FLORIDA DEPARTMENT OF TRANSPORTATION



SURVEYING AND MAPPING HANDBOOK

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ABBREVIATIONS

- 2D – 2 Dimensional
- 3D – 3 Dimensional
- ASCII – American Standard Code for Information Interchange
- ASPRS – American Society of Photogrammetry and Remote Sensing
- AT – Aerial Triangulation or Aerotriangulation
- BEIDOU – Chinese Navigation Satellite System
- BM – Benchmark
- BSM – Bureau of Survey and Mapping
- CADD – Computer Aided Design and Drafting
- CORS – Continuously Operating Reference Station
- CSMO –Central Surveying and Mapping Office
- DEM – Digital Elevation Model
- Department – Florida Department of Transportation
- DMI – Distance Measuring Instrument
- DSMO – District Surveying and Mapping Office
- DTM – Digital Terrain Model
- EOR – Engineer of Record
- F.A.C. – Florida Administrative Code
- FDEP – Florida Department of Environmental Protection
- FDOT – Florida Department of Transportation

- FGDC - Federal Geographic Data Committee
- FHWA – Federal Highway Administration
- FKP - Flächen Korrektur Parameter
- FPRN – Florida Permanent Reference Network
- F.S. – Florida Statutes
- GALILEO – European Navigation Satellite System
- GDOP – Geometric Dilution of Precision
- GLONASS – Russian Navigation Satellite System
- GNSS – Global Navigation Satellite System
- GPS – Global Positioning System
- GSD – Ground Sample Distance
- GVX – GNSS Vector Exchange Format
- iMAC – Individualized Master Auxiliary Concept (iMAX)
- IMU – Inertial Measurement Unit
- INS – Inertial Navigation System
- ISO – International Standard Organization
- KML – Keyhole Markup Language
- KMZ - Keyhole Markup Language zipped
- LiDAR – Light Detection and Ranging
- MOT – Maintenance of Traffic
- MAC – Master Auxiliary Concept (MAX)
- MHWL – Mean High Water Line

- MSTS – Mobile Survey Tracking System
- NAD – North American Datum
- NAP – North American Profile
- NAVD – North American Vertical Datum
- NCAT – Coordinate Conversion and Transformation Tool
- NDP – Network Design Plan
- NGS – National Geodetic Survey
- NGVD – National Geodetic Vertical Datum
- NSRS – National Spatial Reference System
- NSSDA – National Standard for Spatial Data Accuracy
- OHWL – Ordinary High-Water Line
- OPUS – Online Positioning User Service (NGS Web-based Software)
- OPUS-P – Online Positioning User Service Projects (NGS Web-based Software)
- OPUS-RS – Online Positioning User Service Rapid Static (NGS Web-based Software)
- PC – Point of Curvature
- PDF – Portable Document Format
- PDOP – Positional Dilution of Precision
- PI – Point of Intersection
- POC – Point on Curve
- POT – Point on Tangent
- PPC – Project Primary Control

- PT – Point of Tangency
- PSC – Project Secondary Control
- PSM – Professional Surveyor and Mapper
- PVC – Project Vertical Control
- QA/QC – Quality Assurance/Quality Control
- RF – Radio Frequency
- RINEX – Receiver Independent Exchange Format
- RMS – Root Mean Square
- RMSE – Root Mean Square Error
- RS – Rapid Static GNSS
- RT – Real-Time Kinematic Positioning
- RTN – Real-Time Network Positioning
- R/W – Right of Way
- Scope – Project Scope of Services
- SGSS – State Geodetic Services Supervisor
- SRD – State Road Department
- SUEL – Safe Upland Elevation Line
- TBM – Temporary Benchmark
- TIITF – Trustees of the Internal Improvement Trust Fund
- TRB – Transportation Research Board
- USGS – United States Geological Survey
- VRS – Virtual Reference System

- X,Y,Z – Cartesian Coordinates

DEFINITIONS

- **Accuracy** – Degree of conformity with a standard or accepted value. Accuracy relates to the quality of a result and is distinguished from precision which relates to the quality of the operation by which the result is obtained.
- **Artifacts** – Erroneous data points that do not correctly depict the scanned area. Objects moving through the scanner's field of view, temporary obstructions, highly reflective surfaces, and erroneous measurements at edges of artifacts (also known as "edge effects") can cause artifacts.
- **Axis Test** – Method of calibration in which multiple direct and reverse angular readings are used to correct systematic errors in a total station.
- **Baseline** – Coordinate vector resulting from any station pair.
- **Baseline solution** – Solution from processing a single baseline.
- **Bathymetry** – The art or science of determining ocean depths.
- **Horizontal Geometry** – A 2D featurized CADD object with no inherent elevation (zero elevation in a 3D environment).
- **Image** - A pattern formed by electromagnetic radiation that approximately duplicates the pattern formed by a real object or a physical field detectable by the radiation. This definition is more general than the usual definition because many instruments used for detection operate at other than light frequencies but in ways similar or analogous to those used for forming optical images. The kind of radiation forming an image is usually specified by adding a word that identifies the part of the spectrum involved, e.g., radio image, infrared image, optical image, and X-ray image. However, the terms "radar image" and "X-ray image" are used to refer to optical images of the images formed by radar or X-ray. *Source: National Geodetic Survey: Geodetic Glossary. Library of Congress Catalogue Card Number 86-61105. 1986.*

  http://www.ngs.noaa.gov/CORS-Proxy/Glossary/xml/NGS_Glossary.xml
- **Independent baselines** – A baseline that cannot be derived from other baselines in the network and provides unique positioning data; essentially, an independent vector is a non-trivial vector that contributes new information to the solution.
- **LAS** – A binary file standard supported by the American Society of Photogrammetry and Remote Sensing (ASPRS) for storing point location and attribute information primarily used for LiDAR data.

- **LiDAR** – An active optical remote sensing technology which measures the return properties of scattered light to determine range, direction, and other information of a distant line-of-sight object.
- **Linearly dependent (trivial) baselines** – A baseline (the vector between two GNSS receivers) that can be calculated from other existing baselines, meaning it provides no additional independent information and is considered redundant.
- **Localization** – A coordinate transformation from the GNSS reference system to the project specified system as defined by Department approved control.
- **Master Auxiliary Concept (MAC or MAX) -** Transmits all relevant correction data from a CORS network to the rover in a highly compact form by representing ambiguity-levelled observation data as correction differences of dispersive and non-dispersive data for each satellite-receiver pair.
- **Mean High Water (MHW)** – The average height of the high waters over a 19-year period.
- **Mean High Water Line (MHWL)** – The intersection of the tidal plane of mean high water with the shore.
- **Multipath -** A phenomenon in the physics of waves whereby a wave from a source travels to a detector via two or more paths and the two (or more) components of the wave interfere constructively or destructively.
- **Ordinary High Water (OHW)** – The highest reach of a navigable, nontidal waterbody as it usually exists when in its ordinary condition.
- **Ordinary High-Water Line (OHWL)** – The intersection of the plane of ordinary high water with the shore in areas without tidal influence.
- **Orthoimage** - A georeferenced image prepared from a perspective photograph or other remotely-sensed data in which displacement of objects due to sensor orientation and terrain relief have been removed. It has the geometric characteristics of a map and the image qualities of a photograph. *(Source: Federal Enterprise Architecture Geospatial Profile, ver. 2, appendix B (Glossary of terms)(2008).*
- **Point Cloud** - A relatively precise group of three-dimensional point data collected by a laser scanner from a single observation session. A point cloud may be merged with other point clouds to form a larger composite point cloud.
- **Point Density** - The number of points per unit area; can also be expressed as the average distance between points in a point cloud. National Cooperative Highway Research Program (NCHRP) : Report 748. (2013). *Guidelines for the Use of*

Mobile LIDAR in Transportation Applications. Washington D.C.: Transportation Research Board of the National Academy of Sciences.

- **Portable Document Format (PDF)** - A file format that allows users to share and present documents across multiple platforms and software programs.
- **Positional Accuracy** – A statistical estimate of how close the measured position of a point or object is to its true location in a defined spatial system or datum.
- **Precision** – A measure of the uniformity or reproducibility of the result. Precision relates to the quality of the operation by which the result is obtained and is distinguished from accuracy which relates to the quality of the result.
- **Project Specific Datum** – Datum/Realization used for project monumentation (date specific) or specified by the Scope of Services.
- **Session** – An observing period of multiple GNSS receivers.
- **Session adjustment or baseline processing** – 3D least squares adjustment of all possible baseline solutions.
- **Session solution or session processing** – Solution from simultaneous processing of all independent baselines with mathematical correlations between baselines.
- **Space Weather** - The effects of the solar wind, especially on the Earth's magnetosphere, ionosphere, thermosphere, and exosphere. Though physically distinct, space weather is analogous to the terrestrial weather of Earth's atmosphere.
- **Static Survey** - Involves the collection of precise code and carrier phase measurements recorded simultaneously at two or more survey control marks and/or CORS using stand-alone GNSS equipment (comprised of a geodetic grade antenna and receiver). Classic Static also typically involves post-processing by the surveyor.
- **Virtual Reference Station (VRS) -** A Global Navigation Satellite System (GNSS) data processing technique that enhances the accuracy of position calculations by using data from multiple reference stations to create a synthetic reference point.
- **Weather** - The state of the atmosphere with respect to heat or cold, wetness or dryness, calm or storm, clearness or cloudiness.
- **Zipped** - A compressed file that contains one or more files that have been combined and compressed into a single file.

PURPOSE

This handbook sets forth basic guidelines for performing surveying and mapping activities, developing products, and quality assurance/quality control for the Department. It is not intended to be a comprehensive technical manual but is to act as a directive for requirements, guidelines, and best practices. For specific project instructions, see the DSMO.

AUTHORITY

Sections 20.23(3)(a), F.S. and 334.048(3), F.S.

SCOPE OF DOCUMENT

This handbook applies to anyone performing surveying and mapping services for the Department under the Surveying and Mapping Workgroup or referenced or as directed in other guidelines, specifications, or contract requirements.

REFERENCES

Chapter 20, F.S. – Organizational Structure
Chapter 177, F.S. – Land Boundaries
Chapter 287, F.S. – Procurement of Personal Property and Services
Chapter 334, F.S. – Transportation Administration
Chapter 337, F.S. – Contracting; Acquisition; Disposal; and Use of Property
Chapter 472, F.S. – Land Surveying and Mapping
Rule Chapter 5J-17, F.A.C. – Board of Professional Surveyors and Mappers
Rule Chapter 14-75, F.A.C. – Qualification, Selection and Performance Evaluation Requirements for Professional Consultants to Perform Work for DOT
Surveying and Mapping Procedures, Topic No. 550-030-101-c
CADD Manual, Topic No. 625-050-001
Survey Safety Handbook

GENERAL

This handbook supersedes the previous ***Surveying and Mapping Handbook*** dated 3/29/2019 and the ***Right of Way Mapping Handbook*** dated January 2003.

REQUIREMENTS FOR SURVEYS

All surveys done for the Department will be conducted in accordance with the ***Standards of Practice*** set forth in ***Rule Chapter 5J-17, F.A.C.***, pursuant to ***Section 472.027, F.S.*** There may be requirements set forth by the Department that are more stringent than those defined in the ***Standards of Practice*** that must be adhered to as well.

DISTRIBUTION

This handbook will be made available by the CSMO. The Department will consider input from all users concerning the regular upkeep of this handbook. Appropriate contact information will be included in the handbook for users to submit suggestions for revisions to the handbook. Items warranting immediate revision, or revisions mandated by state or federal law, will be made to the handbook after review by the State Surveyor, in the form of revisions to this handbook or ***Surveying and Mapping Bulletins***. These revisions may be temporary in nature or may carry over until the next handbook revision.

TRAINING

See ***Temporary Traffic Control Training Handbook, Topic No. 625-010-010*** for information on Maintenance of Traffic training and certification.

FORMS/TEMPLATES

See ***Appendix D*** for forms and templates. Contact the DSMO for District specific forms and templates.

For additional forms, checklist, documents, and useful links, see ***FDOT Surveying and Mapping Documents and Publications***.

SURVEYING AND MAPPING

1. CONTROL

1.1. HORIZONTAL PROJECT CONTROL (27.1)

Horizontal positions will be reference to the latest realization of the FPRN. Map projections (graphical or digital) will be referenced to the latest State Plane Coordinate System defined by NGS. Existing projects may be referenced to older horizontal datums with prior written authorization from the DSMO. When two or more datums are encountered on a project, additional survey may be required to determine their relationship.

Since there is no direct mathematical method to accurately transform coordinates from one system to the other, the use of data conversion programs, such as NCAT, is discouraged. However, they could be used for specific projects where a general accuracy of ±0.5 ft. is acceptable. This will require written authorization from the DSMO.

All horizontal control shall be referenced to the FDOT FPRN through redundant survey measurements.

Project Network Control Data Sheets will be filled out for all primary control set for a project. See the DSMO for data sheets and instructions.

Note: The Department strongly encourages its consultants to report to NGS and the DSMO any destroyed monuments that are recorded in the published data.

See ***Appendix C*** for horizontal control accuracy requirements for GNSS derived data.

1.2. PROJECT PRIMARY CONTROL NAMING

Project Primary Control station names and any new mark stamping designations will be provided by the DSMO.

1.3. PROJECT VERTICAL CONTROL (27.2)

Elevations are referenced to NAVD 88. Some existing projects may be referred to NGVD 29. When two or more datums are encountered on a project, additional survey may be required to determine their relationship.

In some jurisdictions, there are benchmarks which are on a local or assumed local datum. A local or assumed datum will only be used with written authorization from the DSMO. Exercise caution when using a local or assumed datum. Physical monuments shall be identified with the same designation for every occupation during field collection to ensure proper weighting on post processing adjustments.

Since there is no direct mathematical method to accurately transform elevations from one system to the other, the use of data conversion programs, such as VERTCON, is discouraged. However, they could be used for specific projects where the required project accuracy could be met using this method. This will require written authorization from the DSMO.

All differential leveling for the establishment of Project Vertical Control will be performed by a digital level and the data will be collected electronically.

Note: The Department strongly encourages its consultants to report to NGS and the DSMO any destroyed monuments that are recorded in the published data.

See ***Appendix C*** for vertical control accuracy requirements for GNSS derived data.

