

TxDOT Survey Manual



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Manual: *TxDOT Survey Manual*

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Purpose

The purpose of this manual revision is to update to the new name of Design Division's Remote Sensing Services Section in the Texas Department of Transportation (TxDOT).

Changes

Chapter 2, General Surveying Procedures

- In Section 1, changed Design Division Photogrammetry Section to Design Division Remote Sensing Services Section

Chapter 4, Design Surveys

- In Section 1, changed Design Division Photogrammetry Section to Design Division Remote Sensing Services Section

Disclaimer

Some hyperlinks will not work when a PDF version of this manual is downloaded and used offline.

Contact

Ronny Lackey, ROW Division Surveying Section Director, 713-594-1711 or TxDOT Committee on Geomatics & Surveying (COGS) chair

Archives

Past manual notices are available from a [pdf archive](#).

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Chapter 1: Introduction

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Section 1: General Information Overview

Manual Use

This [TxDOT Survey Manual](#) is primarily intended to be accessed online. The online version takes precedence over printed copies, changes, updates, and edits. However, paper copies may be used in the field. Copies should be checked against the online manual version for currency date to ensure the latest information. Caution should be taken not to rely entirely on the printed version due to ongoing updates and/or changes.

Some information in this manual is excerpted and/or adapted from other sources, both online and standard text. Users should be aware that information found in this manual may change at the source and therefore should check the sources provided to ensure use of the most current information.

The *TxDOT Survey Manual* is intended to provide guidance for planning, executing, and classifying surveys for both Texas Department of Transportation (TxDOT) employees and contractors.

The *TxDOT Survey Manual* contains information governing the operational standards used by TxDOT. These standards are the policies and guidelines set forth by TxDOT regarding surveying processes and procedures.

Documentation of Authority

The following documents authorize the *TxDOT Survey Manual* and the activities it covers:

- *TxDOT Directive 5-92, TxDOT Manual System*
- *Executive Order 1-89, Policy and Procedure Communication*
- *TxDOT Policy Statement P-ROW-SRV-001, Right of Way Division*

Laws and Standards

The *TxDOT Survey Manual* provides the information that TxDOT survey resource users need to comply with applicable legal and policy requirements. Based on federal and state laws, state standards and agency policy, this manual draws upon the following:

- *Texas Government Code, Section 2203.004, Requirement to Use State Property for State Purposes*
- *Texas Government Code, Section 403.275, Liability for Property Loss.*

Administrative Documents

This manual draws upon information contained in the following memos and administrative announcements:

- TxDOT Memorandum, Surveying Operations, Charles W. Heald, March 28, 2000
- TxDOT Administrative Announcement, Professional Land Surveying, Byron C. Blaschke, P.E., September 28, 1990
- TxDOT Memorandum, Survey Datum Designated for Use Within TxDOT, Charles W. Heald, December 7, 1998
- TxDOT Memorandum, TxDOT Surveying Procedures, William Burnett, July 21, 1995.

Section 2: Manual Overview

How to Get Help

The following staff are available to answer questions and discuss procedures and specifications outlined in this manual. Also if there is a need for updates or corrections, please notify one of these contacts:

- Within the Texas Department of Transportation District Offices (Districts), a TxDOT District Survey Coordinator
- Within the Texas Department of Transportation Right of Way Division (ROW), the ROW Division Surveying Section Director

Section 3: Committee on Geomatics and Surveying

Roles

The *TxDOT Survey Manual* and [TxDOT Surveyors' Toolkit](#) are officially supported by the TxDOT Committee on Geomatics and Surveying (COGS). Any questions, requests, or comments should be directed towards the COGS chair or the ROW Division Surveying Section Director. Non-emergency change requests will require approval by COGS. Regular reviews and updates will be performed by COGS, while ROW Division Surveying Section will perform emergency updates and support content generation.

Chapter 2: General Surveying Procedures

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Section 1: Definitions and Procedures

Committee on Geomatics and Surveying

A subject-matter-expert community of practice that includes a cross-section of district and division representatives. Governing authority that reviews and approves survey standards and oversees survey programs.

Emergency

Any change that has an immediate improvement for safety, schedule, or cost.

TxDOT District Survey Coordinator

District employee appointed by the District Transportation Planning and Development Director to ensure compliance with all survey standards and provide written exceptions for design and construction survey standards when needed.

