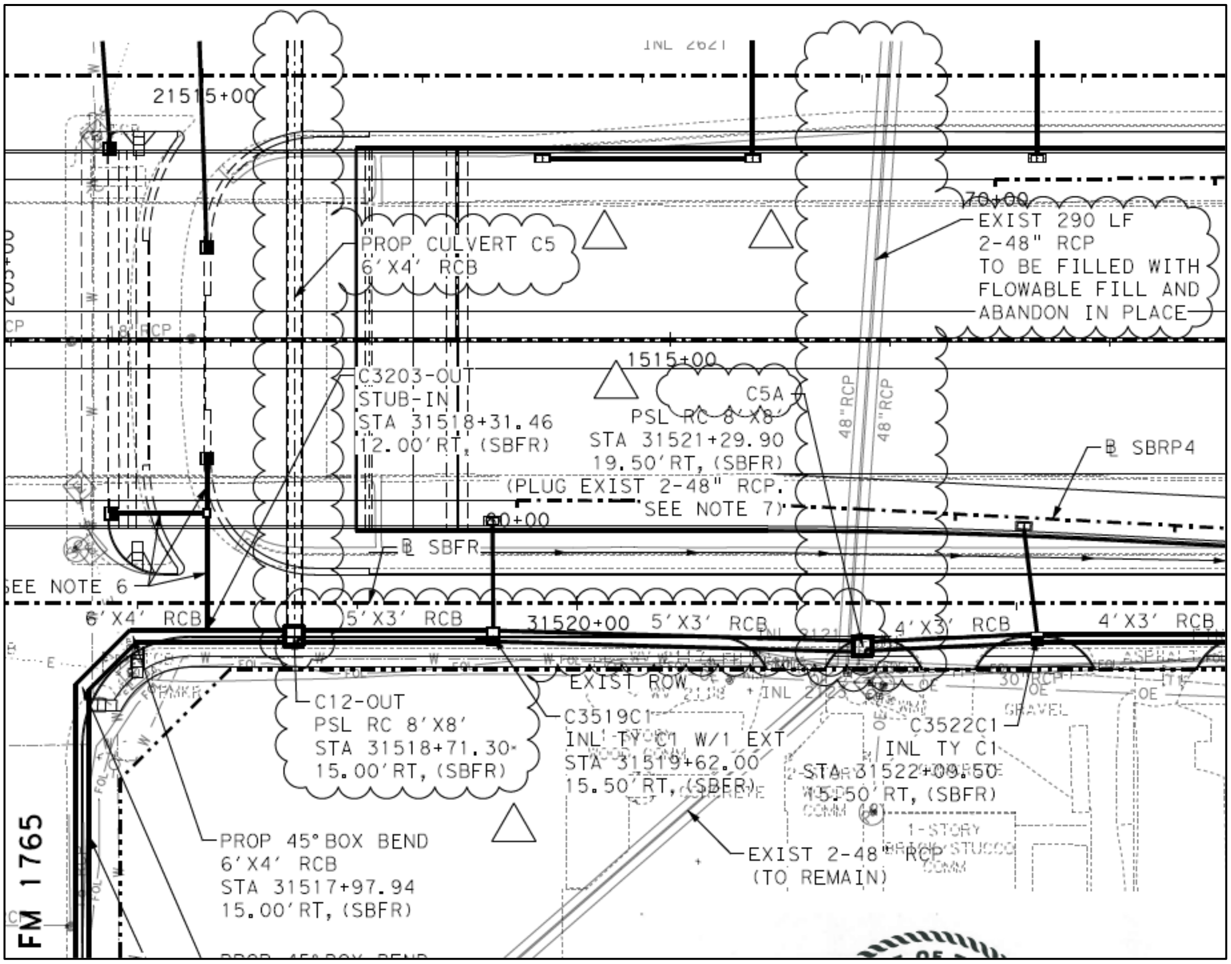

Figure 122. Existing and Revised Proposed Culvert Location[8].

Figure 123. Existing Culvert at RW 12.

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[8] AECOM. (2020). *IH 45 South, SB Frontage Road Drainage Plan & Profile, STA 31511+00 to STA 31523+00*. Drainage Revision. Texas Department of Transportation.

Figure 124. East-Facing View of Drainage at RW 12.

Vauthier Street Crossing (RW 13, RW 14, RW 15, RW 16, RW 17, RW 18, and RW 19)

Vauthier Street previously crossed over IH 45. As shown in Figure 125 through Figure 127, the Vauthier Street overpass has been demolished to make way for a planned IH 45 overpass. In this area, the overpasses are being swapped due to a clear lane initiative. TxDOT is making a clear path from Galveston to Houston without any overpass infringements so that heavy haul, military mobilization, and evacuations may happen without any impediments. The planned overpass will be supported by six retaining walls (RW 13 through 18). The remaining proposed retaining wall is being constructed to support the inside portion of the exit ramp on the southbound side of IH 45.

Additional Project, IH 45 at FM 519

During the site visit, it was mentioned that a sister project is planned on IH 45 to the south of the case study project. The proposed project includes the crossing at FM 519. This project shows the use of temporary retaining walls to help with construction phasing instead of phased permanent retaining walls. Construction has not begun, but it may be interesting to see how the different construction methods compare after both projects are complete.

Figure 125. Proposed Location for RW 13.

Figure 126. Proposed Location for RW 15.

Figure 127. West-Facing View of Proposed Location for RW 16 and 17.

SAN ANTONIO DISTRICT—SL 1604: 2452-03-112; CONVERT NON-FREEWAY TO FREEWAY

Loop 1604 from IH 35 to FM 78 was selected as the case study for the San Antonio District. The project length is 3.1 miles, and it is located in northeast Bexar County within the city limits of Live Oak and Universal City (see Figure 128 and Figure 129). The project CSJ is 2452-03-112 and was designed in 3D. The construction project is currently underway, with a total contract amount of $45,888,888.90. Before construction began, the existing roadway was a four-lane grade-separated roadway with diamond ramps and discontinuous frontage roads. The construction project includes a four-lane expressway with an X-ramp configuration and continuous one-way frontage roads with sidewalks. The project also includes improvements of cross streets. No right of way or temporary construction easements were acquired for the project.

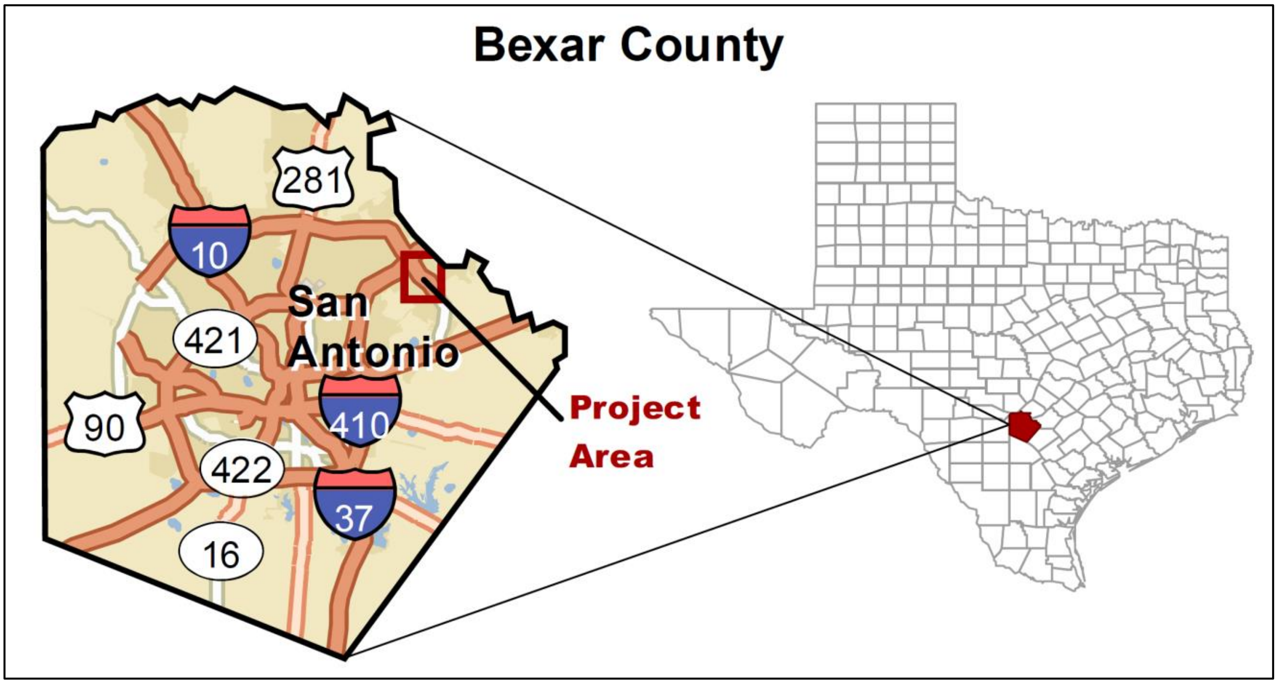

Figure 128. Loop 1604 Project Location within Bexar County[9].

The project site visit took place on Wednesday, March 17, 2021. A TxDOT representative was available to help guide TTI personnel while visiting the site. It was mentioned during the site visit that the project did not experience many issues with utility conflicts during construction.

Figure 130 provides an estimated project schedule. The schedule information was collected from documents provided by TxDOT and information available online. The project design schedule was escalated and can be seen by the overlapping schematic and detailed design. The traffic noise analysis technical report was completed after 60 percent PS&E. Also, NEPA clearance was achieved after the 100 percent design plans were complete. Construction began on October 15,

[9] TxDOT. (2017). Loop 1604 from Interstate Highway 35 to Farm-to-Market Road 78. Project Description Technical Report, Draft. Texas Department of Transportation. Austin, TX.

2018, about four months after project letting. There have been a number of change orders during construction, with some of the latest approved in November 2020.

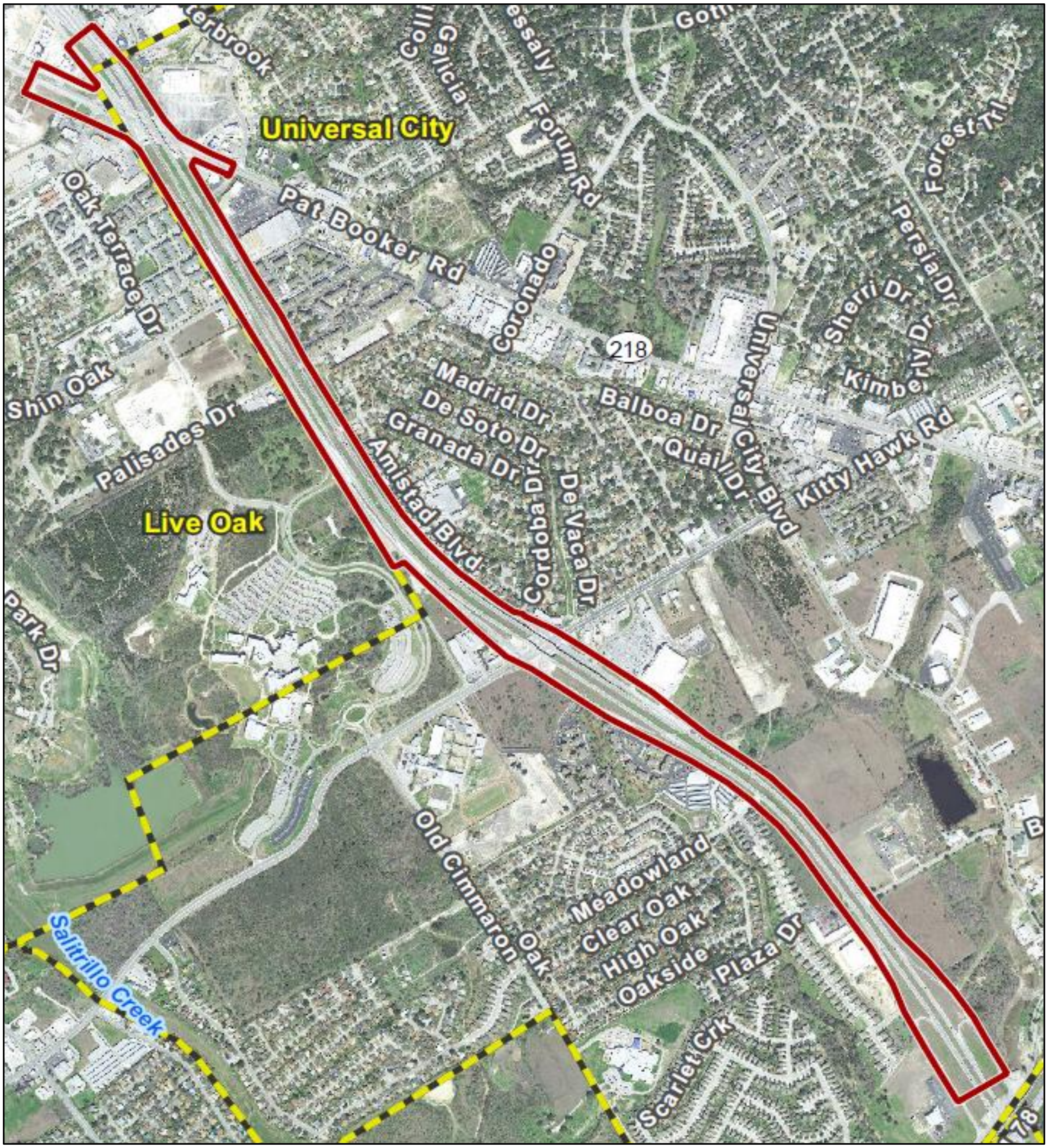

Figure 129. Loop 1604 Project Location within Map[10].

[10] *Id.*

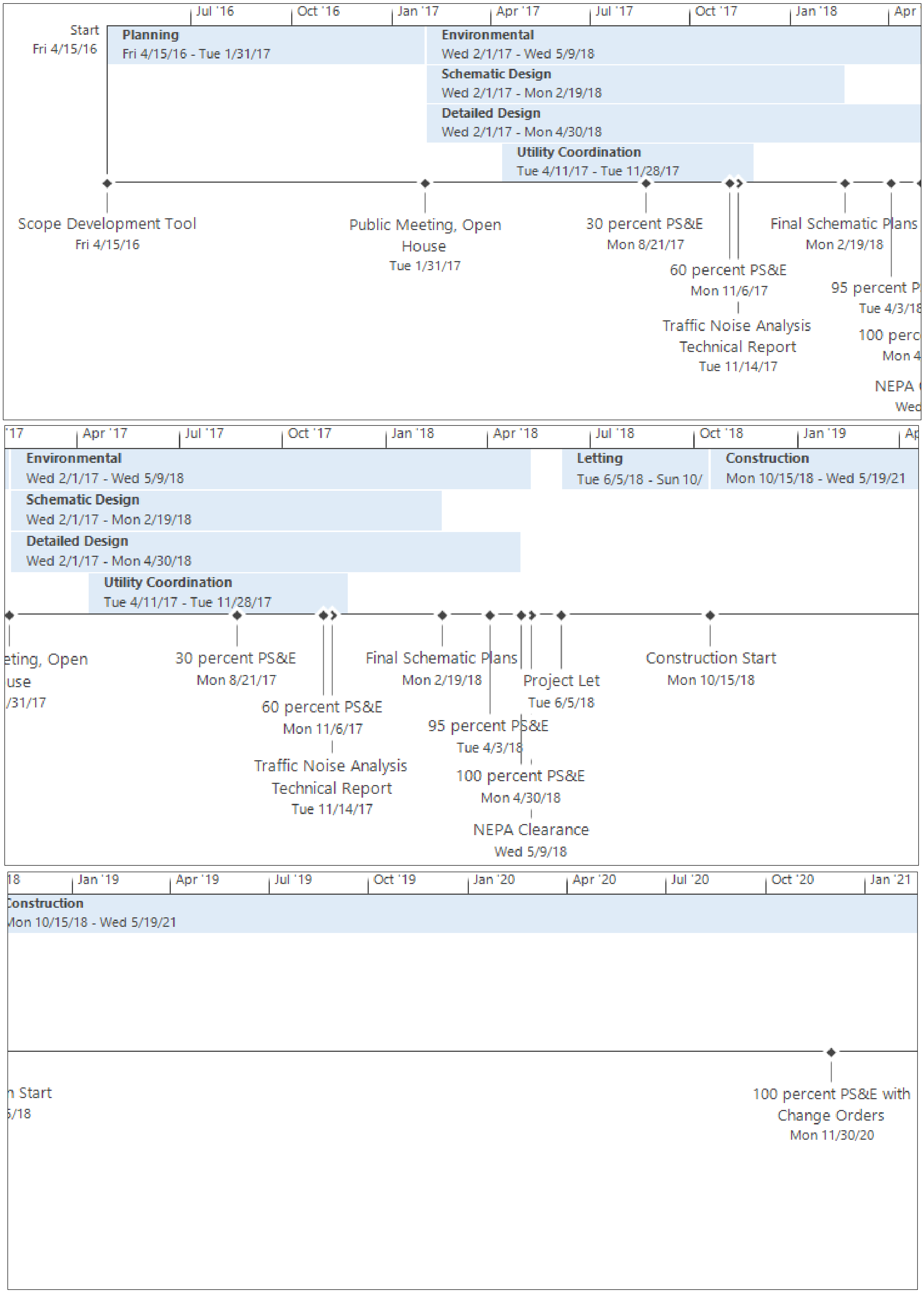

Figure 130. Estimated Project Schedule, SL 1604.

Noise Walls

As noted in the comments from the public meeting documentation from January 2017, the public had an interest in noise abatement since the existing noise from the roadway was already a concern (*52*). In fact, 17 of the 57 general comments mentioned issues with the existing noise or the need for a noise wall. Retaining walls and issues with grade changes were not noted in the public's comments.

Twenty-four representative receivers, six of which were for separate floors of multilevel apartments, were considered for the project's traffic noise technical report. Eighteen receivers had a noise impact. Of these 18 receivers, five represented separate floors of other receivers. For four of the receivers, the proposed noise wall did not meet the minimum noise reduction goal. For representative receivers (R4, R5, and R9–R15), the proposed noise walls were placed adjacent to the right of way. For receivers, R7, R8, and R16, where the location of the noise walls did not meet the feasibility requirements, two alternative locations were assessed in the model. Modeling these locations included placing the noise wall between the frontage road and main lanes.

During design there was an issue with overhead electric lines. Overhead electric conflicts are a top issue when dealing with noise walls. It was determined that CPS Energy, the overhead electric utility, could not back-feed the electrical service to the adjacent properties. Being unable to back-feed the electrical service meant that deenergizing the line for installation of the noise wall was not viable. The district had to find another way to install the noise wall panels.

Instead of using the traditional top-load style precast concrete panels, the district used front-load panels for the top portion of the noise walls. The channel, which holds the precast noise wall panels in place, usually goes all the way to the top, but in this case it only covered the bottom half. Having the channel only on the bottom half allowed the panels to be loaded from the front and lowered into the channel.

The project was designed in 3D, which allowed the designers to cut the cross sections more frequently than is traditional. Cutting the cross sections more frequently allowed the designers to put a 10-foot radial clearance around the bottom electric utility line (see Figure 131).

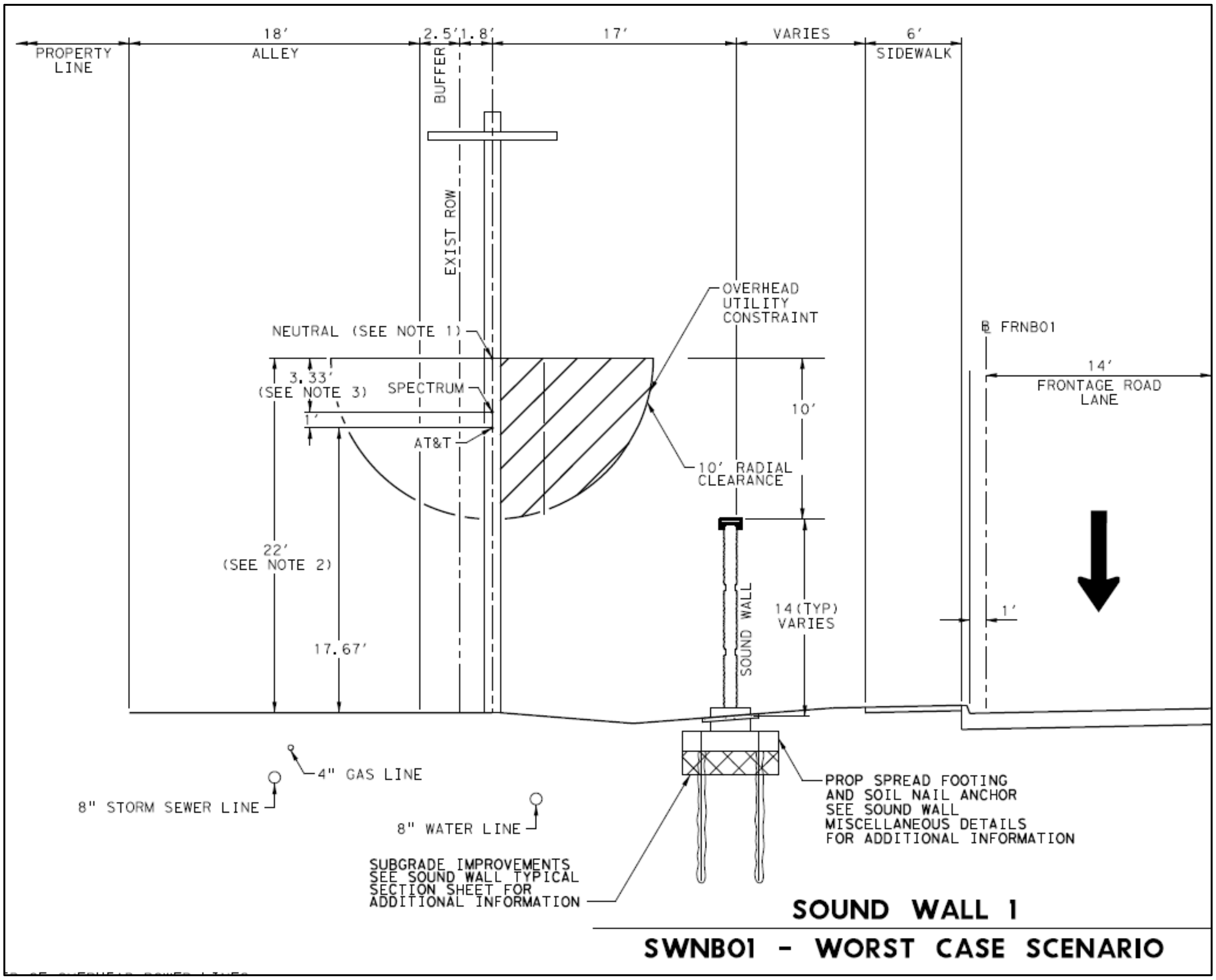

Figure 131. Electric Utility Clearance for Noise Wall Construction[11].

All the noise walls are on the northbound side of the project, between the frontage road and the edge of the right of way. There is a large access area behind the noise walls on the adjacent property. Utilities run parallel with the noise walls, including overhead electrical and underground utilities. The back of the existing utility poles is the edge of the right of way.

There were areas behind the noise walls where trash and debris were collecting. The debris may have been in the area before the noise walls were constructed, but the presence of the debris does raise concerns that debris may build up more readily due to the visual separation from the highway.

Four noise walls are in the final design plans, SWNB01 through SWNB04. Two other walls were listed in the schematic plans, which were combined in the 30 percent PS&E plans to create

[11] Kennedy Consulting, Inc. (2018). *Plans of Proposed State Highway Improvement: CSJ: 2452-03-112*. Design Plans. Texas Department of Transportation. San Antonio, TX.

SWSB01. However, noise wall SWSB01 did not make it into the final design plans. Table 28 provides a breakdown of which noise walls are listed in the plans.

Table 28. SL 1604, Noise Wall Listing by Plan.

30% PS&E (8/21/17)	60% PS&E (11/6/17)	Schematic (2/19/18)	95% PS&E (4/3/18)	100% PS&E (4/30/18)	100% PS&E w/Change Orders (11/30/20)
NWNB01	NWNB01	3A	SWNB01	SWNB01	SWNB01
NWNB02	NWNB02	3B	SWNB02	SWNB02	SWNB02
NWNB03	NWNB03	3C	SWNB03	SWNB03	SWNB03
NWNB04	NWNB04	3D	SWNB04	SWNB04	SWNB04
NWSB01	NWSB01	4A	SWSB01	—	—
		4B			

Note: — means not applicable.

Noise Wall SWNB01

Noise wall SWNB01 is the northernmost noise wall of the project. Figure 132 through Figure 136 show pictures of the wall. Figure 133 through Figure 136 also show trash and debris building up behind the noise wall. That buildup will likely continue to be an issue.

Figure 132. North-Facing View at South End of SWNB01.

Figure 133. Drainage behind SWNB01.

Figure 134. South-Facing View at North End of SWNB01.

Figure 135. Receptor Side of SWNB01, North Facing.


Figure 136. Receptor Side of SWNB01, South Facing.

Noise Wall SWNB02

Figure 137 through Figure 142 show SWNB02. The alleyway serving the adjacent property is visible in the pictures, as are the overhead utilities. Debris is visible behind the wall in Figure 141.

Figure 137. North-Facing View at South End of SWNB02.

Figure 138. South-Facing View of South End of SWNB02 and North End of SWNB03.

Figure 139. South-Facing View at North End of SWNB02.

Figure 140. Noise Wall SWNB02.

Figure 141. Receptor Side of SWNB02, South Facing.

Figure 142. Receptor Side of SWNB02, Facing North.

Noise Wall SWNB03

No issues were encountered for noise wall SWNB03. Figure 138, Figure 143, and Figure 144 show noise wall SWNB03. The noise wall is separated on the north side from SWNB02 by a drainage feature.

Noise Wall SWNB04

Figure 145 to Figure 152 show pictures of the location of noise wall SWNB04, which is the southernmost noise wall on the project. The back of the existing utility poles was adjacent to the right-of-way line. The noise wall was shortened (see Figure 149) on the north end due to a conflict with underground utility facilities (visible in Figure 150 and Figure 151). The manhole and the telecommunication vault are shown in the design plans, but the telecommunication vault is not shown in the exact location on the plans. The vault is in line with the noise wall panels. Instead of relocating the vault, during construction, the proposed panels that were in conflict were omitted. The noise wall was struck within the two weeks before the site visit (see Figure 153 and Figure 154). This occurrence points toward a larger conversation on how far from the travel lanes to place the noise wall and how far from the right-of-way line to install the wall.

Figure 143. North-Facing View at South End of SWNB03.

Figure 144. Receptor Side of SWNB03.

Figure 145. South-Facing View at North End of SWNB04.

Figure 146. Noise Wall SWNB04.

Figure 147. North-Facing View at South End of SWNB04.

Figure 148. North-Facing View at South End of SWNB04, Receptor Side.

Figure 149. Omitted Portion of Wall at North End of SWNB04.

Figure 150. Manhole and Vault at North End of SWNB04.

Figure 151. Manhole and Vault at North End of SWNB04, South Facing.

Figure 152. North-Facing View of SWNB04.

Figure 153. Visible Markings on SWNB04 and Sidewalk from Vehicle Strike.

Figure 154. Visible Marking on SWNB04 from Vehicle Strike.

Retaining Walls

Table 29 shows the listing of retaining walls by design submission. The schematic design plans were submitted between 60 and 90 percent design. Two retaining walls, RWKIT01 and 02, were omitted after the 60 percent PS&E design submittal. Also, retaining wall RWDET01 was added to the 95 percent detailed design plans.

Retaining Wall RWNB01

RWNB01 is located between the frontage road and main lanes (see Figure 155 through Figure 157). The retaining wall was constructed to keep the frontage road and main lanes grade separated at an on-ramp. The frontage road is at a higher elevation than the main lanes in this area. During the site visit, there was limited access to the retaining wall due to the location of the wall and traffic.

Table 29. SL 1604, Retaining Wall Listing by Plan.

30% PS&E (8/21/17)	60% PS&E (11/6/17)	Schematic (2/19/18)	95% PS&E (4/3/18)	100% PS&E (4/30/18)	100% PS&E w/Change Orders (11/30/20)
RWNB01	RWNB01	Unnamed (begin FRNB STA 114+49.45)	RWNB01	RWNB01	RWNB01
RWNB02	RWNB02	Unnamed (begin FRNB STA 174+89.30)	RWNB02	RWNB02	RWNB02
RWSB01	RWSB01	Unnamed (begin FRSB STA 281+54.35)	RWSB01	RWSB01	RWSB01
—	RWSB02	—	RWSB02	RWSB02	RWSB02
—	—	—	RWDET01	RWDET01	RWDET01
—	RWKIT01	—	—	—	—
—	RWKIT02	—	—	—	—

Note: — means not applicable.

Figure 155. North-Facing View at South End of RWNB01.

Figure 156. RWNB01 near North End.

Figure 157. South-Facing View at North End of RWNB01.

Retaining Wall RWNB02

Figure 158 through Figure 162 show the location of RWNB02. This wall is located between the frontage road and the edge of the right of way. The drainage culverts can be seen in Figure 159 and Figure 160. There appeared to be utility markings adjacent to the right-of-way line in the area of the retaining wall.

Figure 158. North-Facing View at South End of RWNB02.

Figure 159. Drainage at Face of RWNB02.

Figure 160. Box Culvert at RWNB02.

Figure 161. North-Facing View of RWNB02.

Figure 162. South-Facing View at North End of RWNB02.

Retaining Wall RWSB01

Retaining wall RWSB01 was originally designed as a perched wall above an existing retaining wall. TxDOT did not allow for the perched wall even though the design consultant produced a calculation showing the perched wall design was sufficient. It was probably best to not allow for a perched wall on top of the existing retaining wall since an old soil nailed wall, which was not considered for the perched wall calculation, was found during construction. The soil nailed wall that was located within the existing retaining wall was unexpected. The soil nailed wall was discovered when the construction team began removing the existing retaining wall to construct the new retaining wall.

There was also a design change initiated in the field due to a proposed inlet. Changes were made to the strap design in the area of the proposed inlet. Figure 163 and Figure 164 show the partially constructed wall with temporary bracing.

Figure 163. South-Facing View at North End of RWSB01.

Figure 164. Temporary Construction Bracing at Face of RWSB01.

Retaining Wall RWSB02

This wall is located between the frontage road and the edge of the right of way, as shown in Figure 165 through Figure 169. This retaining wall was installed due to the drainage area and the amount of grade change longitudinally along the project. Figure 167 depicts drainage at the face of the retaining wall. Trash and debris are visible between the wall and the right of way in Figure 165.

The railing on top of the retaining wall blocks the line of sight when pulling onto the frontage road from Meadowland (Figure 169). It was noted during the site visit that TxDOT has had engineers discussing ways to resolve the line-of-sight issue. Ongoing discussions include the installation of signage to warn motorists on the frontage road of the upcoming intersection with Meadowland and to use caution since other motorists may be turning onto the frontage road. Discussions also mentioned breaking the rail back to allow for additional sight distance for motorists pulling onto the frontage road.

Figure 165. North-Facing View at South End of RWSB02.

Figure 166. North-Facing View of RWSB02.

Figure 167. Drainage at Face of RWSB02.

Figure 168. South-Facing View of RWSB02.

Figure 169. South Edge of RWSB02 at Intersection of Meadowland.

Retaining Wall RWDET01

RWDET01 is located between the main lanes and frontage road. It was added in the 95 percent PS&E plans as part of a detention basin located between the frontage road and main lanes south of Pat Booker Road. As Figure 170 through Figure 172 illustrate, the retaining wall was not fully constructed at the time of the site visit.

Figure 170. North-Facing View at South End of RWDET01.

Figure 171. South-Facing View of RWDET01.

Figure 172. South-Facing View at North End of RWDET01.

Retaining Walls RWKIT01 and RWKIT02

These walls were included in the retaining wall details in the 60 percent PS&E plans. The walls are related to the bridge overpass at Kitty Hawk Road.

CHAPTER 7. SUMMARY AND RECOMMENDATIONS

This research provided background and documented challenges in sequencing and placing noise walls and retaining walls. The research also included preferred methods and best practices for sequencing and placement and design and construction processes. A guidebook was produced from the research to provide a how-to approach to sequencing and placement of noise walls and retaining walls. Recommendations for updates to TxDOT manuals have been documented by the research also.

DATA COLLECTION

Researchers requested, processed, and analyzed data from a variety of relevant data sources to gain a detailed understanding of the sequencing and placement of noise and retaining walls during the TxDOT project development process.

The researchers received access to a set of project records from ECOS and TxDOTCONNECT and then reviewed the data to identify fields that might be useful to help in the analysis. The researchers did not find any data fields related to the development of retaining walls, and only a small amount of data related to design milestones. However, the ECOS database provided several data elements related to the development of noise walls. As a result, the researchers were able to establish a typical sequencing of noise wall activities, the mean number of days between the establishment and completion of the activities, and the mean duration of the noise wall development process. The researchers were also able to relate the noise wall development process to two project development milestones: the environmental clearance date and the actual letting date.

Noise Wall Development Process

The researchers found that most projects that involved a noise wall review tracked only one or two activities, typically the "Perform Noise Analysis" and "Perform Notification of Noise Information to Local Officials" activities. Only 10 percent of projects tracked more than two activities, and only three out of 683 projects tracked the "Perform Mitigation" activity.

The analysis of activity dates found that 151 of 452 noise wall projects (33 percent) had a zero-day duration, given that the earliest start and the latest end dates for the project were the same. For the remaining projects, the mean noise wall project duration was 166 days, with a maximum duration of 1,322 days and a standard deviation of 232 days. The researchers also calculated mean durations for each noise wall process activity, which ranged from a mean of 13 days for "Determine the Need for a Traffic Noise Analysis" to 108 days for "Perform Noise Analysis."

The researchers compared start dates of one activity to start dates of all other activities by calculating mean difference in days to determine which activity typically started before other activities. The researchers then repeated the analysis for the end dates of all activities. The analysis was able to confirm that the suggested order of sequence in the noise wall activity process was supported by the recorded start and end dates. The analysis also established the mean difference in days that can be expected between two specific activities in the noise wall development process.

The researchers compared the final noise wall activity with two milestone dates in the TxDOT project development process: the environmental clearance date and the actual letting date. The analysis found that when focusing on projects where the final noise wall activity ended before the environmental clearance date, the mean difference between the two was 147 days, with a median of 87 days, standard deviation of 163 days, and interquartile range of 188. However, 88 of 308 projects (28 percent) had noise wall activities that ended after the environmental clearance date. The researchers also found several large negative date differences, such as one case where the noise wall process concluded about 27 years after the environmental clearance date.

Comparing the final noise wall activity with the actual letting date, the researchers found 15 of 152 projects that had noise wall activities after the letting date. Focusing on the remaining 137 projects, the researchers found that the mean difference between the two dates was 270 days, with a median of 157 days, standard deviation of 266 days, and interquartile range of 376.

Further Research

The analysis did not address a comparison of the noise wall activity start dates to all other activity end dates and was unable to link the noise wall development process to additional TxDOT project development process milestones. If additional milestone dates become available in the future, for example as part of updates to the TxDOTCONNECT database, this research could be updated to gain further insight into the sequencing of noise wall activities during the TxDOT project development process.

RECOMMENDATIONS

Based on the findings from the literature review, interviews, data analysis, and case studies the research team makes the following recommendations.

Planning and Design

Noise Walls

Identify noise walls earlier in the project development process. This will make utility coordination activities easier. The need for a noise wall is typically identified around 60 percent schematic design. Final roadway geometry, which should be complete around 30 percent schematic design, is required for the environmental team to develop the traffic noise model.

Include the placement of noise walls in schematic design plans. Including noise walls in schematic plans, even if the walls have not been evaluated for feasibility and reasonableness or been voted on by the public, helps inform utility coordinators and other stakeholders of the need for a noise wall early. It will also help project stakeholders, including engineers, designers, environmental, right of way, and utility coordination, engage one another to make proactive adjustments earlier in the project development process.

Ensure that utility coordinators are included in the constructability review. The cost of utility relocations may be considered if utility coordinators are involved in the feasibility and reasonableness process.

Retaining Walls

Ensure effective communication and coordination between designers and project stakeholders. Since the retaining wall designer may be different than the project designer, districts need to ensure that designers for all aspects of the project are effectively communicating. Also, stakeholders such as bridge design, right of way, and utility coordinators should be included in meetings at the beginning of the project since these subject matter experts can provide information to help make better decisions regarding retaining walls.