1.4. AERIAL NETWORK CONTROL (27.4)

Place, locate, and maintain aerial targets and/or photo identifiable points. This includes analysis and processing of all field collected data, existing maps, and/or reports. Placement of these targets will be at the direction of the aerial firm.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

2. ALIGNMENT (27.3)

2.1. RETRACEMENT

The suggested order of importance is:

1. Alignment monumentation as shown on previous Department surveys or right of way maps
2. Alignment reference points from previous projects
3. SRD and FDOT right of way monuments
4. Subdivision monuments and land lines shown on previous Department surveys

5. Significant improvements shown on the existing construction plans
6. Evidence along the right of way not shown on previous Department surveys
7. State plane coordinates from previous right of way documents

2.2. MONUMENTATION (27.25) AND REFERENCE POINTS (27.5)

Set suitable marks at PC's, PT's, PI's, and POT's and POC's at ±1000-foot intervals; reference these points as required. Reference points should be set at right angles or radial to the baseline whenever possible.

2.3. STATIONING (27.3)

Survey stationing proceeds from south to north and from west to east on Department projects. The prevailing direction of the route governs the direction of the survey and the stationing. Thus, all surveys for a route are stationed in the same direction.

If the survey begins on an existing route, then the existing stationing is normally used.

2.4. DEFINITION OF CURVATURE

Arc definition curves are the standard used on current Department projects. On older projects, chord defined curves may have been used. Where chord defined curves are encountered on existing maps, it is necessary to convert the curve data to the arc definition. The most practical method is to compute new curve data, holding the central angle and tangents.

2.5. ALIGNMENT SUBMITTAL/APPROVAL

The deliverable includes:

- a description of all points found.
- a comparison of the field data to the record data.
- a report or narrative describing the process by which the alignment was retraced.
- a sketch or map of the preliminary alignment, including the alignment geometry which consists of stationing, bearings, distances, complete curve data, and coordinates.

When the preliminary alignment has been approved, a final alignment can be shown in the field book with complete geometry and pertinent notes.

3. TOPOGRAPHY (27.6)

3.1. FIELD DESCRIPTIONS

All surfaces should be identified by the appropriate FDOT point or line feature, defined in Appendix F, corresponding with that specific topographic feature.

All attributes associated with the topographic point or topographic line feature being collected, shall be populated at the time of the field survey, if known. Additional information not described by an existing attribute should be added to the comment section of the attribute fields.

Buildings and improvements within 50 feet for urban projects, or 100 feet for rural projects, outside of the existing or proposed right of way line should be located, unless otherwise instructed. Buildings (including overhangs where pertinent) should be listed by type, use, and street address.

When locating fences, describe the kind, type, height, and condition since these fences are usually moved, salvaged, or rebuilt during construction.

Wood lines, changes in types of cultivation, and breaks in terrain should all be indicated. In orchards and groves where trees are spaced in rows, it is necessary to locate the trees affected by the design. Indicate the type of trees and their diameter. Measure tree diameter at breast height (4 ½ feet above the ground on the uphill side). All ties are to be made to the center of the tree. Locate all landscaping such as shrubs, flower beds and hedgerows.

All visible or marked utility features should be located and identified.

When measuring to any improvement which is circular, e.g., poles, manholes, tanks, fire hydrants, ties should be made to the center.

3.2. DIGITAL TERRAIN MODEL – 3D (27.6)

DTM's are used when both horizontal and vertical data are required to fix known drainage or slope issues, to redesign or adjust slope/drainage conditions, and for new design. DTM's are derived from points and break lines and are developed from data collected by ground or aerial survey. When a contour interval is not provided by the DSMO, consultants should use professional judgement to collect all pertinent features and changes in grade with a density sufficient to accurately produce a DTM representative of the existing ground surface.

Check cross-sections or profiles should be performed to verify the accuracy of the DTM.

See ***Section 3.3*** for more information on cross-sections.

3.3. ROADWAY CROSS-SECTIONS (27.8)

Cross-sections are an organized field data collection technique used for obtaining 3D data along linear features such as roadways, ditches, and embankments.

Cross-sections provide information for:

- surface model creation or verification
- cross-slope inspection
- sign placement
- comparison to proposed typical sections
- specific point elevations
- side street returns
- contour generation
- earthwork calculation
- bathymetry
- drainage structures

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

3.4. PLANIMETRIC – 2D (27.7)

Planimetric surveys are used when no vertical data is required for design. This is sufficient when existing slope/drainage data is available and only minor changes are being performed to a road section, such as resurfacing. In these instances, all above ground features and improvements are located horizontally.

See ***Appendix C*** for horizontal accuracy requirements for GNSS derived data.

3.5. SIDE STREET SURVEYS (27.9)

Side street surveys are necessary when design will continue beyond the project specific corridor width. In these instances, data is collected per the requirements in either ***Section 3.2*** or ***Section 3.4***, depending on the application.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

3.6. UNDERGROUND/SUBSURFACE UTILITIES (27.10)

Subsurface utility locations are needed on most projects, in support of design criteria decisions that reduce construction delays and financial risks as well as enhance jobsite safety. For subsurface utilities, the research information, locating tools, and methods used dictate the accuracy of the utility data. Subsurface utilities within the project limits should be identified, and/or located, and properly depicted with their proper “quality levels” so that the engineer can make informed decisions through all phases of a project by having confident knowledge of the utility data accuracy. Only subsurface utilities are referenced to quality levels. The project engineer should depict in the scope what and where differentiating quality level data is needed for the project. Additional underground/subsurface utilities may be in advance of geotechnical operations.

See ***Section 5.3*** for geotechnical support.

3.6.1. SUBSURFACE UTILITY QUALITY LEVELS

Chapter 556, F.S. incorporate locates as described in the 1999 Utility Accommodation Manual (UAM), Section 11.3 Locates. These are no longer described in the UAM.

The following identifies the level of utility locates in ascending order:

Level “D” - Existing Records

Level “C” - Surface Visible Feature Survey (Above Ground Evidence)

Level “B” - Designating

Level “A” – Locating

QL D Information obtained solely from a review of utility records. The comprehensiveness and accuracy of such information is highly limited. Even when existing information for a utility in a particular area is accurate, there are underground systems that are not shown on any records. Level D may be appropriately used in the early development of a project to determine the presence of utilities.

QL C Information obtained to augment level D information. This involves topographic surveying of visible, above ground utility features (e.g., poles, hydrants, valve boxes, circuit breakers, etc.) and entering the topographic data into the CADD system. Level C may be appropriately used early in the development of a project and will provide better data than level D information alone. Designers must be very cautious when working on projects using information for underground utilities that is based only on level C and D locates.

QL B Information obtained using designating technologies (e.g., geophysical prospecting technologies). This is a field activity using remote sensing geophysical scanning technologies, most of which have very specific capabilities and offer various strengths and weaknesses. Applying a variety of techniques is essential to the process of preparing a comprehensive horizontal map of utilities and other underground structures on the site as these tools may react differently to the type of utility conductor, soil conditions, and adjacent utilities or surrounding environments that impact accuracy and disrupt electromagnetic radio frequencies. Designating technologies can provide marginal to good horizontal information but provide limited vertical information and therefore vertical accuracy is not suitable to address potential conflicts in vertical design.

QL A Provides the highest level of accuracy of utility locations in three dimensions. This level may apply to manual, mechanical, or nondestructive (e.g., vacuum excavation) methods to physically expose utilities for measurement and data recording. Levels B, C, and D are incorporated into level A locates. The designer should obtain level A locates at highway and utility conflict points where verified information is needed to make confident design decisions.

3.7. DESIGN SURVEYS

3.7.1. OUTFALL SURVEYS (27.11)

Outfall surveys are conducted to measure the size, shape, flow, capacity and locate the destination of an above ground storm drainage system. This may be required for an existing ditch.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

3.7.2. DRAINAGE SURVEYS (27.12)

Drainage surveys are conducted to determine the description of, location, flow, and capacity of storm water structures, within project specific limits. This will require the 3D location of the flowline(s) of the structure, as well as the size, material, and condition. It is most important to show the nominal pipe size, do not give the skew width or the bell diameter.

To understand the drainage information required on a project, discussion with the DSMO and the District Drainage Engineer may be required.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

3.7.3. BRIDGE SURVEYS (27.13)

Bridge surveys are conducted to gather data pertaining to bridge structures within project specific limits. This will require the location of above ground features and improvements for the project limits. Requirements for bridge surveys are project specific.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

It may also be necessary to perform water boundary surveys in conjunction with bridge surveys to satisfy project requirements. See ***Section 4.2.1*** for information on water boundary surveys.

3.7.4. CHANNEL SURVEYS (27.14)

Channel surveys are conducted to determine the description, location, and capacity of water features, manmade or natural, to/from or through specific projects limits. This will require the location of features and improvements both above ground and/or below the water's surface for the project limits.

Requirements for channel surveys are project specific.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

It may also be necessary to perform water boundary surveys in conjunction with channel surveys to satisfy project requirements. See ***Section 4.2.1*** for information on water boundary surveys.

3.7.5. POND SITE SURVEYS (27.15)

Pond site surveys are used to determine the capacity & capability of a specific storm water retention area. This will require the location of features and improvements, both above ground and/or below the water's surface for the project limits.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

4. BOUNDARY SURVEYS (27.22)

Boundary surveys for the acquisition or disposal of a parcel of land may be required. Specifications for this work will be defined by the ***Standards of Practice*** adopted by the Florida State Board of Professional Surveyors and Mappers.

See ***Appendix C*** for horizontal accuracy requirements for GNSS derived data.

4.1. SECTIONAL/GRANT SURVEYS (27.19)

Sectional/Grant surveys include field location/placement of monumentation for section corners, quarter-section corners, and fractional corners where pertinent, and includes analysis and processing of all field collected data and/or reports.

See ***Appendix C*** for horizontal accuracy requirements for GNSS derived data.

4.2. SUBDIVISION LOCATION SURVEYS (27.20)

Subdivision location surveys include field location/placement of monumentation along existing recorded subdivision/condominium boundaries, tracts, units, phases, blocks, street right of way lines, common areas, etc., and includes analysis and processing of all field data and/or reports. If an unrecorded subdivision is on file in the public records of the subject county, any existing monumentation of its parent tract should be located.

See ***Appendix C*** for horizontal accuracy requirements for GNSS derived data.

4.2.1. WATER BOUNDARY SURVEYS (27.23)

4.2.1.1. MEAN HIGH WATER LINE SURVEYS

The MHWL establishes the ambulatory boundary between state sovereignty lands and those of private ownership in areas of tidal influence.

All MHWL surveys must be performed in accordance with ***Chapter 177 Part II, F.S.***; FDOT; and the FDEP, BSM standards. Contact FDEP, BSM for MHWL elevations and information.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

4.2.1.2. ORDINARY HIGH-WATER LINE SURVEYS

The OHWL is the point up to which the presence and action of the water is so continuous as to destroy the value of the land for agricultural purposes by preventing the growth of vegetation constituting what may be termed an ordinary agricultural crop. This establishes the boundary between state sovereignty lands and private ownership in areas of navigable waters.

Contact FDEP, BSM for OHWL elevations and information.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

4.2.1.3. SAFE UPLAND ELEVATION LINE SURVEYS

While obtaining an easement over sovereign submerged lands a SUEL survey may be performed rather than a MHWL or OHWL survey, at the direction of FDEP BSM. A SUEL is a line that is landward of the sovereign boundary and is used in the easement legal description to ensure all the interest of the sovereign is obtained.

SUEL are not to be considered a sovereignty submerged land boundary and will not be recognized by FDEP for use in controlling future development or for any other use or purpose unless specifically stated by FDEP. Contact FDEP, BSM for SUEL elevations and information.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

5. SPECIFIC PURPOSE SURVEYS

5.1. MITIGATION SURVEYS (27.16)

Mitigation surveys are conducted to locate areas where any given type of environmental impact must be averted or minimized for its protection or the protection of the public. Design professionals frequently rely on these for planning and site design.

See ***Appendix C*** for horizontal accuracy requirements for GNSS derived data.

5.2. JURISDICTION LINE SURVEYS (27.17)

Jurisdiction line surveys are conducted to locate limits of wetlands, usually to satisfy the requirements of governmental authorities. Perform 2D field location of jurisdictional limits as defined by respective authorities. This includes field edits, analysis and processing of all field collected data and/or reports.

See ***Appendix C*** for horizontal accuracy requirements for GNSS derived data.

5.3. GEOTECHNICAL SUPPORT (27.18)

Perform 3D field location, or stakeout, of boring sites established by a geotechnical engineer. This includes field edits, analysis, and processing of all field collected data and/or reports.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

6. RIGHT OF WAY

6.1. MAINTAINED RIGHT OF WAY (27.21)

Perform 2D field location of maintained right of way limits as defined by the maintaining authority. This includes field edits, analysis and processing of all field collected data and/or reports.

See ***Section 27.3*** for information on maintained right of way surveys.

See ***Appendix C*** for horizontal accuracy requirements for GNSS derived data.

6.2. RIGHT OF WAY STAKING, PARCEL/RIGHT OF WAY LINE (27.24)

Perform field staking and calculations of existing and/or proposed right of way lines for on-site review purposes.

See ***Appendix C*** for horizontal accuracy requirements for GNSS derived data.

6.3. RIGHT OF WAY MONUMENTATION (27.25)

Set right of way monumentation as depicted on final right of way maps for corridor, water retention areas, and perpetual easements.

See ***Appendix C*** for horizontal accuracy requirements for GNSS derived data.

7. MISCELLANEOUS SURVEYS (27.28)

On occasion, it may be necessary to perform surveys other than those previously covered herein. Specifications for this work will be defined by the ***Standards of Practice*** adopted by the Florida State Board of Professional Surveyors and Mappers.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

8. SUPPLEMENTAL SURVEYS (27.29)

Incidental surveys that cannot be readily anticipated when scoping the project.

See ***Appendix C*** for horizontal and vertical accuracy requirements for GNSS derived data.

9. SURVEY REPORT

The purpose of a survey report is to adequately communicate the survey methods and results as judged by the surveyor and mapper. To accomplish this, information may be needed such as: data sources, measurement methods, history and lineage of data, limitations pertaining to the information presented, and a list of all included deliverables.

Reports should give a clear description of the methodology used as it relates to both field and office procedures. There should be no doubt in the reader's mind as to the intent of the survey and how it was accomplished.

All survey reports should contain standard content that satisfies the requirements of the ***Standards of Practice*** adopted by the Florida State Board of Professional Surveyors and Mappers and those of the Department. Nothing precludes the Department from requiring more stringent standards than those set forth in the ***Standards of Practice***. See ***Appendix E*** for the survey report format.

Report items are information, as required by other parts of this rule, such as: abbreviations, legends, accuracy statements, feature lists, datums used, and things done or not done as part of the surveying and mapping process. Text report items shall be displayed either through notes on the map, report, or in a text report delivered with the map.