TxDOT Project Manager

The lead TxDOT contact for outside parties who may be assisting TxDOT with completing a project.

Project Team Member

Any stakeholder, inside or outside of TxDOT, whose performance is essential to the completion of a TxDOT project.

Public Entity

Any governmental, educational, or non-profit institution whose mission is the service of Texas citizens.

Public

Any entity that does not fall into the other categories.

ROW Division Survey Section

Publishes TxDOT land survey standards and job aids. Provides support and training in the implementation of standards and job aids. Evaluates and performs emergency updates to standards

and job aids. Generates standards and job aids related to boundary. Assist Districts with compliance with Survey Standards and Best Practices.

Information Technology Division (ITD) Engineering Services

Provides equipment, software, and related support to TxDOT surveyors. Generates standards and job aids related to equipment and software.

Design Division Remote Sensing Services Section

Provides photogrammetric and LIDAR (Light Detection and Ranging) support for TxDOT surveyors. Generates standards and job aids related to remote sensing data acquisition.

Design Division Digital Delivery Section

The Digital Delivery Section is the Office of Primary Responsibility for the implementation and support of OpenRoads, ProjectWise, and MicroStation design tools, providing support to the districts for training and assistance in the use of these software packages. This section is responsible for leading the State in the Digital Delivery Initiative using 3D technology to develop and deliver construction projects.

PEPS Division

Provides and oversees survey contracts for TxDOT. Generates standards and job aids related to contracts.

Construction Division

Provides support for contract administration and inspector development which includes construction surveying. Generates specifications and guidance related to construction contract administration and construction inspection.

GIS Workgroup

A subject-matter-expert community of practice that provides geographic information system support for TxDOT surveyors. Generates standards and job aids related to geographic information systems.

Aviation Division UAS Coordinator

Generates standards and job aids related to Uncrewed Aerial Systems (UAS). Provides uncrewed aerial vehicles and flight training to TxDOT Surveyors.

District Survey Staff

Any District staff that oversees or performs survey tasks whether personally or through contracts.