Placement

Noise Walls

Involve the design team and utility coordinators when first setting the placement of noise walls. Environmental should coordinate with project personnel. This will afford the noise modeler information on utilities, safety, pedestrian facilities, adjacent property, drainage, and other factors that may not be readily available otherwise. The designer team can also consider the placement of the noise wall with respect to other design features.

Utility impacts should be considered when placing noise walls. Conflicts between noise walls and utilities are one of the biggest reasons for delay claims when dealing with noise walls. Providing SUE information, location of utility easements, and right-of-way maps to environmental personnel will help inform them where existing utilities are located when placing a noise wall for the noise analysis.

View the placement of the noise wall with some degree of flexibility. This can be helpful for designers during project design. When conflicts arise with the placement of the wall and other project features designers can collaborate with environmental personnel to alleviate the issue. If some degree of flexibility is not viewed in the placement of the noise wall, then it may have a greater impact to the project. It may be a good for districts to have environmental personnel run the noise analysis a few times with varying placements of the noise wall and provide multiple locations to project designers, so designers can determine decide which placement works best with the project's design.

A tiered spacing approach should be considered when placing noise walls near the right of way. A minimum of 5 feet between the back of the noise wall and the edge of the right of way is needed to accommodate work behind the noise wall, including construction and maintenance. An additional 5 feet, for a total of 10 feet, is preferred to provide sufficient room for construction. If additional room is needed to access utility poles or other utilities, then 15 to 20 feet of space may be needed between the back of the noise wall and the right of way line. Spacing is often project specific and can be influenced by particular factors. The placement may change when considering utility conflicts, environmental concerns, or safety challenges. Design features, such as foundation type, can also make a difference when placing a noise wall.

Consider acquiring a permanent easement to help with noise wall spacing. The amount of space required, for construction and maintenance, between the noise wall and edge of the right of way may be omitted if TxDOT acquires a permanent easement adjacent to the right of way. The need for the permanent easement can be included in right-of-way acquisition when a noise wall is planned near the edge of the right-of-way.

Consider acquiring a temporary construction easement for noise wall construction adjacent to the right of way. When noise walls are placed less than 5 feet from the right-of-way line there is not enough room to construct the noise walls without accessing adjacent property. Current practice includes obtaining a right of entry letter from adjacent property owners during construction. This puts the burden on construction personnel and can strain relationships with property owners, who may have already gone through the right of way acquisition process. The need for the temporary construction easement should be included in right-of-way acquisition. It is a good practice to assume temporary construction easements will be needed to help construct noise walls when placed near the right-of-way line. This practice ensures sufficient time to obtain an easement rather than waiting until construction and ensures that the area is considered in the environmental approval.

Consider placing noise walls off TxDOT right of way. Noise walls are placed within the right of way as a standard practice. But placing a noise wall off TxDOT right of way may be preferred when; a large landscape easements exist between the right-of-way line and receivers, a noise wall within the right of way is not reasonable and feasible, a maintenance agreement with a local municipality is in place, it lessens the impact to utilities in the right of way, there is a lack of available space in the right of way, it provides benefit to adjacent properties.

Consider placing noise walls between the frontage road and main lanes. Locating a noise wall between the frontage road and main lanes is uncommon. Typically, noise walls are located near the edge of the right of way close to affected receivers but there are times when placing a noise wall between the frontage road and main lane may be preferred. Some examples include when; noise walls are primarily needed to decrease noise from the main travel lanes, the main lanes are elevated with respect to affected receivers, the use of transparent noise wall panels is preferred, limited space between the right-of-way line and frontage road exists, there is limited access for maintenance and utilities near the right-of-way line, side streets, alleyways, and driveways feed onto the frontage road, a noise wall near the right of way would block visibility or access to adjacent property and commercial businesses.

Consider placing noise walls from the edge of the right of way. Placing a noise wall away from the edge of the right of way may be preferred when it reduces the impact to utilities, large trees, or other obstructions near the right-of-way line, provides room for construction and maintenance activities, or provides access for utility companies to maintain their facilities. Shifting the noise wall away from the edge of the right of way can lessen the impact to utilities in part because overhead utilities are required to be within 3 feet of the right of way line.

Retaining Walls

Consider the location of utilities and signage when placing a retaining wall. Considering utilities and signage may seem obvious but many times the coordination and placement may happen separately or at a different time within the project development process. Be sure to take into account utility crossings, including overhead lines, when placing retaining walls.

A tiered spacing approach should be considered when placing fill retaining walls near the right of way. Where 5 feet from the edge of the right of way is the minimum spacing required and increases, up to 20 feet, depending on the height of the retaining wall. This distance leaves sufficient space to prevent the wall footing from encroaching on adjacent property, leaves space for maintenance, and provides space for temporary bracing during construction. The actual amount of space needed for construction varies based on the retaining wall type, height, and surrounding conditions. The specifics of the retaining wall will determine the type of equipment needed to construct the wall, and space requirements will vary based on equipment needed.

Consider acquiring a temporary construction easement to assist with retaining wall construction. The easement may be needed to brace fill retaining walls, especially taller walls with longer braces. The amount of space required for constructing a fill retaining wall near the right of way may be reduced. The need for the temporary construction easement should be included in right-of-way acquisition. In areas where space is limited within the right of way, if a temporary construction easement is not acquired then the burden to secure a right of entry letter from owners to access adjacent property falls to construction personnel.

If possible, place retaining walls between the frontage road and the main lanes instead of next to the right-of-way line. Locating a retaining wall between the frontage road and main lanes allows for a constant grade with adjacent properties. This helps maintain access from driveways and side streets onto the frontage road. It also removes the need to purchase the right of access from adjacent properties. This placement may also help avoid utilities.

Noise Walls and Retaining Walls in the Same Area

For instances where a noise wall and retaining wall are proposed in the same area, design walls with the other in mind. This should also take place early in project design phase. Noise wall foundations are substantial and can impact retaining walls if not properly considered. Noise walls and retaining walls should be designed at the same time so that the retaining wall can be included in the traffic noise model. It is important to note that it may be preferrable to have separation between noise walls and retaining walls to provide additional space for construction. There is a concern that the design of the two walls together may be complex and not easily constructable.

Construction Sequencing

Consider installing noise walls early in project construction. The typical construction process allows the contractor to determine the project timeline but if possible, building the noise wall earlier will help with the following: reduce the number of public complaints due to construction noise, secure the construction worksite, and allow for coordination with relocating overhead utilities. For relocating overhead utilities, especially electric, it may be helpful to install the noise wall foundation before the overhead utilities relocate. This step will help alleviate the need for overhead electric lines to be deenergized to install the traditional drilled shaft foundation.

Right of Way

Consider noise walls during the right-of-way development process. For areas where neighborhoods are adjacent to the right of way, it may be good to assume that a noise wall will be required during right of way development. If the right-of-way team is informed on the location of noise walls earlier, it will have a greater understanding of how adjacent landowners are affected and where access to constructed facilities is limited, which impacts how right of way compensates for acquired property.

Wall Designs

Consider different retaining wall types, designs, and right of way when placing retaining walls. Different types of retaining walls may be more appropriate when placed near other design features or existing utilities. Acquiring additional right of way may alleviate the need for a retaining wall. Cost, schedule, availability of sloping, and impact to utilities should be considered when weighing design alternatives.

Consider alternative noise wall types, materials, and designs. The more noise wall options available the better it is for projects since designers can be more flexible. Alternative noise wall types have been used to mitigate utility conflicts. Gates and removable panels have been installed to provide access for utility companies to maintain their facilities. Alternative noise wall designs have been used to lessen the impact of drill shaft installation equipment. And lighter material noise wall panels may help with constructability.

Survey and Geological Information

Collect detailed survey and geological information in areas where noise walls and retaining walls are planned. Some districts have experienced issues in the past with inaccuracies in the topographic survey for noise walls and retaining walls. Verification of survey data helps reduce issues with inaccuracies of existing ground elevation. More detailed topographic survey information for adjacent areas off TxDOT rights of way would be helpful in the noise wall location decision process. When facing changing soil conditions, it becomes increasingly important to prioritize noise walls and retaining walls early in the design. The geotechnical process and the potential need for additional soil borings may be a lengthy process that requires additional time.

MANUAL UPDATES

Based on recommendations presented earlier in the chapter researchers complied recommended updates to TxDOT manuals. Recommended updates are grouped by manual and are separated based on chapter, section, and subsection. The updated portions of text are shown in <u>**bold and underline**</u>.

Geotechnical Manual

Include the following updates in the TxDOT Geotechnical Manual (*53*):

- Chapter 2- Soil Surveys
  - Section 1- Soil Surveys
    - Other Structures:

"Conduct foundation investigations for high-mast illumination, radio towers, **sound walls,** and overhead sign structures when other borings are not located nearby. The typical depth of the boring ranges from 30 to 70 ft. but depends on existing and proposed ground lines, soil strength, and structure loading."

- Chapter 6- Retaining Walls
  - Section 1- Retaining Wall Selection
    - Overview:

"Geometry. Determine applicability of wall type—cut, cut/fill, or fill—based on geometry, site constraints, and wall alignment and location. Identify available right of way. **Acquiring additional right of way may alleviate the need for a retaining wall.** Identify location and type of existing and proposed utilities. **This can usually be accomplished by collaborating with the project's utility coordinator.** Identify location and type of existing and proposed drainage structures."

"Constructability **and maintainability**. Determine whether walls are near water or subject to inundation. Identify access limitations for **construction and maintenance** equipment **and consider spacing from the right of way line**. Ensure adequate horizontal and vertical clearances are provided for installation **and maintenance** of retaining wall types, particularly tied-back, nailed, and drilled shaft walls.

- Chapter 6- Retaining Walls
  - Section 3- Design Considerations
    - General Design:

Add to the end of subsection:

For instances where a noise wall and retaining wall are planned in the same area, take into consideration the noise wall when designing the retaining wall. Noise wall foundations are substantial and can impact retaining walls if not properly considered. Noise walls and retaining walls should be designed at the same time so that the retaining wall can be included in the traffic noise model as well. It is important to note that it may be preferrable to have separation between noise walls and retaining walls to provide additional space for construction and maintenance. The design of the two walls together may be complex and not easily constructable.

A tiered spacing approach should be considered when placing fill walls near the right-of-way line. Consider having a minimum of 5 foot spacing from the edge of the right of way for construction and maintenance activities. This provides space for temporary bracing during construction. The spacing needs for construction will increase with the height of the retaining wall. The actual amount of space needed for construction varies based on the retaining wall type, height, and surrounding conditions. The specifics of the retaining wall will determine the type of equipment needed to construct the wall, and space requirements will vary based on equipment needed.

If possible, place retaining walls between the frontage road and the main lanes instead of next to the right-of-way line. This may be accomplished by collaborating with the designer to shift the vertical alignment of the frontage road to that of the adjacent property. This allows for a constant grade with adjacent properties which helps maintain access for driveways and side streets to the frontage road. It also removes the need to purchase the right of access from adjacent properties. Placing retaining walls between the frontage road and the main lanes may also help avoid utilities.

Take into account the location of utilities including utility crossings and overhead lines, when designing retaining walls.

Landscape and Aesthetics Design Manual

Include the following updates in the TxDOT Landscape and Aesthetics Design Manual (*18*):

- Chapter 3- Project Development Process
  - Section 2- Preliminary Design
    - Establish Preliminary Retaining and/or Noise Wall Locations (2590):

"The project landscape architect should review the location of retaining and/or noise walls. The primary concerns at the preliminary design stage are maintainability and impact of the walls. **A tiered spacing approach should be considered when placing retaining and/or noise walls near the right-of-way line. A minimum of 5 feet between the back of the noise wall and the edge of the right of way is needed to accommodate work behind the noise wall, including construction and maintenance. Ten feet is preferred to provide sufficient room for construction. If additional room is needed to access utility poles or other utilities, up to 20 feet of space may be needed between the back of the noise wall and the right of way line. The placement may change when considering utility conflicts, environmental concerns, or safety challenges. Design features, such as foundation type, can also make a difference when placing noise walls and retaining walls. When placing fill retaining walls, 5 feet from the edge of the right of way is the minimum spacing required and increases depending on the height of the retaining wall. The distance should leave sufficient space to prevent the wall footing**

from encroaching on adjacent property, leaves space for maintenance, and provides space for temporary bracing during construction."

- Chapter 4-Landscape and Aesthetics Guidelines for Common Structural Elements
    - Section 3- Retaining Wall and Noise Walls
        - Wall Color and Finish
            - Some design considerations that will help guide the selection of colors and finishes include the following:

Add to subsection:

Consider alternative noise wall types, materials, and designs. Alternative noise wall materials used include transparent plastic, fiberglass, and composite rubber. Alternative noise wall types have been used to mitigate utility conflicts. Gates and removable panels have been installed to provide access for utility companies to maintain their facilities. And alternative noise wall designs have been used to lessen the impact of drill shaft installation equipment.

Project Development Process Manual

Include the following updates in the TxDOT Project Development Process Manual (*54*):

- Chapter 2- Preliminary Design
    - Section 5- Geometric Schematic
        - 20505: Perform preliminary geotechnical surveys
            - Helpful Suggestions:

Add to the end of subsection:

Collect detailed geological survey in areas where noise walls are planned.

- 20550: Establish preliminary retaining or noise wall locations
    - Subtasks. The following subtasks are common to both retaining and noise walls:

"Coordinate with utility **coordinators** to determine any potential conflicts. **Utility coordinators can provide SUE information, location of utility easements, and right-of-way maps which will help inform where existing utilities are located.**"

- Subtasks
    - Retaining walls:

"Determine the material type for the noise wall. Material weighing four pounds per square foot is dense enough to prevent noise from passing through it. TxDOT typically uses concrete. Wood is not an acceptable material due to maintenance reasons. **Consider the use of alternative materials for noise**

walls Materials, such as fiberglass, transparent plastic, and composite rubber, have been used."

- Helpful Suggestions
  - For retaining walls or noise walls:

"The wall should not be located in gore areas and should be designed to avoid interfering with sight distance - including sight distance at intersecting streets and driveways. **If possible, place retaining walls between the frontage road and the main lanes instead of next to the right-of-way line.**"

  - For noise walls:

"Often, the placement of the noise wall depends on existing or proposed utility lines. Coordinate early with utility **coordinators** to determine locations of existing and proposed new lines."

"Use caution about building noise walls because they might limit future access to adjacent property. **Consider placing noise walls between the frontage road and main lanes.**"

- 20590: Conduct constructability review
  - Helpful Suggestions:

Add to the beginning of subsection:

Ensure utility coordinators are included in the constructability review.

- Chapter 5- PS&E Development
  - Section 2- Begin Detailed Design
    - 50250: Review data collection needs
      - Subtasks:

"Gather, review**, and verify** existing data."

  - Section 8- Retaining/Noise Walls & Miscellaneous Structures
    - 50800: Prepare retaining and/or noise wall layouts
      - Subtasks:

"Coordinate wall locations with proposed utility adjustments for construction clearances. **This should be achieved by coordinating with the utility coordinator regarding the utility accommodation plans.**"

- Helpful Suggestions.

"Coordinate with district maintenance **and construction** personnel regarding maintenance requirements adjacent to walls. **Typically, 5 to 20 feet of space from the right of way is needed for proper construction and maintenance.**

<u>Consider acquiring a temporary construction easement if space for construction is limited.</u>"

PS&E Preparation Manual

Include the following update in the TxDOT PS&E Preparation Manual:

- Chapter 2- Plan Set Development
  - Section 3- Plan Set Preparation
    - Plan and Profile Sheets
      - Miscellaneous:

Add to subsection:

<u>Show noise wall locations.</u>

Roadway Design Manual

Include the following updates in the TxDOT Roadway Design Manual (*55*):

- Chapter 1- Design General
  - Section 6- Maintenance Considerations in Design
    - Maintenance:

"Provide access to areas requiring maintenance (mowing, bridge inspection, etc.). For twin bridge structures, provide sufficient distance (typically 10 ft minimum between) to facilitate access for inspections that may require aerial-vehicles. **<u>For fill retaining walls, 5 to 20 feet of space from the right of way may be needed for to perform proper maintenance activities.</u>**"

- Chapter 2- Basic Design Criteria
  - Section 3- Sight Distance
    - Intersection Site Distance:

"Intersections should be evaluated for the effects of barriers, rails, **<u>noise walls,</u>** and retaining walls on sight distance."

- Chapter 3- New Location and Reconstruction (4R)
  - Section 2- Urban Streets
    - Borders:

"The border, which accommodates sidewalks, **<u>noise walls, utilities,</u>** provides sight distance, and separates traffic from privately owned areas, is the area between the roadway and right-of-way line."

TxDOT Glossary

Include the following update in the TxDOT Glossary (*56*):

- noise barrier:

  "**Also known as a noise wall, sound wall, or sound barrier,** is a solid wall or earth berm located between the **noise source** and receiver location, which breaks the line-of-sight between the receiver and the roadway noise sources. **Noise barriers may be constructed out of a variety of materials including concrete, transparent plastic, fiberglass, and composite rubber.**"

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APPENDIX A. VALUE OF RESEARCH

The appendix summarizes the estimated Value of Research (VoR) for the research project. Qualitative and quantitative benefit types are included.

QUALITATIVE BENEFITS

Based on a review of the research and expected benefits of the project, the research team anticipates the following benefits if the output of the research is implemented fully:

- TxDOT personnel's level of knowledge regarding sequencing and placement of noise walls and retaining walls will be increased.
- The current design and construction management practices for sequencing and placement of noise walls and retaining walls will be improved with the implementation of the recommendations and manual updates produced from the research.
- With the application of recommendations for changes to current practices the research will lead to fewer utility relocations and environmental impacts during construction.
- TxDOT customers will benefit from the research outcomes through reduced project delays because of improved project design and construction coordination.

QUANTITATIVE BENEFITS

For the quantitative analysis, the research team focused on the Reduced Construction, Operations, and Maintenance Cost benefit area and more specifically on the reduction of construction costs. Operations and maintenance costs specific for noise walls and retaining walls was not readily available and was not included. The estimated VoR is summarized in Figure 173. Other areas that economic benefits are expected to be seen but not included in the calculation includes System Reliability. For System Reliability the implemented research recommendations will result in better design practices which will reduce maintenance issues related to the interaction of utilities and noise and retaining walls.

For estimating the quantitative benefits, the research team made the following assumptions:

- Research recommendations are implemented fully at the five metro districts. Non-metro districts are expected to benefit from the research as well, especially from the recommendation related to retaining walls, but are not included in the calculations.
- Full savings are seen at 5 years. This is assumed since some of the recommendations are implemented during design but have an affect later during project construction.
- The research team used a period of 15 years for the estimated value duration. The actual value duration may be longer. Fifteen years was chosen since the majority of the recommendations are based on the implementation of best practices and not on the use of specific technology.
- A discount rate of 5 percent, which is typical based on TxDOT's Research Handbook.
- A percent cost estimate for impacts from noise wall and retaining wall changes, related to issues at three of the five case study projects, is 0.316 percent. Two of the case study projects were early in construction or had not begun construction so a number could not be estimated. This percent is based on the cost of estimated project changes and change order costs divided

by the total projected amount, available from the contractor's estimate package produced from SiteManager.

- The adjusted percent cost estimate, which is half of the percent cost estimate, assumes that the costs impact from noise wall and retaining wall changes are only partially reduced from implementation of the research. This is a conservative estimate, and the research team believes the impact of the recommendations would be higher.
- of 0.158 percent assumes that only half of the issues seen from noise walls and retaining
- A total cost of $324,107,754 for projects expected to contain noise walls and retaining walls to be let at metro districts during fiscal year 2022. This information was collected from TxDOTCONNECT. The pool of potential projects was limited to construction project types that had retaining wall specifications and noise wall special specifications listed. Of the 55 projects reviewed, 29 did not have specifications and special specifications listed. Some of these projects may include noise walls or retaining walls and would also benefit from the research. There were also 22 project that included specifications for retaining walls but not noise walls. These are not included in the calculation but would benefit from the recommendations related to retaining walls.
- The percent cost estimate, 0.316 percent, and the total project costs per fiscal year, $324,107,754, are assumed to be the same in coming years.

The figure shows the VoR per year as $511,407. This is based on the total cost of affected projects let per fiscal year multiplied by the adjusted percent cost estimate for impacts from noise walls and retaining walls. Comparing the yearly expected value of the research to the investment cost it can be seen that the payback period is less than two years. If full implementation of the research could happen rapidly then the payback period would be less than one year.

Texas Department of Transportation	Project #	0-7014			
	Project Name:	Sequencing and Placement of Noise and Retaining Wall on Complex TxDOT Projects			
	Agency:	TTI	Project Budget	$	273,984
	Project Duration (Yrs)	1.8	Exp. Value (per Yr)	$	511,407
Expected Value Duration (Yrs)		15	Discount Rate		5%
Economic Value					
Total Savings:	$ 6,374,311		Net Present Value (NPV):	$	4,170,872
Payback Period (Yrs):	1.84		Cost Benefit Ratio (CBR, $1 : $___):	$	15

Years	Expected Value
0	$0
1	$102,281
2	$204,563
3	$306,844
4	$409,126
5	$511,407
6	$511,407
7	$511,407
8	$511,407
9	$511,407
10	$511,407
11	$511,407
12	$511,407
13	$511,407
14	$511,407
15	$511,407

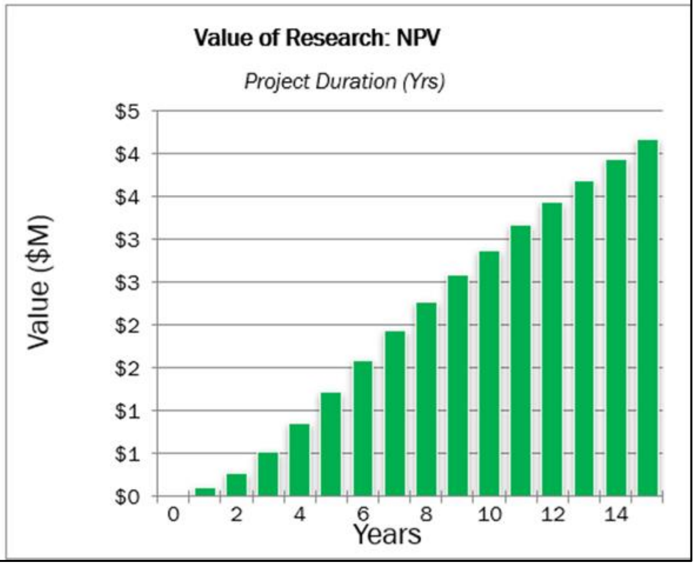

Figure 173. Value of Research for TxDOT Project 0-7014.

APPENDIX B. ECOS DATA REQUEST

NOISE WALL DATA REQUEST

To: TxDOT ECOS Data Manager

As part of TxDOT project 0-7014, TTI is conducting research about the sequencing and placement of noise walls and retaining walls on complex TxDOT projects. We would like to request data elements from ECOS that might help us identify when certain noise wall activities are identified and finalized on a project.

Based on the *TxDOT Environmental Guide Volume 2 Activity Instructions*, we identified the following activities that might provide information about when noise wall decisions are finalized in the TxDOT project development process:

- Perform noise analysis activity
- Perform noise workshop activity
- Perform noise mitigation activity
- Perform notification of noise information to local officials activity

We would like to request data elements (such as timestamps and decision codes) related to these activities that are tracked in ECOS. If possible, we would like to request related data elements for these activities for TxDOT projects that were completed in the last 5 years. If feasible, we would also like to request related basic project data elements such as project name, project limits, and any other project development process timestamps that might help us recreate the sequence of events on a particular project. For example, we would be interested in schematic planning start date, end date, PS&E start date, 30%, 60%, and 90% design complete date, PS&E submittal date, letting date, and construction start date.

Please let us know if you have any question about this request.

APPENDIX C. ECOS DATA DICTIONARY

Table 30. ECOS Data Dictionary.

Field Name	Data Type	Description	Default Value	Valid Values
ACTION_TYPE	VARCHAR2 (150 Byte)	Name of an activity, review, deliverable, or coordination type created under a CSJ.	List of selectable action types based on the selected program area on assignment details	Name of the activity
CSJ	VARCHAR2 (9 Byte)	Unique identifying nine-digit number for a project. Field is entered during project creation in ECOS.	Null	Nine-digit CSJ number
PROJECT NAME	VARCHAR2 (75 Byte)	District environmental coordinator entered name for the project in ECOS.	Null	May contain alphabets, digits, and symbols
DCIS_PROJ_LMT_ FROM_DSCR	VARCHAR2 (255 Byte)	Project start limits read from the DCIS/TxDOTCONN ECT system.	Shows data based on the limits entered in DCIS or TxDOTCONNECT	Text
DCIS_PROJ_LMT_ TO_DSCR	VARCHAR2 (255 Byte)	Project end limits read from the DCIS/TxDOTCONN ECT system.	Shows data based on the limits entered in DCIS or TxDOTCONNECT	Text
DIST	VARCHAR2 (30 Byte)	District name read from the DCIS/TxDOTCONN ECT system.	Shows data based on the district entered in DCIS or TxDOTCONNECT	One of the 25 district names
HIGHWAY NAME	VARCHAR2 (50 Byte)	Highway name read from the DCIS/TxDOTCONN ECT system.	Shows data based on the highway name entered in DCIS or TxDOTCONNECT	May contain alphabets, digits, and symbols; otherwise, null
DCIS_ACTL_LET_ DT	VARCHAR2 (10 Byte)	Actual letting date read from the DCIS/TxDOTCONN ECT system.	Shows data based on the date entered in DCIS or TxDOTCONNECT	Date, otherwise null
DCIS_APRV_LET_ DT	VARCHAR2 (10 Byte)	Approved letting date read from the DCIS/TxDOTCONN ECT system.	Shows data based on the date entered in DCIS or TxDOTCONNECT	Date, otherwise null

Table 30. ECOS Data Dictionary (continued).

Field Name	Data Type	Description	Default Value	Valid Values
DCIS_DIST_LET_DT	VARCHAR2 (10 Byte)	District letting date read from the DCIS/TxDOTCONNECT system.	Shows data based on the date entered in DCIS or TxDOTCONNECT	Date, otherwise null
PROJECT CLASSCIFICATION	VARCHAR2 (5 Byte)	Project classification read from the DCIS/TxDOTCONNECT system.	Shows data based on the project classification entered in DCIS or TxDOTCONNECT	Text
NEPA_ENV_CLEAR_DT	DATE	Environmental clearance date of the CSJ.	Null	Date, otherwise null
LOA_ENV_CLEAR_DT	DATE	Environmental clearance date of the CSJ.	Null	Date, otherwise null
ACTIVITY_DUE_DATE	DATE	Due date entered by any user for an activity, review, deliverable, or coordination type created under a CSJ.	Null	Date, otherwise null
ACTIVITY_START	DATE	Start date entered by any user for an activity, review, deliverable, or coordination type created under a CSJ.	Null	Date, otherwise null
ACTIVITY_END	DATE	End date entered by any user for an activity, review, deliverable, or coordination type created under a CSJ.	Null	Date, otherwise null
ACTIVITY_CREATE	DATE	System-generated date when a user creates an activity, review, deliverable, or coordination type under a CSJ.	Null	Date

Table 30. ECOS Data Dictionary (continued).

Field Name	Data Type	Description	Default Value	Valid Values
WPD_SUBMIT_DATE	DATE	System-generated date when a district environmental coordinator clicks on the Submit button in the WPD III—Project Work Plan screen.	Null	Date, otherwise null
WPD_ACCEPTANCE_DATE	DATE	System-generated date when a district environmental coordinator for a CE or an environmental project delivery manager for EAs/EISs clicks on the Accept button in the WPD III—Project Work Plan screen.	Null	Date, otherwise null
ANTI_ENV_DCMNT_TYPE_CD	VARCHAR2 (50 Byte)	List of selectable anticipated environmental document types.	Null	Text, otherwise null
ANTI_TYPE_OF_DECISION	VARCHAR2 (5 Byte)	List of selectable anticipated environmental document subclassification types.	Null	Text, otherwise null
CLEAR_ENV_DCMNT_TYPE_CD	VARCHAR2 (50 Byte)	List of selectable environmental document types.	Null	Text, otherwise null
CLEAR_TYPE_OF_DECISION	VARCHAR2 (5 Byte)	List of selectable environmental document subclassification types.	Null	Text, otherwise null
Funding Type	VARCHAR2 (5 Byte)	Data based on the project classification entered in DCIS or TxDOTCONNECT.	Null	Federal, state, local, or combination of three values

APPENDIX D. ECOS DATA SAMPLE

Table 31 provides a sample of five ECOS data records organized in 24 categories. The data have been transposed to increase the readability of the table.

Table 31. Sample Records from ECOS.

ACTION_TYPE	Activity—Perform Noise Analysis	Activity—Perform Notification of Noise Information to Local Officials	Activity—Perform Noise Analysis	Activity—Perform Noise Analysis	Activity—Perform Noise Analysis
CSJ	813125	301055	301055	407135	504076
PROJ_NAME	Southeast Connector	I-10 Culberson County Safety Rest Area	I-10 Culberson County Safety Rest Area	0004-07-135, etc. IH 20 Corridor, FM 1936 to JBS Pkwy	0005-04-076 IH 20 in Operational Improvements in Stanton
DCIS_PROJ_LMT_FROM_DSCR	IH 20	8.5 MI E OF VAN HORN	8.5 MI E OF VAN HORN	WEST OF FM 1936	BI 20-F WEST
DCIS_PROJ_LMT_TO_DSCR	BRENTWOOD STAIR ROAD	EVERGREEN RD	EVERGREEN RD	MONAHANS DRAW	SH 137
DIST	FORT WORTH	EL PASO	EL PASO	ODESSA	ODESSA
HIGHWAY NAME	IH 820	IH 10	IH 10	IH 20	IH 20
DCIS_ACTL_LET_DT	0	0	0	0	0
DCIS_APRV_LET_DT	0	0	0	0	0
DCIS_DIST_LET_DT	44460	44366	44366	44224	44216
PROJ_CLASS_CD	WIDEN FREEWAY	SAFETY REST AREA	SAFETY REST AREA	WIDEN FREEWAY	BRIDGE REPLACEMENT
NEPA_ENV_CLEAR_DT	0	Jan/28/2019	Jan/28/2019	0	Apr/11/2019
LOA_ENV_CLEAR_DT	0	Apr/09/2019	Apr/09/2019	0	Oct/07/2019
ACTIVITY_DUE_DATE	Sep/24/2019	Mar/01/2019	Nov/30/2018	Jun/26/2020	Oct/05/2018

Table 31. Sample Records from ECOS (continued).

ACTIVITY_START	0	Feb/04/2019	Nov/19/2018	0	Oct/05/2018
ACTIVITY_END	Nov/27/2019	Mar/01/2019	Nov/19/2018	0	Oct/05/2018
ACTIVITY_CREATE	Apr/01/2019	Mar/01/2019	Nov/01/2018	Jun/17/2020	Sep/20/2018
WPD_SUBMIT_DATE	Feb/24/2020	Jan/28/2019	Jan/28/2019	Jul/29/2020	Apr/10/2019
WPD_ACCEPTANCE_DATE	Jan/27/2012	0	0	Jun/17/2020	0
ANTI_ENV_DCMNT_TYPE_CD	EA	CE	CE	CE	CE
ANTI_TYPE_OF_DECISION	0	- d(5)	- d(5)	- Open-Ended D	- c(22)
CLEAR_ENV_DCMNT_TYPE_CD	EA	CE	CE	CE	CE
CLEAR_TYPE_OF_DECISION	0	- d(5)	- d(5)	- Open-Ended D	- c(22)
FUNDING_TYPE	Federal, State	Federal, State	Federal, State	Federal, State	Federal, State

APPENDIX E. TXDOTCONNECT DATA DICTIONARY

Table 32. Letting Schedule Data Dictionary.

Field Name	Data Type	Description
ID	int	Identifier added by the research team.
LET_SCHEDULE_FISCAL_YEAR	nvarchar	Fiscal year of the letting schedule record.
CONTROLLING_PROJECT_ID	nvarchar	Controlling project identifier.
CONTROL_SECTION_JOB	nvarchar	Control section job number.
PROJECT_ID	nvarchar	Project identifier.
FED_STATE_PROJECT_NUMBER	nvarchar	Federal or state project number.
DISTRICT	nvarchar	TxDOT district name.
COUNTY	nvarchar	TxDOT county name.
HIGHWAY	nvarchar	TxDOT highway number.
PROJECT_DESCRIPTION	nvarchar	Description of the project.
LIMITS_FROM	nvarchar	Description of the project start limits.
LIMITS_TO	nvarchar	Description of the project end limits.
PROJECT_STATUS	nvarchar	Project status (e.g., active or closed).
PROJECT_TYPE	nvarchar	Description of the project type.
PROJECT_SUB_TYPE	nvarchar	Description of the project subtype.
PROJECT_CLASS	nvarchar	Description of the project class (e.g., widen freeway, overlay, or seal coat).
LET_STATUS	nvarchar	Letting status.
PROJECT_LENGTH	nvarchar	Length of the project.
MAXIMUM_WORKING_DAYS	nvarchar	Number of maximum working days.
DESIGN_MANAGER	nvarchar	Name of the design manager.
PROJECT_MANAGER	nvarchar	Name or identifier of the project manager.
CONSTRUCTION_MANAGER	nvarchar	Name of the construction manager.
ESTIMATED_LET_DATE	nvarchar	Estimated let date.
PLANNED_LET_DATE	nvarchar	Planned let date.
APPROVED_LET_DATE	nvarchar	Approved let date.
ACTUAL_LET_DATE	nvarchar	Actual let date.
CST_EST	nvarchar	Cost estimate.
AMOUNT_TYPE	nvarchar	Amount type (e.g., low bid).
NEW_CST_EST	bigint	Updated cost estimate.

APPENDIX F. INTERVIEWS WITH TXDOT DISTRICTS

This section presents the findings from the interviews with the TxDOT districts.

AMARILLO DISTRICT

Projects in the Amarillo District may include retaining walls. The district analyzes noise issues on projects but has not been required to construct a noise wall.

The Amarillo District mainly builds MSE type retaining walls, which are used for bridges and entrance and exit ramps. The district feels that most of the issues regarding the construction methods, sequencing, and utilities can be avoided by proper selection of the retaining wall type.

Sequencing and Contractor Issues

The selection of contractors may also be an issue. The contractor needs to know how to properly build a retaining wall and follow the information provided on the design standard. Every contractor approaches the sequencing of retaining walls differently, and the district cannot always anticipate how the contractor wants to build the retaining walls. Some contractors will subcontract out the construction of the retaining walls. This may lead to the subcontractor wanting to build all the retaining walls on a project at the same time. This preference is usually due to the subcontractor not being local and wanting to mobilize once to the construction site. This may not work with the overall project schedule, especially regarding traffic control. This may be a contractual misunderstanding since the Amarillo District expects the work to be performed according to the traffic control plan.

Proper Construction

The Amarillo District feels that proper construction methods are important in the long-term maintenance and stability of the wall. The district has not had problems but noted that other districts may have issues with vegetation growing out of the MSE wall joints. This issue is due to the filter fabric not being installed properly behind the panels. These issues are covered by TxDOT standards, but good field inspections are needed to ensure retaining walls are constructed properly.

Backfill Material

Another issue for retaining walls is the backfill material. The backfill material needs to allow for drainage of water without the material washing through the wall. The Amarillo District understands the importance of inspecting and testing the material selected to ensure it meets the specifications in the design plans.

Utilities

The Amarillo District feels that it is important to perform test holes on utilities when they are near the footing of a proposed retaining wall. This provides the district with information to help mitigate possible utility conflicts. In certain areas, retaining walls may be used to minimize the need for utility relocations by reducing the amount of right-of-way acquisition needed for a project. In the past, the district resolved a utility conflict by allowing a utility to be encased under a retaining wall.

Placement

If possible, it is advised to construct retaining walls between the frontage road and the main lanes instead of the frontage road and the right of way. This can be achieved by designing the frontage road at a similar elevation as the right of way. This can help mitigate access issues regarding driveways connected to the frontage road. Having the retaining wall away from the right-of-way line can help with access for maintenance. If the retaining wall is near the right-of-way line, the district may need access to the adjoining landowner's property to adequately maintain the top of the retaining wall.

ATLANTA DISTRICT

For the last several years, the Atlanta District has been using MSE retaining walls. Most of the retaining walls in the district are in Texarkana. Projects in the Atlanta District may include retaining walls but not noise walls. The district analyzes noise issues, but there has not been a need for a noise wall in the district.

Placement

Most of the retaining walls are located at bridge crossings, although there are some upcoming projects that include retaining walls located near the right of way. For those projects, the need for retaining walls near the right-of-way line was due in part to the original design, as well as to the right-of-way acquisition being based on existing elevation data that were not accurate. Another reason for the inclusion of retaining walls was the addition of frontage roads on the project. Additional topographic information was collected after right-of-way acquisition was complete, which led to the decision to include retaining walls instead of acquiring additional right of way.