When the report is produced as a text document and a map is attached, the report shall be signed and sealed. When the map is delivered in digital form only, then a report is required. For digital map deliveries all notes formerly shown on paper maps should be included in the report. Each surveying entity submitting electronic data to the Department must prepare a survey report.

When a survey project involves multiple surveyors or firms, a lead surveyor will be identified. A comprehensive survey report will be prepared by the lead surveyor and should detail the total survey, describing the roles and responsibilities of each surveying entity and will reference and include as attachments, all survey reports prepared by the other surveyors involved in the project.

10. OFFICE PROCEDURES

10.1. DOCUMENT RESEARCH (27.30)

Perform research of documentation to support field and office efforts involving surveying and mapping.

10.2. TECHNICAL MEETINGS (27.32)

Attend meetings as required and negotiated by the DSMO.

10.3. QUALITY ASSURANCE/QUALITY CONTROL (27.33)

A QA/QC plan is required from the consultant for each project prior to the commencement of work. This details the proposed methods of providing quality control for all work products. This plan will be kept current with the work requirements.

The main objective of QA/QC is to provide a mechanism by which all products for the DSMO can be subject to a systematic and consistent review. The QA/QC review minimizes errors and creates a quality survey.

A secondary objective is to provide a well-documented trail of the survey process. A properly documented project file should be a by-product of the QA/QC plan. The Department should be able to substantiate its position from properly documented project files if any legal, social or procedural issues arise regarding the project.

10.3.1. QUALITY CONTROL REVIEWS

Every product will undergo a QA/QC review by the consultant as part of the QA/QC plan. The reviewer should be experienced in QA/QC review. Procedures for these quality control reviews are discussed in the sections below.

10.3.1.1. CHECKING SURVEY REPORTS

Once the report writing has progressed to an appropriate stage of development, a draft is sent to the reviewer. Review comments and corrections are marked on the review draft in red. Upon completion of the review, the reviewer signs and dates the cover page of the draft and returns the draft to its originator. The originator then confirms or revises the corrections and comments, adds their own corrections and comments, and makes the corrections to the text. The marked-up draft is placed in the project file after the document is finalized. This marked-up draft is submitted to the Department as part of the final project deliverables.

10.3.1.2. CHECKING DRAWINGS

Drawings are developed progressively by an interactive process using sources of information such as survey data, reports, record data, preliminary sketches, samples, official maps, etc., in conformance with the requirements, survey criteria, and standards and guidelines required by the Department. Before a drawing is considered final, it will be independently checked for:

- Conformance with the mapping criteria and project requirements, including CADD standards.
- Completeness and clarity
- Coordination with other aspects of the project
- Compatibility standards and good mapping practice
- Closure of geometric figures or chains for 3D modeling
- Elimination of erroneous triangles, created in digital surface generation, that do not represent actual survey data.
- Elimination of spikes, holes, or voids created in digital surface generation that do not represent actual survey data.

10.3.1.3. CHECKING SURVEY DATABASES

The project surveyor and survey technician will develop a checklist pertaining to the survey database. The checklist will be updated using comments from Department reviewers throughout the life of the project.

10.3.1.4. CHECKING CORRESPONDENCE

All correspondence will include the financial project number as well as a local name when referring to a project. Any correspondence that is prepared for external customers should be reviewed by another employee for spelling and grammar mistakes.

10.3.2. PROPOSED METHODS OF DOCUMENTATION

10.3.2.1. DOCUMENTATION OF COMMENTS AND RESPONSES

All comments made by external reviewers will be recorded either by copy of memos, e-mail, letters or marked drawings. If comments are received through meetings, there will be minutes prepared that summarize the comments received. All comments will be responded to in writing in a format that identifies the document review date, reviewer's comments, and responses to the comments. All comment/response drafts will be added to the project file.

10.3.2.2. QA/QC RECORDS

The project surveyor will be responsible for maintaining the QA/QC records. At any point in the surveying process, the project surveyor will make records available to the DSMO for a QA/QC review. All submittals may be subject to QA/QC audits by the Department.

When any review by the Department is performed, consultants must not rely on the Department as a part of their QA/QC plan either formally or informally. Survey consultants are expected to follow their own QA/QC plan.

Strong emphasis will be placed on coordination with all the sub-consultants throughout the project. Particular attention will be placed on critical path activities and on the sub-consultant's needs for information required for participating in these and other activities in a timely manner. Regular meetings will take place to facilitate this coordination. All sub-consultants will be required to conform to the QA/QC plan and provide their supplement to the plan if they are performing a specialized service that is not adequately addressed in the plan. Problem areas will be discussed with the sub-consultant and agreed upon remedial actions will be taken by the sub-consultant.

10.4. SUPERVISION (27.34)

Perform all activities required to supervise and coordinate project. These activities must be performed by the project supervisor, PSM, or their delegate as approved by the DSMO.

Any delays that could potentially cause an increase in project duration or cost should be reported immediately by the project supervisor to the appropriate DSMO personnel.

10.5. COORDINATION (27.35)

Coordinate survey activities with other disciplines. These activities must be performed by the project supervisor, PSM, or their delegate as approved by the DSMO.

11. FIELD PROCEDURES

11.1. FIELD REVIEW (27.31)

Perform verification of the field conditions as related to the collected survey data.

11.2. LINE CUTTING (27.26)

Perform all efforts required to clear vegetation from the line of sight. Be cautious of protected vegetation and environmental areas; including wildlife conservation areas, mangroves, wetland mitigation areas, and trees planted for profit on private property.

See the ***Survey Safety Handbook*** for line cutting safety procedures.

11.3. WORK ZONE SAFETY (27.27)

Work zone safety is the first consideration. Project location and scope dictate the measures needed to maintain a safe workplace. Work should not begin at the site until proper traffic control devices, e.g., signs and cones, have been placed and other safety precautions taken. Please refer to the ***Manual on Uniform Traffic Control Devices (MUTCD), Part VI*** for information on traffic control devices.

Appropriate MOT certification should be maintained. See ***Temporary Traffic Control Training, Topic No. 625-010-010***.

Every employee should watch for hazards along the highway, and if one is noted, should act to eliminate it promptly. If it cannot be eliminated, appropriate traffic control devices should be placed to protect the public.

The ***Survey Safety Handbook*** outlines the Department's survey safety program, and is available through the ***FDOT SMO website***. Specific attention should be paid to the placement of control to ensure that consultants, DOT employees, and the public are protected to the greatest extent possible. The historic placement of control on or near the pavement in high traffic areas is discouraged.

AERIAL PHOTOGRAMMETRY

12. OVERVIEW

Photogrammetry is one of many valuable remote sensing methods available to today's surveying and mapping professionals and has a long history of use on transportation projects. This section sets forth basic guidelines for performing manned aerial photogrammetric surveys for the Department.

The requirements herein are at the discretion of the Department and may be waived under certain circumstances such as but not limited to: post disaster mapping, research and development, and equipment testing / calibration. Any deviation from these requirements must be addressed in the scope of services.

This document is organized into sections related to the typical tasks and deliverables associated with a transportation project employing Aerial Photogrammetric technologies.

"Photogrammetry is the art, science, and technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring, and interpreting images and patterns of electromagnetic radiant energy and other phenomenon." (ASPRS Guidelines for Procurement of Geospatial Mapping Products and Services, 2014)

With the advent of digital cameras and digital photography/softcopy image processing we have moved away from film-based products and the traditional photo scale requirements. Since we can easily view and work with digital imagery in differing scales, the film and paper-based criteria have little meaning. The productivity and accuracy improvements of current digital sensor systems over film-based systems especially in the support of 3D design methods are also moving the survey industry away from traditional imagery collection.

Much of the following accuracy standards are based on the ASPRS Positional Accuracy Standards for Digital Geospatial Data, *"This standard defines accuracy classes based on RMSE thresholds for digital orthoimagery, digital planimetric data, and digital elevation data."* (American Society for Photogrammetry and Remote Sensing, 2014). See tables below.

12.1. ASPRS HORIZONTAL ACCURACY STANDARDS FOR GEOSPATIAL DATA

Horizontal Accuracy Class	Absolute Accuracy			Orthoimagery Mosaic Seamline Mismatch (cm)
	RMSEx and RMSEy (cm)	RMSEr (cm)	Horizontal Accuracy at 95% Confidence Level (cm)	
X-cm	≤ *X*	≤ 1.414**X*	≤ 2.448**X*	≤ 2**X*

12.2. ASPRS VERTICAL ACCURACY STANDARDS FOR DIGITAL ELEVATION DATA

Vertical Accuracy Class	Absolute Accuracy			Relative Accuracy (where applicable)		
	RMSEz Non-Vegetated (cm)	NVA[1] at 95% Confidence Level (cm)	VVA[2] at 95th Percentile (cm)	Within-Swath Hard Surface Repeatability (Max Diff) (cm)	Swath-to-Swath Non-Vegetated Terrain (RMSDz) (cm)	Swath-to-Swath Non-Vegetated Terrain (Max Diff) (cm)
X-cm	≤ *X*	≤ 1.96**X*	≤ 3.00**X*	≤ 0.60**X*	≤ 0.80**X*	≤ 1.60**X*

The focus in the following pages will be on three key elements; image resolution or GSD, measurement RMSE, and finally the resulting estimate of positional error of the final photogrammetry product based on the National Standard for Spatial Data Accuracy (Federal Geographic Data Committee, 1998).

12.3. FDOT PROJECT HORIZONTAL ACCURACY STANDARDS FOR PHOTOGRAMMETRY

(Orthoimagery and Planimetric)

Horizontal Accuracy Class	Project Horizontal Accuracy			Orthoimagery Mosaic Seamline Mismatch (ft)
	RMSEx and RMSEy (ft)	RMSEr (ft)	Horizontal Accuracy at 95% Confidence Level (ft)	
X-feet	≤ *X*	≤ 1.414**X*	≤ 2.448**X*	≤ 2**X*

12.4. FDOT PROJECT VERTICAL ACCURACY STANDARDS FOR PHOTOGRAMMETRY

Vertical Accuracy Class	Project Vertical Accuracy	
	RMSEz Non-Vegetated (ft)	Vertical Accuracy at 95% Confidence Level (ft)
Z-feet	≤ ***Z***	≤ 1.96**Z*

13. GENERAL REQUIREMENTS

Unless otherwise stated, this section identifies the general requirements common to all aerial photogrammetric products and services performed for the Department.

All photogrammetric products submitted shall be supported by a survey report containing at a minimum all information necessary to support the precision and accuracy of measurements and products, and meets the ***Standards of Practice*** adopted by the Florida State Board of Professional Surveyors and Mappers. To this end the survey report shall include but is not limited to the documentation and references to digital reports, products and media, identified in this document.

13.1. DIGITAL CAMERA SYSTEM SPECIFICATIONS

- A digital metric camera system with forward motion compensation and a gyro-stabilized camera mount, capable of producing raw source imagery resolutions with horizontal and vertical accuracies necessary to meet project scope.
- Geometric distortions induced by the camera's optical system shall be corrected during post processing using valid calibration data obtained from the camera manufacturer or a facility authorized by the camera manufacturer to provide such data.

13.2. DIGITAL EXPOSURE DOCUMENTATION

- Flight lines shall be numbered from south to north and west to east with the highest numbers ending on the north and east.

- All digital photographic image files shall be saved to final media using the following file naming convention: AAAABB_CCCC (A=MSTS number, B=Flight Line number, C=Exposure number). Example: 492201_0010.tif Digital data shall be provided to the Department in a format which is immediately readable by the Surveying and Mapping Office and the Department.

- Metadata – All final image files provided to the Department shall have a corresponding named metadata file in Extensible Markup Language (xml) format that meets the NAP ISO 19115 2003.

- Example: 492201_0010.xml

13.3. AIRBORNE GNSS PROCESSING (28.5)

Airborne GNSS a.k.a. INS based camera orientation is vital to today's softcopy photogrammetry where typically less ground control is used. Solving for the trajectory of the sensor using post processing technique provides position and orientation of the camera at the time of each exposure.

The required INS accuracies vary depending on the photogrammetric product and are detailed in the appropriate sections. The INS shall be performed such that the resulting

accuracy of the mapping meets ASPRS standards from ***Section 7.7 of the "Accuracy Requirements for Aerial Triangulation and INS-based Sensor Orientation of Digital Imagery"*** (American Society for Photogrammetry and Remote Sensing, 2014).

13.4. POST MISSION REPORTING

Post mission reporting shall, at a minimum, consist of:

- A graphical representation of the vehicle trajectory. Sufficient documentation to verify positional accuracy of camera at exposure events.
- A text file with final post processed exposure events with camera position, orientation (Omega, Phi, Kappa) and associated accuracies sufficient for inclusion into an AT adjustment.

13.5. AERIAL TRIANGULATION/AEROTRIANGULATION (28.9)

The required AT accuracies vary depending on the photogrammetric product and are detailed in the appropriate sections. The AT shall be performed so that the resulting accuracy of the mapping meets ASPRS standards from ***Section 7.7 of the "Accuracy Requirements for Aerial Triangulation and INS-based Sensor Orientation of Digital Imagery"*** (American Society for Photogrammetry and Remote Sensing, 2014).

> *"Accuracy of aerial triangulation designed for digital planimetric data (orthoimagery and/or digital planimetric map) only:*
>
> *RMSEx (AT) or RMSEy (AT) = ½ * RMSEx (Map) or RMSEy (Map)*
>
> *RMSEz (AT) = RMSEx (Map) or RMSEy (Map) of orthoimagery*
>
> *Note: The exact contribution of aerial triangulation errors in z to the overall horizontal error budget for the products depends on ground point location in the image and other factors. The relationship stated here for an RMSEz (AT) of twice the allowable RMSE in x or y is a conservative estimate that accommodates the typical range of common camera geometries and provides allowance for many other factors that impact the horizontal error budget.*
>
> *Accuracy of aerial triangulation designed for elevation data, or planimetric data (orthoimagery and/or digital planimetric map) and elevation data production:*
>
> *RMSEx (AT), RMSEy (AT) or RMSEz (AT) = ½ * RMSEx (Map), RMSEy (Map) or RMSEz (DEM)."*

Aerotriangulation adjustment reporting shall consist of a text file containing sufficient information to independently process raw imagery to verify accuracies achieved.

13.6. BEFORE WORK BEGINS

When a contract is awarded and before any work begins, the consultant will contact the CSMO to request the MSTS number. The MSTS number shall be included in all image file names to facilitate inclusion in the CSMO image library without modifications. The MSTS number should be referenced in all correspondence and project deliverables.