Standards and Job Aids

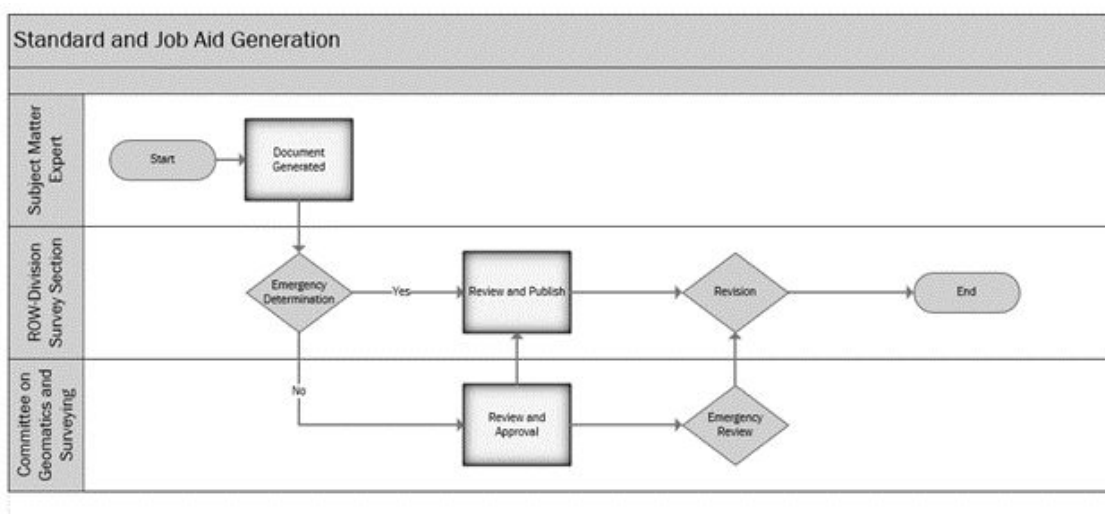


Figure 2-1. Standard and Job Aid Generation

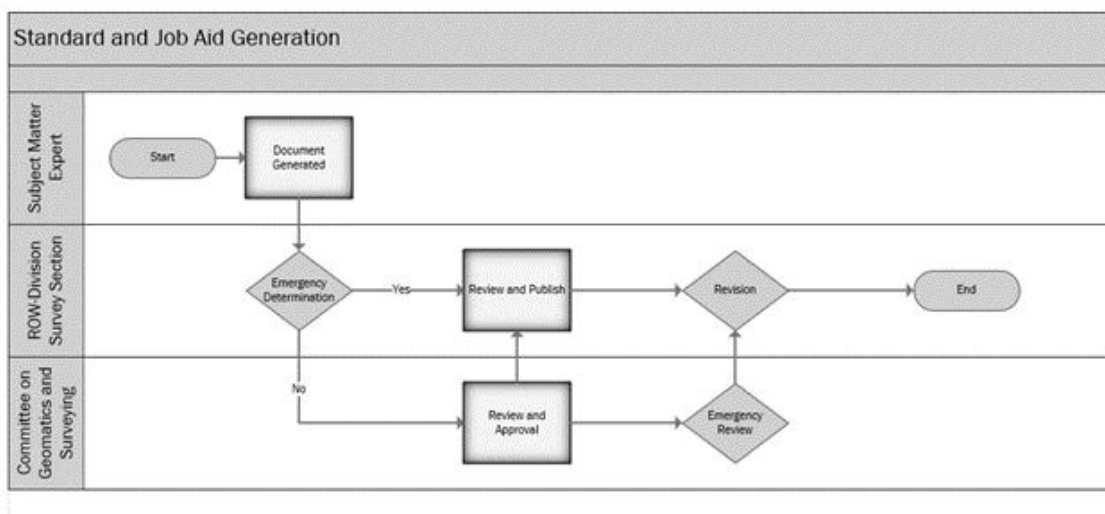


Figure 2-2. Standard and Job Aid Review

Section 2: Data Sharing

Overview

Members of the public should make all requests through the Open Public Records System. TxDOT will provide any documents as required to satisfy the [Public Information Act](#). Documents will be provided as-is with no further processing. Services such as advice and processing will not be provided.

Public entities should make all requests through either the Open Records System, ROW Division, or the local TxDOT District Survey Coordinator. Limited services may be provided as staff are available.

Project Team Members should make all requests related to TxDOT projects through their TxDOT Project Manager or primary TxDOT contact. Any request that does not come from a TxDOT contact will be directed to the Open Records System. Services related to the completion of the TxDOT project will be provided.

TxDOT Project Managers should make all requests related to TxDOT projects. All services related to the completion of a TxDOT project will be provided.

Section 3: Right-of-Entry

General

It is the stated policy of TxDOT that good relations will be kept with the public. Any right-of-entry agreement is an agreement between the signing parties. The right-of-entry letter template as published in the [TxDOT Surveyors' Toolkit](#) should be incorporated as necessary, but consultants and TxDOT employees may modify the letter with the aid of an attorney. Written right-of-entry letters are preferable to verbal agreements and signed letters shall always be sought on every project. Verbal agreements shall be noted in field notes and initialed by the person attesting to the agreement, but a verbal agreement shall only be considered valid for one day for the specific individual receiving it.

Survey staff and consultants are encouraged to utilize remote measurement methods whenever possible to eliminate the need to enter private property. When necessary, all landowners with access to land features or property corners should be approached, not just those affected by the TxDOT project.

Employees and consultants cannot commit TxDOT to liability for anything performed on private property, outside of standard workers compensation. Individual employees may choose to sign liability waivers for landowners, but this cannot be done for TxDOT as a whole. Consultants may provide liability coverage or seek other agreements as required.

TxDOT, as a public agency, does not typically purchase right-of-entries to properties. Safety costs may be budgeted in the case of entry into high-risk areas such as railroads or Department of Criminal Justice property. If right-of-entry is necessary and cannot be acquired through other means, a request for court order should be provided to the ROW Division Survey Section for review and processing. TxDOT staff are encouraged to avoid court orders if possible in order to maintain good relations with the public.

Chapter 3: Control Points

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Section 1: Control Points

Overview

Definitively established points of known location are essential for project data to be referenced to ground conditions in the future. This section goes over the requirements for establishing these points to ensure that project data retains its utility throughout the project life cycle and beyond.

Primary Control Points

Primary control points will be referenced to the National Spatial Reference System (NSRS) through [Continuously Operating Reference Stations \(CORS\)](#) or [Federal Base Network \(FBN\) Stations](#). Primary control points shall not be more than approximately two (2) miles apart and shall be set in intervisible pairs to provide redundancy. Primary control points shall meet the Level 2 accuracy standards as listed in the [TxDOT Survey Levels of Accuracy](#). Surveyors are responsible for knowing whether their equipment and methods can meet these standards.