Existing Elevation

It is also important to have the existing ground elevation accurately portrayed on the design plans. The Atlanta District noted that during the construction phase of the project in the city of Hooks, a proposed retaining wall was not needed. The wall was designed using existing elevation data that were not accurate. The additional time spent designing and planning for construction could have been avoided with correct elevation data.

Utilities

Typically, utilities that are in conflict are relocated before construction begins. If a previously unknown utility is found during construction, the district looks at relocating the utility or possibly doing a redesign, depending on how the relocation will impact the project.

Right of Way

The district noted that if the retaining wall is located near the right-of-way line, it may be necessary to acquire a temporary construction easement from the adjoining landowner to provide additional room during construction.

Backfill Material

Another issue for retaining walls is the backfill material. The Atlanta District had a project where sand was used as a backfill material for an MSE retaining wall. Years later, the backfill material began washing out of the retaining wall panels. The material washing out created a void behind the wall that had to be mitigated. The district now uses crushed stone as the backfill material. The district no longer has issues with material washing through. The Atlanta District recognizes the importance for the contractor to understand and select a proper backfill material.

The district had an issue with the stone backfill related to the installation of guardrails. The bolts used to fasten the guardrail to the retaining wall did not hold as well in the stone backfill. The Atlanta District now tries to minimize the areas where guardrail installations will interact with stone backfill. This process is done in two ways: by revising the location of the guardrail or by using a soil backfill material in areas where the guardrail is to be installed.

Drainage

The Atlanta District noted that the backfill material needs to allow water to drain through the wall instead of being collected behind the retailing wall. It is also important to ensure underdrains are installed. The Atlanta District had an issue with ponding on the top of a wall after a rain. The district had to remove some of the MSE panels and backfill to install drains from the top of the retaining wall to allow drainage of the ponding water.

Maintenance Issues

The district has also encountered maintenance issues with vegetation growing out of the MSE wall joints. The Atlanta District handles this problem by spraying herbicide to keep vegetation down.

Future Planning

An interesting item to consider is building the retaining wall to accommodate future road widenings. The Atlanta District noted that this has been done on a project in the Domino Area Office.

AUSTIN DISTRICT

Precast noise walls are more common in the Austin District than cast-in-place. However, the type of noise wall or retaining wall depends on project specifics and location. The district considered using transparent noise wall panels on the MoPac project so as not to obstruct the views of wildflowers and Lady Bird Lake.

Placement

It is important to get the noise wall alignment early and ensure it is reviewed along with the SUE data to check for conflicts since noise walls are usually placed near the right-of-way line. Utility conflicts are easier to resolve the earlier they are identified. The district recommended including noise walls in cross sections to help review the placement and identify issues during design. A virtual walk-through of the project would be performed to see where there are issues. The district noted that engineering judgment is important for the proper placement of noise walls since every job and location varies.

Noise reduction constraints play a part in the placement of noise walls. Existing utilities should also be considered to avoid additional utility conflicts. This was experienced on the FM 2304 Manchaca Road project, where the noise wall conflicted with utilities. The foundation design for the noise wall varied to avoid utilities. The district tried to avoid relocating utilities that were in conflict with the noise wall since many of the utilities were relocated four years earlier. The previous utility relocations were based off a design that did not include noise walls. The Austin District was hesitant to have the utilities relocated again.

The Austin District recommends having the placement and constructability confirmed before holding a public meeting. This should be accomplished by doing more research on existing features and design elements of the project. Additional stakeholders, such as designers and utility coordinators, may help in placing the noise wall.

The district gave an example on the TX-360 Loop where it is having difficulty placing a noise wall. The district stated that it has conducted three noise analyses at different locations since the affected receptors voted to have the wall. The additional noise analyses were due to conflicts and issues related to the original placement of the noise wall. Additional items besides noise reductions should be considered when placing a noise wall.

For retaining walls, the district recommends avoiding perched walls, or placing a wall on a slope. Since this can cause stability issues, placing the retaining wall at the bottom of the slope or considering a different design is recommended.

Utilities

Early coordination with utility companies is recommended by the district. It is also important to consider clearance requirements of the utility company and include underground utilities, which may be impacted by drilled shafts. The district noted a project where the City of Austin had an existing waterline crossing under a proposed noise wall. The district moved the drilled shafts during construction to meet the City of Austin's clearance requirements. If the city's clearance requirements were known earlier, the change could have been made during the design process.

Right of Way

The district noted that it is important to understand what is required for the project and to ensure that everything required will fit in the right of way. If not, then additional right of way may need to be acquired. This should be addressed early since right-of-way acquisition takes time.

Maintenance

Maintenance between the noise wall and the edge of the right of way may become an issue. An example of a noise wall on the MoPac project near Slaughter Lane and La Crosse Avenue was given. The Austin District is deeming the area behind the noise wall a no-maintenance zone. This decision was mainly due to trees being left behind the wall in accordance with public requests. Since the area behind the noise wall will not be maintained, it may become a security issue.

The district mentioned that it is preferable to leave space behind the noise wall and right-of-way line. This will provide access for trucks and equipment used for maintenance. Maintaining culverts was also mentioned in relation to the space behind noise walls. The district noted that it may be difficult to maintain culverts if there is less than 8 feet of room behind the noise wall to the right-of-way line.

Maintenance behind noise walls installed very close to the right-of-way line is difficult. Leaving a small area between the noise wall and existing fences may be a safety concern. In some areas, adjacent property owners may extend their privacy fences to the back of the noise wall.

Access to Utilities

The district noted that having utilities between the noise wall and the right-of-way line is an issue. Utilities need to be able to access their facilities. The district has installed removable panels or provided access for utility companies on FM 2304 Manchaca Road and on MoPac north of the river. The removable panels on MoPac required a lot of coordination with utility companies. The removable panels do require additional planning by the utility companies when they access their facilities. The additional planning is mainly due to the weight of the removable panels, which are made out of precast concrete.

The Austin District has also installed a hinged guardrail near a bridge crossing to allow a utility to access the sewer lift station. This shows that the Austin District is willing to work with utilities to provide access when possible.

Constructability

It is also important to ensure there is sufficient room in the right of way to construct the noise wall. This includes space to set up the crane and install the drilled shafts. Cranes are normally used to place panels and may be impacted by overhead utility lines. The district noted that for the FM 2304 Manchaca Road project, the contractor was having issues setting the precast noise wall panels due to overhead utility conflicts.

Space is also needed for retaining wall installation. For retaining walls near the right of way, it is important to consider the different steps of construction and the space required. For example, space is needed to install kickers when constructing the retaining wall. The kickers extend out from the face of the wall and provide temporary support. The additional room should be accounted for. Otherwise, the retaining wall may need to be shifted away from the right-of-way line during construction. The Austin District noted that it has shifted walls away from the right of way when adequate space was not accounted for. The district tried to work with the adjoining property owner to allow the contractor to install temporary supports on their property, but the property owner did not allow it.

Topographic Survey

The Austin District noted that having a detailed survey is important. Otherwise, the existing ground elevation may not be accurately known. Incomplete survey data have led to issues with gaps at the base of the noise wall that have to be resolved. Besides the noise mitigation factor being reduced, having gaps in the noise wall near residential areas is a safety issue.

Underground Voids

In some areas of Texas, void mitigation is an issue. The district is dealing with voids on the MoPac project near Slaughter Lane and La Crosse Avenue. The noise walls were placed on top of a fault line that was not known about during design. The contractor encountered numerous voids while installing the drilled shafts. Some parts of the noise wall had to be redesigned and shifted. The district recommends being aware of issues related to voids when designing in karst areas.

Political Issues

Outside influences may have an impact on whether noise walls are built or where they are placed.

Drainage

It is important to ensure that there is adequate drainage for retaining walls. The district noted the need to ensure underdrains are designed. The drains are shown in the standard detail, but where the outflow goes is not accounted for. It is important to understand where the water will go; otherwise, there is a risk it will impact the stability of the retaining wall.

Backfill Material

Another issue for retaining walls is the backfill material. The Austin District understands the importance of inspection to ensure that the proper material is being used for backfilling.

CORPUS CHRISTI DISTRICT

Noise Walls

Overall, experience with noise walls has been limited at the district. At this point, the district maintains about five or six noise walls. The need for a noise wall is identified in the environmental process. Every project with added capacity or significant horizontal or vertical changes requires a noise impact analysis. If there is an impact, the district must determine if a noise wall is reasonable and feasible to mitigate the noise impact. The district does not have a lot of experience with the noise impact modeling. Getting the data required for the modeling from the TxDOT Transportation Planning and Programming Division can be an issue. The outcome is a report that can be created by TxDOT or consultants and contains a recommendation for or against a noise wall, along with a proposed height if applicable.

If a noise wall will mitigate the noise impact, TxDOT must determine if it is feasible. The noise model estimates the projected cost of the wall and compares that to the projected benefit to determine whether the wall is reasonable and feasible. If the model analysis determines that the wall is reasonable and feasible, the district conducts a constructability analysis, which should determine additional right-of-way needs and utility impacts. Either of these issues could lead to a determination that a noise wall is not feasible. FHWA guidelines are well defined for the first step, but not as much for the second step involving utilities and additional right of way. If the district decides a noise wall is reasonable and feasible, the district consults with the geotechnical branch about next steps.

The main issues that the district has encountered with noise walls have to do with existing utilities, either because they are in direct conflict with the noise wall or because they cause a constructability issue with the noise wall. For example, an overhead electric line might prevent the use of certain equipment. In addition, there might be other pole attachments that need separate utility coordination work, such as communication lines.

The district uses test holes if a utility conflict is suspected to get accurate horizontal and vertical location information. With this information, the district tries to keep noise walls at least 2 feet away from known utility lines.

Retaining Walls

Most of the retaining walls are used in fill situations, in which case the district uses MSE type walls. In cut situations, the district usually uses soil nailed walls. If the wall is designed internally, the Bridge Division, specifically the geotechnical branch, will design the wall. In almost all cases, the walls are designed following TxDOT specifications. Deviations from specifications usually do not occur.

Utilities are typically not an issue if they are identified early because they almost always have to move and relocate. The main issues are related to the soil in the district and sometimes issues with the wall foundations. If a utility is in the vicinity of a foundation or very deep and not in conflict with the wall, the utility might be able to remain in place if it is encased. In that case, the utility must provide an engineering evaluation to show that the facility is able to support the weight of the structure above.

A few years ago, the district changed the MSE wall standards. Previously, the standard required the bottom to be 1 or 2 feet below ground, which created a lot of utility conflicts. Now the standard is to be 2 feet below the finished grade, which usually is above the actual ground. In most cases, the design does not cut into the current ground, which avoids most of the utilities.

Depending on the project, the district might have a consultant to help with SUE data collection. If that is not the case, the district asks the utilities to create a test hole and then will use a surveyor to record the utility location information.

One of the main issues with retaining walls involves foundation settlement. Sometimes there is settlement or potential for settlement during construction. This might require foundation or ground improvements, which are very costly.

Best Practices

If possible, the district tries to avoid retaining walls. They usually become a necessity when there is not enough right of way available. There are also ways a bridge design can minimize the need for retaining walls, for example, limiting the height and the length, which can be part of a cost-benefit analysis.

Other lessons learned include early coordination. For example, the sooner the traffic data are available, the sooner the noise wall model can be completed. Noise walls can also include utility workarounds, for example, notch outs or slip joints.

In general, it helps to keep an open mind when dealing with utility conflicts, and to communicate well with utility owners. It also helps if the district communicates well internally between the environmental, design, and utility sections.

Other Issues

On another project, there was a need to install 10-by-10 culvert boxes that required a big crane. The crane was working close to overhead electric lines, which created a problem. The district had an on-site meeting with a contractor and everyone else involved to produce a solution. Options to deal with the issue were to deenergize the line, pull the line back, or both. The option selected often depends on the time required to adjust the line. It is extremely useful to have a good working relationship or partnership with the utility owners.

DALLAS DISTRICT

One of the concerns raised by the Dallas District was that noise walls are identified late in the design process. By the time, a noise wall is included in design, the right of way has been set and the acquisition process may have begun. This translates into additional design features in the same amount of right of way. Utility coordination is well underway, and some utilities may have already relocated. These newly relocated utilities may conflict with the proposed noise wall.

Wall Types

Noise Walls

The type of noise wall depends on the project and area specifics. However, the main type of noise walls installed in the district is post-and-panel type noise walls with precast panels. The Dallas District has used transparent noise walls on a few projects. The panels were installed on top of existing railing. There are about four separate locations where transparent noise walls are installed in the district. Maintenance is minimal, and the panels stay relatively clean. The district keeps trees trimmed back from the panels to ensure they do not get scratched.

Retaining Walls

MSE retaining walls are the most common type of retaining wall in the district. There are situations where other types of retaining walls, including soil nailed walls, are used. The type of retaining wall used depends on the use and location.

Backfill Material

The district noted that the backfill material used for retaining wall construction does not technically meet the specifications called out in the plans and that there is no material in the state that would meet specifications. The district has encountered issues with contractors not protecting retaining walls from erosion of the backfill material during construction. This item is an important aspect since it could lead to rework as well as the contractor requesting to use a flowable fill instead.

Sequencing

The Dallas District noted that if plans specify when noise walls should be constructed, the contractor usually follows the sequencing laid out in the plans. If the sequencing is not specified, the contractor may wait until the end of the project to construct the noise walls. Sequencing is project specific and varies. As an example, drilled shafts may be completed earlier in the project, when the drilled shaft contractor is on the jobsite, and the panels installed later. The district may work with the contractor to get noise walls installed earlier to mitigate noise due to construction.

Utilities

Noise Walls

Utilities are an issue related to noise wall installation. This issue is partly due to designers and utility coordinators being informed late in the design process that noise walls are required on a project. Issues with utilities are also due to the location of noise walls, which are usually located near the right-of-way line. The edge of the right of way is the most common location for utilities. The district noted that overhead and underground utilities are an issue when constructing noise walls, and some utilities have to readjust after construction begins.

Overhead utilities cause a lot of issues during the installation of noise walls. The problem is due to the conflict with overhead lines when installing drilled shafts and lifting wall panels in place. Currently, the district requires the contractor to insulate overhead utility lines to prevent an arc. The district stated that feedback from contractors reveals that utility companies are not allowing contractors to insulate overhead electrical lines. Contractors are also finding it hard to get the utility company to insulate the lines as well. It seems that the electrical company only wants to insulate lines for work being performed for the electric company. Instead, the district and contractors have been working with the electric company to shut down overhead lines to help with noise wall installation. There are fees associated with the shutdowns that should be included in the reasonableness cost evaluation.

The district noted issues on a project where underground utilities had not been cleared for noise wall construction. The district ended up redesigning the noise wall during construction to mitigate utility conflicts. The redesign and subsequent construction led to a nine-month delay.

During the interview, a point was raised about having more verification regarding utility relocations. The district noted that some utility conflicts found during construction are from utilities that relocated to an incorrect location or said they were clear of the project and in fact were not.

Retaining Walls

The district noted that for retaining walls, if there is an existing utility that needs to stay in place, it will design the foundation so that drilled shafts straddle the utility. This accommodation is usually done during design since the majority of utilities are known early in design. When utilities are discovered during construction, they may cause problems with the installation of the retaining wall. Either the utility is relocated, which may not happen quickly, or the retaining wall is redesigned to accommodate the existing utility. The district noted that a retaining wall's design having an installation range, where features of the wall could be shifted slightly in the field, would alleviate some issues seen during construction.

Another issue regarding retaining walls is the installation of utilities in front or behind the wall after construction. The district does not recommend installing a utility in front of the retaining wall since it may cause a stability issue. Also, for utilities installing behind the retaining wall, proper backfill procedures should be followed.

Abandoned Utilities

The district noted that abandoned utilities and the cost to remove them for construction should be considered. An example was given for a project on FM 2499 in the city of Denton. Abandoned utilities were shown on the plans, but the contractor claimed that the plans did not show that certain materials, such as casing pipe, were going to be encountered during noise wall construction. A change order was approved for over $200,000 to cover the cost of the contractor drilling through or removing sections of the abandoned utilities.

One-Call

The district has also run into issues where One-Call was not completing locates in a timely manner. It is recommended to call in earlier to provide additional time for One-Call to complete the locates. The district also recommends calling in additional locates for work expected to take place after the two-week locate period. This method is used as a planning tool to see if there are any unexpected utility issues in the future work area. Contractors may not be this proactive. The district has taken the approach of calling in additional locates to try to get ahead of utility issues in the field.

Right of Way

The Dallas District noted a need for temporary construction easements for noise walls placed near the edge of the right of way. These temporary construction easements may not be included in the right-of-way acquisition process if noise walls are identified after the acquisition process has begun. An example was given of a cast-in-place noise wall. Since the noise wall is cast-in-place, the contractor will use falsework. If the noise wall is planned on the right-of-way line, the contractor will find it difficult to effectively set up and remove the falsework. Items such as these should be considered when placing a noise wall.

Placement

On US 75, the Dallas District designed some of the noise walls to be placed between the frontage road and the main lanes instead of next to the right-of-way line. This alleviated many utility conflicts with noise walls. This type of placement should be considered more for future projects.

The district has also built noise walls off the TxDOT right of way. On TX-114, the Dallas District built a noise wall on the local municipality's easement. There were numerous issues with the installation of the noise wall off the right of way. Once the noise wall was complete, it was dedicated to the community, and the adjoining property owners tied their fences into the back of the noise wall.

Another issue related to the placement of noise walls is sight distance. This may become an issue if the noise wall is placed too close to the edge of the road. It is important to make sure sight distance is considered during design.

Drainage

Noise Walls

Drainage between the noise wall and the right-of-way line may be impacted. The impact on drainage should be considered when designing the noise wall.

Retaining Walls

Regarding drainage, the district gave an example of a retaining wall failure on SH 121. The wall shifted about 3 feet due to pressure building up behind the retaining wall. After investigating the failure, the district determined that underdrains were not installed since they were not shown on the plans. It is important to ensure underdrains are installed. There also may be a need to clarify the installation of underdrains in the design plans.

Constructability

Noise Walls

Cranes are used to place precast noise wall panels and are a point of contention during construction due to the limited amount of space. The use of a crane should be considered during design and should include vertical clearance as well as placement for the crane. Vertical clearance may also be an issue for cast-in-place panels since the concrete needs to be poured in place.

Retaining Walls

The Dallas District noted a successful method of placing backfill for retaining walls. The district recommended that the contractor use a conveyor belt system to place the backfill material. The material is dumped directly onto the conveyor, which transports the material to the appropriate location. This method was implemented due to issues placing backfill material. The contractor was previously pushing material in place, which contaminated the select backfill material with soil. The use of the conveyor system was better, overall. It allowed the contractor to place the material faster and without contamination. In fact, the district noted that the contractor now uses the conveyor method on all its retaining wall projects.

Graffiti

Graffiti is an issue for noise walls and retaining walls. The district installs an anti-graffiti coating, but after a few washes, it is removed with the graffiti. Depending on the area, graffiti may also become a political issue.

EL PASO DISTRICT

Noise Walls

The district gave an overview of the general process to determine the need for a noise wall, including type, height, and placement. On one project, there was a discussion on whether to place the wall closer to the edge of the right of way or between the frontage road and the main lanes. One thing to consider is that the farther the wall is away from the noise receiver, the taller it will need to be.

Utilities can have a significant impact on noise walls, so it is important to have good information about their location. If utilities must relocate, coordination and communication are key because the process is very connected: utilities cannot relocate until the new right of way has been acquired, and right of way cannot be acquired until the environmental process is complete.

One thing that recently changed in the design of noise walls is that they now must be crash rated to a TL-4. This requirement has made the sound walls much sturdier and heavier, which has also changed the size of the drilled shafts and the footing structure.

If there is a raised intersection with a bridge that needs a noise wall, the location of the noise wall becomes an issue because the wall must be higher than the bridge to be effective. On one project, the wall had to be 18 feet high, which required a special crane to construct. In addition, the crane was not tall enough to slide the panels in from the frontage road, which would have required the closing of one or two main lanes due to the crane’s outriggers. Instead, the district added an embankment for the crane placement and closed an exit and entrance ramp.

Since the walls were put between the frontage road and main lanes, there were no conflicts with overhead utilities because the overhead utilities are at the edge of the right-of-way line. In two instances, there were overhead crossings, but they were far enough away that the district did not have to do anything about them.

On a different location, the district has a noise wall that is about 3 feet from the property line. On the edge of the property line, the property owner has a rock wall. Recently, maintenance found that the property owner is breaking the rock wall and incorporating the 3 feet of state property. In other cases, district maintenance staff found that property owners dump trash into the 3-foot space. In both cases, the district had to send letters to the property owners asking them to stop that practice. With only 3 feet of space, maintenance can be challenging because the wall is very long, and a person has to walk in that tight space for thousands of feet. In addition, some property owners had problems with rock walls falling and felt that the noise wall was responsible for their rock wall failure.

In other locations, the district has built noise walls on the edge of the pavement. In that case the space behind the wall is about 20 to 30 feet. Since the wall is in the clear zone, it needs to have special protections.

On a different project, the noise wall was located about 10 feet offset from the right-of-way line, in front of the utilities. The noise wall included gates with shared locks so the utilities could access that corridor if needed. The offset and gates were just large enough for a vehicle to access the corridor.

In general, utilities are a major challenge, and only rarely are all utilities moved before construction starts. Some of the fiber-optic lines are very deep, sometimes 19 to 26 feet deep, which means they might not be relocated.

Retaining Walls

The district uses several types of retaining walls. The district rarely encounters issues with retaining walls and utilities during construction because utilities usually get relocated before construction starts. The only exception is crossing utilities, which are rare.

Noise wall drilled shafts can go down 25 feet, which can cause problems even with very deep underground utilities. Retaining walls do not have drilled shafts that deep. On one project, a gas line needed to be relocated or encased because the load of the design was a concern to the utility.

On one project, the district used two types of retaining walls including one that involve panels that are connected to geogrids. Most of those walls had a Type D rock backfill. During installation, the straps must be laid out and then tightened. The installers were not able to fully tension the straps. As the walls were built up with additional lifts of rock, the bottom panels started to shift. District staff members have seen that shift on several retaining walls, especially the higher walls. To realign panels, the contractor must dig out the rock and reinstall the straps, which can cause adjacent panels to shift. In the end, the shift resulted in a zig-zag type of look, with some panels tilting out and some panels tilting in. In the end, the contractor changed the wall design to the more typical reinforced concrete wall.

Best Practices

On a project on IH 10, the noise walls were placed on top of the concrete barrier. This was a special design that the consultant engineer developed. The project had limited right of way, only a few feet of which was used by several utilities. Due to the drainage running in parallel with the road, TxDOT could not use a footing or drilled shaft for the noise wall.

On a different project, the district had a conflict with a water line, which was mitigated by using a spread footing for the noise wall.

On the project where the district built a noise wall close to the main lanes, the first panel of the wall was placed at an angle of about 45 degrees. The purpose of that was to mitigate a potential crash with a vehicle.

FORT WORTH DISTRICT

The wall types used in the Fort Worth District depend on the area and project specifics. It is important for utility coordinators to see the design for the noise wall early since the wall type, footing, and location affect the coordination process.

Constructability

If the corridor is tight, the district may not be able to fit everything in the right of way. Utilities may have to be relocated off the section of right of way, or the noise wall may need to be omitted. The district noted that for a project on FM 156 in Saginaw, six noise walls were omitted due to the lack of space and existing utilities. If there is not sufficient room on the right of way for the existing and proposed features, then something needs to be removed.

Placement

Noise Walls

Noise walls are usually located near the right-of-way line, which impacts utilities. The district noted that wherever the noise wall is located, access to utilities should be considered. Being close to the right of way makes constructing noise walls more difficult due to limitations and obstructions at the right-of-way line, which include privacy fences. Another drawback of placing the noise wall near the right-of-way line is that it creates a small area between the noise wall and privacy fence. This may be a safety issue and impacts maintenance due to the small area.

Retaining Walls

Retaining walls are usually located away from the right-of-way line. Sometimes they may be placed near existing traffic, which makes construction more difficult.

Sequencing

Noise walls are usually installed later in construction.

Geological Issues

The district noted that underground geological features may be an issue regarding the placement of noise walls and retaining walls. This was seen on SH 183 when an MSE retaining wall was designed in an area with fault issues and the retaining wall caved in.

Right of Way

The lack of sufficient right of way for utilities is an issue on most projects. It affects the location of utilities, noise walls, and retaining walls. The district having the ability to acquire an additional 20 feet of so of right of way on each side of the corridor would alleviate a lot of conflicts and construction issues.

Utilities

It is important to consider the clearance requirements of the utility company. Early coordination with utility companies helps ensure that clearance requirements are known during design. For a project on Highway 360 South, a noise wall was designed and constructed over the top of an existing waterline. The utility company was not happy that its clearance requirements were not met since it was concerned about maintaining the waterline. The utility company decided to abandon the existing waterline and install a new one in a different location.

Electric companies do not like to sleeve their overhead electric lines during noise wall construction. Contractors prefer to have electrical lines deenergized if they are in conflict when constructing noise walls.

Utility Coordination

Sometimes utilities have relocated before noise walls are included in the project. There are also issues where utilities are relocated more than once for a project. On Hwy 26 in Colleyville, some of the utilities were relocated numerous times due to design changes during construction. Most of the design changes could have been avoided by better planning and consideration during design. This issue is not seen on most projects, but it can occur when the project is rushed during design.

The district noted that there have been a few locations where overhead electric was temporarily removed to install a noise wall. The overhead electric was reinstalled once noise wall construction was complete.

For a project on SH 360, the overhead electric lines were able to relocate during the noise wall installation. The contractor installed the wall’s columns and foundation, and then the electric company relocated the utility poles before the panels were installed. For this project, the existing utility poles were not in conflict with the noise wall, but the electric company relocated the poles due to access concerns.

Drainage

It is important to ensure that there is adequate drainage for retaining walls and that water is flowing away from the wall.

Backfill Material

The district provided an example where improper backfill material impacted the construction of a retaining wall. During construction, a rain event washed some of the backfill material through the partially built wall. After inspecting the wall, the district noted that the material did not meet specifications. The district required the contractor to demolish the wall and start over using proper backfill material. It is important to have good inspections to ensure contractors are using the appropriate backfill.

Maintenance

The district recommended considering construction and maintenance during the design of noise walls and retaining walls. This would help reduce issues in construction and would make maintenance to utility facilities easier. Maintenance behind noise walls installed close to the right-of-way line is difficult. The district also recommended designing with maintenance in mind by leaving more space between the noise wall and the right-of-way line. The district mentioned that it is preferable to leave sufficient space behind the noise wall and right-of-way line to accommodate access for trucks and equipment used by utility companies to maintain their facilities.

Smaller spaces between the noise wall and adjacent fences may be a security issue. Some adjacent property owners may extend their fences to the back of the noise wall. This allows property owners to maintain the area. It may also reduce security concerns since the area behind the noise wall will be reduced.

The district noted that on the Midtown Express project, developers used a product that made removing graffiti easier. The product seals the wall and does not allow spray paint to absorb. This method is preferable to painting over graffiti since color matching is difficult, which makes the coverup obvious.

HOUSTON DISTRICT

Identifying noise walls late in the design process can cause issues with design and utility coordination. The district noted that when noise walls are identified at around 80 percent PS&E, there is a rush to identify conflicts and design the wall. There are times when preliminary noise walls are shown on the schematic plans but key information such as wall height is missing. The district noted that more design and placement information earlier in the process will have a positive impact on utility coordination.

Wall Types

The district has a green ribbon program that includes a standard for noise wall aesthetics. MSE retaining walls are the most common in the Houston District. Other types of retaining walls may be used, but it depends on the area and project specifics.

Right of Way

Sometimes the right-of-way acquisition process may be slowed due to a few parcels going through the condemnation process, which takes time. This may delay utility relocations, which in turn delays noise wall construction. Even if most of the new right of way has been acquired in an area, some utility companies will wait to relocate so they can perform their relocation at one time instead of having to mobilize to the site multiple times.

The district would prefer to acquire additional right of way to accommodate noise walls. Many times, this is not possible since noise walls may be identified after right-of-way acquisition begins. It may be a good practice to plan to acquire a few feet of additional right of way in areas where acquisition is already taking place. A few additional feet of right of way would help the district accommodate design features and would help during construction.

Sequencing

It is preferred to install noise walls early in project construction. This method is not always possible and is partially due to the need to perform utility relocations. In certain areas, it may be possible to install noise walls before utilities relocate. This takes additional coordination and early notification of noise walls on a project.

Placement

Typically, designers place noise walls 5 feet from the edge of the right of way. With utility poles located within 3 feet of the right of way, not much room is left for underground utilities. In some areas, underground utilities are stacked or placed on top of one another at various depths.

The Houston District has encountered situations where it installed noise walls in a floodplain. Designers set the bottom of the noise wall level with the floodplain elevation so as not to impede drainage. This leaves a space underneath the noise wall. In an area along US 290, drilled shafts can be seen a few feet under the bottom of the noise wall panels.

The district receives requests for noise walls between commercial and residential areas, where commercial areas are adjacent to the right of way. Noise walls along I-10 and US 290 have been constructed in this manner. The district built the noise walls behind the areas adjacent to the right of way. The local municipality takes charge of the wall once it is complete.

Soil Conditions

Existing soil condition is an issue affecting retaining wall foundations. Sometimes improvements are done to the soil before construction of the retaining wall can begin. The district has been known to use cement-stabilized sand to help improve existing soil conditions. It is important to know the soil conditions for the selected location.

Utilities

Utilities are an issue related to noise walls. Informing utility coordinators earlier in the design process can mitigate some of these issues. The earlier utility coordinators know about noise walls, the sooner they can start coordinating with utility owners and planning relocations if necessary.

The lack of space to install utilities in the right of way is also an issue. There are more utility facilities in the same amount of right of way than there have been in the past. One reason for this is the growth of fiber-optic lines. A corridor may have many different telecommunication companies with their facilities all installed separately. This issue is compounded if the noise wall is placed near the right-of-way line, which is usually where utilities are located.

Overhead utilities can cause issues during the installation of noise walls. This issue is due to the conflict with overhead lines when installing drilled shafts. Currently, the district requires the overhead electric lines to be deenergized for construction.

Access to Utilities

The Houston District has installed doors and gates in noise walls so utilities can access their facilities. It has also offset walls to leave gaps around pipeline corridors. This allows the pipeline company to access its easement and mitigates the installation of a noise wall on top of a pipeline.

SUE

It is important to identify utility conflicts early in the design phase of a project. It can be difficult to get information from utility companies regarding the location of their facilities. Often, this is because utility companies do not have accurate location information available and will have to collect the information in the field to locate the utility. There are also issues with identifying who owns certain facilities. Some utilities change hands, and who owns the utility may not be clear. SUE data help the district identify utility information. Collecting quality SUE information early is essential in identifying utility conflicts early. SUE information should also be used by designers when placing noise walls.

Utility Coordination

One way the district is coordinating construction of noise walls and the relocation of overhead electric is by sequencing the two together. Depending on the area, it may be better to install a noise wall's foundation and columns than relocate overhead electric. After electric is installed, the noise wall panels can be placed. Very early and close coordination with the electric utility is needed. The Houston District has seen that electric companies prefer to have the noise wall installed first since doing so lessens some of the impacts to the utility facility during construction. The Houston District also noted that it includes the use of low-profile equipment in the contractor's notes when working around overhead electric lines.

The cost of utility relocations is expensive and should be considered along with the impact to schedule. The district works to avoid relocations where possible, which it feels has a positive impact on the project since utility relocations take time and may cause delays to the contractor if going into construction.

The Houston District works with utility companies to have most conflicts resolved before the project is let. This includes relocating utilities during the design phase. There have been instances where a utility relocated early for a project before a noise wall was included and had to re-relocate due to the placement of the noise wall. This has a negative effect on the district's relationship with utility companies. If the utility company thinks additional design features will cause them to relocate again, they may be hesitant to relocate early on future projects.

Topographic Survey

It is important to have the existing ground elevation accurately portrayed on design plans. The district noted issues with drainage on projects lacking complete survey data. These issues have been dealt with during noise wall construction by changing the elevation of the drilled shafts and lowering the top of the concrete pad. Having additional survey data in design would help alleviate these in-field design changes.

Maintenance

The space between the noise wall and adjacent privacy fences may be a security issue, and adjacent homeowners have complained about the issue. Some area engineers may allow property owners to extend their fences to the back of the noise wall to allow property owners to maintain the area.

Graffiti is an issue with noise walls and retaining walls. The district has stopped using an anti-graffiti coating since it seemed to only work once.

Backfill

The district uses cement-stabilized backfill material for retaining walls. It is also important to use geofabric around the joints of the MSE panels during construction so that when backfilling, there are no issues with the material washing out.

LAREDO DISTRICT

The district does not have any experience with noise walls.

Typically, the district requests shop drawings from the contractor, which usually come from the manufacturer's engineers. That information includes the type and length of the wall panels, which is forwarded to inspectors and engineers in the district for review. For the most part, the district uses the MSE type of retaining walls.

The design of retaining walls is usually outsourced to consultants or contractors. Once the contractor develops a design and submits it to the district, the district sends it to the Bridge Division in Austin for review and approval.

When it comes to the design, it is critical to have utility information ready for the consultant that is designing the wall so that major conflicts can be avoided. That is the process the district tries to follow, but it does not always work that way, and occasionally a utility is found late that requires a redesign. In one case, the district found a utility just after letting, when the contractor was ready to start construction.

Main Issues

On some projects, there have been issues with the available room for the contractor to build the wall. In that case, the contractor had to put temporary support structures for the wall a little bit closer to the wall.

On the project in front of the district office, the district conducted weekly or biweekly utility meetings. There were several coordination challenges, in part because several utilities were working on their lines simultaneously. Some of the utility work became critical for the schedule, but none of the utility work delayed any of the construction work.

The utility coordination process starts with a notification to the utility owners. The district used to have meetings with the City of Laredo and all utilities on a regular basis, but that practice stopped some time ago. Now the district meets with each utility separately as needed and uses the utility conflict list to keep track of utility conflicts.

On some projects, the district sets the traffic control plan in phases so that there is additional time in some areas for the utilities to relocate.

On minor projects and those that do not require a schematic, the district usually starts utility coordination around 60 percent PS&E. The district has tried to interact with utility owners earlier than that, but most utility owners are not interested, and the district might not get any utility owner involvement until 100 percent PS&E.

Lessons Learned

The district has experienced a variety of conflicts with utilities, and they happen on any given project. However, utility conflicts with retaining walls are rare. The most important recommendation is to communicate early and often with utilities, even if they do not appear interested at first. Another important recommendation is to communicate well internally, for example, with the TxDOT construction office that is overseeing the project.

On projects that take multiple years to complete, it is important to keep track of utility permits that are handled at the area office. A consultant might be tasked with designing a wall but not have all the information about utilities that were recently installed.

Keeping track of oil and gas pipelines can be very time consuming. Ownership of companies or just single pipelines changes frequently. Thus, it is important to account for these potential problems at the beginning of a project and allow extra time for utility coordination.

Inspection of the wall construction can be very helpful. The district found that on several occasions, the wall panels were stacked incorrectly. For example, thicker bottom panels were placed on thinner top panels, which can lead to wall failure.

LUBBOCK DISTRICT

Projects in the Lubbock District may include retaining walls but not noise walls. There has not been a need for a noise wall in the district. The Lubbock District uses MSE retaining walls with standard footings. The soil is stable in the area and allows for deep footings.

Utilities

The district clears all utility conflicts before the project is let. If a utility conflict is discovered during construction, then the project team will address the conflict in the field. The district has not had an issue with a utility in conflict with a retaining wall in about 10 years. This is partly due to the location of the retaining wall, most near existing bridges, and partly because of the utility coordination taking place during design.

SUE is collected early in the design process. The Lubbock District has consultants conduct a SUE investigation for larger projects, and the district collects utility information for smaller projects.

Drainage

One of the main issues the district has encountered has to do with the placement of the drainage for the retaining wall. The Lubbock District sees a need for clarification of the location of the drains in the design plans. Each manufacturer has its own way of having the drainage system installed. The district recommends including a note for the contractor the follow the manufacturer's recommendations for the installation of the drainage system.

This was not an issue in the past, but there seems to be a knowledge gap from previous experience. Thus, the district needs to make sure the contractor knows how to properly build a retaining wall and that the contractor follows the information in the design standard.

Backfill Material

Another issue for retaining walls is the backfill material. The Lubbock District understands that it is important for the contractor to select a proper backfill material that meets specifications.