13.6.1. QUALITY ASSURANCE AND QUALITY CONTROL PLAN (28.23)

All survey projects must have a detailed QA/QC plan developed by the consultant and provided to the DSMO for approval before work begins. See ***Section 10.3*** for additional details and requirements.

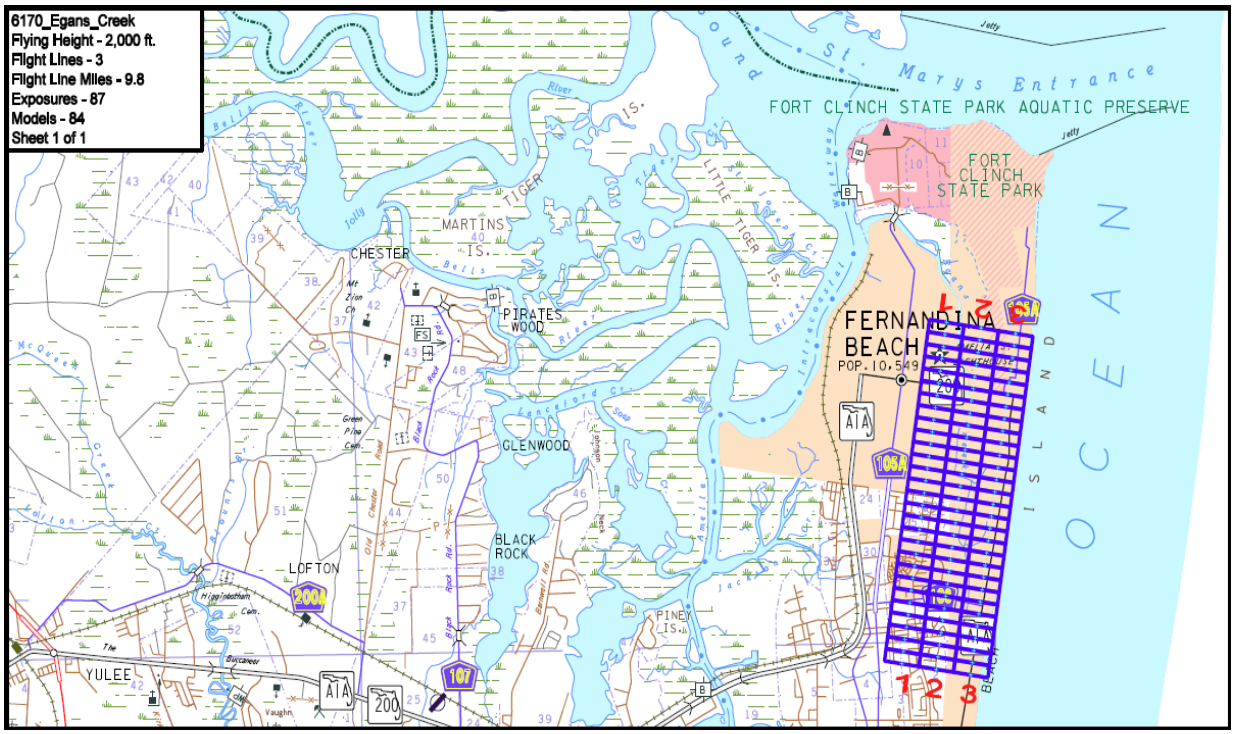
13.7. PLANNING (28.1)

Planning is critical to the success of any survey project. The planning activities should begin with reviewing the project scope and location to develop the detailed aerial survey approach. The approach activities will vary based on project requirements; however, there are important elements common to all aerial survey approaches that are worth noting here.

13.7.1. AERIAL PHOTOGRAPHY MISSION PLAN (28.1)

A graphic aerial mission plan (see below) based on the location and scope of the project should be developed. The mission plan should show proper stereo image model coverage of the project area, as well as other pertinent information supporting the flight mission with the understanding that properly executed, the flight will provide results necessary to achieve the desired survey products.

13.7.1.1. AERIAL PHOTOGRAPHY MISSION PLAN EXAMPLE



13.8. GROUND CONTROL RECONNAISSANCE (28.2)

Suitable locations for the ground control and control point locations should be chosen by the photogrammetrist and identified on a control reconnaissance map for later use by survey crews in the field. The allowable tolerance for moving the control point locations without loss of model adjustment accuracy should be provided.

Targeting of control points should be performed for most high accuracy mapping projects especially those requiring surface model compilation. Photo identifiable (Photo ID) points may be used on small scale mapping projects, or when targeting is not possible.

14. GROUND CONTROL SURVEY (28.2)

Project ground control should be used to establish horizontal and vertical positions on targeted and/or well-defined photo identifiable points. These values will be used as control or check points for aerial photogrammetric mapping.

The activity of establishing ground control falls under Work Type 8.2 and Tab 27, while the coordination of the size, type, and placement of the ground control by the photogrammetrist is covered in Work Type 8.3 Tab 28. The following requirements apply specifically to ground control for aerial mapping purposes. The appropriate surveying & mapping methods referenced in ***Appendix C*** shall be performed such that the resulting accuracy of the ground control meets ***Section 7.8 of the "Accuracy Requirements for***

Ground Control Used for Aerotriangulation" (American Society for Photogrammetry and Remote Sensing, 2014)***.***

> *"Ground control points used for aerial triangulation should have higher accuracy than the expected accuracy of derived products according to the following two categories:*
>
> *Accuracy of ground control designed for planimetric data (orthoimagery and/or digital planimetric map) production* ***only****: RMSEx or RMSEy = 1/4 * RMSEx (Map) or RMSEy (Map), RMSEz = 1/2 * RMSEx (Map) or RMSEy (Map)*
>
> *Accuracy of ground control designed for elevation data, or planimetric data* ***and*** *elevation data production: RMSEx, RMSEy or RMSEz= 1/4 * RMSEx (Map), RMSEy (Map) or RMSEz (DEM)"*

New photo control point positions shall be identified in the field by a survey mark. When aerial panels are used, the vertical offset from top of mark to the panel surface shall be measured and recorded. In rare circumstances where the photo identifiable control point cannot be occupied directly, a horizontal offset from the occupied survey mark may be computed for orthoimagery or planimetric mapping only. Field survey measurements of sufficient precision must be collected and recorded to allow accurate coordinate computation of the photo identifiable point from the offset mark. The higher accuracy orthoimagery required for many transportation projects may preclude the use of offset control points and post identified control.

14.1. CONTROL SURVEY DELIVERABLES

The Professional Surveyor and Mapper in responsible charge of the control survey will prepare a digitally signed and sealed survey report identifying the level of accuracy (see ***Appendix C***) met by the control survey. In addition to these requirements the survey report shall also include the following:

- Project title, Financial Management Number, and MSTS number
- Name and address of corporation
- Certificate of authorization number
- Abbreviations
- Purpose of survey
- Description of equipment
- Accuracy standards per the Scope of Work

- Accuracies obtained (Accuracy reporting will be according to ***Appendix C*** of this handbook)
- Procedure and methodology for establishing control
- List of control points (existing and newly established), including the description, horizontal and vertical coordinates, datum and error estimates at the 95% confidence level. Datasheets for existing geodetic control should be included.
- Statement cross referencing digital media as part of the report by referencing media drive label items. See ***Section 14.3***.
- Index of files on digital media listed by filename, file location (path), and brief description.
- List of field and office personnel who worked on project and their responsibilities.
- First and last date of field survey
- Map displaying the following:
    - Project location
    - Existing horizontal and vertical geodetic control
    - New control established for photogrammetric mapping

14.2. DIGITAL MEDIA (CONTROL SURVEY)

The ground control data shall be submitted to the Department on digital media format agreed upon in project scope. All digital products submitted, along with any digital and hardcopy media shall become the property of the FDOT. The digital media shall be labeled in such a way as not to impede its use, and shall display the following information:

- Statement cross referencing digital media as part of the survey report by including survey report title, Financial Management Number, MSTS number, and date of survey information from the survey report.
- Digital media make, model, and serial number
- Consultant name and contact information.

The digital media shall contain at a minimum:

- Digitally signed and sealed copy of the control survey report
- Existing geodetic control recovery/to-reach descriptions, sketches, field notes, photographs, etc.
- Sketches of photo control point sites identifying measured point location and type of mark including target size and material if applicable.
- Digital pictures of post-mapping photo identifiable control established.
- A Microsoft EXCEL spreadsheet file list of final control with datum header information along with point name, geographic (latitude, longitude), grid (state plane zone northing and easting), and elevation values for control points. Grid coordinates and elevations shall be in units of US survey feet. Any horizontal and vertical mark offsets measured shall be identified and applied to the aerial panel or photo identifiable feature surface. Offset measurements shall be included to verify computations. See ***Section 14.1***.

15. ORTHOIMAGERY (28.11)

Modern digital orthoimagery is often described in terms of resolution using the GSD of the final orthophoto product. GSD is the ground distance represented by a single pixel on the final orthophoto product and the original source imagery that was used to create it. The raw camera GSD or “source imagery” GSD is governed by the camera focal length, the flying height, and the size of a pixel in the camera.

$$\frac{f}{H} = \frac{Ps}{GSD}$$

f = Focal Length

H = Height above ground,

Ps = Camera Pixel Size

GSD = Ground Sample Distance (source imagery)

The acceptable range of the final orthophoto product GSDthat should be derived from a specific source imagery GSD, a.k.a. Original Image Resolution, can be seen in the USGS table on the right (Rufe, 2014). It is generally accepted that the source imagery may be re-sampled to produce an orthoimagery product with a larger GSD thus resulting in a product with less resolution than the source imagery. However, the reverse is not prudent, i.e. an orthoimagery product should not be re-sampled to have a smaller GSD (higher resolution) than the original source imagery. There can be some exceptions to this due to site conditions. Occasionally the altitude necessary for a camera to achieve the desired source GSD is compromised either by terrain or airspace restrictions. The USGS table allows for this by up to 10 percent. This 10 percent over sampling may be allowed on certain FDOT orthoimagery products with written approval from the FDOT project manager if it does not violate the accuracy requirements. Now that we have discussed the imagery resolution, let us go back and look at our accuracy definitions again. Unlike measurement RMSE and positional accuracy which can be directly related, orthophoto resolution is often desired for sharpness of imagery rather than for a specific accuracy. For this reason, orthoimagery resolution and accuracy often need to be defined separately. For example, the positional accuracy for the orthoimagery might be 3 feet while the GSD resolution desired is 1.0 feet. This is not to say the image resolution does not affect accuracy. It is accepted that the image resolution GSD may be smaller than or equal to the desired RMSE, however it cannot be larger. Thus, when the accuracy requirements are dictating the resolution to be acquired, oversampling is not permitted.

> *“Given current sensor and processing technologies for large and medium format metric cameras, an orthoimagery accuracy of 1-pixel RMSEx and RMSEy is considered achievable, assuming proper project design and best practices implementation.”* (American Society for Photogrammetry and Remote Sensing, 2014)

Section 15.1 shows the horizontal accuracies of orthoimagery in terms of final image pixels. The highest accuracy orthoimagery has a one to one or smaller ratio of orthophoto GSD to RMSE.

15.1. HORIZONTAL ACCURACY CLASSES FOR VARYING DIGITAL ORTHOIMAGERY RESOLUTIONS

Orthoimage RMSEx and RMSEy in terms of Pixels	Maximum Orthoimage Mosaic Seamline Mismatch (2 x Pixel*)	Allowable Aerotriangulation (AT) or INS-based (Pixels)		Allowable Ground Control RMSE (pixels)		NSSDA Horizontal Accuracy at the 95% Confidence Level (Pixels) (2.4477 x Pixel*)
		RMSEx and RMSEy (0.5 x Pixel*)	RMSEz (1 x Pixel*)	Horizontal x and y (0.25 x Pixel*)	Vertical z (0.5 x Pixel*)	
1	2	0.5	1	0.25	0.5	2.448
2	4	1.0	2	0.50	1.0	4.895
3	6	1.5	3	0.75	1.5	7.343
4	8	2.0	4	1.00	2.0	9.791

Pixel* = Orthoimage RMSEx and RMSEy in terms of pixels

Orthoimagery produced for the Department shall meet the appropriate "Orthophoto Horizontal Accuracy Class" necessary to fulfill project requirements. See ***Section 25*** for typical horizontal accuracy and quality standards associated with Digital Orthoimagery produced for a sample of GSD pixel sizes.

In addition to meeting the accuracy requirements for INS processing in ***Section 13.3*** and the adjustment accuracy requirements in ***Section 13.5***, the final quality control verification shall be a comparison of the horizontal positions of a sample subset (minimum twenty-five) clearly photo-identifiable features with ground positions for these features independently collected to a higher horizontal accuracy. The resulting check point comparisons shall meet the check point distribution and positional accuracy requirements for the map at the 95% confidence level based on the NSSDA (Federal Geographic Data Committee, 1998) and shall be included in the survey report.

A metadata file must be delivered for each image file and each surface file used in orthoimagery production.

16. PLANIMETRIC (28.16)

The project horizontal accuracy of photography must meet or surpass the required project horizontal accuracy class of the planimetric data compiled from the imagery. The imagery GSD resolution shall be equal to or smaller than the required project horizontal accuracy AND must be of sufficient resolution to clearly define the features to be mapped.

In addition to meeting the accuracy requirements for INS processing in ***Section 13.3*** and the adjustment accuracy requirements in ***Section 13.5***, the final quality control verification shall be a comparison of the horizontal positions of a sample subset (minimum twenty-five) of features with ground positions for these features independently collected to a higher horizontal accuracy. The resulting check point comparisons shall meet the check

point distribution and horizontal positional accuracy requirements for the map at the 95% confidence level (Accuracy r = 1.7308 * RMSEr) based on the NSSDA_(Federal Geographic Data Committee, 1998), and shall be included in the survey report.

17. VERTICAL (28.10)

The vertical accuracies of data compiled from aerial imagery shall meet the Department project scope requirements. When the vertical accuracy is of primary importance, the horizontal accuracy will equate to that which results from using the same AT/INS solution.

> *"For elevation data derived using stereo photogrammetry, the horizontal accuracy equates to the horizontal accuracy class that would apply to planimetric data or digital orthoimagery produced from the same source imagery, using the same aerial triangulation/INS solution."* (American Society for Photogrammetry and Remote Sensing, 2014)

In addition to meeting the accuracy requirements for INS processing in ***Section 13.3*** and the adjustment accuracy requirements in ***Section 13.5***, the final quality control verification shall be a comparison of the vertical positions of a sample subset (minimum twenty-five) of features with ground positions for these features independently collected to a higher vertical accuracy. The resulting check point comparisons shall meet the check point distribution and vertical positional accuracy requirements for the map at the 95% confidence level (Accuracy z = 1.9600 * RMSEz) based on the NSSDA (Federal Geographic Data Committee, 1998), and shall be included in the survey report.