Surveyors shall endeavor to ensure that control covers the entirety of the project area in a stable planar configuration as shown in the [typical control diagrams](#). A control layout, [template](#) provided in the TxDOT Surveyors' Toolkit, shall be provided to the TxDOT Survey Coordinator prior to control point monument construction.

Construction of primary control monuments shall be done with the intent that they survive for future projects. Whenever possible, they shall be in TxDOT right of way and situated away from likely construction. Construction methods and materials shall match the diagrams and processes outlined in the [TxDOT Monument Specifications](#) listed in the TxDOT Surveyors' Toolkit for primary control monuments.

All primary control points shall be documented on a form [ROW-S-2462 Primary Survey Control](#) (in the TxDOT Surveyors' Toolkit) and shall be signed and sealed by a Texas Registered Professional Land Surveyor or Professional Engineer. These control data sheets shall be stored and indexed by the TxDOT District Survey Coordinator for future projects and open records requests. Primary control points shall also be included on Plans, Specifications, and Estimates documents and any ROW Mapsheets developed for the project. These control points shall also go into any computer-aided drafting (CAD) graphics files generated for the project.

Secondary Control Points

Secondary control stations shall meet [TxDOT Survey Level 3 Specifications](#). All secondary control points shall reference and adjust to nearby primary control points as directed by the TxDOT District Survey Coordinator.

These should be intervisible at a maximum of 1,500' distance apart, spaced evenly across the project area as much as possible, as shown in the [typical control diagrams](#). A control

layout, [template](#) provided in the [TxDOT Surveyors' Toolkit](#), shall be provided to the TxDOT Survey Coordinator prior to control point monument construction.

Construction of secondary control monuments shall be done with the intent that they survive until the end of the project. Whenever possible, they shall be in TxDOT right of way and situated away from likely construction. Construction methods and materials shall match the diagrams and processes outlined in the [TxDOT Monument Specifications](#) listed in the [TxDOT Surveyors' Toolkit](#) for secondary control monuments.

All secondary control points shall be documented on Plans, Specifications, and Estimates documents and any ROW Mapsheets developed for the project.

Aerial Control Points

Aerial control points shall meet [TxDOT Survey Level 3 Specifications](#). All aerial control points shall reference and adjust to nearby primary control points as directed by the TxDOT District Survey Coordinator.

These shall be placed at the direction of a photogrammetrist to meet the precision requirements listed in the Design Surveys chapter of this manual. Aerial Panel Layout, [template](#) listed in the TxDOT Surveyors' Toolkit, shall be provided to TxDOT Survey Staff prior to aerial data collection.

Construction of aerial control monuments shall be done with the intent that they survive until the end of aerial data collection. If possible, they shall be in TxDOT Right-of-Way and situated away from likely construction. Construction methods and materials shall match the diagrams and processes outlined in the [Photogrammetry Guide](#) located in the [TxDOT Surveyors' Toolkit](#).

Coordinate Systems and Datum

Federal and state mapping products are referenced to two standard coordinate systems: the North American Datum of 1983 (NAD 83) for horizontal positions and ellipsoid heights, and the North American Vertical Datum of 1988 (NAVD 88) for orthometric heights. Surveys are referenced to these datums through measurements to control points of the National Spatial Reference System (NSRS). All control coordinates will be provided in surface and grid, using [surface adjustment factors](#) posted in the TxDOT Surveyors' Toolkit.

An adjustment was done in Texas using Global Positioning System (GPS), which resulted in the 1993 High Accuracy Reference Network (HARN). The network was extended to nearly all old, conventionally surveyed federal monumentation. Projects should be referenced to the published HARN coordinates of National Geodetic Survey (NGS) monumentation.

Units

Unless otherwise instructed, latitude and longitude will be presented as degrees, minutes, and seconds. Direction indicators N or W will prefix the value and seconds will be carried out five places right of the decimal where accuracy is to approximately 0.001 feet.

Units of length will be in U.S. Survey Feet in all deliverables. Horizontal coordinates should be carried out to 0.01 feet, unless otherwise instructed.