Proper Construction

The district gave an example of a project on the Marsha Sharp Freeway where the contractor was installing straps over compacted backfill material, which made the front of the retaining wall lean outward. Good field inspections and contractor knowledge is needed to ensure retaining walls are constructed properly.

The Lubbock District recommended having training for inspectors if districts have not installed retaining walls on a project for a while. It would be beneficial for the inspectors to be refreshed on what to look for when inspecting retaining walls during construction.

Political Issues—Aesthetics

The district recommended selecting generic themes for use in the aesthetics of retaining walls. The district stressed the importance of selecting a design that minimizes the chance of controversy. An example where the artwork became controversial is on the Marsha Sharp Freeway. A depiction of a person blowing wind, windy man, was selected by the district. Some of the local community did not like the depiction, and the choice of artwork became a local political issue.

LUFKIN DISTRICT

Projects in the Lufkin District may include retaining walls but not noise walls. The district analyzes noise issues, and there is usually not a need for a noise wall. On the rare occasion that a noise wall is needed, it does not meet the reasonable and feasible threshold to construct.

The Lufkin District mainly constructs MSE and soil nailed type retaining walls. The wall type is selected by the designer, which may be a consultant.

Construction

The district noted that many local construction contractors subcontract out the retaining wall portion of projects. The district is not as familiar with the subcontractors as it is with the local contractors. Thus, the district makes sure good inspection practices exist for the retaining walls.

The Lufkin District understands the importance of inspection to ensure the contractor is installing the retaining wall property. When the district has a retaining wall on a project, it usually has someone from TxDOT headquarters assist with inspection. This helps the inspection staff since the district may only have a project that includes retaining walls every few years.

Utilities

The district has not had many problems with existing utilities during construction. It tries to resolve any utility conflicts during design. The Lufkin District noted issues with drainage structures and retaining walls. Drainage structures may be designed adjacent or even through a retaining wall.

Backfill Material

Another issue for the district is backfill material. Contractors have a challenging time sourcing the right material since there are no locally available sources that meet specifications. Bringing in the correct backfill material is likely to raise the cost of a retaining wall. The district recommends considering this additional cost when deciding whether to use a retaining wall at a bridge or select an alternate bridge design that does not include a retaining wall.

An example was given for the FM 2914 project regarding acceptable backfill material. The contractor was unable to source material that met specifications. The district worked with TxDOT headquarters to see if there was a design that would work with the available material. TxDOT performed gradation and shear tests on the material. TxDOT allowed the contractor to use the backfill material that was available but monitored and tested the material stockpile before it was used. There have not been any issues with the retaining wall since construction.

Maintenance

The district has had problems in the past with backfill material washing through the retaining wall. This problem was resolved by sealing the MSE panels to prevent additional loss of backfill material. The district works with TxDOT headquarters to ensure that sealing the panels does not cause any further damage to the retaining wall.

Right of Way

The district tries to avoid using retaining walls and considers acquiring additional right of way before installing a retaining wall.

SAN ANTONIO DISTRICT

Noise Walls

District staff provided an overview of recent noise wall projects. On FM 1103 in New Braunfels, several noise walls were built in limited right of way. The district used a consultant to design the walls that used 24-inch drilled shafts that were placed within 2 feet of the wall on each side, for a 6-foot total footprint of the noise wall. There were multiple utility conflicts on the project, including power and communication companies. To manage the utility conflicts, the district divided the project into several phases. The first phase included sections that did not have utility conflicts, which were then connected in the second phase. Overall, the project involved around 700 drilled shafts.

A main issue the district encountered was the height of several electric lines, which needed to have a certain clearance from the noise wall. During construction, the district found that in several locations, there was not sufficient clearance to construct the wall, which involved the placement of precast wall elements that needed to be lifted by a crane. Further, the drill rig was too close to several utility lines, and the drilling itself occurred too close to some of the existing utility lines.

A solution to these problems was the use of half-size panels that reduced the height that the crane had to lift the panels. For the drill rig issue, the district asked the power company for a temporary outage. In the case of overhead electric lines, that was very interruptive to the power customers, so TxDOT made several local requests whenever needed. Underground utility outages were much more easily accommodated.

Construction of the noise wall required a special rig for the drilled shafts that was limited in height. That drill rig required more effort, and drilling the shafts was more time consuming than standard drill rigs.

There were some recently installed utility lines within the project limits. To make sure they were in the correct location, the district used a consultant to create test holes as needed. Only in one case was the line not where the as-built drawings documented that it was supposed to be located.

Initially, the district considered a noise wall design that was partly metal. Due to the concerns of the electric company, the district changed that design to fiberglass whenever a pole was in the vicinity of the wall.

The wall design placed the noise wall in front of several poles, which created a maintenance problem for the poles. The district considered keeping a 14-foot access space between poles and the noise wall, but that turned out not to be feasible. The district then considered the use of notch outs, where the wall would create a notch around the pole. That did not work out because the utility company provided incorrect locations for the poles, so the notch locations and pole locations did not match up. In the end, the district solved the issue by using panels in front of the poles that could be removed.

In the future, it might be useful to consider notch outs again, but that requires the utility company to complete its design on time. It would be great if electric utilities could be joint bid with the construction contract to avoid these issues. In that case, it might be necessary to add some contract time to allow the electric utility installation, but it would take care of many utility issues. However, electric companies might not be interested in joint bidding.

Retaining Walls

The district does not have many issues with utilities and retaining walls. If utilities are identified on time and accommodated, they typically are not an issue.

One issue that sometimes comes up is the need to account for additional excavation on drill shaft retaining walls. Another issue is that construction of the drilled shafts sometimes needs additional space behind the shaft, which might require a construction easement. There can also be issues with existing poles if the drilling occurs too close to the pole.

If a utility must remove a line, it destabilizes the soil. The utility or its contractor is often not equipped to compact the soil, so it simply backfills the hole. There is also no inspection from TxDOT due to lack of resources. TxDOT used to test the soil on embankments, but that practice went away. The contractor might be required to test the soil, but there is no check on the contractor, so the test might not occur.

WICHITA FALLS DISTRICT

Projects in the Wichita Falls District may include retaining walls but not noise walls. There has not been a need for a noise wall in the past, but the district is investigating the need for noise walls on its I-35 project.

The Wichita Falls District has consultants design retaining walls. Most of the retaining walls in the district are MSE walls.

Utilities

The district has not had many utilities in conflict with retaining walls. This is partly due to the location of retaining walls, which are mainly located at overpasses. If utilities are in conflict, then the district clears the conflict before the project goes into construction. The district did note a relocated telecommunication line that was in conflict during construction. The conflict was due to the utility company not installing the relocated line to the required depth.

The Wichita Falls District mentioned an interesting resolution to utility conflicts on an interstate project. The project had multiple utility owners and not a lot of room for utility relocations. Thus, utility companies were vying for relocation space. The district was able to include the utility relocations in the construction contract, which made the project go much smoother. The contractor relocated utilities at the beginning of construction.

Maintenance Issues

The district has had problems with the backfill material washing through retaining walls. This issue is usually seen where the contractor used a smaller granular material than was specified. The district tries to resolve this issue during construction by ensuring the filter fabric is installed properly and that the contractor uses the appropriate backfill material.

Another issue the district faces is graffiti. The district deals with graffiti on retaining walls by adding a washable coating to the wall. This method is especially helpful in areas where the district expects graffiti to be a problem, such as in town. It is not an anti-graffiti coating but helps seal the concrete to make graffiti easier to remove.

Aesthetics

The district is currently coordinating with the City of Gainesville and Cooke County on aesthetics for the I-35 project. The district is trying to guide the city and county into selecting a reasonable design for construction.

The district noted that on a past project, multiple groups had brought forward various design ideas. The district worked with the city to bring support for a single design. The mold for the design already existed, which saved money. Thus, it is important to work with the local municipality to gain support for the aesthetics of the retaining wall.

The district also recommended using generic themes and artwork for retaining wall aesthetics. Sometimes, detailed designs become difficult to portray and may cause issues. This issue was seen in Montague County, where locals selected a design for the retaining wall. Once the design was placed, some of the detail was lost and the community was no longer happy with the selection.

Right of Way

The district has found it less expensive to acquire right of way than install a retaining wall. The district looks at acquiring additional right of way before considering installing a retaining wall. The exception to this is on the current I-35 project. The district made a commitment to try to minimize right-of-way acquisition and avoid impacting existing structures off the current right of way.

APPENDIX G. INTERVIEWS WITH TXDOT DIVISIONS

BRIDGE DIVISION

Noise Walls

The Bridge Division does not advise on the type of wall design used for noise walls but can make recommendations. The districts provide layouts, and the Bridge Division provides the foundation design. Even though it is not the Bridge Division's responsibility, it checks the geometry, soil boreholes, and potential utility conflicts.

Some of the main issues for noise walls cited by division representatives include drilled shafts being too short, panels rotating from wind, and water not draining away from the column's footing. Water collecting around the footing can result in soft soil, which has led to panels settling out of alignment. The Bridge Division has observed the connection of the wall column and panels having too much rotation, which results in cracking or rotation of the panels.

The division also noted geological issues when installing noise walls. In particular, karst features can create gaps around drilled shafts. For a particular project, shafts were drilled deeper and casings were used to reduce gaps. The division recommended performing geophysical testing in karst areas and testing borings at a spacing of 200 feet.

Retaining Walls

For retaining walls, division representatives noted that MSE walls that are too tall are more difficult to build. Also, MSE walls are designed to self-correct with compaction during construction, and contractors find it hard to get the correct vertical plumb. Another issue is improper drainage around retaining walls. Water adds pressure behind retaining walls and pushes on the wall. The Bridge Division also stated that soil nails can be too short or used in the wrong type of soil.

Utilities

The division recommended using a spread footing instead of a deep foundation to help avoid utility conflicts.

The Bridge Division has designed culverts or pipes through MSE retaining walls to accommodate utilities. The division provides special notes in the construction plans for utilities through retaining walls. An example would be noting that a slip joint should be placed on each side of the culvert. A note would also be provided in the plan sheets for MSE walls with underdrains.

The Bridge Division provided a list of common issues in construction when dealing with noise walls and retaining walls.

- Change orders, contractors not reading the plan sheets, over-excavation, and using soils that do not meet specifications.

- Political issues, such as property owners showing up on the jobsite and aesthetics of the retaining wall.
- Privacy fences adjacent to wall and removal of debris are maintenance issues.
- Changes in soil conditions from what was anticipated and foundations by others placed or designed at the wrong depth can cause design changes during construction.
- Being aware of the right of way for soil nailed retaining walls since the soil nails must remain within the right of way.
- Relocation of retaining walls near the right of way due to the wall encroaching. A realignment of the wall is used to avoid the right-of-way line.

CONSTRUCTION DIVISION

Sequencing

Noise Walls

A good practice is to construct noise walls at the beginning of construction. This will help alleviate noise impacts to affected receptors from construction. For example, on a project in the Dallas District, noise walls were let in a separate project and were installed before the main project began construction. This was noted as being a successful practice.

Retaining Walls

For a project in the Dallas District, a contractor wanted to complete the retaining walls after beginning bridge construction. Bridge construction was on the critical path, and the contractor installed the drilled shafts for the bridge abutments where the retaining walls were to be installed. The contractor came back later to backfill around the bridge abutments to construct the retaining walls. There was some concern regarding the compaction of the backfill material near the abutments. Sequencing the work in this manner makes it difficult to check for proper compaction.

Placement

For noise walls placed near the right-of-way line, sufficient room should be left between the noise wall and the right of way to allow the contractor to construct the wall. For a project in Denton, the noise wall was placed very close to the right-of-way line. The contractor was unable to construct the noise wall without accessing the adjacent property and removing privacy fences. If the noise wall design would have left more room between the wall and right of way, the installation would have gone smoother, with less disruption to the adjacent property owners.

Contractors would prefer to have sufficient room for a truck or equipment to be able to access the back of the noise wall. This may not be the best use of the right of way, but sufficient room should be left to allow for utilities and access for construction and maintenance of the noise wall.

Placement off Right of Way

In some areas, the local municipality’s right of way may be adjacent to the state right of way. In this case, placing the noise wall on the state right of way may leave a large space between the noise wall and adjacent property owners. This has been seen in the Dallas District. To mitigate the large area, designers worked with the local municipality to install the noise wall on the right of way. This allowed the noise wall to be closer to affected receptors.

Utilities

Typically, noise walls and utilities are installed near the edge of the right of way, which means they are vying for the same space, leading to conflicts. This is especially true for areas where the space between the back of the curb to the right-of-way line is minimal. Conflicts may be minimized by placing the noise wall away from the utility corridor.

On I-30 in Dallas, a hinged door was installed to provide access to utilities. The door is made of concrete instead of fiberglass and was installed in the early 2000s.

Utility Coordination

Traditionally, utility relocations take place before construction of noise walls and retaining walls. There have been instances where utilities needed to be relocated after construction was complete. In the past, the Dallas District has temporarily relocated overhead utilities to construct noise walls and retaining walls. Once construction was complete, the utilities were relocated back.

Constructability

Cranes and overhead utility conflicts are an issue when installing noise walls. Working around overhead utilities is also risky, and extra precaution is taken by the contractor. The use of front-installing panels would be a welcome addition to current installation methods. This would help mitigate conflicts with overhead utilities when constructing noise walls.

Retaining Wall and Noise Wall in Same Area

Installing a retaining wall and a noise wall in the same area of a project raises the level of complexity. Designers have to be aware of where the noise wall is placed to ensure the foundation does not impact the retaining wall. An example would be offsetting the noise wall to ensure the drilled shafts do not impact the retaining wall straps. The level of utility conflicts also increases.

Political Issues

Noise walls and their placement may become a political issue. For example, political concerns played a part in the decision to install transparent noise wall panels in the Dallas District. The placement of retaining walls may also become a political issue. Retaining walls may be viewed as a site barrier that impacts local businesses and billboards. Owners are concerned that customers cannot see their advertisements and businesses and will lose revenue. In addition, complaints of retaining walls limiting site distance have been received.

Drainage

The lack of underdrains in retaining walls is an issue during construction. This may be attributed to the underdrains being included in the standard detail instead of being designed. This may lead to the installation of underdrains being overlooked in construction. Ensuring that the tie-in with the storm drain is shown in the design plans will help ensure that underdrains are installed properly.

Also, when underdrains are shown in the design plans, they become a pay item. Currently, underdrains are a subsidiary item and are not tied to payment. Making underdrains a pay item is an effective way to ensure they are installed. TxDOT also has more say in the installation and product selection for pay items versus subsidiary items.

Backfill Material

An example was given for a retaining wall on the George Bush Turnpike. The inspector noted the backfill material did not meet specifications. The retaining wall was partially constructed, and TxDOT required the contractor to demolish the wall and start over using proper backfill material. It is important to have good inspectors in the field to ensure the project is being built properly.

There have also been issues where retaining walls required repair due to the use of manufactured sand for backfill material. Over time, the manufactured sand sets up and no longer moves with MSE walls. The backfill material begins cracking and leads to material washing out of the bottom of the wall when it rains.

Maintenance

Maintenance behind noise walls installed very close to the right-of-way line is difficult. Leaving a small area between the noise wall and existing fences may also be a safety concern. In some areas, adjacent property owners may extend privacy fences to the noise wall.

DESIGN DIVISION

Wall Types

The statewide standard for retaining walls includes precast and cast-in-place concrete walls. Cast-in-place wall types include reinforced and non-reinforced options. Other types of retaining walls that have been used include dimensional quarried limestone, metal fence and panels, and interlocking articulating concrete blocks.

There is not a statewide standard for noise walls, but the Houston and Dallas Districts have created specifications that include cast-in-place and precast concrete panels. Besides concrete panels, other materials have been used around the state, and special specifications exist for transparent noise walls and fiberglass panels.

Construction Methods

Noise walls and retaining walls should be constructed in accordance with details shown on the plans, approved working drawings, and pertinent requirements in the related standard items. The standard items related to retaining walls include excavation, embankment, excavation and backfill for structures, concrete substructures, waterproofing membranes for structures, and pipe underdrains.

The standard items related to noise walls include concrete substructures, hydraulic cement concrete, precast prestressed concrete structural members, post-tensioning, surface finishes for concrete, reinforcement for concrete, steel structures, metal for structures, galvanizing, field cleaning and painting steel, and anchor bolts. Unless otherwise shown on the plans, noise wall panels should be constructed out of concrete.

Utilities

Coordination with utility companies is required whenever conflicts are discovered during the planning stages. Construction management plans are required whenever utilities cannot be moved or cleared prior to construction. Having sufficient horizontal clearance is an issue when dealing with noise walls. Relocation of overhead utilities may be necessary to provide the required clear zone when constructing noise walls.

Drainage

Noise walls impede the natural flow of runoff and may create drainage issues such as ponding and scour.

Aesthetics

Noise wall design should be pleasing and acceptable to the general public.

Maintenance

Emergency response and access to local property can be affected by noise walls. Hand trimming is a maintenance issue around noise walls. Mow strips and hardscapes are used to reduce maintenance.

Right of Way

Retaining walls may not be needed if sufficient right of way is available. Otherwise, retaining walls are needed when the purchase of right of way is an issue. Right-of-way constraints play a big part in whether a retaining wall is used in lieu of embankment on bridge approaches.

Retaining walls are used almost exclusively in urban areas but are sometimes used in rural areas if the adjoining land use presents constraints. An example was given for a project in the Odessa District involving construction of retaining walls in a rural area. The four corners of the intersection of two state highways were occupied by industrial sites.

ENVIRONMENTAL AFFAIRS DIVISION

Noise walls are typically constructed of concrete and are usually precast panels with drilled shaft supports. Sometimes panels are cast-in-place, and sometimes they are located on top of crash barriers. In a few areas, on I-30 and US 75 in Allen, transparent acrylic panels have been used. Opaque Plastic panels with concrete footing have also been used and can be seen on SH 183 in Euless.

The main issues when dealing with noise walls are constructability and the timing of decisions that might affect whether a proposed noise barrier is reasonable and feasible. From the division's standpoint, noise wall construction design aspects are usually determined after environmental clearance by the design team and/or the construction contractor.

Constructability and site constraints may factor into the initial noise barrier proposal if coordination occurred with the design team before environmental clearance. Confirmation that a preliminary barrier proposal is still reasonable and feasible after adjustments due to site constraints should be made before holding a noise workshop.

Design Sequencing

An important milestone after environmental clearance but before construction is that a noise workshop must be held to determine if the adjacent property owners and residents want the wall. At least some design work needs to occur before the noise workshop to confirm placement, height, and aesthetics so that TxDOT can provide affected receptors with enough information to make an informed decision. Noise workshops are considered a post-environmental clearance activity.

Construction Sequencing

Construction sequencing is usually left up to the construction contractor; however, there are projects where the design-build contract explicitly states that noise walls must be constructed before any construction work occurs in the area near the wall. From a noise abatement standpoint, early noise wall construction is a good practice since affected receptors would be shielded early on from construction and traffic noise.

Noise walls are usually one of the last features to be built on a project. Often, this is because of tight right of way, other construction activity associated with the project, and potential utility adjustments needed to accommodate the noise wall.

Utilities

Utilities are a common factor for why design teams say noise walls cannot be built. This factor is due to the complexity to construct and/or the expense of moving utilities to accommodate the noise wall. The Environmental Affairs Division has a method to consistently consider whether the cost due to utilities is reasonable.

Noise Analysis and Design

When a noise analyst proposes a noise wall to address a predicted traffic noise impact, they are often working with limited information regarding site constraints, such as utilities, drainage, and sight lines. Final noise wall placement and even height may be adjusted during PS&E.

A noise analyst typically does not have an engineering background and therefore bases the preliminary noise wall proposal (placement and height) on whether the modeled noise wall meets the acoustic reduction and cost-effectiveness criteria. Noise walls are most effective when they are placed either close to the sensitive receptors or close to traffic, which is the noise source. Noise walls are typically placed along the right of way since the less common practice of placing noise walls along the outside of main traffic lanes can limit future widening, involves the potential for crashes, and may affect aesthetics.

Noise Workshop Timing

Some designers may be reluctant to include noise walls in detail until they know they are wanted by the affected receptors. This means that designers may wait until after the noise workshop to avoid designing a noise wall that is not needed. However, from a public involvement standpoint, TxDOT does not want to go back to the affected receptors after they voted for a noise wall to tell them it cannot be built.

Risks

There is a risk that an installed noise wall will not provide sufficient noise abatement. This may be due to a change in the noise wall height or placement between the environmental analysis and construction. No program exists to monitor or confirm that constructed walls perform as predicted.

Political Issues

Noise walls can be a very political issue. Also "wall envy" may occur, which is when one neighborhood along a project gets a noise wall and another does not, or when different neighborhoods have walls with different heights.

Maintenance

Adjacent property owners are often concerned about maintenance and access, especially if there will be a small amount of space between the adjacent property line and the noise wall. Some districts allow adjacent property owners to extend their fences to the back of the noise wall.

Design Changes

When design changes occur on the project level, an environmental reevaluation will be conducted if the changes trigger an update to the noise analysis. During design of the individual noise wall, if there are changes to the placement or height due to site constraints, ideally someone checks to ensure the wall is still reasonable and feasible. This requires communication and coordination between the environmental district staff and the design team. Communication and coordination between the environmental team and the design team during design of the noise wall is recommended as a best practice.

Right of Way

TxDOT rarely purchases right of way solely to accommodate noise walls. The division knows of one recent example. The Pharr District plans to purchase right of way to avoid utility conflicts. Most noise walls are placed closest to the affected receptors, which is usually at the right-of-way line.

RIGHT OF WAY DIVISION

Before the interviewee joined the Right of Way Division, they worked at the San Antonio District, and prior to that for a utility company. The feedback provided includes lessons learned from experiences in past roles as well as their current role at the Right of Way Division.

One of the concerns raised is that project designers and utility coordinators are informed late in the design process, after schematic design, about where noise walls are required on a project. Noise workshops may happen before designers and coordinators are informed. This may lead to additional utility conflicts and more complex installations during construction since utility conflicts are reviewed at the schematic phase and early in the detailed design phase. One way to resolve this problem is to assume a noise wall will be included in the design before the noise workshop is held.

This may help in determining if a noise wall is feasible and reasonable and allow utility coordinators to consider the noise wall placement when working with utility companies to resolve conflicts. The noise wall can be removed from the design if it is determined to not be feasible or reasonable or the affected owners and residents decide they do not want the wall. Otherwise, the noise wall is kept in the project design. It is much easier to remove a noise wall later in design than to include one.

An example of a noise wall that was included late in design, 95 percent PS&E, is on US 281 Phase 1. The San Antonio District had the design consultant review the noise wall for feasibility and reasonableness since there were a lot of affected utilities in the area. It was determined that the noise wall was not reasonable due to the cost of utility relocations in the area, and the district decided not to include the noise wall in the project. The reasons why the noise wall was added so late are not clear at this point. Additional investigation is needed to determine why the project team was not informed earlier in the design process.

Noise Wall Types

In the past, the San Antonio District mainly used post-and-panel type noise walls with precast panels. This type of noise wall may lead to conflicts with utilities during construction. Depending on the depth and location of utilities the drilled shafts may conflict with existing utilities. Also, the installation of the panels, which are required to be lifted over the posts with a crane, conflict with overhead utilities.

Currently, the San Antonio District does not have a standard noise wall design to be used on projects. Instead, the district considers different noise wall types depending on the project and location. The district tries to minimize the footing by considering the use of a spread footing. The San Antonio District also tries to minimize the size of the crane used by contractors to install panels.

The San Antonio District included the use of panels that install from the front side of the post instead of the top for a noise wall on Loop 1604 from IH 35 to FM 78. The noise wall was also shifted away from the right of way to provide additional room to construct the noise wall. The project is currently in construction. Further inquiry is needed to see how the installation went compared to the traditional top-load panels.

Noise Wall Material

It was mentioned that it would be helpful to consider different material types than concrete for noise walls. This would allow for more creativity in noise wall design, as well as possibly saving money on construction. The project on Loop 1604 looked at using different materials for noise walls during the design phase.

Utilities

Noise walls are usually located near the right-of-way line, which is where utilities are generally located. Not only does that block or limit access to utilities in the future, but it makes the installation of the noise wall more difficult. It is also important to get quality SUE information and identify utilities early in the design process. Utility companies should be included throughout the project delivery process, especially early in the preliminary design.

Access to Utilities

For a noise wall on the Loop 1604 project, the San Antonio District added removable panels in a few areas to allow the utility companies to access their facilities for maintenance and emergencies. On the FM 1103 project, there was a large valve for a high-pressure gas line that was going to be located behind a proposed noise wall. The district was able to work with the gas company and provide a gap in the noise wall so the valve could be accessed from the highway by the utility company.

Overhead Utilities

Overhead utilities are one of the biggest challenges regarding the construction of noise walls. This is mainly due to the height of the neutral line, which is the lowest electrical line on the pole and is located above the telecommunication lines. Switches are also located along the neutral line, and they may be located in the same area as a proposed noise wall. The switches are installed at a certain height to allow the electric company to access the switch from the ground in case of an emergency. Since this height of the neutral line is lower where a switch is located, the height of the neutral line impacts the maximum height of the telecommunication lines.

The switch height and spacing of telecommunication lines from the electrical lines vary depending on the service provider. In San Antonio, switches are located 22 feet from the ground level, and telecommunication lines start 40 inches below the neutral line and maintain a minimum of 1 foot away from each. This leaves the telecommunication lines much lower than the primary electrical line. Thus, in understanding these requirements, it is clear that raising the primary electrical line will not necessarily resolve conflicts with overhead utilities during the construction of a noise wall.

During the environmental field visit, items such as switches and down guys should be noted. Down guys should be considered with respect to the location of the noise wall. They should be treated the same as a utility pole for utility relocation purposes since down guys are a supporting structure and may be installed as deep as a utility pole.

The interviewee provided a presentation that included items to consider when placing a noise wall. Some of the items from the presentation are:

- Overhead electric:
    - Clearance requirements.
    - Height of primary electric lines.
    - Electric switch locations and height of neutral line.
    - Need for utility pole bracing including cost, room, and temporary construction easements.
    - Deenergizing including feasibility, cost, and timeline.
    - Sleeving including cost and use.
- Overhead telecommunication:
    - Height of telecommunication lines.
    - Steps for lines to relocate.

The previous items should be considered during design. Once a noise wall goes into construction, these items will impact the installation of the noise wall and may lead to the noise wall not being able to be built.

Retaining Walls

Retaining walls are easier to work around than noise walls in terms of utilities. The type of retaining wall is important to know when dealing with utility conflicts. Different retaining wall types may allow for utilities to be located in different areas.

For utility poles, the design of a retaining wall may include a notch or workaround to allow the existing utility pole to stay in place. Underground utilities are not placed under retaining walls, but utilities may be placed in a casing if they are located near a retaining wall. This allows the utility company to maintain its line without disturbing the retaining wall.

Utility Coordination

A project on FM 1103 was given as an example regarding utility coordination and noise walls. The project has 13 noise walls and is currently in construction. The project also spans three counties and is impacted by three separate electrical companies. Since electrical companies are usually the owner of utility poles, having multiple electric companies added additional complexity to utility coordination.

The traditional method of coordinating the relocation of utility poles during the design process involves TxDOT staking the proposed right of way. This step is followed by the utility company staking its proposed pole locations. TxDOT then surveys the proposed pole locations and checks the locations with the current design to ensure there are no additional conflicts. If the proposed pole location does not work with the design, TxDOT goes into the field and moves the stake for the proposed pole. The utility company then goes into the field, records the new stake location, and updates its utility relocation design. This method is mainly due to the utility company and TxDOT using different design software. The amount of surveying and field work adds complexity to the coordination process and costs more due to the number of times the survey crew must visit the site.

Unnecessary Utility Relocations

For a project on Loop 410, the underground utilities were relocated in preparation for the construction of a noise wall. However, due to a constructability issue, the contractor was unable to build the wall. Thus, the utilities were unnecessarily relocated since the noise wall was not constructed.

Right of Way

In areas of limited right of way, it is difficult to do all the work planned. With utility relocations and noise walls, sometimes not all the work can take place. It is important to have conversations early in the preliminary design phase to determine what needs to be done.

The acquisition area should be looked at very early on when considering a noise wall. Even if the need for a noise wall has not been determined, it is safe to assume a noise wall will be included near neighborhoods. The location of utilities should also be considered early in the right-of-way acquisition process.

The San Antonio District has right-of-way agents who are involved in the project at the beginning of the schematic design phase. The right-of-way agents should be included in project meetings for utilities and design. Getting input from the right-of-way project manager early in the schematic phase is critical.

Sequencing

Depending on the project and location, it may be better to leave existing overhead lines in place until after the noise wall is constructed. Once the noise wall is in place, the overhead lines can be relocated.

Constructability

In the past, the San Antonio District noted in the plans that contractors should use horizontal boom cranes to mitigate conflicts with overhead utilities while constructing noise walls. The district was transferring the risk to the contractor. Unfortunately, horizontal boom cranes are not readily available in Texas and are rarely used by contractors. It is recommended to consider constructability more during design, which reduces the amount of risk instead of shifting it to the contractor.

A project on Loop 410 in San Antonio was given as an example. A noise wall was voted on by the affected receptors. The right-of-way line is about 10 feet from the edge of the pavement, and the area has seven utilities in the right of way. The area includes switches on the overhead neutral line. Thus, the overhead telecommunication lines are lower in the area. There are also a number of alleys where the noise wall will block one entrance. The public still wants to maintain the same level of access to the alleys, which means that there will be a number of breaks in the noise wall to maintain access. Also, blocking the alley may impact the level of service the affected parties receive from the local municipality, such as garbage service, since some local services and utilities use alleys to maintain service. The noise wall will probably be canceled. The district will have to approach the affected owners and residents to inform them that the noise wall will not be built. Situations such as this may be prevented if additional investigation into the constructability, including utilities and access, is completed before public meetings are held in the schematic phase.

Retaining Wall and Noise Wall in Same Area

Installing a retaining wall and a noise wall in the same area of a project raises the level of complexity for construction. For the US 281 Phase 1 project in San Antonio, the overhead electric utility temporarily relocated to the other side of the highway to allow for the installation of a retaining wall and noise wall. The electric utility plans to reinstall the overhead line to the original side of the road after construction is complete. The coordination of the utilities was seen as a success since construction would be much more difficult without the cooperation of the electric utility company clearing the way for construction. There were also multiple underground utilities in the area. The district granted an exception to policy for one of the utilities to stay in place under the pavement.

Drainage

Drainage between the noise wall and the right-of-way line may be impacted. The impact on drainage should be considered when designing the noise wall.

Political Issues

Owners and residents may have an issue when TxDOT is unable to deliver a noise wall after an affirmative vote by the affected receptors. They may contact their political representatives or even decide to file a lawsuit. It is always better to have additional due diligence regarding constructability and other utility issues that may impact construction before holding a noise workshop.

Maintenance

Maintenance of design features, right of way, and utility facilities should be considered when designing noise walls and retaining walls. Also, proper maintenance behind noise walls may be an issue if adequate room is not left between the noise wall and the right-of-way line.

APPENDIX H. PRELIMINARY INTERVIEW GUIDE

Sequencing and Placement of Noise Walls and Retaining Walls on Complex TxDOT Projects

Preliminary Interview Guide

INTRODUCTION

Difficulties can arise when constructing noise walls and retaining walls due to conflicts with utilities, construction phasing, and inadequate access. The purpose of this research is to provide guidance on the sequencing and placement of noise walls and retaining walls on complex projects. The research includes examining issues such as noise and retaining wall selection, standards and specifications, preferred methods and best practices for sequencing and placement, and design and construction procedures.

The preliminary interviews are an important part in the research process. The purpose of the preliminary interviews is to review existing practices and identify issues related to noise and retaining walls. The research team will create a summary of meeting notes, including lessons learned, from the preliminary interviews. The preliminary interviews will also help to identify a short list of districts for a second round of in-depth interviews.

The research team plans to conduct the preliminary interviews by conference call or WebEx. The following page includes a list of questions to aid in the discussion. Interviews are expected to take about one hour. For additional information about the preliminary interviews or the research project, please contact Kris Harbin (Principal Investigator) at k-harbin@tti.tamu.edu.

DISCUSSION TOPICS AND QUESTIONS

- Please provide an overview of the general process to design and construct noise walls and retaining walls, including the following aspects:
    - Wall types
    - Footing types
    - Construction methods
    - Sequencing
    - Utilities
- What are the main issues you have encountered when dealing with noise walls?
- What are the main issues you have encountered when dealing with retaining walls?
- What are some of the best practices you use to avoid issues when dealing with noise and retaining walls?
- What are some lessons learned from dealing with noise and retaining walls?
    - Risks
    - Political issues
    - Maintenance
    - Design changes
    - Right of way

    - Relocations
    - Contractual misinterpretations/misunderstandings
    - Permitting/code requirements
    - Etc.
- Can you give examples of any unique or interesting workarounds for utility conflicts?
    - Example: removable fiberglass access panel (noise wall)
- Can you describe an installation of a noise or retaining wall that went well?
    - In your opinion, what led to the success of the installation?
- Can you describe an installation of a noise or retaining wall that did not go so well?
    - In your opinion, what were some of the factors that led to the project issues?
- Do you have any other suggestions regarding noise walls or retaining walls?
- Do you have any documents that would be helpful to the research?
- Would you be interested in participating in a follow-up interview?
- Are you aware of a project that would be a good candidate for an in-depth case study?
- Is there anyone else that you would recommend we contact regarding this research study?

APPENDIX I. DISTRICT INTERVIEW SUMMARIES

This appendix presents the findings from the interviews with TxDOT districts.

AUSTIN PLANNING AND DESIGN

The Austin Planning and Design group focuses on many of the traditional considerations when placing a noise wall or retaining wall, such as location of utilities, design needs, and safety. The team typically lets walls with the highway project to better integrate the structure. Noise walls are typically constructed later in the construction process, after final grading is complete. One noteworthy point is that obtaining a temporary construction easement or purchasing additional right of way is similar. So, if additional space is needed it is usually more effective to purchase the additional space.

Planning and Design

In constructing a noise or retaining wall, the need for these walls is typically determined prior to the end of the schematic phase. The height, length and placement of a noise wall is typically determined during the environmental process (between 60 and 90 percent schematic design), and the design team is notified after the noise analysis.

The Austin District has a standard aesthetic for noise walls that is presented to the public at the noise workshop. This alleviates issues with choosing an aesthetic for the noise wall. The placement, height, and aesthetic are known during the noise workshop.

After the noise workshop and the public votes, the detailed design team is notified whether they will have to include the noise wall in the detailed design. The detailed design for the noise wall is not started until after the noise workshop and the noise wall is voted on by the public, which usually takes place early in PS&E.

Alternative noise wall types and materials may be considered on projects at the Austin District. They may be considered to lessen the impact to utilities and help the installation of noise walls.

For a retaining wall, while need and location is determined early (during schematic), there could be further refining of the plans with new retaining walls added and previously planned retaining walls removed later in design. The retaining wall layouts are turned in at the same time as the bridge layouts, which is between 30 and 60 percent detailed design.

Different retaining wall types are considered during design. Alternative designs are considered for retaining walls, including acquiring additional right of way to mitigate the need for a wall. Cost and schedule have an impact on which alternative is selected with the schedule usually dictating the alternative chosen.

Sequencing

For both noise walls and retaining walls, the timeline of construction varies. It was recommended to consider installing noise walls later in construction, after the final grade has been achieved for the area. This recommendation varies depending on the area, with respect to existing grade and neighborhood preference. In some instances, there may be no change to the existing grade. Also, the district has had requests, during the noise workshop, to construct the noise wall as soon as possible to help mitigate noise from construction.

For retaining walls, construction sequencing is often related to grading. Retaining walls are essential to achieving the desired cross-section. For this reason, it is typical to construct retaining walls early in the project along with the earthwork. An additional recommendation is to build a retaining wall all at one time instead of building it in sections.

For both wall types, it is more common to let walls within the same construction project. While a separate letting could allow for a contractor to give their full attention to a wall, two letting schedules could create scheduling conflicts and create additional construction costs if one construction schedule is delayed.

Utilities

In central design, the design engineer looks for utility conflicts. Design engineers are responsible for trying to work around utility conflicts early in the design phase.

The Austin District requires SUE and a preliminary UCM to be complete by the end of the schematic phase for design-bid-build projects. The design is scoped out with special attention to utility conflicts. The design team receives all the information for utilities during schematic, as well as SUE and topographic survey information. The design team tries to integrate this information into design as early as possible to avoid conflicts. Some utility information may be collected during the schematic phase for design-build projects, but most of the utility coordination is built into the design contract.