When verifying corridor surfaces cross-section measurements may be used with or instead of check points, as long as cross sections cover the surface and are spaced appropriately.

18. TOPOGRAPHIC MAPPING (28.15)

When performing topographic mapping from aerial photography where both horizontal and vertical accuracy is important, the more stringent aerial accuracy requirements shall be followed. Requirements of topographic map products are addressed in ***Section 3*** and in the ***CADD Manual, Topic No. 625-050-001***.

19. DRAINAGE BASIN (28.17)

Usually this is specific topographic mapping of additional storm water retention areas outside of the main mapping corridor. Often the surface model accuracies are less stringent than those required within the corridor. As with other topographic surveys the mapping methods used must meet the accuracy requirements for the model.

20. CADD EDIT (28.18)

Cartographic edits are performed after the field reviews. The aerial mapper receives information from the field review and updates the map database. The optimal method is for the surveyor to update the map directly during the field review.

21. DATA MERGING (28.19)

When merging files from photogrammetry, field survey, and data from other sources to develop a complete survey project database, it is critical for the all the project surveyors to coordinate data exchange to create deliverables. This effort can be reduced significantly if all consultants use the standard Department feature codes listed in the ***CADD Manual, Topic No. 625-050-001*** before merging data.

22. FIELD REVIEW (28.21)

This review of field conditions by the surveyor allows for identifying object attributes such a traffic sign type and wording, which cannot be discerned from the aerial imagery, or in some cases identify a feature that should have been collected but was missed by the aerial mapping operator. Traditionally this was performed by marking up map sheets to be transcribed in the office by the mapper. Today this process can be performed much more efficiently using an electronic field device which allows the field reviewer to make edits directly to the map using Department feature codes. This eliminates the need to transcribe information reducing time and errors.

METADATA (28.23)

Geospatial metadata provides descriptive information in a standard format about geospatial datasets. Metadata describes the content, quality, fitness for use, access instructions, and other characteristics about the geospatial data. Geospatial metadata increases the longevity of geospatial data by maximizing its use.

ISO Compliant metadata

Metadata must be compliant with the International Organization for Standardization

requirements: ISO 19115-2, Schema ISO-19139

Guides to metadata creation:

https://www.fgdc.gov/metadata/iso-standards

https://www.usgs.gov/data-management/metadata-creation

23. AERIAL SURVEY DELIVERABLES

The PSM in responsible charge will prepare a digitally signed and sealed survey report that shall, at a minimum, include the following items:

- Project title, Financial Management Number, and MSTS number
- Name and address of corporation
- Certificate of authorization number
- Abbreviations
- Data sources
- Purpose of survey
- Project description
- Description of equipment, software, specifications, calibration, etc.
- Statement cross referencing digital media as part of the report by referencing media drive label items. See ***Section 23.1*** for information on digital media.
- Index of files on digital media listed by filename, file location (path), and brief description. The imagery and metadata files need only be referenced by directory, and not individually.
- Reference citing ground control survey accuracies. If ground control survey performed by others a reference to the control survey report as well as a digitally signed and sealed copy of the report should be included.
- Description of the planning, collection, processing, adjustment, and quality control methodology used to produce aerial surveying and mapping product(s).
- Horizontal and/or vertical NSSDA accuracy reporting.
- List of field and office personnel who worked on project and their responsibilities.
- Field date of aerial survey (first and last date of imagery acquisition).
- Map displaying the project location

23.1. DIGITAL MEDIA

The project data shall be submitted to the Department on digital media format agreed upon in project scope. All digital products submitted, along with any digital and hardcopy media shall become the property of the FDOT.

The digital media shall be labeled in such a way as not to impede its use, and shall display the following information:

- Statement cross referencing digital media as part of the survey report by including survey report title, Financial Management Number, MSTS number, and date of survey information from the survey report.
- Digital media make, model, and serial number
- Consultant name and contact information.

The digital media shall contain at a minimum:

- Final photogrammetric product(s); survey scope items, i.e., orthoimagery, planimetric map, topographic map, surface, etc.
- Copy of the Scope of Work
- Digitally signed copy of the control survey report
- All raw imagery
- Sketches and digital pictures of base station sites identifying measured point location and identification of mark.
- Copies of field notes or GNSS data logs/static occupations.
- All airborne system (GNSS/INS) data observed including the raw observation data and processed sensor trajectory information including reports.

24. REFERENCES

American Society for Photogrammetry and Remote Sensing. (2014, November). ASPRS Positional Accuracy Standards for Digital Geospatial Data. *Photogrammetric Engineering & Remote Sensing*, Vol. 81, No. 3, pp. A1–A26. Retrieved from http://www.asprs.org: http://www.asprs.org/PAD-Division/ASPRS-POSITIONAL-ACCURACY-STANDARDS-FOR-DIGITAL-GEOSPATIAL-DATA.html

(2014). *ASPRS Guidelines for Procurement of Geospatial Mapping Products and Services.* Falls Church: American Society of Photogrammetry.

Federal Geographic Data Committee. (1998). Part 3: National Standard for Spatial Data Accuracy. *Geospatial Positioning Accuracy Standards*. Retrieved from http://fgdc.er.usgs.gov/fgdc.html.

Rufe, P. P. (2014). Digital orthoimagery base specification V1.0. In U. S. Survey, *Chapter 5 of Section B, U.S. Geological Survey Standards Book 11, Collection and Delineation of Spatial Data* (p. 13). Reston, Virginia: USGS; http://dx.doi.org/10.3133/tm11B5.

Slama, C. (Ed.). (1980). *Manual of Photogrammetry* (Fourth ed.). Falls Church, Virginia, USA: American Society of Photogrammetry.

25. EXAMPLE ACCURACIES FOR ORTHOIMAGERY

Final Ortho Image Pixel Size (ft)	Horizontal Accuracy Class RMSEx and RMSEy (ft)	Ortho Image RMSEx and RMSEy in terms of pixels	Horizontal Accuracy RMSEr (ft)	Maximum Ortho Image Mosaic Seamline Mismatch (Pixels)	Maximum Ortho Image Mosaic Seamline Mismatch (ft)	Allowable AT or INS-based (ft)		Allowable Ground Control RMSE (ft)		NSSDA Horizontal Accuracy at the 95% Confidence Level (ft)
						RMS Ex and RMS Ey	RMS Ez	Horizontal x and y	Vertical z	
0.05	0.05	≤1-pixel	0.071	2	0.10	0.025	0.05	0.013	0.025	0.12
	0.10	2-pixels	0.141	4	0.20	0.050	0.10	0.025	0.050	0.24
	0.15	3-pixels	0.212	6	0.30	0.075	0.15	0.038	0.075	0.37
	0.20	4-pixels	0.283	8	0.40	0.100	0.20	0.050	0.100	0.49
0.10	0.10	≤1-pixel	0.141	2	0.20	0.050	0.10	0.025	0.050	0.24
	0.20	2-pixels	0.283	4	0.40	0.100	0.20	0.050	0.100	0.49
	0.30	3-pixels	0.424	6	0.60	0.150	0.30	0.075	0.150	0.73
	0.40	4-pixels	0.566	8	0.80	0.200	0.40	0.100	0.200	0.98
0.25	0.25	≤1-pixel	0.354	2	0.50	0.125	0.25	0.063	0.125	0.61
	0.50	2-pixels	0.707	4	1.00	0.250	0.50	0.125	0.250	1.22
	0.75	3-pixels	1.061	6	1.50	0.375	0.75	0.188	0.375	1.84
	1.00	4-pixels	1.414	8	2.00	0.500	1.00	0.250	0.500	2.45
0.35	0.35	≤1-pixel	0.495	2	0.70	0.175	0.35	0.088	0.175	0.86
	0.70	2-pixels	0.990	4	1.40	0.350	0.70	0.175	0.350	1.71
	1.05	3-pixels	1.485	6	2.10	0.525	1.05	0.263	0.525	2.57
	1.40	4-pixels	1.980	8	2.80	0.700	1.40	0.350	0.700	3.43
0.50	0.5	≤1-pixel	0.707	2	1.0	0.250	0.50	0.125	0.250	1.22
	1.0	2-pixels	1.414	4	2.0	0.500	1.00	0.250	0.500	2.45
	1.5	3-pixels	2.121	6	3.0	0.750	1.50	0.375	0.750	3.67
	2.0	4-pixels	2.828	8	4.0	1.000	2.00	0.500	1.000	4.90
1.00	1.0	≤1-pixel	1.414	2	2.0	0.5	1.00	0.250	0.500	2.45
	2.0	2-pixels	2.828	4	4.0	1.0	2.00	0.500	1.000	4.90
	3.0	3-pixels	4.243	6	6.0	1.5	3.00	0.750	1.500	7.34
	4.0	4-pixels	5.657	8	8.0	2.0	4.00	1.000	2.000	9.79
2.00	2.0	≤1-pixel	2.828	2	4.0	1.0	2.0	0.50	1.0	4.90
	4.0	2-pixels	5.657	4	8.0	2.0	4.0	1.00	2.0	9.79
	6.0	3-pixels	8.485	6	12.0	3.0	6.0	1.50	3.0	14.69
3.00	3.0	≤1-pixel	4.243	2	6.0	1.5	3.0	0.75	1.5	7.34
	6.0	2-pixels	8.485	4	12.0	3.0	6.0	1.50	3.0	14.69
	9.0	3-pixels	12.728	6	18.0	4.5	9.0	2.25	4.5	22.03
5.00	5.0	≤1-pixel	7.071	2	10.0	2.5	5.0	1.25	2.5	12.24
	10.0	2-pixels	14.142	4	20.0	5.0	10.0	2.50	5.0	24.48
	15.0	3-pixels	21.213	6	30.0	7.5	15.0	3.75	7.5	36.72

RIGHT OF WAY MAPPING

26. MASTER CADD FILE

A master CADD file will be created for all right of way related maps prepared for the Department. Files will be delivered in a format that adheres to the ***CADD Manual, Topic No. 625-050-001***.

Master CADD files may contain any number of the following elements as directed by the DSMO:

26.1. ALIGNMENT (29.1)

The line work along with all required data will be placed in this file. Required data includes bearings on tangent lines, stationing, all curve elements, and points of intersection station value with deflection angle left or right.

26.2. SECTION AND QUARTER-SECTION LINES (29.2)

The line work along with all required data will be placed in this file. Required data includes labeling of bearings/distances and ties by station/distance to the survey alignment. Closure reports, if required, will be calculated from this file.

26.3. SUBDIVISIONS (29.3)

The line work along with all required data will be placed in this file. Required data includes name, recording data, boundaries (with arrow indicators), lot/block lines, lot/block numbers, street names, alleys, and platted easements. Subdivisions will be tied to the survey alignment with station values. The DSMO will determine the method of ties, whether by 90 degree offsets or by straight-line extension. Closure reports for each block, if required, will be calculated from this file.

26.4. EXISTING RIGHT OF WAY (29.4)

The line work for existing right of way by deed, maintenance or dedication for mainline corridor and/or side streets will be determined, verified, and placed in this file. Required data includes name of the street, width (or varies) and source of creation, i.e., plat, deed, maintenance map.

26.5. TOPOGRAPHY (29.5)

The topographic elements will be referenced to this file at the desired scale. Elements will be adjusted and modified, as necessary. Required elements include, but are not limited to, buildings, canopies, signs, fences, groves, parking/pavement, above ground utilities, and bodies of water. Dimensional data required by the ***Survey and Mapping Procedures, Topic No. 550-030-101*** will be shown on the Right of Way Map Detail Sheets.

26.6. PARENT TRACT PROPERTIES AND EXISTING EASEMENTS (29.6)

A title search analysis will be performed to determine the location of parent tract boundaries and existing easements. The line work will be shown and identified by the appropriate symbology, e.g., cell/block, and be placed in this file. A parcel identification number depicted in a parcel bubble will be placed and assigned in accordance with the ***Right of Way Procedures Manual, Topic No. 575-000-000***.

26.7. PROPOSED RIGHT OF WAY REQUIREMENTS (29.7)

The Roadway Designer or EOR will provide right of way requirements to the PSM. The EOR, in coordination with the DSMO and the Right of Way Acquisition Manager, will determine the type of interest required, i.e., fee, permanent or temporary easement, or license agreement. The line work will be placed in this file. All takes and remainders will be calculated, labeled, and dimensioned with station and offsets designated at each change in direction of the right of way. Closure reports will be prepared for each take and remainder area.

26.8. LIMITS OF CONSTRUCTION (29.8)

The line work will be provided by the Roadway Designer or EOR and placed in this file. Coordination with the Roadway Designer or EOR will be required to resolve problem areas. The line work will be labeled “L.O.C.”. Care will be taken to ensure the limits of construction do not extend beyond the existing or proposed right of way as well as ensuring the proposed right of way is supported by necessity in the construction plans. Limits of construction will be shown, at minimum, on all Federal Aid Right of Way projects.

26.9. JURISDICTIONAL/AGENCY LINES (29.9)

The line work for jurisdictional wetlands, water boundaries and city/county limit lines will be placed in this file. The DSMO will determine how and when these lines or areas will be depicted on the actual right of way maps.

See ***Sections 4 and 5*** for information on water boundary and jurisdictional surveys.

27. SHEET FILES

Sheet files will be created to form the actual control survey, right of way map, or maintenance map, in the following designations:

27.1. RIGHT OF WAY CONTROL SURVEY

A right of way control survey is prepared to provide horizontal position data for the support of right of way related maps.

At the discretion of the DSMO, a digital file and a signed and sealed survey report may be submitted in lieu of a hardcopy control survey map.

27.1.1. GENERAL MAP REQUIREMENTS

The map or digital file will depict, at a minimum, the following:

- The survey alignment with reference points
- Sufficient land line ties
- Recorded subdivisions, condominiums, and cooperatives along with recording data
- A north arrow and scale of map when a hardcopy map is produced
- County and state lines unless excepted by the DSMO
- City names with city limits unless excepted by the DSMO
- State, county, or municipal roads intersecting the survey alignment
- The bearing basis
- The source of dimensions: Field (F), Plat (P), Deed (D), Calculated (C)
- Sufficient general notes on sheet 1 or in the survey report
- The Department standard title block when a hardcopy map is produced
- A legend of abbreviations and symbols
- Found monumentation

27.1.2. RIGHT OF WAY CONTROL SURVEY COVER SHEET (29.10)

The Department's approved sheet title block will be used in preparation of this cover sheet. The legend, general notes, location map and certifications will be placed on this sheet.