Conversion from meters to U. S. Survey Feet must be made using the following formula:

Meters * 3937/1200 = U. S. Survey Feet

The factor is 3.280833333333 and working with State Plane Coordinates (SPCs) in the millions, one must carry the factor out to 12 places to the right of the decimal as shown.

Conversions and Transformations

TxDOT will not accept any datum transformations for control. If a change to the NAD83 project datum is needed for comparison of old surveys, two (2) control points can be resurveyed (GPS or conventional) from references in the new datum. Then, a translation-rotation-scale can be done holding to the two (2) points common to both datums. Or, if original raw GPS data is available, it can be reprocessed holding the new datum coordinates rather than the original datum coordinates.

Both CORPSCON and AASHTOW Survey Data Management Systems (SDMS) are acceptable software programs for the mathematical conversion of:

1. Metric to US Survey Foot (or visa-versa)
2. SPC zones to adjoining SPC zones
3. Universal Transverse Mercator (UTM) to SPCs and
4. Latitude/Longitude to SPCs.

In addition to these strictly mathematical conversions, these software programs provide useable combined adjustment factors (CAF) at the specific location of a point if the elevation is included in the input.

Chapter 4: Design Surveys

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Section 1: Design Surveys

Overview

Design surveys are an essential part of the design process. These surveys touch on a multitude of specialties including Photogrammetry, Geographic Information Systems, and Engineering Services. Design surveys are defined as topographic data collection for precise engineering decisions.

Roles and Responsibilities

The TxDOT District Survey Coordinator shall enforce standards and provide exceptions as necessary.

TxDOT Survey Staff shall track all project requirements and complete projects.

ROW Division Surveying Section shall curate and provide training for all survey standards and processes.

Information Technology Division (ITD) Engineering Services shall develop software and hardware processes and procedures. They shall also provide training for all processes and procedures that they develop.

Design Division Remote Sensing Services Section shall develop processes and procedures for remote sensing data processing. They shall also provide training for all processes and procedures that they develop.

The Design Team shall provide all project specifications to District survey staff and provide specific deadlines for receipt of data.

Open Roads Designer

All graphic design survey files shall be provided in [MicroStation Open Roads Designer \(ORD\)](#). These shall follow all standards within the [TxDOT Surveyors' Toolkit](#) and seamlessly integrate with TxDOT systems. Only TxDOT ORD formats such as fonts, cell libraries, linestyles, and other graphics styles shall be utilized. It is the responsibility of the surveyor to provide the design team with files in the appropriate format with no further processing required by design to fully utilize the files.

Aerial Data

All data acquired from aerial platforms shall be processed under the supervision of an American Society for Photogrammetry and Remote Sensing (ASPRS)-certified photogrammetrist. Flight plans and photogrammetric procedures shall follow the [Photogrammetry](#)

[Guide](#) and [Photogrammetry Feature Collection Standards](#) provided in the TxDOT Surveyors' Toolkit.

Precision Standards

Both Schematic and Plans, Specifications, & Estimates (PS&E) surveys shall follow the same precision standards. These standards are below:

- Horizontal accuracy error allowance:
 - Bridges and other roadway structures: less than 0.1 feet.
 - Utilities and improvements: less than 0.2 feet.
 - Cross-sections and profiles: less than 1 foot.
 - Bore holes: less than 3 feet.
- Vertical accuracy error allowance:
 - Multi-phase bridges: less than 0.02 feet.
 - Single-phase bridges and other roadway structures: less than 0.04 feet.
 - Utilities and improvements: less than 0.1 feet.
 - Cross-sections and profiles: less than 0.2 feet.
 - Bore holes: less than 0.5 feet.
- Spatial density requirement:
 - Manmade features: Maximum distance between measurements is 25 feet.
 - Natural features: Maximum distance between measurements is 50 feet.

It is the responsibility of the surveyors to understand the capabilities of the measurement devices used for the survey. Recommended practices and procedures are provided in the [TxDOT Surveyors' Toolkit](#). TxDOT District Survey Coordinators shall randomly check data using the recommended practices and procedures to ensure compliance. The surveyor is responsible for reacquiring all data for a survey that does not satisfy the random checks.

Completeness of Survey

Surveyors are responsible for the measurement of all required features in the specified survey area that exists on the date of survey(s). If a survey takes place over multiple months, then all features that exist at the end of the survey period shall be measured and provided to the design team. A list of required features and their measurement methodology exists in the form [ROW-S-DesCheck Design Survey Checklist](#) and the [Photogrammetry Feature Collections Standards](#) in the TxDOT Surveyors' Toolkit.