Additional SUE information, including test holes, may be collected to help with the design and confirm the location of utilities. During the project delivery phase, design engineers meet with every utility company for every project once a month. This coordination begins when the team learns of their project and has sufficient information to share with the utility companies. The team typically has sufficient information to begin conversations with utility owners around 30 to 60 percent design for. This can allow for proactive adjustments on utility conflicts if a company is willing to work with the project team. But if the project team initiates meetings with utility companies too early without adequate information, the company might lose interest in meeting. It is important to keep the lines of communication open.

The district likes to see utility companies begin their relocations after 60 percent design to ensure utilities have sufficient time to relocate without impacting the let date. But the actual relocation start depends on the utility company and may not happen until later.

Placement and Maintenance

Noise Walls

Determining placement for a noise wall is largely contingent on the location of utilities within a project. The design team tries to avoid all utility conflicts on a project, and they relocate utilities when the conflict is unavoidable, and they have a detailed design mostly complete.

For spacing, it would be helpful for the design team to have some kind of standards and requirements across projects, such as 2-foot spacing needed from a water line, but this is not always the case. The team adjusts as they are able, and in some situations, a spacing like 2 feet can be adequate. In other situations, having a noise wall 2 feet from the right of way line is not sufficient due to maintenance needs. This is also the alignment for overhead electric. Utilities have location assignments within the right of way. A rule of thumb for spacing may help reduce issues related to the placement of noise walls.

Providing QLB SUE information may help inform environmental personnel, who are placing the nose wall for the noise analysis, where existing utilities are located. This may help reduce conflicts between noise walls and existing utilities.

The project team tries to acquire new land as they are able, and if they are highly limited on land, they adjust in ways such as removing all grass from behind a wall when it would not be feasible for a mower to access the space behind a wall. Between 5 and 15 feet is required to accommodate mowing and other maintenance activities.

Off TxDOT Right of Way

The district does not build permanent structures off TxDOT right of way due to maintenance and liability issues. The district would purchase additional land for the placement of the noise wall.

Between Frontage Road and Main Lanes

If you can place a noise wall between main lanes and the frontage road, this method is preferable. With this spacing, the wall would be closer to the noise source, the wall could have more continuity with fewer breaks increasing effectiveness especially in areas with many side streets. There would be less impact to site distance when pulling out of side streets onto the frontage road. It would also be far easier to avoid utility conflicts and provide more room near the right of way line.

If a wall is placed near the main lanes, the team would have to pay special attention to barriers and crash protection for the wall and drainage challenges with proximity to the main lanes. Elevation differences between the location of the noise wall and affected receptors may affect the height of the wall. If a noise wall can avoid these issues, then placing a noise wall between the frontage road and main lanes provides good opportunities.

Away from Edge of Right of Way

For situations where the district is evaluating placing a noise wall close to travel lanes and further from the edge of the right of way, it is important to consider safety, maintenance needs, future development, and utilities. Shifting the noise wall away from the edge of the right of way can lessen the impact to utilities. Moving a wall closer to the travel lanes can bring about additional risks to the traveling public and the construction and maintenance crews, as well as increased barrier needs for the wall. This placement can also limit future expansion

Retaining Walls

The placement and spacing of retaining walls are more dependent on the type of wall being constructed. A cut wall versus a fill wall will have different requirements for support and space needed. Typically, a minimum of 5 feet of space is between the retaining wall and the edge of the right of way. The need for spacing increases with the height of the retaining wall and could possibly need as much as 20 feet of spacing for construction and maintenance.

In evaluating the placement of retaining walls between the frontage road and main lanes, a primary concern is spacing. When placing an obstruction, such as a retaining wall, the design team looks at the crash risk. Minimizing this risk usually means placing the wall outside of the clear zone, which is approximately 30 feet. This can be difficult to accomplish when placing a retaining wall between the main lanes and frontage road. Due to this, it is typically easier to put it near the main lanes and put a crash barrier up, but the considerations should always be crash worthiness, clear zone spacing, and usual considerations such as drainage and utilities.

Noise Wall and Retaining Wall in Same Area

If a noise wall and retaining wall can be designed together, this can be an effective use of the same space. It would be important to ensure that the retaining wall could accommodate the additional load from the noise wall. So, if these are considered in the design together these can be integrated.

Right of Way

Noise walls should be considered during the right of way development process. Right of way and environmental should always be in communication about the amount of right of way needed. This allows for full disclosure of information, such as land needed for noise walls and retaining walls, early in the project. This can curb later needs such as purchasing additional right of way later in the project. If a project team realizes additional space is needed, the Austin District would prefer to purchase additional right of way rather than requesting a temporary construction easement as the cost between the two is similar. The Austin District typically operates by acquiring what they need.

Survey and Geological Information

Detailed survey information is collected in areas where noise walls and retaining walls are planned. The district has experienced issues with inaccuracies of the topographic survey.

Geological information is collected in areas where retaining walls and noise walls are to be installed. Test bore spacing is based off the TxDOT geotechnical manual. The district has experienced issues with underground voids regarding the placement with noise walls and retaining walls.

AUSTIN ENVIRONMENTAL

Wall Types

Noise Walls

The need for a noise wall is identified during the schematic phase after the development of the noise technical report. The technical report is prepared after the traffic data is approved and the noise model is run. Typically, the district would know if there is a need for a noise wall before the 30 percent schematic. After the completion of the noise technical report, the environmental team will sit with the project manager on the design side to convey information on the warranted noise walls. Then they will begin to look at what is on the ground. The project delivery method (design-build or design-bid-build) does not affect this process since the district typically manages the NEPA process and schematic development.

The evaluation of the feasibility and reasonableness of a noise wall takes place during the schematic design phase. After the completion of the technical report, the district will begin to look at utility information, right of way information, other constraints (e.g., large trees), and public feedback through the public meetings. The new noise guidance has affected the voting process and the alternative noise wall analysis for evaluating the costs. The district environmental team reviews the noise technical reports, the utility information, and other constraints.

Traffic Noise Wall Workshops

The noise workshops are held after environmental clearance has been finalized. In the past, the district has conducted a workshop before the NEPA decision but, due to design changes, it was not efficient. Now the district waits for the NEPA decision. The project managers are involved in the noise workshop process. The project manager can also answer questions regarding the project as a whole that the public may ask about. The utility coordinators are not involved in the workshop itself except for the planning of the wall and the feasibility. The degree of completion of noise wall design at the noise workshop can range from just beginning the PS&E to 100 percent PS&E with an average of about 60 percent PS&E.

Noise Wall Construction Sequencing

The Austin District environmental team would like to construct the noise walls first, which would cut down on public complaints and help secure the worksite. However, the existing construction process allows the contractor to schedule the work. Unless the district adds notes in the plans that the noise walls must be built first, they typically will not get built until near the end of the project.

The Austin District would not recommend letting the noise walls separate from the main highway project. The noise walls need to be a commitment to the main roadway project. FHWA may not allow separation of the noise walls as environmental commitments from the main project and may interfere with federal funding.

Placement of Noise Walls

He would change the new voting rules. Following the new voting rules, collecting votes from apartments is a logistical challenge given that the apartment votes could not overturn the votes of the property owners.

Typically, the district will not place noise walls off the TxDOT right of way. Access and maintenance of off-right-of-way noise walls are difficult. The Austin District cited two exceptions. In one case, a commercial business did not want a proposed noise wall blocking the view of the business. The commercial business bought land adjacent to the right of way to reroute the wall. The commercial business then deeded the purchased property back to TxDOT. TxDOT maintains this noise wall since it is within the TxDOT right of way. In the second case, traffic noise impacts were identified within a residential area where a railroad runs parallel and between the highway and the impacted residential area. Working with the City of Austin, TxDOT constructed a noise wall on the city property along the opposite side of the railroad to mitigate the residential traffic noise impacts. The City of Austin maintains this noise wall.

Typically, the Austin District will place a noise wall close to the edge of the right of way—close to the receivers. Placement of noise wall close to the travel lanes may be preferable when there are utilities along the right of way, large trees, or other obstructions; or when there is a large grade separation between the frontage road (depressed) and the main lanes (elevated). When placing a noise wall near a travel lane, the noise wall should be crash rated or crash tested. Drainage should also be considered.

Utilities

The district is informed of utility conflicts as soon as they have the utility data and the noise technical report. The district then compares the Quality Level B utility layouts with the schematics. This is where the district decides if further utility investigation is warranted. The schematic project manager typically provides the utility coordinator a copy of the noise wall plans after the noise workshop and after the noise walls are voted in.

Noise Wall Constriction Materials

The Austin District considers alternative noise wall types and materials since this always comes up in the public comments. The district considers it but has never done it. The Austin District typically uses concrete for maintenance and aesthetic reasons. The district tries to match the noise wall with the roadway elements. Alternative noise wall types are used to mitigate utility conflicts through the addition of gates to access utilities, or through hand-built sections to address constructability issues. However, these noise walls generally look the same as the standard noise walls.

Elevation Issues

The Austin District obtains detailed elevation survey information from the as-built of the walls. The district has experienced issues with inaccuracies of the existing ground elevation survey and cited an example where the schematic and design did not match and where construct identified found elevations that were not right.

The Austin District collects geological information typically using geotechnical boreholes. If the proposed noise wall is in Karst Zone 1 or 2, test bores will be drilled in wall locations to look for karst voids. The district has had to move some noise wall columns around to avoid the voids found in the drilled shafts. Test bores are collected at every noise wall column location for wall located within Karst Zones 1 or 2, otherwise, the standard borehole spacing is used.

AUSTIN BRIDGE

The Austin District plans for and integrates noise walls and retaining walls early in the design process. There are many factors surrounding the installation of a noise wall or retaining wall, such as the cost to the contractor, soil evaluation, utilities' location, and placement of the wall, that require a wall to be planned for and placed early. The placement of a wall should typically occur by 60 percent schematic to allow for adequate planning for budget, utilities, construction and maintenance spacing, and the other related needs. If a wall is planned for early in the project delivery timeline, it is easier to adjust to the different circumstances of each project and stay on a proper timeline and budget.

Construction

The Austin District deals with some challenges that other districts do not face to the same extent. For example, a project west of Interstate 35 might be constructed on ground composed of a hard limestone while a project east of Interstate 35 might require modifications to improve the in-situ soil. When facing changing soil, it becomes increasingly important to prioritize noise walls and retaining walls early in the design process. The geotechnical process, and the potential need for additional soil borings, make this a lengthy process which requires as much time as possible. Typically, the Austin District tries to have this completed and walls developed prior to PS&E.

Placement

When determining where to place a noise or retaining wall, this is largely contingent upon a number of factors including maintenance requirements, design of wall (height, etc.), type of footing needed, availability of a construction easement, proximity to travel lanes, utilities, and other issues.

Alternative retaining wall types are considered during design. Some of the factors that go into decision-making include availability of sloping, schedule, cost, and impact to utilities.

In deciding how much spacing is needed, it is key to know what type of retaining wall is being placed in a certain location. For example, a fill wall would likely require more space than a cut wall, for which a 3- to 5-foot offset might be sufficient, but it is typically preferable to have 10 to 20 feet of offset from the right of way line. This would leave enough space to prevent any footing from going on to adjacent property and it would leave space for maintenance activities.

Between Frontage Road and Main Lanes

With respect to placement relative to travel lanes, much of the concern with placement is related to the possibility of a vehicle impacting the wall, the right of way available, and the surrounding properties. Regarding vehicle impact risk, it is always preferable in the Austin District to have a shoulder or barrier, or both, between travel lanes and a noise wall or retaining wall. The requirements for a shoulder or railing barrier vary for different types of roads but adding this buffer can minimize potential damage to the structure as well as risk to travelers.

Other considerations for wall placement regarding main lanes and the frontage road are usually right of way, utilities, and access to adjacent properties. The Austin District always considers proximity to travel lanes when constructing retaining walls, but if there is a conflict with utilities, environmental issue, or issue with adjacent property access, the district will place a wall between the frontage road and main lanes. If possible, the most preferable would be to have enough of a buffer between the frontage road and main lanes that they are able to avoid a retaining wall in this location altogether. These structures are costly, require longer periods of time for construction, and sometimes have issues following completion, so if possible, it is ideal to avoid retaining walls.

Noise Wall and Retaining Wall in Same Area

In an instance in which a noise wall and retaining wall are proposed in the same area, these walls should be designed with the other in mind and brought up early in project design. Some of the considerations for this situation could be spacing, in providing an opening wide enough to allow for ramps, or proximity of the two structures and the potential for sound bounce back which could require a taller noise wall. Noise walls and retaining walls are typically designed together now, with the sound wall placed on top of the retaining wall. If this is possible, and the need for both walls is known early, constructing both structures in close proximity is much easier to do.

Utilities

The Bridge team at the Austin District, do not connect directly with utilities or the project engineer to discuss exact utility conflicts, but the team finds out about utility conflict during design. Utilities are typically discussed in the kickoff meetings for preliminary planning, and can be lengthy discussions, as the right of way and utilities are major aspects of the project.

Designers usually receive a copy of SUE plans early in PS&E (before 30 percent PS&E). Structural designers consider SUE information when designing retaining walls and other structural elements. Generally additional SUE information is not required. The SUE plans are usually sufficient to design the retaining wall.

Right of Way

The district prefers to construct noise walls and retaining walls without acquiring temporary construction easements. Sometimes construction easements needed and cannot be avoided.

As mentioned in earlier, right of way is a significant factor in the construction of noise walls and retaining walls, and this is always considered when planning for and designing projects. It is important to consider spacing needs when determining placement.

Additional right of way is considered when designing retaining walls. The cost is considered when determining to buy additional right of way versus building a retaining wall. In one case, the Austin District was able to remove a costly retaining wall from a project due to right of way availability. The team was able to buy slightly more property and add a grade slope rather than constructing an entire wall, which cut costs for project delivery. In other situations, additional right of way could be obtained for future expansion.

Geotechnical and Survey

Detailed survey and geotechnical information are collected in areas where retaining walls are planned. Soil bores are collected every 200 feet. Additional soil bore may be collected every 100 feet if the samples have a lot of variation within a short distance. It is not often but there have been survey and geotechnical issues during construction.

Alternative Wall Types

Alternative noise walls have been used at the district, including transparent noise walls.

AUSTIN UTILITIES

Placement and Design

Noise Walls

Personnel are usually informed about the need for noise walls on a project during plan review. This may be as early as 30 percent schematic and as late as 60 percent PS&E. District utility personnel are not involved in the noise workshop. Noise walls are not fully designed until after the noise workshop.

Off TxDOT Right of Way
The district is not aware of any noise walls been placed of TxDOT right of way in the district. But if noise walls are planned off right of way, then need to ensure the area is environmentally cleared. The district has experienced similar issues when joint bidding a utility where part of the utility is outside TxDOT right of way.

It would not be preferable if TxDOT had to maintain the noise wall off right of way or if created access issues. Also, the location of existing utilities outside of the right of way is also a concern if placing a noise wall off right of way. But locating the noise wall off right of way would lessen the impact to utilities in the right of way. So, depending on the location of utilities and available space it may be beneficial to consider placing a noise wall off right of way.

Between Frontage Road and Main Lanes
Since this is not a typical area for utilities, except for TxDOT lines and utility crossings, it would be less of an impact on existing utilities. Since they are usually located near the right of way line. Also, not placing the noise wall near the right of way line would provide more room for utility accommodations and other project considerations.

Locating a noise wall between the frontage road and the main lane may be good to consider when there is limited space near the right of way line or when the noise wall blocks the visibility to commercial businesses. Also, drainage should also be considered anytime when placing a noise wall.

Away from Edge of Right of Way
Shifting the noise wall away from the edge of the right of way is happening more often at the district. This lessens the impact to utilities. Overhead utilities are required to install within 3 feet

of the right of way line. Also, gas companies are responsible for surveying and probing their gas lines to verify there are no leaks. Gas companies have told the district that the farther the gas line is away from asphalt the less false readings they get. Gas companies would prefer to be farther away from the travel lanes and closer the to the right of way line to reduce the number of false readings. Utilities in general prefer to be farther away from the travel lanes and closer to the edge of the right of way.

Placing the noise wall away from the edge of the right of way is preferable. If the noise wall can be located farther away from the edge of the right of way, then it would lessen the impact to utilities. Shifting the noise wall away from the edge of the right of way provides more room for maintenance for TxDOT as well as utility companies.

Retaining Walls

Placing retaining walls between the frontage road and main lanes would lessen the impact to utilities versus placing a retaining wall near the right of way line. It is not always possible to shift a retaining wall. Utility crossings should be considered whenever placing a retaining wall.

Utilities

Project designers are responsible for identifying utility conflicts. Utility coordinators at the district handle utility agreements and requests for exceptions to policy. Typically, utility coordinators get involved between 30 and 60 percent PS&E. If the project is design-build, then the contractor takes on the responsibility for utility coordination.

SUE information is collected during schematic phase and may be collected as early as 30 percent schematic. Additional SUE information may be collected around 30 percent PS&E. Utility companies begin relocating around 90 percent PS&E, if not sooner.

The district considers alternative materials and noise wall types to lessen the impact on utilities. Front-install panels have been used on a project (Manchaca Road) at the district to allow for easier removal to provide access to utilities for maintenance.

Right of Way

Noise walls should be considered during the right of way development process.

AUSTIN MAINTENANCE

Austin District Maintenance offered significant information on the considerations related to right of way and how to space projects with attention to functionality of the noise wall or retaining wall and maintenance responsibility following the completion of a project. One of the greatest takeaways is that constructing projects off TxDOT right of way can be beneficial for multiple entities if an agreement is in place and comprehensive documentation has been completed to ensure that responsibility is clearly outlined in the near and long term.

Right of Way

In discussing right of way, the Austin maintenance team emphasized the importance of communication between entities on right of way space. While many districts typically stick to the safety of avoiding placing structures off TxDOT right of way, Austin operations offered a perspective which included considerations for placing a wall off TxDOT right of way. While placing a wall on TxDOT right of way provides for clear-cut responsibility moving forward, there can be opportunities in which a structure could be better suited off TxDOT right of way.

For example, if the wall is being placed to benefit adjacent commercial properties (economic impact), or another entity is willing to acquire the land and take responsibility for future maintenance, placing a structure off TxDOT right of way could be beneficial for all stakeholders. In this situation, TxDOT could pass off responsibility for future maintenance such as mowing and upkeep to another willing party, which decreases future cost and obligations, but it is extremely important to properly document these agreements. This could become problematic if there is not a formal agreement with attached documents, or if a new property owner moves into the area. Situations like this can often become more challenging in the long run as turnover within TxDOT and adjacent properties occurs, but if this can be executed effectively, it can be useful.

If there is not significant economic impact to nearby properties, or need to adjust to other circumstances, it is typically most reasonable and consistent to have a uniform approach of placing all TxDOT projects on TxDOT right of way. This would allow for a standard, or best practice, across all districts.

Placement and Maintenance

In placing a noise or retaining wall onto TxDOT right of way, Austin maintenance offered many of the typical considerations such as limited right of way and utility conflicts as considerations when placing a noise wall or retaining wall. An added consideration included environmental impact and the location of things like trees, and one caveat for retaining walls is that these structures are handled differently as they typically deal with grade changes. Between noise and retaining walls, it is always important to consider how placement impacts travel lanes. It is a best practice to think about how placement impacts risk for a vehicle striking the wall and other safety considerations, maintenance spacing around the wall, and spacing between the wall and adjacent properties.

Noise Wall

Noise wall are primarily geared toward decreasing noise generated from the main travel lanes. Because this is, it may be beneficial to place the noise wall between the frontage and main travel lanes rather than near the edge of the right of way. This can also allow for easier access for maintenance and utilities because there would be less challenges in accessing limited space available in the right of way when a project is lined up to the edge of right of way. Also, between the main lanes and the frontage road may be a good area to implement transparent noise walls.

A tiered approach may be considered when placing noise walls, which may include location of utilities, amount of right of way available, and other concerns such as creeks and trees. As always, the placement can change when considering utility conflicts, environmental concerns, or safety challenges. Adequate space should be available for the traveling public to pull onto the shoulder. Also, no less than 10 feet of space should be available for maintenance between the back of the noise wall and the frontage road.

For other situations, when placing a noise wall near residential areas, each project could be unique in needs. When placing a noise wall closer to travel lanes and away from the right of way line, this could create additional right of way space left on the residential side of the wall which could allow for potential encroachment on this space by property owners. This could create future conflicts by property owners beginning to treat this space as their own to store things like travel trailers, could muddle the maintenance responsibilities or access for maintenance if property owners begin to claim this space, or could leave additional space for other personal uses.

Unless there is an opportunity to do something with this space, such as a hike and bike trail, it would be best to leave just enough space for maintenance and utility access without leaving an excess of space. A minimum of a 5-foot buffer, between the back of the noise wall and the edge of the right of way, was recommended for work behind the wall. This may include construction and routine maintenance. The need for space between the noise wall and edge of the right of way may be omitted if TxDOT could get a permanent easement adjacent to the right of way. The need for the permanent easement could be included in the right of way acquisition when a noise wall is planned within 5 feet of the edge of the right of way.

Retaining Wall

Retaining walls have different spacing requirements than noise walls because these structures have a grade change to overcome. A tiered approach to spacing requirements may be considered. A minimum of 5 feet would be required and would increase as the height of the retaining wall increased. This may be accomplished by considering height in 5-foot increments, where up to a 5-foot wall would require a certain amount of space and a wall between 5 and 10 feet would require a greater amount of space behind the retaining wall.

When exploring the possibility of placing a retaining wall between the frontage road and main lanes, one of the primary considerations is future expansion. It is important to examine the potential for long-term needs and potential growth as a retaining wall will be very limiting for any future expansion of the roadway. When you commit to a wall location, the space becomes very limited for other uses. But if the location between the frontage road and main lanes allows for constant grade with adjacent properties and helps maintain access, this can be an incredibly useful tool.

Noise Walls and Retaining Walls in Same Area

For areas of a project where noise walls and retaining walls are to be constructed in the same area maintenance between the two should be considered during design. Adequate spacing and access should be included. The amount of right of way should be considered to ensure that there is sufficient room for both with spacing for maintenance needs.

Other

Related to placement and maintenance of noise walls is graffiti. Depending on the location of noise walls graffiti may be more difficult to see. Also, clear and transparent noise walls may make graffiti more difficult for the traveling public to see.

DALLAS PLANNING AND DESIGN

Sequencing

Noise Walls

Scheduling noise walls early in the construction phase is preferred. If noise walls are scheduled early in construction and an issue arises, such as an unknown utility, there is more time to resolve the conflict. Also, the earlier noise walls are installed the sooner they will mitigate noise from construction. There may be instances, due to grading or other project features, where noise walls cannot be done early in construction.

Noise walls have been constructed before the main construction project. This may be done to mitigate construction noise on to the surrounding areas. Generally, the district prefers to let noise walls with the main construction project. If noise walls are let separately it is preferred to let them before the main construction project instead of after.

Retaining Walls

Sequencing of retaining walls is usually dictated by the project's critical path, TCP, and the sequence of other design features.

Placement and Design

Noise Walls

In the Dallas District, project designers are placing the noise walls. Environmental and design work with each other to determine the best placement of the noise wall. Project designers work with environmental personnel. Environmental determines the length and height of the noise wall. The need for a noise wall and the feasibility are important factors when deciding where to place a noise wall. It is helpful during project design to view the placement of the noise wall as being able to shift. This can help designers when conflicts arise with the current placement of the wall and other project features.

The need for a noise wall is typically identified around 60 percent schematic, after the roadway geometry is set. Evaluations for feasibility and reasonableness usually take place around 90 percent schematic. Design is involved in the feasibility evaluation.

Often the noise workshop is held after the schematic plans have been approved, shortly after the public meeting for the project. Design personnel attend noise workshops to answer general questions about the project. During the noise workshop the noise wall design consists of location, height, and possibly aesthetics. Detailed design of the noise wall is usually complete around 60 percent PS&E.

Since the schematic design phase is the same no matter the project delivery method, the process to identify noise walls does not change with the delivery method.

The UAR, which governs where utilities are accommodated in the right of way, places electrical in the first 3 feet from the right of way line. There have been several times where the location of the relocated overhead electrical lines conflict with the placement of the rig installing the drill shafts for the noise wall. The conflict is a vertical conflict with the construction methods, not a horizontal conflict with the noise wall. Guidance to help with this issue would be useful. The UAR may need to be updated to consider the placement of utilities considering the noise wall location. Updating TxDOT's Roadway Design Manual may also be helpful. Currently the Roadway Design Manual calls for a 15-foot border width. This could be updated to 18 feet, to include 3 feet from the edge of the right of way to place a noise wall if one is required. If a noise wall is not required, the additional 3 feet could be used to further accommodate utilities. Increasing the minimum border width in the Roadway Design Manual, to accommodate noise walls, will help prevent issues with the placement of utilities.

Off TxDOT Right of Way

Placing a noise wall off TxDOT right of way will reduce the impact to utilities located in the right of way. TxDOT would need to ensure the area considered for placement has been environmentally cleared. This may be an issue if the location is outside the project's footprint. Early planning would help lessen this issue.

If the noise wall is placed off TxDOT right of way, then TxDOT should not be responsible for maintenance. This reduces the overall maintenance cost for TxDOT which reduces the cost to taxpayers. If there is an opportunity where a developer or local municipality is willing to take on the responsibility of maintaining the noise wall, then TxDOT should be open to the possibility.

Between Frontage Road and Main Lanes

Placing a noise wall between the frontage road and main lanes can lessen issues with utilities, since it removes the noise wall from the utility corridor. If the noise wall is meeting the noise reduction requirements this type of placement can be beneficial for the project. This can also be a benefit in areas where the main lanes are elevated with respect to receivers.

There may also be an opportunity to place the noise wall on top of barriers. Depending on the actual placement between the frontage road and main lanes, maintenance activities may be hindered and may require a lane closure for major maintenance activities.

Away from Edge of Right of Way

Shifting a noise wall away from the edge of the right of way may impact utilities more rather than placing it near the right of way line. The location of utilities should be considered when placing a noise wall. If shifting the noise wall closer to the travel lanes can reduce the impact to utilities and still be functional, then it should be considered an option.

Retaining Walls

The majority of retaining walls are identified around 60 percent schematic design. A minimum of 5 feet should be left between the retaining wall and the edge of the right of way to provide access construction and maintenance activities.

Placing a retaining wall between the frontage road and main lanes is preferable compared to placing it next to the right of way line. It will reduce the impact to utilities since they are mostly located near the right of way line. Also, if the retaining wall can be shifted next to the main lanes, from the edge of the right of way, it can help with roadway access issues from adjacent property. Also, if a retaining wall does impact access from adjacent property, it can cost more in terms of right of way acquisition, since TxDOT must purchase the right of access for areas where access is impacted.

Noise Wall and Retaining Wall in Same Area

If a noise wall and retaining wall is required within the same area, it is preferable to place the noise wall on top of the retaining wall to limit the impact of the structures to the utility corridor and other design features. The retaining wall and noise wall need to be designed with each other in mind.

Utilities

QLB SUE collection begins when the project begins. Project designers receive SUE information between 30 and 60 percent schematic design. The UCM is then developed by the schematic project manager. SUE information is considered when designing the project. Additional SUE information, including QLA, may be requested around 30 percent PS&E.

Utility coordinators, at the local area office, oversee utility coordination but the PS&E project manager is included in the meetings. Detailed utility coordination begins around 60 percent PS&E. The district meets with utility companies monthly and may meet weekly depending on the level of coordination needed.

Ideally utilities are ready to begin their actual utility relocations the day the last parcel is acquired (which may be one year after 60 percent PS&E, plans adequate). Being ready to begin relocating includes having utility relocations plans complete and approved.

Right of Way

The district has moved away from using temporary construction easements since they have similar time and cost requirements are acquiring property. If access is needed to construct a wall, then a right of entry document is used instead during construction.

Noise Walls

Noise walls should be considered during the right of way development process. For areas where neighborhoods are adjacent to the right of way, it may be beneficial to assume that a noise wall will be required during right of way development.

The amount of available right of way is considered when planning for and designing noise walls. This may be a reason a noise wall is shifted near the main lane and away from the right of way line.

Retaining Walls

The amount of available right of way may dictate the need for retaining walls. Acquiring additional right of way may be considered a design alternative to mitigate the need for a retaining wall. Cost and impact to utilities are considered when comparing design alternatives.

Survey and Geological

Detailed survey information is collected for the project, which includes areas where noise walls and retaining walls are located.

Geological information is collected every 200 feet for retaining walls, which is based on the geotechnical manual. There have been a few geological issues experienced in the past for retaining walls. Geological information is typically not collected for areas where noise walls are placed.

Alternative Wall Types and Materials

The district believes there are only a few approved options for noise walls. A few alternative noise walls have been constructed at the district to assess their functionality. But the district is not aware if the alternative types have been approved for widespread use. More options that are available, regarding noise wall types and materials, the better it is for projects. Since it allows designers to be more flexible when needed.

Other

The purpose of a noise wall is often misunderstood by the public. Sometimes neighborhoods want a noise wall because an adjacent neighborhood has one. Or the need may be more of an aesthetic instead of for noise reduction.

It may be a good recommendation for districts to have environmental personnel run the noise analysis a few times while varying the placement of the noise wall and provide a few locations to project designers for them to see which placement works best with the project's design.

DALLAS CONSTRUCTION

Sequencing

Noise Walls

Regarding recommendations for sequencing noise walls during construction: Due to the contracts and the way they are funded, it is easier because noise walls are noise abatement from the environmental study. The sequence of construction is due to funding. In a perfect world noise walls would be built at the beginning of construction. But some are on top of retaining walls and other infrastructure. Depends on when you can build them. Some walls have issues with utilities not being cleared.

Have some that are built on the right of way and have easements in backyards. Are there fences in the way. If you are off the right of way line you have more space for construction but when you are done you cannot get to the area behind the noise wall. Landowners will need to maintain, or it becomes an empty area.

If there were certain things that could be done, letting noise walls separately from the highway project would be feasible. Restraints are within TxDOT's process. Ideally, noise walls would be built first. This would help mitigate construction noise too. Have many constraints (vertical, horizontal), utilities are main constraints.

If you did it at the end of the project, it would be cleaner as far as construction conflicts.

Usually, noise walls go in at the end of projects, as last phase of construction contract.

Environmental study includes need for noise wall. To meet environmental, you need noise wall if it shows needed. Would not be able to let after because project warrants noise wall.

Retaining Walls

Retaining walls are built as needed for construction. These are phased based on construction needs and material that is being retained. Construction sequencing is always a part of construction phasing. Part of traffic control plan.

District has a phasing sequence in plans. Contractor has the option to propose a new traffic control plan. Oftentimes, contractors will not change the plan if everything is clear.

Generally, retaining wall construction sequencing depends on traffic control and need to move traffic to a certain location. Contractors generally work in phases or may work on multiple phases at once. When areas are accessible, it is recommended to do what work you can when access is available. Retaining walls usually mean limited space to work and limited access both vertically and horizontally.

Would recommend that if there are limited restraints, retaining walls should be sequenced early in construction to get them built. Downside is the potential damage of retaining walls and contamination to backfill material requirements. If built too early run the risk of disturbing walls or damaging them during the remaining construction activities.

Contractor phasing follows the traffic control plan. They are figuring out when to schedule crews and their subcontractors. TxDOT does not control this, but milestone dates can get them to do things by a certain date.

Placement

Noise Walls

Space between Noise Wall and Edge of Right of Way
In perfect world, put wall to edge of the right of way so there is nothing that needs maintained. Cannot build them that way. A lot of times they are offset 3 or 4 feet (ideally 8 feet) to allow room for construction and maintenance. Need to leave room for mowers (6-foot bush hog).

If you relocate utility poles up to 3 feet from the right of way, those will be in place before construction of the noise wall starts. Need to leave 10 feet between power line. Offset makes it easier for construction but harder for maintenance. Utilities constrain how close to right of way line.

For one project, the contractor had to change means and methods because of overhead transmission line, pictures shared during preliminary interview. Could not place noise walls on line and offset by 8 feet.

Placing walls against the edge of the right of way creates issues. Can property owners tie into back of the noise wall. How to maintain that strip.

Guidebook should be if, then format. Include checklists of important items. Might be a choose your own adventure type of guide.

Best practice is early in schematic phase going into environmental. Early communication is needed so decisions can be made. Do not want to make decisions during construction, constraints should be figured out beforehand.

One noise wall on retaining wall had a turn lane that created a line-of-sight issue.

Utilities do not want to be on both sides of the noise wall. They want to be on one side or the other. If you put walls 10 feet from the edge of the right of way, then people will take that space as part of their yard. This creates issues with utilities accessing the space for maintenance.

Put gates in to allow utilities access on one wall. Need to leave access for utilities and maintenance. Eliminated a couple panels on walls (with approval from environmental).

Will move waterlines to clear for construction, then build noise walls on top of old waterlines, which creates issues trying to drill through. Biggest issue is with utilities. Need to know where they are and where they are going. Many walls go where utilities are supposed to go. Conflicts between noise walls and utilities is one of the biggest reasons for delay claims.

Off TxDOT Right of Way
Have placed walls outside of TxDOT right of way. Have a motto that nothing good comes from building off the right of way. This causes the biggest issues because they have no control of utilities outside of the right of way.

Had to offset 8 feet to coordinate with utilities and accommodate them. This raised issues with access and allowing property owners to tie into wall. Everything in the project had to be redone. This caused a nine-month delay and cost TxDOT one million dollars in delay claims. Ultimately, the noise wall was turned over to city. Cities want control over plans and what is being done, TxDOT loses control over construction.

Between Frontage Road and Main Lanes
Instances happen where noise walls are placed between the frontage road and main lanes. For one project, the city wanted to put their logo on the wall but was on another city's side of the freeway. Cities were fighting each other over label so TxDOT moved wall even though that was the preferred location for construction. The public did not want the wall between the frontage road and main lanes.

TxDOT would prefer the noise wall between the frontage road and main lanes because it allows utilities to be at edge of the right of way and allows room for maintenance.

When placing a noise wall between the frontage road and main lanes, should consider freeway versus state highway. Not preferable where safety issues would impede clear zone and line of sight. Location that is more urban have more ramps, and walls create line-of-sight issues. Would also have gaps in wall if between main lanes and frontage roads. Makes walls less effective. Would need to create additional walls to help close gaps, makes design not feasible because more wall is needed and its harder to construct. Noise wall would not dampen noise from frontage roads. Some frontage roads are multilane and have a lot of traffic. Would need noise analysis to make sure that enough noise is abated. Could create need to go back through environmental study. Environmental studies the location. In one location they raised the road 10 feet, which was not part of noise wall study. Probably should have added a wall.

Away from Edge of Right of Way
When shifting a noise wall away from the edge of the right of way, would have to address clear zone requirements. Cannot place within clear zone regardless of preference. If it is not in the clear zone than it would be easier. If it is in the clear zone, it would create more issues with safety countermeasures. Addressing noise wall construction issues creates safety hazard and other problems.

There are places that have six-foot sidewalk and then a noise wall. Depends on the right of way. In urban areas, the right of way is so compressed there is no room for anything. Most likely to have noise walls in urban areas where right of way is compressed anyway.

Right of Way

Temporary construction easements have been requested in the past to help construction noise walls. Had one recently that did not work out well. Did not factor in fences, sheds, landscaping, and people having dogs. Did not have it in the contract to replace all those things. These would need to be cleared before construction. Made the easement unusable. City had easement that was platted a long time ago. All the property owners had built fences on the easement and made it part of their yards. TxDOT ended up shifting wall off the easement a little.

Alternative Wall Types and Construction Methods

Have a noise wall on Loop 28 that is a prefabricated noise wall. Set up or poured columns and slipped panels into the slots. Not very visually appealing wall. Have to make sure what showed in noise wall study is comparable to what TxDOT gives them. People say why are we getting a cheap noise wall here when nice neighborhoods get fancy walls.

All for making it easy, but TxDOT must be consistent with delivering what is shown at the noise wall workshop.

Survey Issues

Noise Walls

Occasionally, issues result from inaccuracies of the existing ground elevation surveys. One noise wall did not have slots for drainage and created a pool behind it. Drainage is always a constraint for noise walls. One instance where drainage was coming off the city's right of way onto TxDOT's right of way. Running in ditch that was blocked by the noise wall. This should have been picked up by survey.

If putting it right up against the right of way line, you get issues with trees being against the right of way and TxDOT kills the roots during construction.

One issue with ground elevation where elevation varied significantly from design plans. Deeper (and more expensive) shafts had to be created. Did not have detailed topographic survey.

Retaining Walls

The same issues apply to retaining walls as for noise walls. Spread footing retaining walls have encountered a lot of ground water. This combined geological and elevation issues. Were between rock face and clay soils. Had to address issues with three-month LIDAR survey to monitor movement of the retaining walls.