The following certification by the PSM will be placed on the cover sheet:

I hereby certify this right of way control survey was made for the purpose of surveying, referencing, describing and mapping the survey alignment, and providing horizontal position data for the support or control of right of way related maps for the transportation facility shown and depicted hereon. I further certify said survey was done under my responsible charge and is in compliance with the Standards of Practice as set forth by the Board of Professional Surveyors and Mappers in Chapter 5J-17, Florida Administrative Code pursuant to section 472.027, Florida Statutes.

This drawing, consisting of sheets _____ through _____, is a true, accurate and complete depiction of a field survey performed under my direction and completed on _____.

_____
Name
Florida Professional Surveyor and Mapper No. _____
Address
Date

THIS MAP AND REPORT OR COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

27.1.3. RIGHT OF WAY CONTROL SURVEY KEY SHEET (29.11)

This sheet(s) is derived from the master CADD file at an appropriate scale to show alignment(s), with reference points; section line ties; subdivisions, condominiums and cooperatives with recording data; and other elements, including monumentation identified as to size, type, set or found, as may be required. The relationship of the detail sheets may also be depicted on this sheet if required by the DSMO. The line work, text, etc. will be added/modified to fit the key sheet scale.

27.1.4. RIGHT OF WAY CONTROL SURVEY DETAIL SHEET (29.12)

This sheet(s) is derived from the master CADD file at an appropriate scale to depict the field right of way survey data. The line work, text, etc. will be added/modified to fit the detail sheet scale. The DSMO will determine if detail sheets will be prepared for the entire project or if only recorded subdivisions will be shown on the detail sheets. All subdivision block lines will be tied by station and offset to the survey alignment. The DSMO will determine the method of ties, whether by 90-degree offsets or by straight-line extension.

27.2. RIGHT OF WAY MAP

A right of way map is prepared when real property rights are to be acquired for a transportation facility. It will be designed to provide a high degree of uniformity and maximum readability.

At the discretion of the DSMO, a boundary survey or sketch of description, as defined in ***Rule Chapter 5J-17, F.A.C.***, may be used for situations such as advance acquisition, hardship acquisition, donations, etc., in lieu of preparing a right of way map.

27.2.1. GENERAL MAP REQUIREMENTS

The map will depict, at minimum, the following:

- If a control survey was not produced, all control survey elements will be a requirement of the right of way map.

  See ***Section 27.1*** for information on control surveys.

- The survey alignment with reference points
- Sufficient land line ties
- Recorded subdivisions, condominiums, and cooperatives, along with the recording data
- A north arrow and scale of the map
- County lines and state lines unless excepted by the DSMO
- City names with city limits unless excepted by the DSMO
- State, county, or municipal roads intersecting the survey alignment
- The existing right of way
- Existing easements with recording data.
- Right of way requirements with all data necessary to describe the parcel
- The bearing basis
- The source of dimensions: Field (F), Plat (P), Deed (D), Calculated (C)
- Sufficient general notes on sheet 1
- The Department standard title block
- The date of photography on projects using aerial photography
- Parent tracts with required geometry and boundaries labeled

- The parcel identification number shown in a parcel bubble for each acquisition. The parcel number assigned will be in accordance with the ***Right of Way Procedures Manual, Topic No. 575-000-000***.
- Buildings, improvements and key topographic features, e.g., groves, fences, signs, bodies of water, etc. within the proposed right of way. Buildings, canopies/overhangs, and signs, etc. severed by the acquisition will be dimensioned accordingly. Buildings and improvements located within 50 feet for urban projects, or 100 feet for rural projects, outside of the proposed right of way line will be shown graphically only, unless otherwise instructed by DSMO. Buildings within 25 feet of the proposed right of way will show a distance from the nearest corner of the building to the proposed right of way line. Buildings will be labeled to show use if apparent, e.g., residential, commercial.
- Encroachments within existing right of way
- A legend of abbreviations and symbols
- A table of ownerships
- The statement: *THIS MAP IS NOT A SURVEY* on each sheet
- The statement: See sheet 1 for legend and general notes on each subsequent sheet
- Additional data required by FHWA on projects that have federal funding, e.g., limits of construction

27.2.2. RIGHT OF WAY MAP COVER SHEET (29.13)

The Department's approved sheet title block will be used in preparation of this cover sheet. The legend, general notes, and location map will be placed on this sheet. On projects that do not require a cover sheet, the foregoing information may be shown on the key or detail sheet(s) as directed by the DSMO.

27.2.3. RIGHT OF WAY MAP KEY SHEET (29.14)

This sheet(s) is derived from the master CADD file at an appropriate scale to show alignment(s), section ties, subdivisions, condominiums and cooperatives with recording data, large parent tracts and other elements as may be required. The relationship of the detail sheets may also be depicted on this sheet if required by the DSMO. The line work, text, etc. will be added/modified to fit the key sheet scale.

27.2.4. RIGHT OF WAY MAP DETAIL SHEET (29.15)

This sheet(s) is derived from the master CADD file at an appropriate scale. The line work, text, etc. will be added/modified to fit the detail sheet scale. These detail sheets may also

be copied from the existing detail sheets of the control survey. Detail sheets will include parcel numbering by use of bubbles, complete geometry for all takes and geometry for remainders as directed by the DSMO, topography, limits of construction, if required and jurisdictional or agency lines, if required.

27.2.5. MAP PROCESSING

Processing will be as follows:

- The designated District authority will approve and date each map sheet.

27.2.6. MAP REVISIONS

Prior to revising approved right of way maps, documentation will be provided to the project file to identify:

- the person(s) requesting the change.
- the person(s) authorizing the change.
- a detailed description of necessary change(s).
- an explanation of why the changes are necessary.

27.3. MAINTENANCE MAP

A maintenance map is prepared and filed with the Clerk of the Circuit Court when the DSMO has determined that there has been no formal conveyance of right of way or accepted dedication or there is notification/evidence that a formal conveyance was ineffectual to pass title to the Department.

27.3.1. GENERAL MAP REQUIREMENTS

The map will depict, at minimum, the following:

- The survey alignment with reference points
- Sufficient land line ties
- A north arrow and scale of map
- County and state lines unless excepted by the DSMO
- City names with city limits unless excepted by the DSMO
- A State, county, or municipal roads intersecting the survey alignment
- The existing right of way
- The maintained right of way lines with station and offset to the survey alignment

- Key topographic features
- The bearing basis
- The source of dimensions
- Sufficient general notes on sheet 1
- The Department standard title block
- The date of photography on projects using aerial photography
- A legend of abbreviations and symbols

27.3.2. MAINTENANCE MAP COVER SHEET (29.16)

The Department's approved sheet cell will be used in preparation of this cover sheet. The legend, general notes, location map and certifications will be placed on this sheet. On projects that do not require a cover sheet, the foregoing information may be shown on the key or detail sheet(s) as directed by the DSMO.

The following certifications will be placed on the cover sheet:

1. The Department certification

THIS IS TO CERTIFY that sheets numbered _____ to _____, inclusive, constitute a true copy of the State of Florida Department of Transportation Maintenance Map for a portion of State Road _____, designated as _____ in _____ County, Florida.

THE PROPERTY labeled _____ on said sheets has been vested in the State of Florida Department of Transportation pursuant to the provision of Section 95.361, Florida Statutes

IN WITNESS WHEREOF, we have hereunto set our hands and affixed the seal of the State of Florida Department of Transportation, at _____, Florida, this _____ day of _____, A.D. 20__.

_____ _____

District Secretary *(Witness)*
Department of Transportation
State of Florida

2. The recording certificate

Filed for record in the office of the Clerk of the Circuit Court for the County of _____, State of Florida, in Road Plat Book _____, Page _____, on the _____ day of _____, A.D. 20__.

3. The PSM's certification

This survey was performed for the specific purpose of establishing a survey alignment and locating the limits of maintained right of way as identified by the Maintenance Engineer for the transportation facility shown and depicted hereon. I hereby certify to the best of my knowledge and belief this is a true, accurate and complete depiction of a field survey performed under my direction and completed on _____. I further certify that said drawing is in compliance with the Standards of Practice as set forth by the Florida Board of Professional Surveyors and Mappers, in Chapter 5J-17, Florida Administrative Code pursuant to Section 472.027, Florida Statutes.

_____
Name
Florida Professional Surveyor and Mapper No. _____
Address
Date

THIS MAP AND REPORT OR COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

4. If the responsible maintenance engineer or authority has not signed an affidavit, he or she must certify as follows:

This is to certify that the limits of maintained right of way as shown on this map were identified by myself as having been maintained continuously for four (4) years without interruption.

_____
Name and Title
Date

27.3.3. MAINTENANCE MAP KEY SHEET (29.17)

This sheet(s) is derived from the master CADD file at an appropriate scale to show alignment(s), section line ties, subdivisions, condominiums and cooperatives with recording data, and other elements as may be required. The relationship of the detail sheets may also be depicted on this sheet if required by the DSMO. The line work, text, etc. will be added/modified to fit the key sheet scale.

27.3.4. MAINTENANCE MAP DETAIL SHEET (29.18)

This sheet(s) is derived from the master CADD file at an appropriate scale. The line work, text, etc. will be added/modified to fit the detail sheet scale. These detail sheets may also be copied from the existing detail sheets from the right of way control survey. All maintained right of way along the mainline corridor will be supported by certified field notes. At the direction of the DSMO, reference to the appropriate field books will be made either in the general notes on the cover sheet or by reference on the detail sheet. Station and offsets will be shown at each change in direction of the right of way.

27.3.5. MAP PROCESSING

Processing will be as follows:

- After the map has been accepted by the DSMO, the original and 1 set of prints will be submitted to the appropriate authorities for certification and witnessing.
- After the map has been certified and witnessed, the DSMO will obtain 1 film copy and file the original map with the Clerk of the Circuit Court. The Clerk will affix the recording information on the set of prints for DSMO records and the recording data will be placed on the film copy retained by the DSMO.

27.4. REFERENCE POINT SHEET SET (29.19)

This information as derived from field book data or electronic files will be plotted into a CADD file. The line work, text, etc. will be added/modified to fit the sheet scale, if applicable. There will be a maximum number of 15 reference points per sheet. Reference point sheets will be prepared at the direction of the DSMO as appropriate to the project. This sheet(s) will be included with the control survey, right of way map, and maintenance map.

27.5. PROJECT NETWORK CONTROL SHEET (29.20)

This information as derived from field book data or electronic files will be plotted into a CADD file. The line work, text, etc. will be added/modified to fit the sheet scale, if applicable. Project network control sheet(s) will be prepared at the direction of the DSMO as appropriate to the project.

This sheet depicts the baseline, benchmarks, primary and secondary control points and their reference points including the type of material used for each point, their X,Y,Z coordinates, scale factors and convergence angles. This sheet(s) may be included with the control survey map, right of way map, and maintenance map.

27.6. TABLE OF OWNERSHIPS SHEET (29.21)

The Department's approved sheet cell will be used in preparation of the ownerships sheet. Required data will include parcel number, sheet numbers on which the parcel appears, name of property owner(s), the area in square feet or acres of the part to be acquired and the remainder (when there is no remainder show 0), any necessary comments, and the recording data of the executed or condemned parcel when completed.

28. MISCELLANEOUS SURVEYS AND SKETCHES

28.1. PARCEL SKETCHES (29.22)

Parcel sketches may be prepared for various purposes at the direction of the DSMO. Purpose, format, scale, etc. are designated in the scope as required.

28.2. TIITF SKETCHES (29.23)

Sketches are prepared for the Department to obtain rights over sovereignty submerged lands or state-owned uplands. Specific requirements, e.g., purpose, format, scale, are designated in the scope or by the requirements of FDEP, BSM.

28.3. OTHER SPECIFIC PURPOSE SURVEYS (29.24)

These may include preparation of maps for mitigation surveys or jurisdiction line surveys. Specific requirements, e.g., purpose, format, scale, are designated in the scope.

28.4. BOUNDARY SURVEY MAP (29.25)

This survey may be prepared for any specific need at the direction of the DSMO. Specific requirements, e.g., purpose, format, scale, are designated in the scope.

28.5. RIGHT OF WAY MONUMENTATION MAP (29.26)

This survey is prepared for the depiction of the field-monumented right of way. The right of way map set is the basis for this map with minimal adjustments to the cover sheet, including adding the proper certification. The recording data is shown on the table of ownerships sheet. It is prepared and filed after the right of way has been monumented.

28.5.1. ADDITIONS TO THE RIGHT OF WAY MAP

The following will be added to the original right of way map:

- The appropriate symbol where each right of way monument was set
- A note on each map sheet describing the symbol indicating the right of way monument
- The recording data for each parcel acquisition or condemnation in the table of ownerships

28.5.2. CERTIFICATIONS

A reproducible copy of the original right of way map that meets the requirements of the appropriate Clerk of Circuit Court will be made after the above is completed and the title blocks will be revised to show *RIGHT OF WAY MONUMENTATION MAP.* The note *THIS MAP IS NOT A SURVEY* will be removed from all sheets of the reproducible copy and the following will be added.

The certificate of the PSM in responsible charge on sheet 1 as follows:

This certification is made exclusively to the Florida Department of Transportation.

This survey was performed for the specific purpose of monumenting the existing right of way only for the transportation facility shown hereon. I hereby certify that to the best of my knowledge and belief, the right of way monumentation as shown by the symbol for Permanent Right of Way Markers (P.R/W M.) and depicted on this drawing, consisting of sheets _____, is a true, accurate, and complete depiction of a field survey performed under my direction and completed on _____. I further certify that said drawing is in compliance with the Standards of Practice as set forth by the Florida Board of Professional Surveyors and Mappers, in Chapter 5J-17, Florida Administrative Code pursuant to Section 472.027, Florida Statutes.

_____

Name of Surveyor
Florida Professional Surveyor and Mapper No. _____
Address
Date

THIS MAP AND REPORT OR COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

The recording certificate on sheet 1 as follows:

Filed for record in the office of the Clerk of the Circuit Court for the County of _____, State of Florida, in Road Plat Book _____, Page _____, on the _____ day of _____, A.D. 20__.

29. MAP PREPARATION

29.1. SIZE & FORMAT

All final right of way related map sheets will be a size which is determined by the DSMO to be acceptable to the Clerk of the Circuit Court for recording.

All sheet formats will have a standard title block with provision for a federal project number.