No Acceptable Failure Rate

There is no acceptable failure rate for any TxDOT survey. Any surveys found not in compliance with the precision and completeness requirements above shall not be considered finished and cannot be invoiced.

Teams to Receive Surveys

Upon receipt of a finished survey, design survey graphics files shall be stored in Projectwise and notification of their location provided to the following teams: District Design Team, ROW Division Commercial Signs Section, and TxDOT District Utility Coordinator. If the contact for any of these teams is unknown, contact ROW Division Surveying Section for support.

Chapter 5: Boundary Surveys

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Section 1: Boundary Surveying

Overview

Boundary surveying is essential to ensure that the rights of the State and the public to their lands is protected. This chapter is devoted to establish the accountability of boundary tasks among different stakeholders.

Roles and Responsibilities

A Texas Registered Professional Land Surveyor is required to supervise creation of all documents and data that are intended to show the precise location of boundary. This includes but is not limited to plats, descriptions, maps, graphics files, easements, dispositions, encroachment exhibits, reports and geodatabases. In the case of documents, the Texas Registered Professional Land Surveyor shall sign and seal each document that they produce. In the case of digital files, the Texas Registered Professional Land Surveyor shall sign and seal a report indicating that the data delivered is true and accurate. This report may exclude external parties from the project team from claiming liability over the data, such as members of the public and public entity stakeholder classes. TxDOT and Project Team Members are covered by the Texas Registered Professional Land Surveyor or Survey Firm if the digital files are not correct.

All surveys shall follow the relevant requirements from the [TxDOT Surveyors' Toolkit](#). This includes:

- [ROW-S-PDCheck Property Description Checklist](#)
- [Monument Specifications](#)
- [ROW-S-LLAcqCheck Local-Let Acquisition Survey Checklist](#)

Any variation on these requirements must be granted by written exception from the ROW Division Surveying Section.

The ROW Division Surveying Section is responsible for the adoption and communication of all state boundary survey standards. The Section will also support Districts, project partners, and the public with tasks related to the completion of TxDOT projects. This includes:

- Quality control assistance
- Project completion assistance
- Education
- Mentorship

District Registered Professional Land Surveyors are responsible for the adequate monumentation and recovery of right-of-way boundary lines in their District. This includes:

- Project completion
- Quality control
- Recovery and remonumenting of existing right of way

TxDOT District Survey Coordinators are responsible for ensuring that Texas Registered Professional Land Surveyors map and monument the right of way. They ensure that qualified assistance is acquired via contract, employment, or request to the ROW Division Surveying Section. They monitor and assist efforts to maintain the location of the right of way within their District. This includes:

- Contract supervision
- Quality control
- Field support
- Data maintenance

Location of TxDOT Boundary

All TxDOT boundary lines shall be located under the supervision of a Texas Registered Professional Land Surveyor. This includes right of way lines, easements, and other rights that TxDOT has to the use of property. The Texas Registered Professional Land Surveyor shall locate boundary in accordance to the rules of the Texas Board of Professional Engineers and Land Surveyors, state law, case law, and the [ROW Preliminary Procedures for the Authority to Proceed Manual](#) .

Location of boundary is considered a service. TxDOT staff shall provide all the services needed to advance TxDOT projects and maintain TxDOT facilities. These services shall be relied upon by all project partners to complete their tasks.

Members of the public are encouraged to obtain the services of a private Texas Registered Professional Land Surveyor or a real-estate attorney if they are uncertain about the location of a TxDOT boundary. TxDOT will meet all statutory requirements on provision of records, but the private Texas Registered Professional Land Surveyor or real-estate attorney is responsible for all research outside of our records.

TxDOT will defend the true location of our boundary even if we were previously mistaken in our opinion of the location.

The true location of our boundary is best located from the recorded acquisition documents. ROW Maps, Geographic Information Systems, and Engineering Plans only serve as an index to find further evidence for the location of our right of way.

TxDOT ROW Documents

All TxDOT ROW Documents should match the standards in the [ROW Preliminary Procedures for the Authority to Proceed Manual](#) and the form [ROW-S-PDCheck Property Description Checklist](#). ROW Maps are not required, but should be submitted to the ROW Division Surveying Section for inclusion on the Real Property Asset Map if they are created.