Have designed retaining walls where they place soil nails that go beyond the right of way line. Typically, will have to redesign if this happens.

DALLAS ENVIRONMENTAL

Wall Types

Noise Walls

The need for noise walls is not identified until the district begins the traffic noise technical report and start the noise modeling. The technical report can begin once they have the project footprint and approved traffic. These can be obtained as early as 60 percent schematic if there are no changes to the schematic, but the report could be considered at-risk if the district moves forward with a 60 percent schematic. The district shows the traffic noise technical report to the general public at the public hearing when the schematic is approved (schematic as 100 percent). The noise walls are included in the approved schematic. When the schematic is approved (100 percent), the PS&E is usually at about 30 percent. The district is given a year from the approved schematics to clear a project.

The district works one-on-one with the design team is after the noise workshop after the noise walls have been voted for and the workshop summary is approved. We let the designers know about the noise walls during the schematic phase, but the actual noise wall design will not start until after the noise workshop.

The project delivery method for design-build projects is different than the design-bid-build project since, on the design-build projects, the district is dealing with the general contractor. The general contractor has full control of the schedule, design, and activities. TxDOT reviews the general contractor's work.

The interviewee is involved with the NEPA documents, conducts reviews to ensure that the traffic noise technical reports and the TNM models are accurate and correct, and addresses design and constructability issues. They make sure any changes are documented and if a noise wall is affected by a change, that the noise wall is still effective. High-profile projects will also be reviewed by ENV.

Traffic Noise Wall Workshops

The noise workshops are typically held after the environmental clearance and preferably, after determining if there are constructability issues. Constructability issues should be defined before the public hearing and the noise workshop to avoid changes after the public has been engaged. We need to work hand-in-hand with the PS&E. Project designers and utility coordinators are having much more early involvement than they did previously. PS&E is involving everyone else.

The degree of completion of the noise wall designs at the noise workshop depends on the project. Typically, most of the design is completed after the noise workshop.

Noise Wall Construction Sequencing

The interviewee recommends constructing the noise wall at the end of the projects so that changes in the design do not impact the roadway project. The interviewee would prefer that the noise walls were conducted as a separate project/bids. They have seen several large projects that released the noise wall project as separate bids. It is recommended that noise walls and retaining walls be designed at the same time so that you can include the retaining walls in the traffic noise model, and to construct the retaining wall first, then follow it up with the construction of the noise wall.

Placement of Noise Walls

The Dallas District requests that noise walls are placed along the proposed right of way and most noise walls are placed there. Noise walls are shifted from the right of way for utility conflicts or other constructability issues. The interviewee thinks that walls along the frontage road could be more effective; however, there are ramps, utility lanes, driveways, etc. along the frontage road.

In the interviewee's experience, the Dallas District only builds noise walls within the right of way.

Retaining Walls

Make sure that you are modeling the retaining wall and the noise wall together in the TNM.

Utilities

The environmental team is notified of utility conflicts typically between 30 to 60 percent PS&E where the noise walls are included in the PS&E. The interviewee would like to have identified all the construction issues so they can make the changes needed before the public hearing. To identify utility conflicts for the design-build project, the team is looking at the ground as well as the plans. With the design-bid-build projects, the team is looking only at the plans.

After the noise workshop and after the environmental team receives the approved noise workshop summary. Once the project is environmentally cleared, then it goes to right-of-way acquisition, the right of way is purchased, and then the utility coordinator begins relocating utilities. Typically, the Dallas District would like to have all the utilities cleared before the noise workshop. The project manager for the schematic provides the noise wall plans to the utility coordinator after the noise workshop.

Noise Wall Construction Materials

By default, the Dallas District does not propose alternative wall types and materials. Alternative materials are used in only special situations. There are least three alternative noise wall type projects in the district. The Dallas District has used transparent acrylics in special cases since it can be installed on top of existing walls. There are instances of cast-in-place noise walls based on the location and utilities. The cast-in-place noise walls require footers. Also, Dallas area cities may provide funds to upgrade TxDOT standard walls.

Elevation Issues

The project surveyors collect detailed survey information within the right of way. TIN files, which are MicroStation files that provide contours and elevations, are used for areas outside of the right of way for noise modeling. The Dallas District experienced an issue with the accuracy of the survey when a noise wall was constructed in the wrong location after the drilled shafts were first placed in the wrong location.

The Dallas District has not experienced any noteworthy geological issues with noise walls except for a few cases of subsidence or settling under noise walls that may have caused minor movement or cracks.

Recommendations

For modeling noise walls, it is recommended to model an additional 2 feet on top of the noise walls being modeled (e.g., if the wall is feasible when modeled at 10 feet, use 12 feet instead). The difference in the decibel reduction may only be one or two but provided the dB(A) buffer for a potential error of plus or minus three (plus or minus three is the number used in the noise validation procedure within the 2019 noise rules). This recommendation is based on experience with the validation of noise models instead of just the minimum required.

DALLAS UTILITIES

Placement

Noise Walls

Utility coordinators are not involved in the feasibility and reasonableness evaluations for noise walls and are not involved in the noise workshop process.

It is recommended to make as little of an impact to the utility corridor as possible. The way to achieve this is to place the noise wall away from the edge of the right of way. This may be accomplished by placing the noise wall closer to the roadway or between the frontage road and main lanes.

Off TxDOT Right of Way
As a rule of thumb, utility coordinators recommend that design features, including noise walls, be located within the right of way footprint. But utility coordinators also realize that locating a noise wall off TxDOT right of way may alleviate conflicts with utilities, including large transmission lines. It this is the case then locating off TxDOT right of way should be considered. Attention should be given to how TxDOT would reimburse a utility if a noise wall placed off TxDOT right of way requires the utility to relocate.

Between Frontage Road and Main Lanes
Considerations when placing noise walls between the frontage road and main lanes instead of next to the right of way line include location, amount of right of way available, and number of utilities near the edge of the right of way. It would be preferable to place the noise wall by the main lanes if there is not a lot of space adjacent to the right of way for the utility corridor and noise wall.

Away from Edge of Right of Way
It would be preferred to shift a noise wall away from the edge of the right of way when they conflict with utilities. Shifting the noise all away from the right of way would also provide access for utility companies to maintain their facilities, which should be taken into consideration.

Retaining Walls

Utility crossings, including overhead lines, should be considered whenever placing a retaining wall.

Utilities

SUE investigation begins early in preliminary design. A detailed conflict analysis is performed when utility coordinators receive plans adequate and QLB SUE information. The utility conflict analysis is done by the design project manager. A copy of the analysis is given to the district utility coordinator and the area office utility coordinator.

Coordination with utility companies regarding conflicts happens monthly, starting at plans adequate. Earlier coordination may begin in preliminary design if there is a major utility, such as a transmission line, which requires a long lead time or additional coordination. Large utility transmission facilities, including overhead and underground, usually need a lot of time to relocate their facilities. Utility relocations begins when TxDOT acquires all the right of way on the project.

New utility installations, done between the original SUE study and the final design of the noise wall, can have an impact. The Dallas District has many requests for new utility installations and depending on the project, it could be years between the original SUE study and detailed design.

Utility coordinators usually get detailed noise walls information around plans adequate, 60 percent PS&E, from the PS&E project manager. This is also when plans are sent to utility companies. During preliminary design, utility coordinators are aware that noise walls may be needed on a project but do not have a design, permanent placement, or even if they are wanted by the public. Utility coordinators recommend for noise wall designers to consider the impact to utilities when placing noise walls in the right of way.

Right of Way

Noise walls should be considered during the right of way development process.

Alternative Wall Types and Construction Methods

Alternative noise wall types and materials would be considered if they lessen the impact to utilities.

DALLAS MAINTENANCE

We talked about three noise wall projects that David was involved in over the past few years:

1. Marsha Sharp Freeway in Lubbock, US 62 and Slide Road.
2. I-30 and Sylvan Avenue in central Dallas.
3. President George Bush Turnpike and Miller Road in northeast Dallas.

The Marsha Sharp Freeway noise wall in Lubbock is located on the south side of US 62 at the intersection with Slide Road. The project was completed about 10-12 years ago. Figure 174 provides a view of the wall from the freeway, and Figure 175 provides a view of the back of the wall, or view from the residences.

Figure 174. Noise Wall on Marsha Sharp Freeway in Lubbock, Freeway Side.

Figure 175. Noise Wall on Marsha Sharp Freeway in Lubbock, Residents' Side.

The wall consists of concrete posts and concrete panels and was placed at the edge of the right-of-way line. The wall has an anti-graffiti coating, but graffiti has not been an issue in the past few years. The wall is accessible for maintenance from the backside using a city street.

The utility poles were place in front of the noise wall, as shown in Figure 174. Most likely, the wall was built first, and then utility poles were placed in front of the wall. Since there was sufficient right of way, there was no need to have utility cut-outs for the poles, or place poles behind the wall.

The noise wall located at I-30 and Sylvan Avenue is shown in Figure 176. The noise wall is located on the south side of I-30 to protect residences close to the freeway in this area. The noise wall consists of transparent panels that were attached on top of an existing concrete wall. The noise wall is about 4,500 feet long and has a few overlapping sections at on- and off-ramps. The cost to construct the wall was about $1 million.

Construction of the wall was fairly straight forward, and there were no utility conflicts since the supporting concrete wall already existed. The wall was constructed about 4-5 years ago, and since then there have been few maintenance issues. In a few areas, there are trees rubbing against the wall and brush growing in between panels. The district has a contractor to cut back trees and shrubs on a regular basis, so this is not a major issue.

Figure 176. Noise Wall on 1-30 in Central Dallas.

A few of the panels became loose over time. The district found that a gasket between the metal support and the transparent panel was installed backward in those cases, which, over time, led to the gasket working itself out and loosening the panel.

The district has had no problems with graffiti so far. In one case, a driver threw a bucket of paint against the wall. The district was notified and removed the paint with a pressure washer. There have been no issues with grime, the panels are mostly self-cleaning. There have been no problems with yellowing, the panels have stayed clear and translucent. One issue that is noticeable are glare and reflections from vehicle headlights at night. However, the district found that this is not a safety issue, and there have been no complaints from drivers.

The noise wall located at President Bush Turnpike in the northeast of Dallas at the intersection with Miller Road is shown in Figure 177. Figure 178 shows the backside of the noise wall before the transparent panels were attached to the concrete wall. The noise wall was constructed using the same construction method (transparent panel on concrete wall) as used on the I-30 project. However, the transparent panel is much lower than the panels used on I-30.

The district was unable to provide feedback on the placement or sequencing of retaining walls. However, it was noticed that some retaining walls in the district have issues. For example, some retaining walls lose some of their fine material at joints. If a wider filter paper would be used during construction, this might remedy the problem. Currently, a 4-inch strip is being used, but a 12-inch strip would be preferable. In addition, it is important to use consistent backfill material.

Figure 177. Noise Wall, President Bush Turnpike, Freeway Side.

Figure 178. Noise Wall, President Bush Turnpike, Residents' Side, Before Construction.

In closing, the district recommended that when building a noise wall, it is critical to research your options. Typically, there is a wide variety of noise wall options, but all have various benefits and drawbacks. It is further critical to know where all buried utilities are located on a project. If new utilities need to use the right of way, it is critical to have a plan where each utility should go instead of leaving it up to the utilities where to locate.

FORT WORTH CONSTRUCTION

The Fort Worth District follows many of the same general construction methods discussed with other districts within the state. One noteworthy recommendation from the construction engineers interviewed was the recommendation to try to look at noise and retaining walls together to take advantage of limited available space, to try to incorporate these walls in the preliminary design phase with the other elements such as utilities, and to construct these walls early in project delivery to allow for secondary benefits to the construction team.

Sequencing

Noise walls and retaining walls should be better integrated into the preliminary design phase of project development to allow the structures to be better incorporated into projects. Beyond the design phase, it was advised that retaining walls and noise walls should also be constructed early if possible. But for most projects, the contractor determines the timeline of the project. The contractor can leverage resources as they choose on the schedule which is most beneficial to them. This often leads to wall structures being completed later in the delivery process, which is typically not an issue if utilities are considered.

Letting a noise wall separately could cause an array of issues with too many moving parts, and communication may not be as effective. On the other hand, if there is some flexibility, building a noise wall early in the construction process can provide benefits in preventing delayed conflicts with utilities. If a noise wall is incorporated into the same part of planning which examines utilities, these conflicts are addressed early on rather than coming across unanticipated issues further along in the construction process.

Utilities

Utilities are always considered in the construction and placement of noise walls and retaining walls. It was mentioned that integrating utilities in the project design phase earlier would help avoid some of the utility conflicts. Also, if TxDOT does a specific contract to relocate utilities for a construction project, it could be useful to include the construction of noise walls in the same project. This would ensure that noise walls and utilities are considered at the same time in project design to minimize conflicts and help with coordination.

Placement and Maintenance

Noise Walls

In placing the noise walls on a project, the first consideration is utilities and related issues. As mentioned earlier, Fort Worth recommend addressing these issues earlier and getting the walls placed by a noise wall subcontractor.

Off TxDOT Right of Way

These walls are typically placed on TxDOT right of way as a standard. While the district prefers to keep design features on the right of way, placing it elsewhere could be considered depending on need to accommodate the adjacent property and with the appropriate agreement for maintenance in place.

It may be a good option to place the noise wall between retail properties, adjacent to right of way and residential areas. This would provide a noise reduction to the residential areas while not impacting the visibility for the retail businesses. This may also be an option to limit the visibility/aesthetic impact to parks and other green spaces adjacent to right of way.

Between Frontage Road and Main Lanes

The district might consider placing a noise wall between the frontage road and main lanes in situations such as the frontage road being at a lower elevation than the main lanes.

Away from the Edge of the Right of Way

Leaving additional space behind these walls can create challenges in allowing for transient persons or storage of personal items. The district typically does not object to residents utilizing the space behind noise walls as long as they maintain the space and allow access as needed.

The preferable spacing is usually 6 feet from the edge of the right of way. It is better to provide this space for construction, as it could be challenging to get a construction easement if the wall is placed closer to the right of way line.

Retaining Walls

For retaining walls, placement can change depending on the type of wall and the elevation of properties. For example, if a road is lower than surrounding property, it could be useful to leave about 10 feet of so to ensure there is enough space for the support needed during construction.

When placing a retaining wall between the frontage road and main lanes, the primary concern is grade change, and the district might prefer to construct all their retaining walls in this location due to managing grade change and avoidance of utility conflicts.

Alternative Noise Wall Types

The Fort Worth District has considered the use of other materials for noise walls, but most of their walls are concrete. Concrete is considered an old highway custom and has become the default material for these walls. While they consider other materials, these materials may not be as forgiving as the traditional concrete. For example, they faced an issue with an acrylic wall which was placed into plans before they district realized this. While these walls can be highly effective, the posts for these walls must be placed at a very certain angle to allow for the panels to be slipped into the precisely 90-degree slots. This can create difficulties in relying on these materials. When alternative noise wall types and material are used it is important to ensure that the proper specifications are included in the project documents. Also, there may be local requirements for noise walls, such as wind loads, that need to be taken into account when considering alternative noise walls.

Survey and Geotechnical

From time-to-time issues with survey information has been encountered for retaining walls. This is not really an issue for noise walls. The ground is unique in areas of Fort Worth and geological issues cannot always be prevented. But it is important to keep in mind that projects have faced ground material challenges before. One example that was mentioned was the failure of an MSE wall that was about 75 percent complete. The wall slid down due to a slipping plane about 40 feet under the wall. The wall had to be completely redesigned. It is unclear whether additional borings could have even picked up the issue. Some areas are prone to challenges with slope and soil.

Right of Way

For right of way, the district will request temporary construction easements if they do not have the 6 feet they prefer, but if possible, they might attempt to get a letter from the adjacent property owner for access permission to avoid the environmental process for the easement. The acquisition of the needed easement is time consuming and could potentially delay a project.

FORT WORTH ENVIRONMENTAL

Wall Types

Noise Walls

Typically, the need for a noise wall identified between 60 to 90 percent schematic design when placement, height, and length is of a noise wall has been determined. The initial proposals for preliminary traffic noise walls are included in the schematic design. There is some overlap before the end of the environmental process and schematic design. Noise wall detail is provided during the PS&E phase. The Design team is informed that a noise wall is needed on a project during the schematic design phase. The need for noise walls is usually identified later in design-build projects than in design-bid-build projects since the design-build projects are more fluid.

The evaluation for feasibility and reasonableness takes place during the environmental and schematic design phases. This includes an initial constructability review for design and utilities. The process is coordinated by the district's environmental supervisor.

Traffic Noise Wall Workshops

Typically, noise workshops are conducted right after NEPA clearance. There are situations where the noise workshops can be conducted between the public hearing and the NEPA clearance, but the district usually waits until after the NEPA clearance to start developing and scheduling the noise workshops.

The project designers are usually involved with producing the part of the presentation providing the design files and displays. The project manager typically will give part of the presentation to describe more of the design and project development, and possibly project sequencing.

The utility coordinators are also involved in terms of constructability review and to make sure there has not been any additional utility information that has come in that might be pertinent to the information presented at the workshop or if there is anything with construction sequencing or utility relocation that might need to be involved. Utility coordinators usually attend but typically do not present at the noise workshops.

When the traffic noise workshop is conducted, the noise wall designs include the initial dimensions; height, length, location, and possibly the materials (when they give the public their wall aesthetic options). The noise wall designs are not anywhere near 100 percent. Designers are leery of getting to total completeness until they know they are voted on by the public. In the workshop, designers may (but not always) give preliminary information on what the construction is going to look like; whether they are going to use drilled shafts, spread footings, etc.

Noise Wall Construction Sequencing

When dealing with the public, the public almost always wants the wall installed at the front end of the project rather than the end. Typically, the noise walls are installed near the end of the project when the project has completed all its grading and the rest of the construction. Installing the noise walls early rarely happens.

The district would only consider letting noise walls separately from the project if it is let sooner than the project. The district's concern is that if the project was completed first, there is a chance that the wall project may not move forward and be implemented like it should have been to meet the project commitments for NEPA. If the wall project were on someone's letting schedule, that would not likely happen, but there is the fear that it may not be developed.

Placement of Noise Walls

The topography, drainage features, and locations of other design features are considered in the decision-making process when deciding where to place a noise wall. Considerations include the general characteristics of the roadway areas between the existing road, the elevations of the proposed roads and the adjacent property, access points, cross streets, driveways, utility requirements (existing or relocations), and where the wall is most effective.

The district is capable of conducting its noise modeling and also outsources modeling. The district has not conducted in-house modeling under the new [2019] rules, just through consultants.

On a recent larger project, the district knew that they were going to need noise walls, so to make sure all the possible wall locations were considered, the district coordinated with the designers and the consultant noise modeler and went through the project to select what locations to consider for modeling walls. Utility coordinators and designers were then asked if they had any issues with each location. The idea was to address noise location at the front end of the project to cut down the amount of remodeling needed later.

More detailed topographic survey information for adjacent areas off the right of way would be very helpful for the noise wall location decision process. It can be a challenge using topo maps or other sources to find off-right-of-way elevation data. Most of the time, the district receives utility information early, but sometimes later in the process. Also, sometimes, the utility survey contract or SUE consultant will not get initiated until later in the decision process. It would be helpful to have this information early in the process.

Being able to know exactly what the design criteria are for traffic noise wall placement: offsets needed, spacing requirements for overhead utilities, distance from sidewalks, sight distance, etc., would be helpful. The district is trying to have those conversations with the designers early in the process to identify what those limitations would be. The Fort Worth District has not placed any traffic noise walls off TxDOT right of way.

For placement of a traffic noise wall between the frontage road and the main lanes, the district considers ground elevations, sight distance for ramps, frontage roads, and gores. Also, the district determines if there are any utilities, retaining walls, drainage, and illumination considerations. The district considers the fact that the noise wall may not be as effective if noise walls were placed at the edge of the right of way, because the wall would not shield any of the frontage road traffic.

Placement of a noise wall between the frontage road and the main lanes is preferable if you have a narrow right of way between the frontage road and the edge of the right of way and need to fit utilities, illumination, bus stops, pedestrian elements, or anything else that may cause a wall along the right of way to be eliminated. When placing a noise wall closer to travel lanes, the district considers the overall clearance widths between the edge of the pavement or curb line, that the barrier design is crash tested, bus stops, pedestrian elements, utilities, maintenance, and security.

Placing a noise wall closer to the travel lane may avoid issues that may occur closer to the edge of the right of way such as extreme elevation changes or grading issues that could potentially affect noise wall placement.

For noise walls and retaining walls proposed in the same area, consideration of the modeling of how it will affect noise patterns in the area. Also, designers should consider drainage and pedestrian issues in the area.

Utilities

The district's environmental team is notified of utility conflicts as part of the noise wall constructability review. The process could differ based on project delivery type (design-build versus design-bid-build) since there may be changes later in the process in design-build projects.

The utility coordinator is typically provided a copy of the noise wall design plans before the noise workshop and are provided by whoever is heading up the project. It is usually the project manager, but can be a combination project manager, designer, and our advanced project development group.

Right of Way

Traffic noise walls should be considered during the right of way process. The district looks at the available right of way prior to the start of modeling to decide where to locate noise walls. The Fort Worth District has not acquired any right of way specifically for noise walls.

Noise Wall Construction Materials

The Fort Worth District has started considering alternative noise wall types (e.g., front-install panels) and construction materials (e.g., fiberglass), but has not proposed or constructed any using alternative wall types or materials.

FORT WORTH BRIDGE

The bridge engineering department at the Fort Worth District includes both bridge inspection and design.

Typically, the district aims to include retaining walls in the design as early as possible. This may happen during schematic design but sometimes happens during PS&E. Good communication and coordination was recommended to help ensure retaining walls are included in design sooner rather than later. Stakeholders, including bridge design, right of way, and utility coordinators, should be included in meetings at the beginning of the project. Stakeholders, including subject matter experts, can help provide information to help make better informed decisions.

Early coordination with utility coordinators is recommended. Identifying what utility accommodation methods, including utility relocation, is going to be used on which utilities is helpful in designing retaining walls. Designers may need to design around utilities.

Early coordination between all the disciplines, especially the noise wall and retaining wall designers, is the key to success in every project. Many times, the wall designers are different than the project designer. Need to ensure that the designers for all aspects of the project are effectively communicating on the project.

Sequencing

It was noted that coordination during construction is important to ensure proper installation. The contractor should have a well-thought-out plan for how the construction of all the design features are considered. This helps ensure the construction of the retaining wall happens in the proper sequence for the project.

Placement

As much space as possible is recommend between retaining walls and the edge of the right of way, but 10 to 12 feet should be the minimum for proper construction and maintenance. The amount of space needed may vary depending on the type of retaining wall. The space is needed to properly access the area with equipment for maintenance and repair.

Between Frontage Road and Main Lanes

It would be preferable to shift the retaining wall between the frontage road and the main lanes instead of having the wall near the right of way line if there is sufficient room between the frontage road and the main lanes and if it lessens the impact to utilities. The cost of placing the retaining wall should be considered as well as the impact to utilities and drainage.

There may be older non-TxDOT utilities that were installed between the frontage road and main lanes so the location of these utilities should be considered as well when designing retaining walls. If the elevation difference is not that great or if there is sufficient room near the edge of the right of way for the retaining wall and utilities, then it may be preferable to locate the wall near the right of way line.

Noise Wall and Retaining Wall in Same Area

When considering placing noise walls and retaining walls in the same area it is good to get representatives from different disciplines together including right of way, utilities, and drainage. Designers should look for a way to incorporate the two walls together. Since this would eliminate the need for two different foundations and conflicts with utilities. It may also reduce the need for additional right of way.

Environmental is not complete when the retaining wall design begins. So, designers do not know for sure if a noise wall is going to be placed in the area. Around 60 percent PS&E is when the determination of a noise wall is complete.

Utilities

Structural designers are informed of utility conflicts but would like to be informed earlier of conflicts. The structural design process includes a question regarding utilities. It is at this time that the structural designers reach out and get a copy of the SUE plans. Including SUE information as a layer in the design would be helpful for structural designers. Structural design may begin during schematic or PS&E and depends on the project. It seems like district structural designers find out about utility conflicts earlier for design-build projects even though their role is more oversight.

Designers consider SUE information when designing the structural elements of the project. Additional SUE information, including test holes, has been requested when additional information is needed regarding utility conflicts.

Right of Way

The district considers the amount of necessary right of way when planning for noise walls. Purchasing additional right of way is considered when placing retaining walls. Cost is considered when reviewing details of constructing a retaining wall versus omitting the need for a retaining wall by acquiring additional right of way for sloping.

Temporary construction easements and right of entries are not used much at the district. Since, if the easement is needed to construct the wall, access will probably be needed later for maintenance.

Alternative Designs

Alternative noise wall types are considered. The district looks for the most feasible and economical wall type. The district strives to be good stewards of the taxpayer's money.

Geological Information

Geological information is collected in area where retaining wall are planned. Information in the TxDOT geotechnical manual provides good information for project designers regarding soil borings. The district is aware other district have experienced geological issues regarding retaining walls.

FORT WORTH RIGHT OF WAY AND UTILITIES

Placement and Design

Noise Walls

It is recommended to identify the placement of noise walls early on in schematic, or early in PS&E if the schematic phase is skipped, so that the location of noise walls can be considered when planning to relocate utilities.

Before the noise workshop the design of the noise concentrates on features that are of more interest to the public, such as the height and location of the wall. The foundation, and other design features are not included until after the wall has approved after the noise workshop. Having a more detailed noise wall design, before the public meeting, may reduce the chance a wall is canceled later in design or construction, when the design is compared with available SUE information to identify utility conflicts earlier.

The TxDOT project manager provides a copy of the noise wall design to the utility coordinator. Generally, the type of project delivery method should not affect when noise walls are identified on the project.

Off TxDOT Right of Way

One of the reasons to consider placing a noise wall off right of way may be due to lack of available space in the right of way. Responsibility for maintaining the noise wall should be considered. If a local municipality, or other entity, is willing to maintain the wall it be may good to consider placing off right of way. If placing a noise wall off TxDOT right of way and in a dedicated utility easement the rights of the utility in the easement need to be considered. The district would prefer to work on TxDOT right of way.

Between Frontage Road and Main Lanes

Locating a noise wall between the frontage road and main lanes should be considered when it can safely be placed there, since it alleviates conflicts between the noise wall and other features in the right of way, including utilities. This would especially be a benefit for projects where the right of way corridor is tight on the project. Locating a noise wall between the frontage road and main lanes would reduce the number of conflicts with utilities, since they are usually located near the right of way line.

The district has seen where a homeowner's association, HOA, was concerned that a noise wall placed near the right of way line would limit access for maintaining their privacy wall and other features near the right of way. In instances where adjacent property owners are concerned about access, locating the noise wall between the frontage road and main lanes should be considered.

Away from Edge of Right of Way

Shifting a noise wall away from the edge of the right of way would provide additional room, between the back of the noise wall and the right of way line, for utilities to access their facilities and TxDOT to perform maintenance. But placing a noise wall closer to the travel lanes may limit sight distance for side streets accessing the frontage road.

Retaining Walls

When possible, shifting the placement of a retaining wall from the edge of the right of way to the area between the frontage road and main lanes would allow for better access to the frontage road from driveways and side streets. It would also lessen the impact to existing utilities which would benefit the project. Placing retaining walls between the frontage road and the main lanes is preferable from a utility coordination standpoint.

Utilities

If SUE is not part of the design contract, then district utility coordination will develop their own SUE work authorization. TxDOT has more of a hands-on role for design-bid-build. And for design-build projects, TxDOT has more of a management role. The district still performs SUE during the schematic phase no matter the project delivery method.

Utility coordinators try to get involved in the project early to help mitigate the impact of utilities and are usually brought in during the schematic phase. Utility conflicts are identified during schematic and PS&E. And utility relocations typically begin after 60 percent PS&E. Utility coordinators meet and communicate with utility owners starting about four times a month. Less meetings may be held the closer the utility is to being clear of the project.

Regarding noise walls, the timing of when utility coordinators are informed of the need for a noise wall varies. It may be during the schematic phase or right before the project is let. Utility coordinators are not too involved in the feasibility and reasonableness evaluations for noise walls but are asked for their opinion on what the utility impacts will be. There seems to be more coordination between utilities and environmental regarding the evaluations lately. Utility coordinators are not currently involved in the noise workshop process. Coordinators may be invited to attend the workshop but would rather discuss the noise wall separately with environmental rather than attend the workshop. The location of utility crossings should always be considered when placing noise walls.

For larger utility conflicts, such as a lengthy longitudinal utility relocation, utility coordinators may coordinate with district right of way personnel on how to best handle the situation, which may include parcel acquisition priority.

Right of Way

Right of way is getting involved earlier in the project development process, usually during schematic but sometimes in the planning phase. Noise walls should be considered during the right of way development process. Also, it does not appear that the amount of available right of way is considered when placing noise walls. It would be beneficial to have right of way personnel more involved in discussion about the placement of noise walls and retaining walls.

Determining right of way needs varies by project. During the planning stage project personnel are trying to refine the right of way, but there still may be changes to the footprint as late as 90 to 100 percent PS&E. The Fort Worth District tries to get a head start on making offers for parcels by performing some front-end activities such as title work and appraisals for areas where the project footprint is not expected to change.

If additional right of way is requested late in the project development, it may be out of the area where environmental approval has been granted. In this case a reevaluation would need to be done to include the additional parcel in the project. This may take time to perform.

The district must go through a similar process to secure a temporary construction easement as they do to acquire right of way. The need for temporary construction easements needs to be identified early in the project to be able to secure the easement without affecting the project. It is usually too late to obtain a temporary construction easement once the project goes to construction. It may also be too late to pursue a construction easement for areas where a parcel has already been acquired from the property owner.

It may be a good practice to assume temporary construction easements will be needed to help construct noise walls when placed near the right of way line. This would ensure there is sufficient time to obtain an easement rather than waiting until construction. It would also help to ensure that the area is considered in the environmental approval.

Alternative Wall Types and Construction Methods

The district is interested in considering alternative noise wall types and materials to lessen the impact on utilities and help with constructability.

HOUSTON PLANNING AND DESIGN

While the Houston District follows many of the typical formal and informal standards mentioned by other districts, this region faces unique challenges in planning due to the frequency of severe weather incidents and the makeup of soil in the area. The district works with the city and property owners and is more flexible in potentially placing a project off TxDOT right of way or cost sharing with another entity.

Planning and Design

Noise Walls

The need for a noise wall may be determined in different parts of the project development process. In some instances, the need may be known in the planning phase before a project begins. But in other situations, the need for a noise wall might be added at 90 percent PS&E or even in construction. While a noise wall is generally identified early and integrated into plans by 30 percent PS&E, it can fluctuate as it is contingent upon the noise analysis. Which is done, if the planning group is more certain on the need of a wall, it will be on the schematic, but this can vary. The typical timeline for the integration of walls is by 90 percent PS&E.

Noise workshops may be held in schematic design or later. Designers are not really involved in the noise workshop process. The limits of the noise wall, placement, and height are available during the noise workshop. The detailed noise wall design is not done until after the noise workshop. Houston District has a green ribbon program regarding wall aesthetics. Another issue with planning for noise walls is community involvement. Houston has faced situations where a wall has come in and out of favor with the local community and may be voted on multiple times.

For the physical placement of a noise wall, this is generally determined by environmental. Design has less involvement in determining the placement of noise walls. Many factors go into determining where a noise wall will be placed, including the characteristics of the wall. After a noise wall is placed by environmental it is sent to the designers for review. Designers look at the placement of the noise wall with respect to other design features. It is always important to consider utilities when placing a noise wall as well as drainage and safety requirements.

Utilities are always a consideration in deciding on the location of noise walls. If a noise wall is required to be a taller structure, this can create conflicts with overhead utilities. If there are too many issues with placement then designers send the noise wall back to environmental to see if there is another location to place the noise wall. Providing the location of utility easements, and right of way maps, to environmental planners may help in determining the placement of noise walls.

The district usually uses a 4-foot spacing and center the noise wall on it. This leaves 2 feet between the noise wall and right-of-way line. There have been issues with overhead utility lines due to this spacing. Sometimes the wall is shifted to allow for more room behind the noise wall for utilities. A minimum 5-foot spacing behind the noise wall would be beneficial in placing the noise wall. The Houston District does not object to residents using the back of the noise wall as an extension of their privacy fence. This reduces the amount of maintenance the district performs behind the noise wall.

Off TxDOT Right of Way

Houston faces some unique situations regarding noise wall placement. Sometimes noise walls are added to a project and are located off the right of way. This is usually done because they were requested and may be added later to a project. These often occur at the request of a stakeholder, such as the city, and the projects usually involve a mix of spending by the city and state on the project. The city may clear land and relocate utilities if TxDOT will construct the wall. The noise walls can be built by TxDOT and then transferred to the city for maintenance. These walls may be requested late and therefore are integrated into the project after letting. The Houston design team is more flexible in allowing projects to be constructed off TxDOT right of way if issues arise where right of way was very tight and there is a significant need, but the district would prefer to place all project features on TxDOT right of way. For noise walls placed off TxDOT right of way, the district usually requires a 5-foot easement for the wall and a 20-foot easement for access.

Between Frontage Road and Main Lanes

TxDOT will at times place a noise wall between the frontage road and main lanes. This placement is usually desirable from the public's perspective. Depending on the orientation, noise walls can cause issues such as casting too much shade and hindering plant growth on adjacent properties. There is also a feeling with much of the public that frontage roads are community roads, and the public wants them separated from the main lanes. Placing a noise wall between them would provide this separation. Noise walls located between the frontage road and main lanes can be a useful option as long as safety is not impacted by keeping traffic from being able to pull over or affecting drainage along the main lanes.

Away from the Edge of Right of Way

When placing a noise wall closer to travel lanes and away from the edge of the right of way, many of the same items, safety, utilities, right of way, and maintenance, should be considered. There must be access behind the area for a mower, the wall cannot create significant crash risk for travel lanes, the location of utilities must be considered, and right of way spacing is always important. The public usually prefers noise walls placed closer to the travel lanes instead of next to the right of way line.

An additional issue to consider when shifting the noise wall away from the edge of the right of way is the potential for the extra spacing behind the noise wall to create a risk for adjacent properties. Overall, keeping a wall further from travel lanes is preferable for safety, but shifting a noise wall can be a useful tool to alleviate utility conflicts.

Retaining Walls

Retaining walls have different challenges in the Houston District, but these walls are also decided upon during schematic design. In the case of retaining walls, it is up to designers to determine the length, height, foundation, and other characteristics of the wall.

For retaining walls, the planning group in Houston recommends leaving a minimum of 2 to 5 feet of space between the retaining wall and the right of way line. The design team considers options such adding rip rap, or a drainage swell in the area between the retaining wall and right of way line.

Drainage needs to be considered when placing retaining walls between the frontage road and main lanes. For major grade differences between the right of way and adjacent property placing a retaining wall between the frontage road and main lanes by reduce this. Since it would allow the frontage road to be closer to the grade of the adjacent property.

Sequencing

Noise Walls

Regarding construction sequencing, the Houston District would like to have noise walls constructed first. This is usually an expectation from residents, but contractors never seem to complete the noise wall first. While the district recommends this, the contractor does not always follow this guidance. It is typically related to challenges with utility relocations or waiting for the panels to be made.

As far as letting, the Houston District lets noise walls in the same contract as the rest of the project. The district does not see significant benefit in letting noise walls separately. While the district would like to see walls placed first, it should not be separate from the rest of the project unless there is an extenuating circumstance that requires it.

There was a recent project where a noise wall was let after the main construction project. The noise wall was added to the project during construction. The contractor had finished the main construction project by the time the local municipality acquired the easement and relocated utilities for the noise wall to be built.

Retaining Walls

For Houston specifically, the district likes to see retaining walls built and backfill placed quickly due to the ground characteristics of the region. If a retaining wall is placed and constructed early, the backfill can be added and the wall can sit for a while and consolidate. After settling, a little additional backfill can be added prior to the remainder of the project weight being added on top.

Phased construction like this is difficult due to project timelines in Houston. But this would be an ideal strategy for the region.

Utilities

The planning and design team in Houston is informed of utility conflicts on projects. They generally find out about conflicts between 60 and 90 percent PS&E. By then they usually have a preliminary storm sewer designed.

Design works with utility companies throughout the project, and they will sometimes hire a utility coordination consultant to maintain communication channels between entities. Communication typically begins with a kickoff meeting. There are also meetings at the completion of the 30, 60, and 90 percent PS&E. This keeps utility owners informed about the development of the project. Utility companies begin to become more interested around the 60 to 90 percent PS&E. This is where utility conflicts are shown on the design plans.