All final right of way maps prepared for the Department are to be delivered in hard copy and/or electronic format that adheres to the ***CADD Manual, Topic No. 625-050-001***.

29.2. MATERIAL

The map material for all final right of way related map sheets delivered in hard copy will be submitted on a reproducible material that meets the requirements of both the DSMO and the Clerk of the Circuit Court.

30. TITLE SEARCH AND DOCUMENT PREPARATION (29.28)

The procurement of lands for transportation facilities requires a current report of the present ownership and all encumbrances on each parcel to be acquired. This includes, within the report, a list of all conveyances of the subject land made during the most recent five-year period together with the consideration paid based on documentary stamps. Title search reports are prepared in accordance with the ***Right of Way Procedures Manual, Topic No. 575-000-000*** and based upon a thorough search of the public records, which may require searching back to the earliest public records. The services of a qualified title company or title examiner are usually obtained for this purpose. In Districts where the Department has qualified personnel experienced in title examination, the DSMO may elect to obtain its own updates and to do some or all original title searches.

Information received from title searches is analyzed by surveying and mapping personnel in order to make property boundary determinations necessary for adequate map and

document preparation. Specifically, the descriptions of the various ownerships are plotted to scale for inclusion on the maps. In addition, a determination of the various encumbrances such as mortgages, liens, easements, etc., of record against each parcel are identified based upon the report of title search. In some instances, the assistance of the District general counsel and/or the Department's general counsel may be required for specific interpretations.

Documents of conveyance are prepared in accordance with the ***Right of Way Procedures Manual, Topic No. 575-000-000***.

30.1. TITLE SEARCH MAP (29.27)

This map is prepared utilizing property appraiser maps or preliminary right of way maps. The purpose of this map is to depict the properties affected by the proposed project requirements. This map is used to obtain title search reports necessary to develop the right of way maps. The DSMO directs the schedule of preparation.

30.2. RIGHT OF WAY MAPPING RESPONSIBILITIES

Obtaining, analyzing, and processing current title search and updates is the responsibility of the DSMO under direction of the District General Counsel until delivery of the right of way project to the Office of Right of Way. Title search reports/updates are certified to within six months of delivery of the project to the Office of Right of Way. After the project is delivered the responsibility for updating title is determined by the District.

Title search reports reflect all documents that create, or purport to create, an interest, lien, or encumbrance in the parcel. Title searches should cover a sufficient period to include any existing easements or reservations. A description of all conveyances that occurred in the five years immediately preceding the completion date of the title search is also included.

On all title search contracts for the Department, the DSMO serves as contract manager and has the following responsibilities:

- Enforcement of performance of all contract terms and conditions
- Liaison between the Department and the title examiner

30.3. ORDERING A TITLE SEARCH

The contract manager furnishes the title company or title examiner with a copy of the title search map. Occasionally, the title examiner may find a reference to plats and subdivisions that have not been depicted on the preliminary maps or property appraiser maps. In such cases, he includes a copy of the plats with the title search so that the maps can be corrected. When the maps are submitted to the title company or title examiner, the contract manager may include an estimate on time of completion and an authorized

expenditure with the letter of authorization for the title examiner or title company to commence work on the project.

The letter of authorization to the title company or title examiner may also provide the following:

- Reference to the title search agreement under which the search is being ordered, and the amounts quoted for the various types of search under the agreement
- The number of copies of the search to be furnished as required by the contract manager
- A tentative due date for the search

30.4. CERTIFICATION OF UPDATE

The title examiner, under the provisions of the title search contract agreement, is required to certify any update of the original search. The update shows the owner's name and mailing address. The title examiner also provides specific data as to outstanding encumbrances not already listed in previous title searches, such as mortgages (with book and page reference) and satisfaction of mortgages (with book and page reference).

31. LEGAL DESCRIPTIONS (29.29)

31.1. MINIMUM REQUIREMENTS

All points of commencement, where practical, should be outside of the required right of way. Descriptions must also be prepared and certified in accordance with the ***Surveying and Mapping Procedures, Topic No. 550-030-101***. The format will be determined by the DSMO.

31.2. INFORMATION FOR WRITING LEGAL DESCRIPTIONS

- A set of right of way maps that show the required right of way with all necessary geometry.
- Title information from the most recent title search, including any updates. This information should include the current record owner, the legal description of the property, and a list of all encumbrances on the property. Easement locations must be plotted to determine whether they will affect the right of way taking. Determination may then be made to ascertain if the taking will be subject to an existing easement, subordinated or fully cleared. Private easements may be brought to the attention of the DSMO by title examiners, surveyors, appraisers, and others. This information must also be included on the right of way maps.

- Other information may be obtained from additional field survey, local surveyors, or other sources to clarify the property boundary location and title data. On consultant prepared projects, the consultant will coordinate this effort with the DSMO.

31.3. EARLY INVOLVMENT IN MAP PREPARATION

- Includes analyzing the title search to define parent tracts and ownerships affected by the proposed right of way acquisition.
- Includes reviewing the title search for errors in the legal description or omissions in the title evidence. Items requiring clarification must be referred promptly to the title examiner or Title Company to complete the title work before the preparation of legal descriptions. Title updates may indicate revisions for which the maps should be adjusted.
- The record parent tract legal description for each right of way parcel and the proposed right of way requirements will be depicted as required on the right of way map and assigned a numbered parcel bubble in accordance with ***Section 31.4***.

31.4. ASSIGNMENT OF PARCEL NUMBERS

Parcel numbers are assigned conforming to the numbering convention as follows:

- Series 1 – 99 is reserved
- Series 100 – 699 is used for all parcels to be acquired in fee
- Series 700 – 799 is used for temporary easements
- Series 800 – 899 is used for perpetual easements, including TIITF parcels
- Series 900 – 999 is used for all license agreements

In the event any series exceeds the above range on a project, the series is extended by beginning with the first number of that series and adding 1000. For example, 100 – 699 would become 1100 – 1699, etc.

Once a parcel number is assigned and transmitted to the Office of Right of Way it may not be reused or reactivated if voided.

31.5. VESTING OF TITLE TO ROADS

When a state road intersects a street or dedicated right of way owned by a local governmental agency, that portion of the right of way that is required for maintenance of the state road after construction should be clearly depicted on the right of way map. If legal descriptions are required, they are prepared at the direction of the DSMO in accordance with local agency requirements. If necessary, a parcel number(s) may be assigned.

31.6. PREPARATION OF LEGAL DESCRIPTIONS

Having completed the analysis of the title evidence, plotting of ownerships, reconciling conflicting information, and showing the information on the right of way map, including right of way requirements, the legal descriptions can be prepared. The DSMO will determine the description format.

All data, distances and bearings used in a legal description should be readily discernible from the right of way map, with all data between the map and the legal description in complete agreement.

Computations and closure reports are prepared to support the description and provide additional data that may be required on the right of way map.

31.6.1. BASIC METHODS

The basic methods to be used for the description of real property are:

- Metes and bounds
- Survey alignment description
- Sections, lots, blocks or specific parts thereof

31.6.2. AREA

Areas are shown in all legal descriptions in square feet or acres, usually not both. The areas agree with the table of ownership sheet and depicted as follows:

- Areas of a half-acre or more should be shown in acres, to 3 decimal places. Areas less than a half-acre should be shown in square feet, to the nearest foot, or as directed by the DSMO. Areas, both acres and square feet, should be followed by *more or less.*
- For legal descriptions with multiple parts where some of the parts are less than or equal to 1/2 acre but the total amounts to more than 1/2 acre, the parts may be shown to the nearest square foot following each part of the legal description and the total in acres at the end of the legal descriptions. Parts should be clearly tied together by "*AND"* or "*ALSO"* to clearly show the intent. Care should be taken to ensure that the "part" areas add up to the total area with no rounding differences, and there are no discrepancies with the table of ownership sheet. The DSMO directs the method of depiction on the table of ownership sheet, i.e., total area only or parts shown.

31.6.3. METES AND BOUNDS DESCRIPTIONS

This type of description is one which requires adequate field survey information to identify the point of beginning and list the bearings and distances that define the limits of the parcel. This is the preferred method if a simpler description is not suitable.

Each metes and bounds description should adequately identify the land described and make the title certain with regard to adjoining ownerships by the use of proper qualifying language.

31.6.3.1. PARENT TRACT

In some instances, minor flaws may be detected in the parent tract description that would not materially affect the right of way. In such instances, the parent tract should be placed in direct quotes to indicate the description of the parent tract is being used exactly as the conveyance was made to the current owner.

However, when major discrepancies are detected such as improper sections, townships or ranges that would place the property a considerable distance from the actual location on the ground, the property owner should be advised of the discrepancy and should file a corrective deed before the Department takes title. In the event this cannot be accomplished, an alternate method for describing the right of way should be pursued such as by direct metes and bounds or survey alignment description.

31.6.3.2. EXCEPTIONS TO THE PARENT TRACT

Occasionally, a parent tract description contains one or more areas that are excepted from it. These may be described by copying the parent tract description and following it by the description of the exception, clearly denoting it as an exception.

31.6.4. SURVEY ALIGNMENT DESCRIPTION

Where partial takings of a generally constant width are involved throughout a considerable length of the project, the survey alignment description is often the most practical type of description. This description is based upon right of way taking of a portion of land out of a given parent tract that lies within a specific distance of a survey alignment.

31.6.4.1. SURVEY ALIGNMENT TIES

This line may be a survey alignment, or a construction centerline tied at both ends to known land corners such as a section corner, quarter section corner, subdivision block corner or permanent reference monument. The distance between ties should not normally exceed one mile except through large acreage tracts where it is permissible to cover the entire tract without intermediate ties. When crossing large acreage tracts, a beginning tie to a substantial corner prior to reaching the large tract is required. List the sections that

are being crossed and tie to a substantial corner or just past the ending boundary line for the tract.

31.6.4.2. SURVEY ALIGNMENT CURVES

Describe by curve data, tangent lengths, and bearings, the survey alignment used in the description.

The description of the curve should contain the following information:

- concave direction
- direction of curve
- central angle
- length
- radius

If the curve is non-tangent, additional information to define the curve will be included.

A survey alignment beginning on a curve will have the tangent bearing or chord bearing at the beginning indicated and the curve data should define only that part of the curve included in the description.

31.6.4.3. SURVEY ALIGNMENT IDENTIFICATION

The survey alignment, centerline, and construction centerline may or may not be common lines, so it is important that the line on which the right of way is based be clearly identified in the description and on the right of way map. Survey alignments should be described as beginning and ending on a land line, with a bearing and distance to the nearest land corner. It is most important that the bearing of the land line be shown to have complete ties.

Many variations of the survey alignment description are used, but the principle remains the same. Each line is identified by name such as baseline, centerline, survey alignment, etc. as shown on the maps.

In most cases, especially where the width of the right of way varies, direct metes and bounds is the best method to describe real property.

31.6.4.4. RIGHT OF WAY WIDTH

After defining the survey alignment, then define the width of the taking. The right of way map indicates the required width.

Where there is existing right of way, it should be clearly stated in the description, e.g., *excepting 25 feet of existing right of way on each side of the survey alignment…*, and the area for the taking should also exclude the area of the existing right of way.

31.6.4.5. VARIABLE WIDTH RIGHT OF WAY

Occasionally, a description requires a change of right of way width within the parcel. This change may be defined by station and offset located in the description of the survey alignment that follows.

Breaks can be located on property lines, instead of station numbers. Occasionally, a transition in the right of way may be needed.

31.6.4.6. DESCRIPTIONS FOR FEDERAL LAND TRANSFERS

Where survey alignment descriptions are utilized to describe parcels for federal land transfers where the taking is uniform throughout, recite the beginning and ending stations where the survey alignment enters and leaves the federal lands.

In most cases, especially where the width of the right of way varies, direct metes and bounds is the best method to describe federal lands.

31.6.5. WHOLE AND PARTIAL TAKINGS

31.6.5.1. WHOLE TAKING

An entire ownership as described in the title evidence may be used if all the land is acquired and the description is correct in all respects.

31.6.5.2. PARTIAL TAKING

Partial takings may be defined in various ways; however, the intent should be clear.

These various ways are:

- By recited dimension in a designated direction, sometimes called a strip description
- By area, specified or proportionate
- By exception of portion not conveyed
- By division line between parcels

Care should be exercised in describing partial takings, especially with parcels that do not lie in cardinal directions, and those with irregular shapes.

31.6.5.3. SECTIONAL DESCRIPTIONS

Surveyors should follow best practices for referencing lands defined by the Public Land Survey System as defined by the ***Manual of Survey Instructions for the Survey of the Public Lands of the United States, 2009***.

31.7. MULTIPLE DESCRIPTIONS, LIMITED ACCESS & FREE ACCESS

A description may consist of more than one area of land to be included in the parcel. It is most important the descriptions of these parts be tied together by *"AND*" or "*ALSO*" in order to clearly show the intent. Care should be exercised to ensure the separate parts do not overlap as this can cause confusion as to the intent and possible duplication of acreage.

Locations where access rights are acquired must be defined and clearly separated from free access and other interest included in the same document. Limited access takings must include the following language: “Together with all rights of ingress, egress, light, air and view between the above described property and the Grantor’s remaining property.

31.8. EASEMENTS

31.8.1. TEMPORARY EASEMENTS

A time limit is used on temporary easements for stockpiles, detours, construction easements, and other easements required during the period of construction. These time limits run from the date of execution of the instrument unless otherwise noted.

31.8.2. PERPETUAL EASEMENTS

Perpetual easements are generally used for drainage outfalls, drainage inlets, slopes, wall maintenance, ingress/egress and other easements that need to be permanent.

31.9. VERIFICATION

Verification of all descriptions, original or revised, will be included as part of the QA/QC plan.

31.10. CERTIFICATION

The description for each parcel must be certified, i.e., signed, sealed, and dated, by a professional surveyor and mapper as meeting the *Standards of Practice* pursuant to *Section 472.027, F.S.*, and must also be prepared in accordance with the *Surveying and Mapping Procedures, Topic No. 550-030-101*.

Unless each description is certified individually, the professional surveyor and mapper will prepare a certification letter as follows:

I hereby certify that, to the best of my knowledge and belief, the attached legal descriptions of parcels _____as shown on the right of way maps designated as _____ are true, accurate, and were prepared under my direction.

I further certify that said legal descriptions are in compliance with the Standards of Practice as set forth by the Florida Board of Professional Surveyors and Mappers in Chapter 5J-17, F.A.C., pursuant to Section 472.027, F.S.

_____
Name of Surveyor
Florida Professional Surveyor and Mapper No. _____
Address
Date
THIS MAP AND REPORT OR COPIES THEREOF ARE NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER.