SUE information is usually received around 30 percent PS&E. Additional SUE information may be requested, including test holes. They may be requested to help clear or confirm utility conflicts. Communication with the different types of utilities varies. For example, a transmission corridor or pipeline company many be notified earlier that a project is being developed, and other utility companies may be informed later in PS&E. It is ideal for traditional utilities to begin relocating around 90 percent PS&E for the sake of the project timeline, but it often does not work this way. Most often these companies begin relocating about a month prior to letting.

Right of Way

It was mentioned that acquiring additional right of way to accommodate the noise wall should be considered. The cost of acquiring right of way in the Houston District has increased greatly over the years and continues to increase. The Houston District is more flexible in placing noise walls if an opportunity presents itself to cost share with another entity.

If necessary, the Houston District will request temporary construction easements to help construct noise walls and retaining walls. Temporary easements may be considered when planning for noise walls and retaining walls.

Alternative Wall Types

The Houston District is beginning to incorporate removable fiberglass panels around utility poles to mitigate relocating utility poles. The use of removable fiberglass panels has been used at the San Antonio District.

Alternative designs are considered to mitigate the need for a retaining wall. Cost, schedule, and impact to utilities are considered when weighing alternative designs. The district mainly uses MSE retaining walls.

Geotechnical Issues

The Houston District has experienced geological issues when dealing with retaining walls. Part of this is due to fault line in the district.

Additional Recommendations

It would probably be beneficial to have a statewide guidance on noise walls, including the types and materials that can be used.

HOUSTON CONTRUCTION

Regarding noise walls and retaining walls, the Houston District deals with many of the same challenges as other districts such as managing utilities, safety of construction/maintenance teams, and balancing relationships with adjacent property owners. The district faces additional difficulties since the Houston area requires a greater amount of attention to challenges such as more frequent severe weather and drainage issues.

Construction

Within the sequencing of a project, noise and retaining walls are typically started early in a project. When the contractor begins pouring foundations, the foundations for these structures are laid as well. The contractor prefers to construct noise walls last. This is due to right of way acquisition and utility relocation not being complete at the beginning of construction. From a construction standpoint, it is recommended to acquire all the right of way and relocate any overhead and underground utilities in conflict before construction begins. It is also recommended to leave sufficient room to access the area during construction with heavy equipment. The district recommends letting noise walls as part of the main construction project. The cost, right of way acquisition, and ease of utility relocations are factors in this recommendation.

Placement and Maintenance

Noise Wall

In constructing a noise wall, the Houston District tries to find a balance between the spacing of a project, maintenance needs, and adjacent property owners. Placing a wall can create some challenges in that the team has to ensure that there is an appropriate amount of space behind a noise or retaining wall for the necessary future maintenance, but this can be a double-edged sword as the property line between TxDOT right of way and adjacent property owners can become less clear over time.

The Houston District usually does not have an issue with an adjacent property extending their property back to the edge of a wall, but they have to assure that a contractor can still have access to the backside of that wall during construction. This is also important for maintenance crews for all future work. It is typically ideal for there to be a 5-10-foot buffer between a TxDOT structure and an adjacent property to minimize any potential conflicts. This spacing allows for access for a mower, as well as contractors and maintenance crews, and this prevents any confusion in ownership of property. Drainage and flooding can be an issue when placing noise walls, as can be seen in Figure 179 and Figure 180.

Figure 179. Mossy Oak Retaining Wall and Noise Wall.

Off TxDOT Right of Way

In determining placement relative to adjacent properties, the Houston District prefers to keep all projects on TxDOT right of way to minimize potential conflicts and ensure maintenance access. It is also easier to maintain the relationship between TxDOT structures and utilities since moving off TxDOT right of way pushes a project onto an easement.

Figure 180. Drainage Issue near Noise Wall.

It is not policy to construct or build anything off TxDOT right of way. The projects that develop outside the right of way are due to requests from state representatives or a municipality. If the district were to consider placing a project off TxDOT right of way, it would usually be due to insufficient accommodation for TxDOT to access for maintenance and/or a clear-cut agreement that someone else will be building and maintaining a project. The district would require accurate ground elevation information and that the area be clear for construction, including utilities and homeowner safety.

Between the Frontage Road and Main Lanes
For placement relative to other roadways, the considerations include maintenance, construction, drainage, and utilities. When asked for thoughts on placing a noise wall between the frontage road and main travel lanes, the Houston Districts greatest concerns were safety and the possibility of someone hitting the wall, storage of supplies and equipment during construction, utility locations, and drainage with severe weather events.

Placing a noise wall closer to main lanes can be effective in that the structure will be closer to the sound it is trying to mitigate, but it can increase the likelihood of damage from higher speed travelers which impacts the wall and the traveling public. This situation could be preferable if right of way is too limited to place this in another location or community preference. It would require an additional crash cushion, but it could be possible. The district typically likes to avoid placement in this location.

Away from the Edge of the Right of Way
For placement of a noise wall closer to travel lanes and away from the edge of the right of way, issues with additional space behind a noise wall and cutting spacing for things like sidewalks arise. If the wall is closer to travel lanes, the same issues with impact to the wall are present, but additional issues with the potential for people to live behind a wall or store things behind a wall would also need to be considered.

A wall closer to travel lanes could also cut the space needed for a sidewalk or shared use path, which are typically pretty wide (about 10 feet wide). Consideration also needs to be given to the end treatment of the noise wall. The ends of the wall would need to be designed to not be a hazard to the traveling public. This placement may be considered when there are utility conflicts that cannot be resolved by other means. It would usually be more preferable to place walls closer to the edge of right of way and away from travel lanes to provide for adequate spacing of other needs. See Figure 181 for an example of a noise wall closer to the frontage road and away from the edge of the right of way.

Retaining Wall

Retaining walls are also developed early in the construction phase when a contractor lays initial foundations. These structures often deal with grade changes and impact the roadway spacing differently, but many of the considerations are the same. Utility locations are always a concern when developing a structure, but additional considerations can include signage and safety. A spacing of 10 feet from the edge of the right of way is recommended for construction and maintenance of the retaining wall. See Figure 182 for an example of supports used during the construction of fill retaining walls. Figure 183 and Figure 184 show the completed retaining walls.

Between the Frontage Road and Main Lanes
In placing a retaining wall between the frontage road and main lanes, challenges could arise in determining where to place signage. It could also be difficult to determine where utilities should be located because TxDOT does not prefer for utilities to be located under roadways. While these may be some of the considerations, TxDOT in Houston does not deal with this situation frequently enough to speak to it in detail.

Figure 181. Noise Wall at Brickhouse Gully.

Figure 182. Metro Bus Lane Construction.

Figure 183. Completed Metro Bus Lane at IH 610 at Post Oak, View A.

Figure 184. Completed Metro Bus Lane at IH 610 at Post Oak, View B.

Noise Wall and Retaining Wall in Same Area

For the construction of noise and retaining walls in the same areas, the team would like to see more separation between the walls to have more space to bring in cranes and other needed supplies. Proper studies need to be performed by designers and engineers to justify noise walls in the same area as retaining walls. See Figure 179 for an example of a noise wall and retaining wall installed near each other.

Right of Way

For right of way, some of the challenges which arise during projects can include conflicts with adjacent property owners. The Houston District likes to place noise walls right against the right of way, so they have to let property owners know if they intend to step out into adjacent properties. While this can be difficult, these adjacent owners are usually flexible as they are getting a nice noise wall upon completion. Requesting permission from owners is often easier than going back to request an easement as it would have to go back to environmental for clearance.

Survey and Geological Issues

The district has experienced issues with the accuracy of survey information when dealing with noise walls. Poor soil conditions, fault lines, and saturated soils are some of the geological issues encountered when dealing with noise walls and retaining walls.

Alternative Wall Types and Materials

Alternative noise wall types and material would be considered for use in the Houston District. Different material types may be able to absorb more noise, and they may be more aesthetically pleasing.

Other

Some homeowners have expressed a need for a noise wall as a safety device or security fence from the public. The district would recommend stressing the reason for a noise wall in public meetings and noise workshops and why TxDOT is placing them. Noise walls are for noise mitigation and not for security reasons.

HOUSTON ENVIRONMENTAL

Noise Wall Types

The Houston District has been rather aggressive with noise abatement to provide noise abatement whenever they can. The district uses noise wall cost averaging across individual subdivisions and neighborhoods to benefit as many residences as possible within a common neighborhood or subdivision.

Sequence

Noise Walls

Typically, the need for a noise wall is identified before the schematic is completed. When I look at a project, I look at the volume of traffic on a roadway and the proximity of residential properties. That alone will tell me if there is a good possibility of the need for noise wall. We need the 30-percent schematic to model it to tell whether we need a wall or not. The difference between 30-percent and 90-percent schematics typically changes the schematics of only a few feet. That does not change a noise model very much.

When the design team is informed that a noise wall is needed depends on whether the schematic design is being done through a consultant contractor through TxDOT's Advance Projects Development Section. In the project development, the district works with the Advanced Project Development Section during the schematics, so when the schematic is complete, the recommended noise wall locations are on the schematics. When the schematics go to whoever is doing the PS&E, they have the proposed noise wall information. It works pretty much the same way with consultant contractors. Typically, by the release of the 30-percent schematics, the consultant contractor should know where the district recommends placing the noise walls so they can make any accommodations. This does not mean that the noise walls need to be designed since TxDOT still needs to go through the noise workshop process to determine if the recommended walls will be desired. Proposed noise walls do get rejected occasionally.

The utility coordinator is typically provided a copy of the noise wall design plans after the noise workshop (during PS&E). Typically, PS&E is not started until after the noise workshop. Also, designers of the noise walls need to know what noise wall texture or design that was selected by the public vote resulting from the noise workshop. The district does not want to waste time designing noise walls that the public may not want.

PS&E provides the utility coordinator the noise wall plans since PS&E has the final noise wall locations. PS&E will coordinate with the utility coordinators about this in their process of developing the plans. The utility coordinators will find things that the designers did not know about.

Noise walls are included in the design during the schematic phase. During public involvement for the schematic design, the district likes to have recommended noise walls included in the exhibits showing the recommended roadway alignment. This helps the district receive feedback from the public. It also alerts the public to the proposed design and prepares them for the noise workshops after the project has been approved.

Would also like to see the engineers be a little more creative in the placement of noise walls. For example, in one wall location adjacent to a floodway, the flood control district was concerned with the wall blocking flow. The engineers designed the drilled shafts for the noise wall to extend up to the 100-year floodplain level while the mow strip was designed at ground level. The section of the noise wall over the floodway was perched on the drilled shafts allowing flow of high water within the floodway. These perched noise walls do not attenuate as much noise as a ground-mounted noise walls would attenuate but are feasible and reasonable noise walls providing some mitigation. This technique is being applied in other locations and districts.

Retaining Walls

The sequencing of retaining wall construction with noise wall construction depends on how close the retaining wall is to the noise wall. Heavy equipment used for drilling the drilled shafts for a noise wall can damage the foundation for existing retaining walls if placed too close. The equipment to construct retaining walls is much lighter than what is required for drilled shafts so drilled shafts for the noise wall could be placed before the retaining wall is constructed. These activities will need to be coordinated for construction.

Delivery

The project delivery method (design-build, design-bid-build, etc.) does not affect when the noise walls are identified. It only affects the coordination effort. By the time a design-build project received a design package, the package has been approved and typically includes the proposed locations of noise walls. For design-build projects, PS&E is bundled with construction.

The district typically would not recommend letting noise walls separately from the project. It is likely more expensive since the equipment is already out there. The public only has to deal with one entity to interact with regarding the construction of the roadway and the construction of the noise walls.

Modeling

The evaluation for feasibility used to determine if a noise wall will be recommended at a specific location. This is completed before the noise wall is added to the schematic.

During the review of any noise model and the technical report, proposed barriers are reviewed for residences/receptors within a common neighborhood or area that are excluded from the proposed wall solution. For proposed noise walls that do, the district explores other wall configurations that could include them and remain reasonable and feasible. This may include cost averaging for multiple walls within the project. This is based on the district's experience of hearing from the excluded residents during public noise workshops. The district has been leaning toward using uniform wall heights across individual residential subdivisions and neighborhoods within a corridor. The district representative stated that this uniformity reduces public complaints and makes it easier for the contractors during construction.

Noise Workshops

Most of the time (90 plus percent of the time), noise workshops are held after the project has been cleared through the environmental process. Until the noise workshop is conducted, and the noise walls are approved by the public, noise walls are considered "proposed" noise walls.

Project designers and utility coordinators are involved before and after noise workshops, not during the noise workshop process. Noise workshop can involve the Advanced Project

Development Section personnel, environmental personnel, personnel from the area office, and some schematic personnel. Typically, it is just the district's environmental personnel.

Typically, the noise wall design has not been conducted when a noise workshop is conducted (e.g., depth of drill shafts or the exact placement of the noise wall). Options for textures, color, or other aesthetic options are presented at the noise workshop. Utilities are reviewed in advance, but some things about utilities are not known. Some utilities are taken into account when noise modeling such as pipeline easements. Pipeline easements result in breaks in the noise wall.

Noise Wall Location

To place a noise wall, the district needs to know is how much space we are going to have outside the pavement. We try to model our walls right at the edge of the right of way. That is the preferred location because it gets the wall closer to the receivers and gives the residences a better security situation.

If you place the noise wall at the edge of the pavement, you have the receptors located further out to the edge of the shadow of the noise reduction. You also can also have problems with vehicles that run off the pavement and areas for sidewalks.

It is uncommon to place a noise wall between the frontage road and the main lanes of a highway. The district generally does not do this because the noise from the frontage road would not be abated. In cases where multiple driveways, alleyways, or businesses located along the frontage road would make too many "holes" in the wall for it to be effective, a noise wall located between the frontage road and main lane would be preferable if reasonable and feasible. Also, noise walls placed on concrete traffic barriers along the road are limited to a maximum height of 10 feet. Twelve-foot heavy-duty vehicle exhaust stacks are not abated. The district can build noise walls higher along the right of way than they can along the travel lanes.

Generally, TxDOT prefers to construct noise walls on the right of way. It is difficult to place walls off right of way. To place a noise wall off TxDOT right of way, the district has to find an appropriate entity to work with TxDOT. If the county does not want to work with TxDOT, we have to consider working with the MUD or a city. If you cannot find someone to work with you, and the wall does not work within the right of way, then you have to note that we could not find a location that a wall would work. TxDOT would prefer placing noise wall off the right of way for areas that have large landscape easements between the right of way and the residences when a wall in the right of way may not be reasonable and feasible.

The distance from the edge of the right of way for modeling is about 2 feet because the district's mow strips are typically about 4 feet wide, and the wall would go right in the middle directly on top of the noise wall's drill shafts. Generally, we have about 15 feet outside from the edge of pavement to the right of way. Our location is fairly standard, but it can vary.

TxDOT considers the following when deciding where to place a noise wall.

- **Adjacent Land Use**—The presence of landscape easements adjacent to residential subdivisions. If we keep the noise walls in the right of way, the buffer zone created by the residential landscape easement "eats up" some of the noise reduction.

- **Security**—The noise wall also creates security issues by creating a visual shield for people to go over the fence with no one seeing them unless the homeowner happens to be home and sees them. The district does not like going off right of way to construct walls because TxDOT cannot own and maintain the walls. They would have to work with the municipal entity to do that. Some municipalities are more cooperative than others.
- **Utility Conflicts**—The district may have to work around existing utility easements. Overhead utilities affect the ability to place wall sections during construction due to crane equipment electrical hazards.
- **Drainage**—Noise walls placed in or near drainage features may affect hydrology or prevent the extension of walls across certain areas.

Elevation

Typically, the district does not collect detailed elevation survey information for the noise walls. The district relies on the elevations obtained from the schematic design or, as a last resort, from Google Earth. Elevation data inside the right of way is generally good. Outside of the right of way is less so. The district has experienced some issues with the accuracy of the existing ground elevation survey data when dealing with noise walls. Sometimes, we will assume that the back of the ditch will be the same elevation as the roadway, but we find that it could be a foot or two different, which is why we like to look at schematics that will give us elevation information for those elements. We typically do not have access to good elevation data when we are doing our noise analysis.

Right of Way

The district should know about the noise walls before the right of way development process. The district is restricted from buying right of way strictly for noise walls. The amount of available right of way is considered when planning for and designing noise walls. Municipal entities working with the district have provided right of way or easements for the construction of noise walls. In these cases, the district is not acquiring the right of way. The district is constructing the noise wall for the municipal entity to benefit residential properties. The municipal entity will maintain these noise walls.

Construction

The district has considered alternative noise wall types. Where they could not get drill shaft equipment into a location. In this case, the district considered an absorptive plastic since small equipment is used for its installation. The district has considered acrylic panels, but they are more expensive and would have to be mounted on a concrete traffic barrier. The district prefers traditional concrete and has stayed away from acrylic panels. The district has one experimental noise wall that is semi-absorptive made up of a mixture of concrete and Styrofoam beads. Alternative noise wall types will still have to stand up to the safety aspect of the noise wall. At least four walls have been physically broken by vehicles since the interviewees time at the district. For noise walls installed next to residential property, the district wants the wall to protect the property.

Geological information in the area where noise walls are placed is collected by the designers. The designers schedule the soil borings for the walls.

Utilities

If the utility conflicts affect the noise wall, the utility coordinator will come to the district or area office. When the district is developing the noise wall during modeling, we look for pipelines and always avoid those. More and more now, we are looking to see if we have small local-distribution pipelines in the area, telephone poles, power lines, storm sewers, sanitary sewers, etc. We complete a simple SUE to determine where the utilities are (in the right of way, in an easement, etc.) through Google Earth or CAD files in the modeling phase. We will try to determine if the utilities may be a problem that we can avoid. You will have the same problems regardless of the project delivery method (design-build, design-bid-build, etc.). It is a matter of who is handling it.

The utility coordinator is typically provided a copy of the noise wall design plans after the noise workshop (during PS&E). Typically, PS&E is not started until after the noise workshop. Also, designers of the noise walls need to know what noise wall texture or design that was selected by the public vote resulting from the noise workshop. The district does not want to waste time designing noise walls that the public may not want.

PS&E provides the utility coordinator the noise wall plans since PS&E has the final noise wall locations. PS&E will coordinate with the utility coordinators about this in their process of developing the plans. The utility coordinators will find things that the designers did not know about.

HOUSTON BRIDGE

Design

The district has their own design standards for retaining walls due to local soil conditions. Retaining wall placement is usually determined early in schematic design. Alternative designs may be considered for retaining walls, including acquiring additional right of way to mitigate the need for a retaining wall. Considerations when comparing alternatives include cost, schedule, and utility conflicts.

Placement

The designer should determine the proper spacing between the retaining wall and the edge of the right of way to ensure proper construction. The amount of space needed for construction varies based on the type of wall (cut or fill), height, and surrounding conditions. The specifics of the retaining wall will determine the type of equipment needed to construct the wall and the space requirements will vary based on the equipment needed.

Between Frontage Road and Main Lanes

Some items to consider when determining whether to place a retaining wall between the frontage road and main lanes or next the edge of the right of way include amount of cut or fill, the cost to construct, and drainage/flooding. Since the Houston District is relatively flat there is not much need for retaining walls near the edge of the right of way.

Noise Wall and Retaining Wall in Same Area

When retaining walls and noise walls are placed in the same area the retaining wall design needs to consider the noise wall. The district usually tries to place noise walls and retaining walls in separate locations.

Utilities

SUE information is considered when performing the detailed design of retaining walls in PS&E. All the existing utilities should be identified by 30 percent PS&E. Additional SUE information, including test holes, may be requested in areas where more clarification is needed regarding the location or depth of a utility.

Right of Way

Project designers may request additional right of way to accommodate the retaining wall. Sometimes temporary construction easements are required to help construct retaining walls if additional right of way cannot be acquired. This is mainly seen in urban areas. Additional right of way, or temporary construction easements, need to be identified early since the acquisition process is lengthy.

Survey and Geological Issues

Verification of survey data helps reduce issues with inaccuracies of existing ground elevation, which can affect design.

HOUSTON UTILITIES

Noise Walls

Personnel are informed of the need for a noise wall during schematic and preliminary engineering. A noise study is performed to see if a noise wall is warranted. It may show noise wall is warranted but still needs to go to affected property owners for a vote to ensure that they want it. Usually around 60 percent PS&E or later when they really find out.

Actual process starts during schematic, but it rarely gets finished that early. Starting earlier would make life easier for utility coordination and relocation. Most of the time it gets added at the end, so they scramble to modify utility designs to fit in wall.

Noise walls are let as separate projects from highway projects. Usually associated with road widening projects. Noise walls come in late to the project and wreak havoc on utility adjustments. Sometimes utility agreements will have to be reworked. Noise walls should be planned and designed for during schematic phase but does not really happen.

A lot of noise walls are politically generated. A homeowner's association reaches out a state representative who contacts the district engineer to get the ball rolling that a community wants a noise wall.

Utility company finds out about noise wall from the 30 or 60 percent plans or if designer draws attention.

Planning

Design-bid-build is normal process. Some design-build projects have noise walls which are identified through the environmental process.

Noise studies are done in environmental. Detailed design is completed when SUE is available.

There is a noise workshop after preliminary sound study. Involve property owners and basically yes or no do they want it. Homeowners are asked what kind of noise wall they want.

No involvement of utility coordinators or utility companies at this point.

Utility coordinators involvement would be to do a SUE study early on.

Need to involve utilities earlier. Some designers do not know that you need 10 feet clearance between lines and drill shafts and cranes for construction.

Utilities

Utilities have problems with noise walls as being the first ones to relocate. Once wire is up and energized then contractor wants to drill piers for noise walls. The machinery is what causes clearance issues.

A noise wall does not go through a 30, 60, 90 type of utility accommodation process. A noise wall is mandatory based on environmental and so it comes in late in the process. Not a part of PS&E, it has its own process. No lengthy utility coordination process for noise walls. First people they go to are utilities because of potential delays. Try to determine conflicts as early as possible. Noise wall locations are restricted to edge of right of way or off TxDOT right of way onto an easement.

Placement

Noise Walls

Off TxDOT Right of Way

Installing a noise wall off TxDOT right of way is uncommon. Happens occasionally but not common. Might be easier to avoid utility conflicts. Normally want to put noise walls on TxDOT right of way because of maintenance. Will not make a maintenance agreement with a homeowner's association but will with local governments.

If you put a noise wall off TxDOT right of way you only have two options, create a landscaped area that provides access or access the noise wall from other people's property. CenterPoint prefers noise walls on TxDOT right of way. Sometimes have constructability issues or maintenance access issues.

Between Frontage Road and Main Lanes
Locating a noise wall between the frontage road and main lanes is not common. There are only two places in the Houston District. TxDOT is trying to do this in Dallas-Fort Worth area. The Houston District does not do this because it defeats the purpose of a noise wall. Not stopping sound from frontage roads. Want to showcase frontage roads in Texas. Advertisement for commercial and business development along frontage roads. Creates visibility issues at ramps for merging.

Away from Edge of Right of Way
When shifting a noise wall closer to the frontage road and away from the edge of the right of way the same issues as mentioned earlier are seen. Placing on edge of travel lanes could create issues with future development. Cannot go back to add lane or shoulder. Backslope is least utility impact area. Crash worthiness could be an issue.

Would create issues for utility companies to access right of way for maintenance and construction. Create large no-man's-land that people cannot access. Not just an access issue for the utility but also for TxDOT maintenance access.

AASHTO guidelines about clear zone and lines of sight that would impact how close noise walls can be placed to the edge of roads. Could be more common off-system.

Retaining Walls

For retaining wall between the frontage road and main lanes, generally they are for overpasses when going over cross streets. There are only a few retaining walls between the frontage road and right of way. Generally, at the main lane side of things.

Most retaining walls are MSE, that start at grade. Drill shaft walls could impact underground crossings because of depth.

Utilities

The Houston District tries to collect SUE early on.

When SUE is conducted, usually do not have information about noise wall. No location or alignment. Have done SUE specifically for noise walls because they come in late in process.

Actual noise wall design plans are as late as construction. Sometimes 30 of 60 percent design.

Have current project on FM 1960, where the project has let but the contractor is delayed for other reasons. Just now found out a noise wall is going in, do not have plans yet. Now doing SUE for the noise wall. Several longitudinal utilities where noise wall will be directly over them. Could have been mitigated if they knew about this during design.

Conflicts with noise walls will then become part of ongoing utility coordination. A lot of times they know roughly where noise wall will go.

More of a construction phasing issue that would be helpful to CenterPoint. Drill shafts are the biggest concern. If piers could be drilled before poles are relocated that could then tilt supports up. Would not need to deenergize lines after their installed. Some access issues with where poles are located.

Right of Way

Regarding considering noise walls during the right of way development process: Environmental people will say we need to do a noise study. Utilities feel like these studies take a lot of time. Should start earlier in the process.

A significant portion of noise walls are politically driven, so they do not know they will put a noise wall in until homeowner's association, attorneys, or state representative contacts the district.

Alternative Noise Wall Types and Construction Methods

San Antonio used fiberglass noise walls around the poles and have a special provision for that. Houston is considering putting one in on one project. Will look at different methods of constructing noise walls to reduce utility impacts. Use low-profile rigs to keep away from power lines when drilling shafts.

Survey Issues

Normally see this with retaining walls more than noise walls. Site conditions are different than design happens all the time. Built a little retaining wall with noise wall panels on top because of elevation differences in the past. Sometimes drainage is missed in the survey. Normally adjust in the field sometimes need to involve designers.

Geological Issues

A lot of soils are not great and encounter ground water issues. Conduct foundation improvements all the time. Removed 5 feet of soil and put in cement-stabilized sand. Put in deep drill shafts. Used stone columns for deep foundations.

HOUSTON MAINTENANCE

Placement

Noise Walls

When placing a noise wall, designers need to ensure there is sufficient room for maintenance and consider where utilities are going to go, since they will be in the right of way and affect maintenance. It may be best to consider what the minimum width and the desired width should be with respect to access for maintenance. There may be other issues that arise if there is excess space behind the noise wall.

Currently the district places concrete rip rap behind the noise wall. A minimal amount of space, usually 3 to 4 feet, is desired behind noise walls for maintenance.

The location of transverse utilities should be considered when placing a noise wall. As an example, a noise wall cannot be placed on top of a gas pipeline crossing. This needs to be considered during design. A break in the noise wall may be used to resolve the issue.

Off TxDOT Right of Way

Maintenance is important to consider when placing a noise wall off the right of way. Need to ensure that there is an arrangement in place for the wall to be maintained. This should include who is responsible for maintenance and access for maintenance. It may be preferable to locate a noise wall of right of way is another entity was responsible for maintaining the noise wall. If there was no way to access the noise wall for maintenance, then it would not be preferred to locate the wall of TxDOT right of way.

Between Frontage Road and Main Lanes

When locating a noise wall between the frontage road and main lanes damage to walls from vehicle impacts needs to be considered. Finishes should be considered when placing a noise wall since repairs to the wall may or may not be able to match the existing finish.

Placing a noise wall between the frontage road and main lanes may not be the best option in most cases. Designers need to consider how the area around the noise wall will be accessed. The placement of noise walls should consider retaining walls, since retaining walls are normally located near the main lanes at the district.

It would benefit businesses adjacent to the right of way since noise walls near the right of way can block visibility and access to businesses. Litigation may ensue a business feels it is adversely impacted by a noise wall or other project features.

Away from Edge of Right of Way

When considering shifting the noise wall away from the edge of the right of way it is important to look at where utilities are located since utilities run along highway corridors. Wherever the noise wall is placed, sufficient room should be provided for the sidewalk and access for installation and maintenance need to be considered.

Depending on the space there may not be sufficient room for maintenance equipment to access the area behind the noise wall. If there is a more sizable distance between the back of the noise wall and the right of way line then it may create a space for unwanted activities, such as encampments, pedestrian access near adjacent properties.

An alternative use for area behind the noise wall would be as a shared use path. It could be beneficial although it depends on how it is designed. If the area is extremely narrow, then it may not be an inviting place for pedestrian use. Sight distance for users' needs to be considered as well. If the area is wide enough it could work very well as a shared use path.

Retaining Walls

Sufficient room should be left at the base of the retaining wall for construction and maintenance equipment. Depending, 15 to 20 feet may be needed.

When considering placing a retaining wall between the frontage road and main lanes, versus near the right of way line, access to and from the main lanes should be considered. In some areas there may be multiple access points in a short distance. Access to the frontage road from adjacent property needs to be considered as well.

Noise Wall and Retaining Wall in Same Area

The noise wall and retaining wall designs should account for one another. Noise wall foundations are rather substantial and can impact retaining walls if not properly considered. Access is also an issue. Need to consider how the area will be accessed, which may include equipment, to maintain the retaining wall and the noise wall.

Other Issues

There have been issues with the existing ground elevation with respect to retaining walls. Also have experienced flooding.

Additional Recommendations

Bike and pedestrian access are a big concern. Want to include room for a bike and pedestrians. Including access in retrofitting and roadway widening projects can be difficult. It would be good to include room for the bikes and pedestrians.

Sight issues are also a big concern, especially for roadway crossings. This is particularly an issue when bike paths are separated from the roadway.

HOUSTON RIGHT OF WAY

In the Houston District, the right of way group is primarily responsible for right of way purchase and development and is less involved in design logistics related to noise walls and retaining walls. In recent years, there has been a push to get right of way involved in the early stages of projects as they can anticipate some of the design issues and right of way needs in the earlier stage, but for noise walls, the need for these is often determined during the design stage by the environmental group.

Noise Wall Placement

Specific to the location of noise walls relative to travel lanes and right of way, the Houston District places walls with sufficient spacing to conduct maintenance and access for utilities. This could influence the decision to place a noise wall closer to travel lanes and further from the edge of the right of way, but the general consideration is access in spacing from the right of way line.

Off TxDOT Right of Way

In deciding on the location of noise walls, the Houston right of way team primarily places these walls on TxDOT right of way. Under normal circumstances, it is preferable to place this wall on their right of way as it prevents any confusion in which entity will be responsible for future maintenance, but there are other factors which could influence placement. If TxDOT were to have another entity willing to fund and maintain the noise wall, or if there were significant utility conflicts, causing the need to shift the location off TxDOT right of way, it would be possible to place a noise wall on property owned by another entity.

Between Frontage Road and Main Lanes

The Houston District has little to no experience, or potentially past need, to place a wall between the frontage road and the main lanes of traffic.

Utilities

The Houston District has a team specifically tasked with handling issues which arise with utilities. The team is responsible for all utility issues and works with right of way to indicate things like which parcels might need to be acquired and worked on first in a project. The two teams work together, and right of way is typically informed of utility issues on projects, depending on the complexity of the project.

Although right of way stays active in much of the design portion of project delivery, they are less active in the early stages of utility coordination. Right of way usually gets a copy of the utility conflict list once it is developed by utility coordination.

While right of way may attend some of the utility coordination meetings, these meetings seem to be less beneficial for right of way as they are more complex and cover detailed utility issues. Individual utility coordination meetings are held monthly for each utility and cover every project where the utility is impacted during the meeting. Right of way may attend if a question about right of way arises. With numerous ongoing meetings to attend, it can begin to feel excessive to attend all meetings. It is more worthwhile to begin attending utility coordination meetings after the project is let, mainly since right of way acquisition takes time and may be complete around letting. This is when utility issues begin to emerge from the right of way scope as this is when the already purchased right of way has been cleared and work can begin.

Another factor in the timeline of communication between the teams on utility issues depends on the type of project being developed. For example, the process of right of way acquisition and early phases of work may begin earlier in a design-bid-build project, as TxDOT has the opportunity to begin purchasing right of way while the contract is still being settled. They can work off preliminary plans to get a start on the early phases of project delivery, and they are more likely to be made aware of utility conflicts due to the timeline. A design-build contract may provide fewer opportunities to be made aware of utility conflicts due to the pace of the project. One of the right of way agents is responsible for acquiring right of way in the early phases of this project, so information sharing could be more limited.

Right of Way Development

In recent years, there has been a push to get the right of way team in Houston involved earlier in project design as the team is better able to anticipate some of the potential design issues and right of way needs. They were finding that the project designers were coming across issues at a later stage in project delivery which called for the opinions of right of way specialists, and it was too late to adjust and change projects with ease. The Houston District right of way team now gets involved early in the project, between 0 to 30 percent schematic design and stays active in the process. They attend meetings monthly and may meet biweekly depending on the complexity of the project.

The right of way for a project is set early in design. It must be set before they can draw the right of way map, so right of way is set by at least 30 percent schematic. The environmental group is typically responsible for determining the need for noise walls, which limits the involvement of right of way in this portion of the project. Environmental is also tasked with providing clearance for right of way acquisition to begin. The timing of this clearance fluctuates significantly from project to project, ranging from having clearance one to two years prior to a project start date, to the delay of development of a project while waiting for clearance.

Since right of way acquisition is contingent upon environmental clearance the clearance process must be repeated if a project is determined to require further right of way. It might be possible that environmental could hedge a bit to provide some flexibility on project spacing by making the area included in the environmental study larger than the project footprint.

In the past, the district has acquired right of way to accommodate a noise wall. Temporary construction easements are not really considered for noise walls and retaining walls. A concern with using temporary construction easements is that if you need an easement to construct a noise wall or retaining wall then you will probably need access later to repair or maintain the wall. By this time, you will no longer have access since the easement was temporary and now there is an access issues with respect to maintenance.

Right-of-Way Considerations

As mentioned above, the placement of noise walls is determined in the early phases of design by the environmental group. This leads to the development of the right of way map. From there, the right of way team then goes out to purchase needed right of way for a project. While this system is effective for the teams, the right of way group is at times less informed on the exact placement of noise walls within the project design. This can affect compensation acquired right of way since a noise wall can cause a denial of access from the adjacent property to the frontage road. If the team was more informed on exact location of walls, they would have a greater understanding of how adjacent landowners are affected, and where access to constructed facilities is limited, which impacts how right of way compensates for acquired property.

SAN ANTONIO PLANNING AND DESIGN AND RIGHT OF WAY

The San Antonio District takes a very comprehensive approach to constructing noise walls and retaining walls within construction projects. Within the district, engineers and designers from various teams, such as environmental, planning and design, right of way, and utilities, are engaged early and often in the project delivery process to improve communication and proactive adjustments on projects.

Design and Placement

Noise Walls

The need for a noise wall is typically identified at final schematic, near the end of the NEPA process. If noise walls are identified earlier, 30 to 60 percent schematic design, the noise analysis may be inaccurate. This could be a result of changes in alignment, final grades, and other design aspects.

Environmental conducts a noise analysis and evaluates different heights, lengths, and wall types which would be adequate for the project. Once a length is set, the design team handles the placement of the wall longitudinally within the right of way with consideration for utilities, safety, pedestrian facilities, adjacent property, drainage, and other factors.

The primary goal when placing a noise wall is determining a location which minimizes impact from the noise wall. Some of the considerations when doing this are utilities, spacing, pedestrian facilities, and vegetation. Environmental typically determines the basic characteristics of a noise wall, and the planning and design team will take this information and determine where the wall will fit within the project spacing. The design team is usually responsible for figuring out the spacing and moving a wall longitudinally within the right of way. The environmental team will go back and adjust wall characteristics, such as height, accordingly.

During the early phases of a project, the environmental team handles much of the work related to the need for noise walls. This team will conduct the required noise analyses for an area to determine the need for a noise wall and the very basic physical characteristics of a wall, such as length. As this process progresses, further details of the wall will be determined, and around 60 percent PS&E, the noise workshop will be held. At this time, wall characteristics, such as height and material, are used in conversations with the public.

The feasibility and reasonableness assessments are performed at the end of the NEPA process, usually around 90 percent schematic. Designers validate the noise model by going through the cross sections and ensure details of the topography is considered. There can be an issue with noise models especially when done by consultants. The cost of utility relocations is considered during the feasibility and reasonableness process. Utility coordinators are involved in that process.

The design of the noise wall needs to be complete to perform the constructability analysis. This includes the size and spacing of the foundation but maybe not the depth of drilled shafts. Noise wall designs are pretty complete by the time the noise workshop is held since the constructability analysis is performed before the workshop.

Sometimes designers will informally talk to apartment building owners to see whether they are interested in a noise wall or not.

Between 60 and 90 percent PS&E the designers have begun working the noise wall into the design plans, paying specific attention to integrate the wall in alongside existing structures and shifting the wall longitudinally as necessary. The project team works closely in this phase to determine the cost of moving various utilities, how to best integrate the wall into the design, and what changes need to be made to the noise wall based on these adjustments. The design team works with many other engineers on the project team. The team has access to SUE and other information during the schematic phase.

Given this information, the area the San Antonio District has found is most often amenable to placement of noise walls is 5 feet off the edge of the right of way. With this spacing, the team can typically adjust to utilities conflicts and give adequate spacing for future maintenance. If necessary, the district can place concrete rip rap behind the wall to remove the need for mowing which decreases required maintenance.

For noise wall placement with respect to roadways, the San Antonio District considers factors such as utilities, drainage during and after construction, location of sidewalk, security, and vegetation in determining the impact of a noise wall.

Between Frontage Road and Main Lanes

The team does not usually place any noise walls between the frontage road and main lanes due to the inability of this situation to satisfy the requirements of the reasonable and feasible evaluation. This is typically not ideal but could be considered in a situation where the entrances and exits to main lanes are permanent. The placement of a noise wall in this area could limit adjustments to future growth.

Away from Edge of Right of Way

The San Antonio District has found it less preferable to place a noise wall closer to travel lanes and away from the edge of the right of way. Aside from the typical safety considerations which come when a wall is placed closer to the traveling public, such as a vehicle striking the structure, there could be additional safety considerations for behind the wall. The noise wall could potentially provide block visibility and create access to the back of adjacent properties, creating safety challenges for those owners. While it is less ideal to have a sidewalk between high-speed lanes and a noise wall, a sidewalk on the backside of the wall has issues as well. The San Antonio team prefers to maintain a 5-foot buffer between the noise wall and adjacent properties for maintenance access without providing unwanted access to adjacent properties.

Retaining Walls

The need for retaining walls is determined in schematic design, since this information is important for some of the project cost estimates as well as for right of way needs. Retaining walls are integrated into project designs around 60 percent PS&E. At 30 percent detailed design, there is an understanding of where retaining walls will be placed and what type of wall will be constructed. At 60 percent detailed design, retaining walls have been designed and incorporated into plans. Slight adjustments may be made later in the project to retaining wall designs when additional geotechnical information is received.

The 5 feet from the edge of the right of way rule applies when placing retaining walls. But retaining walls have different requirements which may change the spacing needed. For example, the space required for the structural supports, during construction, changes based on the wall type. A taller wall, MSE wall, or cut wall with soil nails would all have different requirements because the bracings at the bottom of the wall or the length of the soil nails will vary structure to structure.

When evaluating retaining will placement with respect to roadways, the proximity to travel lanes is always considered. Much of the placement with respect to main lanes, frontage road, and right of way is more focused on the location of ramps. The driveways do not dictate the need for retaining walls. Project characteristics are ranked based on importance beginning with ramps and include utilities.

Sequencing

Noise Walls

In sequencing a noise wall during construction, the San Antonio District typically recommends constructing noise walls early. This is often ideal from the public's perspective. If the construction schedule is left up to the contractor, they may phase the project differently to leverage resources. Additionally, structures by the right of way line are more difficult to construct early because these are the structures most in conflict with utilities.

Retaining Walls

In sequencing retaining walls, these structures are tied to other elements which creates a less uniform approach to sequencing. Some of these structures may need to be started early to allow for settling of the foundation before placing other structures on top or to address grade changes early, but these factors vary greatly from project to project.

Utilities

The San Antonio design team stays active in utility meetings in the project delivery process. SUE is started at the beginning of the schematic phase and is received during schematic. There is typically a kickoff meeting when coordinating with utility companies. Meetings are also held during the schematic milestone dates. The same process will occur during PS&E to keep everyone updated in terms of utilities on projects.

As far as communication with utility companies, communication begins early in schematic. Major utility conflicts are known, if from a high level, by about 60 percent schematic. Additional SUE information is requested as needed. With utility conflicts being reasonably clear in schematic, the team will begin working with utility companies on ways to mitigate utility conflicts, which includes relocation plans. This coordination also allows utility companies to be prepared to break ground in PS&E. The district makes sure to communicate to utility companies that if the project changes TxDOT will reimburse the companies for the soft costs incurred during this preparation.

Beyond communicating on active projects, engineers also meet with the utility companies quarterly to share information on their list of projects for the upcoming years.

Right of Way

The right of way team also becomes involved in a project very early. Right of way is invited to every meeting throughout the project. Meetings occur monthly and right of way will attend to stay up to date on what is going on with the project to help mitigate any issues which could arise and need input from right of way.

Right of way is tasked with acquiring parcels set out in the right of way map, which is usually complete by 90 percent schematic design. They are tasked with meeting with adjacent property owners around 60 percent schematic, so it is typically around this time that they have more detail on what the right of way will look like for the project. Within the project map, project engineers will prioritize various parcels and structures to plan which parcels need to be acquired first and which project elements should be addressed earlier in the project development process. This helps prevent issues where the right of way team has to go back and acquire additional parcels. If additional right of way is required, the process should begin early to prevent delays on the project. The San Antonio District usually needs to have all the right of way finalized by 30 percent PS&E.

If the project team needs additional room for construction, they may use a construction license agreement rather than a temporary construction easement. Although right of way acquisition begins right after environmental clearance is received, sometimes permission will be requested for advanced acquisition of right of way. This may happen if there are parcels which will require a lengthier acquisition process.

Alternative Designs

The San Antonio District is open to exploring and considering alternate materials or noise wall types on projects. This could include fiberglass or other types of panels.

For retaining walls, the district considers design alternatives including sloping to mitigate the need for a retaining wall. The alternative selection considers schedule, cost, utility conflicts, and other factors.

Geological Issues

Another issue which can be present in San Antonio is changing geological conditions. So, when needed, the project team will collect additional survey and geological information before placing noise walls and retaining walls.

Other

In the incorporated areas of San Antonio, the district reviews the plats for any developments that is adjacent to a TxDOT roadway. Homes in a new development will be build adjacent to a highway with only a 6-foot privacy fence. The plat notes include a note saying that the developer is responsible for noise mitigation. But many times, developers do not take any steps to mitigate noise. The district will receive call from new homeowners complaining about noise and want a noise wall installed.

There is one suburban city within the San Antonio District that ensures developers follow the noise mitigation note. The City of Schertz requires developers to construct an 8-foot masonry wall and have a minimum setback of 150 feet from TxDOT facilities. The district is currently working on similar expansion projects through the Cities of Schertz and Converse. No noise walls are required for the expansion project through Schertz where eight or nine noise walls are required through the City of Converse. This shows that municipal requirements can help mitigate noise.

One of the biggest complaints the district receives from the public is about noise. Having local municipalities share in the cost of noise walls may help incentivize municipalities to enforce the noise mitigation notes and rules that already exist. This may get cities interested in ensuring developers take noise mitigation steps when constructing new developments.

SAN ANTONIO CONSTRUCTION

The timing for constructing noise walls or retaining walls within a project depends on a variety of factors, including how the contractor leverages resources, spacing of the project, congestion in the area, and utility clearance. For noise walls specifically, there is a greater amount of flexibility and can be influenced by additional aspects such as neighboring properties, noise evaluations, and even the type of roadway material used since some materials generate more noise than others.

Sequencing

In constructing a noise wall or retaining wall, some of the considerations are amount of right of way available, spacing, drainage during construction, contractor preference, and utilities. Much of the sequencing of a noise or retaining wall is determined by the contractor and how they want to leverage resources. A contractor can decide which portions of a project to finish early on to free up other resources further into the project.

An interesting consideration for construction from the San Antonio area was the recommendation to let a noise wall project after constructing the roadway project. Because some roadway material reduces noise more than others, this could allow for a noise evaluation to determine whether a noise wall is still necessary. This could also allow for additional time to clear utility conflicts, since noise wall placement and design is not tied to the highway design schedule. Once a noise wall is voted on and approved by the public, it can be a challenge to remove from the project. So, letting the noise wall project after the highway project could allow for additional time needed to evaluate the necessity.

Placement and Maintenance

Noise Walls

The design and placement of noise walls is often determined by technical information such as location of the project, right of way, neighboring areas of congestion, and location of utilities.

For the placement of a noise wall, San Antonio typically considers 5 to 10 feet of spacing behind the noise wall adequate for construction. This provides suitable spacing to install the drill shaft foundation. This could change for other foundation types. For a spread footing, the distance may need to be adjusted to a minimum of 10 feet. Spacing is often project specific and can be influenced by particular factors associated with the different types of foundations.

Placing a noise wall off right of way may be considered if there is an easement to do so. This placement would require considerations such as the impact to off-site drainage, landscape features, and utilities. Utilities should always be considered when placing a noise wall and this is always discussed in planning conversations. If utilities need to be accommodated during construction, which may include relocation, minimizing grading to meet clearance requirements, and temporary shutoffs. In determining where to place a noise wall, it would be preferable to place it off TxDOT right of way if utility conflicts exist and cannot be properly accommodated. If there are no issues with placing a noise wall in the right of way, such as utilities, drainage, or landscape, then it is typically preferred to place the noise wall in TxDOT right of way.

For placement with respect to travel lanes, when placing a noise wall between the frontage road and main lanes, some items to consider include safety and temporary drainage. While this placement could alleviate utility issues, as those are typically closer to the edge of the right of way, this creates a new set of challenges including raising the risk of the noise wall being hit during construction and operation. Placing a noise wall between the frontage road and main lanes could be a strategy when faced with major utility conflicts but keeping noise walls away from the traveling public is preferable for safety.

When considering a noise wall closer to travel lanes and away from the edge of the right of way, the main concern during construction is drainage, but this strategy could be effective in avoiding utilities. Generally, it is useful to keep the noise wall away from the traveling public and reduce excess space behind the wall. But in the case of a major conflict, with utilities or other feature, shifting the noise wall closer to the travel lanes and away from the edge of the right of way may be useful.

Retaining Walls

When placing a retaining wall, a general rule of a minimum of 5 feet from the back of the wall to the edge of the right of way is recommended. This spacing allows access for maintenance. If mowers are needed, this space may need to increase to 5 to 10 feet. Generally, these retaining walls require between 5 and 10 feet of spacing but depending on the height of the wall more space may be needed.

The main issues which would prevent placing a retaining wall between the frontage road and main lanes instead of next to the edge of the right of way would be drainage issues and future roadway needs. Future efforts to widen the roadway could be hindered by placing the retaining wall between the frontage road and main lanes.

Utilities

Utilities are considered on all projects. They are often relocated or deenergized to avoid conflicts. But if the conflicts are major, the district will look for alternative options for the placement of noise walls and retaining walls.

Right of Way

Noise walls are usually placed far enough away from the edge of the right of way to not require a temporary construction easement.

Other

The San Antonio District has used alternative noise wall types to alleviate issues with utilities.

SAN ANTONIO UTILITIES

The research team met with subject matter experts from the San Antonio District to discuss utility issues related to the placement of noise and retaining walls. The subject matter experts shared the following experiences with the research team:

The project teams have a general idea if there is a need for a noise wall or retaining wall and will notify utilities as the information becomes available in the design process. The overall process to design and receive approval for noise walls is very lengthy and must determine if the wall is feasible and reasonable. It can take a long time until a noise wall decision is made, which is problematic if a utility might be impacted by the proposed wall. Until the decision is made, utilities are hesitant to cooperate and relocate. If there was a way to accelerate the decision-making process it would be very beneficial for all parties involved.

To coordinate with utilities, it is sufficient to make certain assumptions for the final design of the noise wall, if the decision is made that the wall will be needed. The decision, however, is often not made until 30 percent design is complete, and occasionally even later, between 60 and 90 percent design. On a recent project, the height of the noise wall changed late in the project because the electric lines had to be at a certain height so they would not interfere with the noise wall.

When dealing with power and communication lines, there are minimum approach distances for construction equipment that cannot be reduced. For example, the minimum for communication lines is 18 feet. There are also specifications on how close a communication line can be to an electric line.

Shafts of the noise wall can be very deep, sometimes 20 feet. On one project, the installation rig would have gotten too close to the power lines due to the required height of the rig. The project manager consulted with the area engineer, contractors, and other practitioners.

On the FM 1103 project northeast of San Antonio, the decision for a noise wall was made early in the PS&E phase. Due to constructability reasons, TxDOT asked the utility to increase pole height from 45 feet to 65 feet. This allowed the utilities on the project to mount their lines temporarily higher than usual. Once the noise wall was constructed, the utility could drop their lines to the preferred height. Only one communication company had an issue with height. In a few areas there were underground risers, which limited their height to 23 feet. On the FM 1103 project, the project manager encountered a lot of Blackland Prairie clay which is known to be a problematic soil. Structures built on the soil might sometimes move or lean.

On the same project, the consultant designer planned notch outs in the noise wall for the utility poles. The project manager sent a survey crew to verify the locations multiple times, but the district is not sure if the extra effort was worth it. When poles were set, in some cases the augers hit a rock and the contractors simply shifted the location of the pole. The utilities do not want to be boxed in by a prescribed location for their pole. In other cases, utilities eliminated poles that were planned earlier. Since that project, the district is reluctant to use noise walls with notch outs and instead prefers noise walls with removable fiberglass panels. The fiberglass panel must be relatively light so that a standard bucket truck can remove the panel, which most overhead utility companies use.

Noise walls also create utility conflicts with buried utilities. To avoid utilities underground, the district usually provides 5 feet from the right-of-way line for utility installations. Poles should be located as close as possible to the right-of-way line to reduce the safety risk for drivers and to facilitate mowing of the area. If an underground utility is in conflict, the district usually asks the utility to relocate.

On a different project, the noise wall was placed directly at the right-of-way line, and utility poles were placed behind the wall in a private easement, with access to the easement from behind the noise wall.

Noise wall foundations that require deep drill shafts require a tall drill rig which can create conflicts with overhead utilities. During the construction of the above ground portion of the noise wall, a tall crane is usually required to set the noise wall panels. If the panels are designed as half sections, the necessary crane will not need to be as tall.

Noise walls made from concrete are heavy and require heavy equipment. Lighter material, such as light weight concrete, would provide benefits during installation and the foundation would not need to be as deep.

Regarding retaining walls, it is important to understand and communicate the steps required for the construction of the retaining wall. This will allow the utility engineer to properly identify areas of concern or potential conflicts. When designing retaining walls, the district takes care to maintain desired offsets of the retaining wall from existing structures.

In the field, more issues might be discovered. For example, excavation near an existing pole might compromise the pole's foundation. The preferred solution for this issue is pole bracing, but that might require an easement for the guy wires, and a force account for additional cost. If this issue is discovered during the construction phase of the noise wall, the contractor will be responsible to coordinate with the utilities. If an easement is required, the utility must get the easement, which can be very time consuming. TxDOT or the contractor cannot help utility companies with acquiring easements.

Utility conflicts are identified cooperatively by the design engineer and a utility engineer or utility coordinator. For internally designed projects, the design engineer selects a SUE consultant and provides recommendations for test hole locations. For externally designed projects, the consultant designer is responsible for making decisions related to SUE data collection.

Overall, the district tries to avoid multiple utility poles in one location, so coordination among users of that pole is important. Joint-use corridors are a challenge because power companies must clear the design and often dictate requirements of other utilities occupying the corridor. As a result, some communication utilities prefer to locate the lines into their own private easements.

SAN ANTONIO MAINTENANCE

Placement

Noise Walls

How much space is needed between the back of the noise wall and the edge of the right of way to ensure proper construction and maintenance really depends on situation. Noise walls are usually associated with neighborhoods. More room the better for accessing utilities. Have done some that are within 5 feet of the right of way. Design on noise wall makes a difference. If foundation requires a drill rig than cannot get too close to power lines. If a crane is needed or hanging panels, cannot get too close (minimum 10 feet away). Electric lines have radius that need to stay away from.

If the right of way grade is level, closer to the right of way the better for maintenance. Install concrete rip rap or other material where little maintenance is needed. If vegetation is behind the wall, more room is better. Some areas personnel need to weed eat grass behind.

Location depends on design. Ideally minimal distance is better because then its maintenance free. Want close to the right of way with impermeable cover.

Off TxDOT Right of Way

When considering placing a noise wall off TxDOT right of way, one important thing would be that you need an agreement with the landowner. Those agreements would need to iron out expectations of maintenance requirements. People think a wall behind their property is now their fence line. If the homeowner’s association agreed that this would become new property line, homeowners would be responsible for maintenance. Have never seen this but would consider it if possible. TxDOT could address graffiti and structural issues, while the homeowner’s association addresses landscaping and mowing.

Previous maintenance supervisors and area engineers have made agreements with municipalities and landowners to plant trees on the right of way. Then TxDOT trimmed the trees and people got angry. There were no written agreements about the tree planting.

Could acquire an easement for noise wall if there are too many utility constraints in the right of way.

Do not have any noise walls they are aware of that are on private property. Landowners would consider the wall to be their property line which could create issues.

Between Frontage Road and Main Lanes

The district started evaluating the placement of a noise wall between the frontage road and main lanes on a project that had a lot of utility conflicts. Dallas has done one, put plexiglass panels on top of barrier. District looked into it but would constrain widening in the future. Would need to remove wall. Drainage could be a problem in future construction.

Had one in San Antonio on a parkway. Almost a chain link fence with plastic panels slid in. Wanted to move noise wall from right of way to overpass.

Avoiding utility conflicts is why you would want to put noise wall between frontage and main lanes. Constructability could factor in.

Clear zone and sight lines could be reasons to not build noise wall between frontage road and main lanes. Crash worthiness of walls could prevent them being placed too close to lanes.

Away from Edge of Right of Way

Have seen a noise wall where a ditch was built behind because of runoff from other parts of the right of way without noise wall and runoff from private property. Designed noise wall to be against sidewalk with a drainage ditch behind.

Would do this to get away from overhead power lines. Would do this to create additional room to get equipment behind walls for maintenance.

Do not want walls too close because of sidewalks being right up against lanes or because they are not crashworthy.

Retaining Walls

If retaining soil on right of way, would want to leave sufficient space to get equipment or mowers in, about 10 to 15 feet. Would need access without having to get on to people's property.

If roadway is below grade, retaining walls need to have sufficient room where soil nails fall within the right of way. Sometimes soil nails extend beyond the right of way, which could be a problem if land is developed and excavated.

When a retaining wall is a fill wall, panels need to be braced during construction. Some walls are close to the right of way line and there is not enough room for braces during construction. Sometimes a temporary construction easement is needed to brace walls, especially taller walls with longer braces. Construction experience gets missed in design.

Usually, maintenance of walls is just graffiti clean-up. Sometimes have a failure or they need to monitor movement of wall, then space is a concern.

Between Frontage Road and Main Lanes
For placing a retaining wall between the frontage road and main lanes the considerations are very similar as to what was mentioned above.

Older overpasses that have concrete rip rap on slope create a lot of erosion. Always make comments of entertaining a retaining wall because it helps with maintenance issues compared to sloped bank.

Retaining wall usually has storm sewer for drainage, usually has an outfall to down below. Some designers run vertical pipe out of inlet and horizontal line from middle of wall to outfall past the wall. Sometimes get a pipe failure and a wall bulges out because water is not draining from behind.

When they have slope coming on bridge, they will put soil nails in but do not have enough room to get drill rigs in for holes for soil nails. May need to close a lane or shoulder, which creates traffic and additional costs for traffic control.

Noise Wall and Retaining Wall in Same Area

Never come across this situation. Had a wall extension on top of a rail at an overpass but never retaining wall and noise wall in the same area. Would be very complex design. Would not be easy to install noise wall foundation on top of retaining wall.

Survey and Geological Issues

Have had issues with design and elevations being incorrect. Retaining wall alignments are usually done by one designer, roadway by another, drainage by a third. Easy to not communicate with each other. Had one retaining wall where outfalls for drainage had issues with final grade, were below grade and not draining to outfall ponds.

Had a noise wall that had a lot of steps because of grade changes. Contractor proposed alternate foundation design by installing drill shafts and soil nails. Drill shafts would sit under beam and wall would sit on top. Contractor was responsible for final grading and had issues with some of the beam being exposed. Design was for beam to be buried, was more of a contractor issue than design.

Had two bridges that were being replaced with one bridge. Designers did not account for removal of bridges. Were supposed to put in soil nails but there was not much soil (mostly rock). Material was fractured rock and not what soil samples showed. Had to do a change order to figure out what they would do.

Same design where contractor came up with soil nails had issues with designer and TxDOT thought material was classified as something else. Contractor’s equipment broke and they left exposed material. TxDOT told them to cover it up, but they did not because they were going to start working again soon. Rain came in and started cracking wall. Had to shut down a lane and have bridge and Geotech come in. Could have been resolved with better geotechnical investigations.

Follow strict environmental process when they discover karst features. Edwards Aquifer has unique features only found this area.

Use of Pavement for Noise Mitigation

Noise walls and retaining walls are becoming more common. Came across a study from a concrete conference that concrete is quieter when texturing is done longitudinally with traffic. Houston was able to mitigate some noise walls by doing community outreach and showing that longitudinal texturing is quieter. District usually paves with asphalt but getting more into concrete. Typical modeling does not capture differences in pavement types or texturing.

APPENDIX J. DETAILED INTERVIEW GUIDE

During the detailed interview, the following discussion questions were grouped based on the functional area of the interviewees. Not every question listed was asked of every interviewee. The questions were grouped per the area labels provided in parenthesis at the end of each question.

Sequencing and Placement of Noise Walls and Retaining Walls on Complex TxDOT Projects

Detailed Interview Guide

INTRODUCTION

Difficulties can arise when constructing noise walls and retaining walls due to conflicts with utilities, construction phasing, and inadequate access. The purpose of this research is to provide guidance on the sequencing and placement of noise walls and retaining walls on complex projects. The research includes examining issues such as noise wall and retaining wall selection, procedures, preferred methods, and best practices for sequencing and placement.

The detailed interviews are an important part in the research process. The purpose of the detailed interviews is to collect more in-depth information on existing practices and issues related to noise walls and retaining walls as identified during the previous preliminary interviews and develop a short list of potential case study projects.

Interviews are expected to take about one hour, and we will use the following questions as a guide. For additional information about the detailed interviews or the research project, please contact Kris Harbin at k-harbin@tti.tamu.edu.

DISCUSSION QUESTIONS

General

Noise Walls

- When is the need for a noise wall identified? (Example: 30% schematic, 90% PS&E, etc.) (Planning and Design, Environmental)
    - When is the design team informed that a noise wall is needed on a project? (Planning and Design, Environmental)
    - When are you informed that a noise wall is needed on a project? (Utilities)
    - Does the type of project delivery method (design-build, design-bid-build, etc.) affect when noise walls are identified? If so, please explain? (Planning and Design, Environmental, Utilities)
- When in the project development process are noise walls included in design? (Planning and Design, Environmental)
- Where in the project development process does the evaluation for feasibility and reasonableness take place? (Planning and Design, Environmental, Utilities)

    - How much are you involved in the feasibility and reasonableness evaluation? (Planning and Design, Environmental, Utilities)
        - What is your role in the evaluation? (Planning and Design, Environmental, Utilities)
- When are noise workshops typically held in the project development process? (Planning and Design, Environmental)
    - How involved are you in the noise workshop process? (Planning and Design, Utilities)
    - How much involvement do project designers and utility coordinators have in the noise workshop process? (Planning and Design, Environmental, Utilities)
    - Typically, how complete are noise wall designs when the noise workshop is conducted? (Planning and Design, Environmental, Utilities)

Retaining Walls

- When in the project development process are retaining walls included in design? (Planning and Design, Bridge)

Sequencing

Noise Walls

- Do you have any recommendations for the sequencing of noise walls during construction? (Planning and Design, Environmental, Construction)
- Would you recommend letting noise walls separately from the project? If so, when (before/after main construction project, etc.) and why? (Planning and Design, Environmental, Construction)

Retaining Walls

- Do you have any recommendations for the sequencing of retaining walls during construction? (Planning and Design, Environmental, Bridge, Construction)

Placement

Noise Walls

- What goes into the decision-making process when deciding where to place a noise wall? (Planning and Design, Environmental)
    - Would you change anything about the process? (Planning and Design, Environmental)
    - Is there any information/assistance you would like to have to help in the decision-making process? (Planning and Design, Environmental)
        - Would spacing requirements between noise walls and the edge of the right of way help when placing noise walls? (Planning and Design, Environmental)

- How much space would you recommend leaving between the back of a noise wall and the edge of the right of way to ensure proper construction and maintenance? (Planning and Design, Construction, Maintenance)
- What considerations are important when placing a noise wall off TxDOT right of way? (Planning and Design, Right of Way, Utilities, Maintenance, Environmental, Construction)
    - In what instances would placing a noise wall off TxDOT right of way be preferable? (Planning and Design, Right of Way, Utilities, Maintenance, Environmental, Construction)
    - In what instances would placing a noise wall off TxDOT right of way not be preferable? (Planning and Design, Right of Way, Utilities, Maintenance, Environmental, Construction)
- What considerations are important when placing a noise wall between the frontage road and the main lanes? (Planning and Design, Right of Way, Utilities, Maintenance, Environmental, Construction)
    - In what instances would placing a noise wall between the frontage road and the main lanes be preferable? (Planning and Design, Utilities, Maintenance, Environmental, Construction)
    - In what instances would placing a noise wall between the frontage road and the main lanes not be preferable? (Planning and Design, Utilities, Maintenance, Environmental, Construction)
- What considerations are important when placing a noise wall closer to the travel lanes and away from the edge of the right of way? (Planning and Design, Right of Way, Utilities, Maintenance, Environmental, Construction)
    - In what instances would placing a noise wall closer to the travel lanes and away from the edge of the right of way be preferable? (Planning and Design, Utilities, Maintenance, Environmental, Construction)
    - In what instances would placing a noise wall closer to the travel lanes and away from the edge of the right of way not be preferable? (Planning and Design, Utilities, Maintenance, Environmental, Construction)

Retaining Walls

- When placed near the right of way line, how much space would you recommend leaving between the back of the retaining wall and the edge of the right of way to ensure proper construction and maintenance? (Planning and Design, Bridge, Construction, Maintenance)
- Is the proximity to existing travel lanes considered when designing retaining walls? (Planning and Design, Bridge)
- What considerations are important when placing a retaining wall between the frontage road and the main lanes? (Planning and Design, Bridge, Right of Way, Utilities, Maintenance, Construction)
    - In what instances would placing a retaining wall between the frontage road and the main lanes be preferable? (Planning and Design, Bridge, Utilities, Maintenance, Construction)

    - In what instances would placing a retaining wall between the frontage road and the main lanes not be preferable? (Planning and Design, Bridge, Utilities, Maintenance, Construction)

Both

- Do you have any recommendations regarding noise walls and retaining walls proposed in the same area? (Planning and Design, Bridge, Environmental, Maintenance, Construction)
    - Is the proximity to retaining walls considered when placing a noise wall? (Planning and Design, Environmental)
    - Is the proximity to noise walls considered when placing a retaining wall? (Planning and Design, Bridge)

Utilities

- Are you informed about utility conflicts on the project? (Planning and Design, Bridge, Environmental, Utilities, Right of Way)
    - If so, when in the project development process are you informed? (Planning and Design, Bridge, Environmental, Utilities, Right of Way)
        - Does it differ depending on the type of project delivery method used (design-build, design-bid-build, etc.)? (Planning and Design, Bridge, Environmental, Utilities, Right of Way)
- How often do you coordinate with utility companies regarding their facilities and the associated utility conflicts? (Planning and Design, Utilities)
    - When do you begin communication with utility companies in the project development process? (Planning and Design, Utilities)
- When do you begin to collect SUE information? (Planning and Design, Utilities)
- Do you consider SUE information when designing the project? (Planning and Design, Bridge)
    - If so:
        - When do you receive SUE information? (Planning and Design, Bridge)
        - Do you request additional SUE information (including test holes) to help with the design? (Planning and Design, Bridge)
- Do you request additional SUE information (including test holes) to help clear/confirm utility conflicts? (Planning and Design, Bridge)
- When in the project development process do utility relocations typically begin? (Planning and Design, Utilities)

Noise Walls

- When is the utility coordinator typically provided a copy of the noise wall design plans (before or after the noise workshop)? (Planning and Design, Environmental, Utilities)
    - Who provides the utility coordinator the noise wall plans? (Planning and Design, Environmental, Utilities)

Right of Way

- When do you first get involved in the project? (Right of Way)
  - How often do you attend project design meetings? (Right of Way)
    - When do you begin to attend design meetings? (Right of Way)
  - How often do you attend utility coordination meetings? (Right of Way)
    - When do you begin to attend utility coordination meetings? (Right of Way)
- When in the project development process is the right of way set on a project? (Right of Way)
  - When does the right of way acquisition process begin? (Right of Way)
  - At what point is it too late to acquire additional right of way without impacting the project schedule? (Right of Way)
  - At what point is it too late to acquire a temporary construction easement without impacting the project schedule? (Right of Way)

Noise Walls

- Are noise walls considered during the right of way development process? (Right of Way)
  - If so, how? (Right of Way)
  - If not, why are noise walls not considered? (Right of Way)
    - Should noise walls be considered during the right of way development process? (Planning and Design, Environmental, Utilities, Right of Way)
- Are temporary construction easements requested to help construct noise walls? (Planning and Design, Right of Way, Construction)
- Is the amount of available right of way considered when planning for and designing noise walls? (Planning and Design, Environmental, Right of Way)
- Have you acquired right of way to accommodate a noise wall? If so, please discuss. (Right of Way, Environmental)

Retaining Walls

- Are temporary construction easements requested to help construct retaining walls? (Planning and Design, Bridge, Right of Way)
- Is the amount of available right of way considered when planning for and designing retaining walls? (Planning and Design, Bridge, Right of Way)
  - Is additional right of way considered? (Planning and Design, Bridge, Right of Way)

Other

Noise Walls

- Are alternative noise wall types (front-install panels, etc.) and materials (transparent acrylic, fiberglass, etc.) considered during placement and design? (Planning and Design, Environmental)

    - If not, why are alternative wall types and materials not considered? (Planning and Design, Environmental)
    - If so, are alternative noise wall types and materials considered to mitigate utility conflicts? (Planning and Design, Environmental)
        - Would you consider alternative noise wall types (front-install panels, etc.) and materials (transparent acrylic, fiberglass, etc.) if they lessen the impact to utilities and make installation easier? (Planning and Design, Environmental, Utilities, Construction)
- Do you collect detailed survey information in areas where noise walls are placed? (Planning and Design, Environmental)
    - Have you ever experienced issues with the accuracy of the existing ground elevation (survey) when dealing with noise walls? (Planning and Design, Environmental, Utilities, Construction)
- Do you collect geological information in areas where noise walls are placed? (Planning and Design, Environmental)
    - If so, how frequent are test bores collected? (Example: every 200 feet) (Planning and Design, Environmental)
- Have you ever experienced geological issues when dealing with noise walls? (Planning and Design, Environmental, Utilities, Construction)

Retaining Walls

- Are alternative designs considered to mitigate the need for a retaining wall (Example: acquiring additional right of way, etc.)? (Planning and Design, Bridge)
    - If so, what is the process to decide which design alternative to choose (schedule, cost, utility conflicts, etc.)? (Planning and Design, Bridge)
- Are different types of retaining walls considered during design? (Planning and Design, Bridge)
    - If so, what is the process to decide which retaining wall type to select (schedule, cost, utility conflicts, etc.)? (Planning and Design, Bridge)
- Do you collect detailed survey information in areas where retaining walls are planned? (Planning and Design, Bridge)
    - Have you ever experienced issues with the accuracy of the existing ground elevation (survey) when dealing with retaining walls? (Planning and Design, Bridge, Utilities, Construction, Maintenance)
- Do you collect geological information in areas where retaining walls are planned? (Planning and Design, Bridge)
    - If so, how frequent are test bores collected? (Example: every 200 feet) (Planning and Design, Bridge)
- Have you ever experienced geological issues when dealing with retaining walls? (Planning and Design, Bridge, Utilities, Construction, Maintenance)

Wrap-Up

- Do you have any recommendations on the placement of noise walls and retaining walls with respect to maintenance? (Maintenance)

- Do you have any recommendations on the placement of noise walls and retaining walls with respect to construction? (Construction)
- Do you have any other recommendation regarding noise walls and retaining walls? (Planning and Design, Environmental, Bridge, Utilities, Right of Way, Construction, Maintenance)
- Do you know of a project that would make a good case study? (Planning and Design, Environmental, Bridge, Utilities, Right of Way, Construction, Maintenance)
- Is there anyone else that you would recommend for us to contact regarding this research study? (Planning and Design, Environmental, Bridge, Utilities, Right of Way, Construction, Maintenance)

APPENDIX K. CASE STUDY PROJECT LIST SUBMITTAL

TxDOT Project 0-7014, Sequencing and Placement of Noise Walls and Retaining Walls on Complex TxDOT Projects

Case Study Project List

Date: October 28, 2020

The research team submits the following list of case study projects for review. A project from each of the five metro districts has been identified and listed in Table 1 [Table 33]. A listing of alternative case study projects is also provided (Table 2 [Table 34]). The potential case study projects and information were collected from interviewed personnel and project data in TxDOTCONNECT. The research team concentrated on recent projects that were: in the final stages of design, construction, or completed. Preference was given to projects recommended by TxDOT personnel. The identified projects have both noise walls and retaining walls listed in the project specification list in TxDOTCONNECT. Please provide approval and feedback on the case study projects. The research team plans to begin collecting case study data, including design plans, and existing utility information once approval is received.

Table 33. Case Study Projects.

District	Name	Project Description	CSJ	County	Hwy	Let Date	Project Stage	Classification
Austin	FM 2304 from Ravenscroft to FM 1626	Reconstruct existing 2-lane divided roadway with center left turn lanes to a 4-lane divided roadway with center left turn lanes	2689-01-023	Travis	FM 2304	08/2019	Construction	Widen Non-Freeway
Dallas	IH 30 from Bass Pro Drive to Dalrock Rd	Construct 0 to 6 lane frontage roads, bayside bridge, & ramp modifications; reconstruct Dalrock interchange	0009-11-241	Dallas	IH 30	03/2021	PS&E	Widen Non-Freeway
Fort Worth	IH 30; 1-mile West of SH 360 to Great SW Pkwy	Construct direct connector interchange at SH 360 & traffic management system	1068-02-076	Tarrant	IH 30	11/2015	Construction	Interchange (New or Reconstructed)
Houston	IH 45, South of FM 1764 to North of FM 519	Reconstruct to 8 main lanes and two 2-lane frontage roads	0500-04-105	Galveston	IH 45	08/2019	Construction	Widen Freeway
San Antonio	SL 1604: 2452-03-112; Convert Non-Freeway to Freeway	Expand from 4-lane divided to 4-lane expressway	2452-03-112	Bexar	SL 1604	06/2018	Construction	Convert Non-Freeway to Freeway

Table 34. Alternative Case Study Projects.

District	Name	Project Description	CSJ	County	Hwy	Let Date	Project Stage	Classification
Austin	IH 35 at Williams Dr	Reconstruct interchange	0015-08-147	Williamson	IH 35	07/2020	Construction	Interchange (New or Reconstructed)
Austin	SL 1 from North of Slaughter Lane to South of La Crosse Ave	Grade separation of main lanes at Slaughter and La Crosse with 2 through-lanes in each direction	3136-01-015	Travis	SL 1604	08/2017	Construction	Interchange (New or Reconstructed)
Dallas	SH 161 from South of SH 183 to North of Belt Line Rd	Widen and reconstruct 4 (6 lanes during peak travel) to 8 general purpose lanes	2964-01-048	Dallas	SH 161	06/2018	Construction	Widen Freeway
Dallas	US 377 from IH 35E to South of FM 1830	Widen 2-lane to 6-lane divided urban section	0081-04-025	Denton	US 377	07/2018	Construction	Widen Freeway
Fort Worth	IH 20; Bryant Irvin to Winscott	Construct 1 aux lane in each direction	0008-16-042	Tarrant	IH 20	04/2020	Construction	Widen Freeway
Fort Worth	SH 360; N of E Abram to IH 20 Interchange	Widen & reconstruct 6 to 8 lanes	2266-02-086	Tarrant	SH 360	02/2018	Construction	Widen Freeway
Houston	IH 610, Post Oak Blvd to IH 10 West	Dedicated bus lane	0271-17-163	Harris	IH 610	12/2017	Construction	Intersection & Operational Improv
Houston	SH 99, Fairfield Village, Boudreaux Estates	Construct sound wall	3510-06-014	Harris	SH 99	08/2017	Construction	Miscellaneous Construction
San Antonio	FM 1103: 1268-02-027; Widen Non-Freeway	Expand from 2 to 4 lanes with medians, turn lanes, sidewalk, and bike lanes	1268-02-027	Guadalupe	FM 1103	06/2021	PS&E	Widen Non-Freeway
San Antonio	FM 1103: 1268-01-013; Widen Non-Freeway	Expand from 2 to 4 lanes with medians, turn lanes, sidewalk, and bike lanes	1268-01-013	Comal	FM 1103	06/2021	PS&E	Widen Non-Freeway