32. MISCELLANEOUS

32.1. ROAD TRANSFERS

After notice has been given, pursuant to ***Transportation System Jurisdiction and Numbering, Topic No. 525-020-010***, that a state road has changed jurisdictional classification, the orderly transfer of rights of way by deed or the filing of a right of way map must be initiated. The use of right of way maps is the preferred method. Below is the certificate to be used.

This right of way map, when recorded, is an instrument of conveyance, transferring in accordance with Section 337.29(3), F.S., all right, title and interest of the Florida Department of Transportation in the road, street, highway, set forth on this map to_____ County.

Recorded in Public Records of _____County, Florida, this_____day of _____, A.D. 20___, in Road Plat Book_____, Page _____.

_____
Clerk of the Circuit Court
_____ *County, Florida*

33. OFFICE PROCEDURES

33.1. TECHNICAL MEETINGS (29.32)

Attend meetings as required and negotiated by the DSMO.

33.2. QUALITY ASSURANCE/QUALITY CONTROL (29.33)

See ***Section 10.3*** for information on the QA/QC Plan.

33.3. SUPERVISION (29.34)

Perform all activities required to supervise and coordinate project. These activities must be performed by the project supervisor, PSM, or their delegate as approved by the DSMO.

33.4. COORDINATION (29.35)

Coordinate survey activities with other disciplines. These activities must be performed by the project supervisor, PSM, or their delegate as approved by the DSMO.

33.5. SUPPLEMENTAL MAPPING (29.36)

This task is to cover efforts resulting from major design and/or development changes after 60% map development that affect the right of way requirements/parent tract property lines and may include any number of tasks. Request and approval to utilize the supplemental mapping hours will be in writing and approved by the DSMO prior to any work being done under this task.

33.6. FINAL MAP/PLANS COMPARISON (29.30)

The PSM will perform a comparison of the final right of way maps, with the available construction plans, to review the correctness of the type of parcel to be acquired and the stations/offsets to the required right of way. The PSM will coordinate with the EOR to resolve any conflicts or discrepancies and provide documentation of the review.

34. FIELD PROCEDURES

34.1. FIELD REVIEWS

Perform verification of the field conditions as related to the survey data.

TERRESTRIAL MOBILE LiDAR

35. INTRODUCTION

The intent of this document is to provide guidelines to help insure proper and efficient use of TML technology in support of Department projects.

This document was adapted from *CALTRANS Surveys Manual 2018.* ***https://dot.ca.gov/programs/right-of-way***

Where possible this document is intended to coincide with the National Cooperative Highway Research Program (NCHRP) : Report 748. (2013). *Guidelines for the Use of Mobile LIDAR in Transportation Applications.* Washington D.C.: Transportation Research Board of the National Academy of Sciences. ***http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_748.pdf***



36. Terrestrial Mobile LiDAR methods

TML uses a laser scanner(s) in combination with GNSS receivers, IMU, and DMI to produce accurate and precise geospatial data from a moving terrestrial platform.

LiDAR sensors use an active (projected) light signal to measure the relative x, y, z, position and reflective properties of a point on an object. In practice this results in a point cloud with image qualities similar to other remote sensing technologies. This allows the value of a point cloud to be extended when it is mined for topographic features and information beyond what was required of the intended survey. However, the origin and accuracy of the point cloud data must be supported by a survey report for it to be used with confidence and to ensure the survey information with any byproducts are not misused.

36.1. TYPES OF TML SURVEYS

The focus in this document is on three major survey categories of TML. The examples given here are not intended to be exhaustive.

Type A – High Accuracy Surveys:

- Design engineering topographic
- As-built
- Structures and bridge clearance

- Deformation surveys

Type B – Medium Accuracy Surveys:

- Design engineering topographic corridor study/planning
- Detailed asset inventory and management surveys
- Environmental
- Earthwork
- Urban mapping and modeling coastal zone erosion analysis

Type C – Lower Accuracy Mapping:

- Preliminary planning
- Transportation statistics
- General asset inventory surveys

37. TML Project Selection

The following are some of the key factors to consider when determining if TML is appropriate for a particular survey project:

- Safety
- Project deliverables desired
- Budget
- Project time constraints
- GNSS data collection environment
- Terrain and length/size of project
- Traffic volumes and available observation times

38. TML Equipment

All of the equipment in the TML system used to collect, process, and adjust data must be of sufficient precision to meet the accuracy requirements of the project and applicable accuracy standards described in this document. This determination can be made from the stated specifications of the equipment by the manufacturers, analysis of the systems performance on projects with similar requirements, and the expert opinion of the Professional Surveyor and Mapper in responsible charge of the project survey data and supporting survey report.

38.1. MINIMUM TML SYSTEM SENSOR COMPONENTS

- LiDAR sensor
    - Follow ***OSHA Regulation 1926.54*** and manufacturers' recommendations when using any laser equipment. Never stare into the laser beam or view laser beams through magnifying optics, such as telescopes or binoculars. Additionally, the eye safety of the traveling public and other people should be considered at all times and the equipment operated in a way to ensure the eye safety of all.
- GNSS receivers
    - One or more onboard (roving) GNSS dual frequency receiver(s) capable of RTK data and kinematic collection. Base stations may be FPRN stations or Virtual Rinex stations
- An IMU which typically consists of an electronic gyro within a sealed unit mounted securely on or near the primary sensor.
- A DMI typically mounted near vehicle wheel housing. It is used primarily as a supporting measurement that allows for sensor collection at relative distance intervals and can suspend measurements while the vehicle is motionless due to vehicle traffic stops during collection.

The collection rate (epoch) of the TML system sensors must be sufficient to meet project accuracy and point density requirements.

39. TML PROJECT SPECIFICATIONS AND PROCEDURES

39.1. TML Mission

When a contract is awarded and before any work begins, the consultant will contact the CSMO to request the MSTS number. The MSTS number shall be included in point cloud data file names so the data can be included in the CSMO image data management system. The MSTS number should be referenced in all correspondence and project deliverables.

To maximize the quality and production of measurements, mission planning should be conducted before the collection of TML project data commences.

During a TML data collection mission, simultaneous GNSS signals from a minimum constellation of 5 satellites should be maintained between at least one GNSS base station receiver, and the GNSS roving receiver(s). The GNSS constellation PDOP should be 5 or less at the base and roving units during data acquisition. The occasional momentary loss of GNSS signals, also known as cycle slips, may occur. In these cases, the position of the LiDAR sensor is dependent on the IMU and degrades quickly over time from the last corrected GNSS position. To avoid poor and erroneous measurements the period of

lost GNSS corrections should never exceed the IMU's ability to accurately position the sensor over this time interval. The inadvertent scanning of moving targets such as traffic and pedestrians will adversely affect measurements, as well as the texture, shape, and color of the surface being scanned.

The accuracy of a project point cloud is affected by many error factors. Some of these factors can be mitigated while others can be eliminated through proper procedures. Two important factors impacting accuracy related to sensor specifications that can be controlled are; the effective range of sensor and the resulting point density.

LiDAR sensor measurement precision diminishes as the distance from the sensor increases. The effective range of the LiDAR sensor, for purposes of this document, is determined by the sensor manufacturer specifications of precision as they relate to the accuracy requirements of the project or specific areas of the project.

Point density is primarily determined by the measurement distance to object, measurement rate of the sensor and speed of the sensor platform during measurement. The point density must be sufficient to identify and extract physical detail to the accuracy specified for the project while meeting the TML application requirements in ***Section 39.6.2***.

All points with compromised accuracies, especially those collected outside the effective range of the scanner, shall be classified as erroneous.

Projects with difficult TML survey conditions should be reconnoitered first to identify as many of these variables as possible and develop a plan to mitigate their effect on the data. Usually this will require additional control to ensure the TML measurements in these areas meet the project accuracy requirements.

39.2. PROJECT BASE STATION CONTROL ESTABLISHMENT

The project base station control that will be used to post-process the TML GNSS data shall be placed at intervals to ensure that no processed baseline exceeds the survey type requirements listed in ***Section 39.6.2*** Short baselines contribute to the best possible positional accuracy outcome. Base stations may be FPRN stations or Virtual Rinex stations. During TML collection two or more GNSS base station occupations are highly recommended to guard against the possibility of wasted effort and useless data from base station failure due to equipment, accident, or human error in station setup, and also allow redundant post-processing. Base stations shall be appropriately spaced along the corridor to meet the baseline length limitations listed in ***Section 39.6.2*** for the project area to be mapped. This limitation does not apply to data collected outside of the project as often happens during vehicle staging at the beginning and ending of each pass. All control set shall be done in accordance with the Department's GNSS Guidelines listed in ***Appendix B***.

39.3. EQUIPMENT MAINTENANCE AND BORE SIGHT CALIBRATION

All the sensor equipment in the TML system shall have records documenting maintenance to the manufacturer's recommendation, including all repairs and adjustments to the sensors.

Sensor alignment (bore sighting) procedures sufficient to meet project accuracy requirements shall be performed and documented immediately before and after collecting the TML data for a project. This must be performed on site if the system has been disassembled for transport.

39.4. REDUNDANCY

TML data collection shall be conducted in such a manner as to ensure redundancy of the data. This means that more than one scan pass is necessary. The data shall be collected so that there is overlap between scan passes. The minimum amount of overlap along the sides of the scan passes should be 20% for Type A and B surveys. More overlap is often necessary to cover critical areas where high accuracy surfaces are needed. The redundant passes can be made in the same direction or in opposite directions. A minimum of 15 minutes between the end of one pass and the beginning of the next overlapping pass is required. The objective is to ensure sufficient satellite constellation changes have occurred between passes, reducing the opportunity for bias in the GPS measurements.

39.5. MONITORING DATA COLLECTION

Monitoring various component operations during the scan session is an important step in the QA/QC process. The following is a list of minimum items that should be monitored and documented during TML data collection:

- Loss of GNSS reception
- Uncorrected IMU drift both in distance and time
- Proper functioning of the laser scanner
- Vehicle speed

The system operator should be aware and note when the system encountered the most difficulty and be prepared to take appropriate action in adverse circumstances.

39.6. PROJECT CONTROL AND CHECKPOINTS

In order to improve the project accuracy of the collected TML point cloud data, a project geometric correction must be applied. The two leading methods currently employed for this process both require targeted project control points visually identifiable in the TML point cloud (see ***Section 39.6.1***), measured independently, and having higher project accuracies than required for the TML data.

The preferred method incorporates simultaneous adjustment (least squares) of the raw navigation trajectory with weighted (constrained) project control points. This establishes the best trajectory and exterior orientation parameters for the LiDAR sensor (and any other sensors such as a camera). The best trajectory method produces improved results over the second method and allows for sound relationships between multiple sensor data collected from the moving vehicle.

The other method is a least squares adjustment of the horizontal and vertical residuals between established project control points, and the corresponding values from the point clouds to produce the transformation parameters of translation, rotation, and scale for the horizontal values and an inclined plane for the vertical values. These parameters are then applied to the point cloud to produce more accurate final geospatial data within the localized area of control. This method should be used with caution especially in longer projects that may require segmented adjustments.

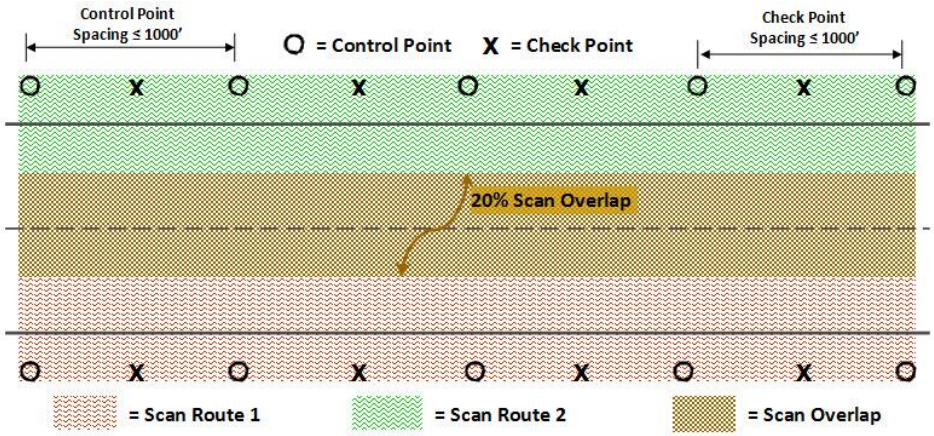
Checkpoints must be established with the same project accuracies as the control. Checkpoints by definition are not constrained in the adjustment of the TML data to project control points. Checkpoints are to be used for statistical accuracy computations validating the adjusted TML point cloud.

Control and checkpoint targets for Type A and Type B TML surveys must be of sufficient size and reflectivity to ensure identification and correct measurement within the point cloud. The type, shape and dimensions of the target(s), along with a graphic (picture or drawing) should be included in the survey report.

The recommended geometry of Project Primary control pairs should be located at the beginning, end, and evenly spaced throughout the project to ensure that the project TML collection area is bracketed. The recommended maximum distance with respect to route centerline stationing spacing between these points shall be based on the type of survey as defined in ***Section 36.1***. See ***Section 39.6.2*** for TML survey specifications.

Checkpoint pairs are used to check the geospatial data adjustment. Checkpoints should be located at the beginning, end, and evenly spaced throughout the project. The recommended maximum distance with respect to route centerline stationing spacing between these points shall be based on the type of survey as defined in ***Section 36.1*** portion of this handbook. See ***Section 39.6.2*** for TML survey specifications.

39.6.1. TML TYPE "A" PROJECT CONTROL LAYOUT



Note: Since all projects are different, these are only recommendations. The Surveyor & Mapper in responsible charge of the TML must choose the appropriate accuracy and geometry of the project control points and checkpoints to ensure the TML survey data and products meet or surpass accuracy requirements of the project.

39.6.2. TML SURVEY SPECIFICATIONS

Operation/Specification	TML Survey		
	Type A	Type B	Type C
Bore sight calibration of TML system per manufacturers' specifications before and after project data collection.	Required		
Dual-frequency GNSS	Required; See note 6		
IMU	Required; See note 6		
DMI	Required; See note 6		
GNSS positioning shall be constrained to project control.	Yes		See note 10
Minimum horizontal (H) and vertical (V) accuracy for GNSS control base stations.	Must be of higher project accuracy than required for TML data.		
Minimum accuracy of project control points and checkpoints	See note 5		

Operation/Specification	TML Survey		
	Type A	**Type B**	**Type C**
TML positional accuracy requirements relative to project control points and checkpoints (values shown at the 95% confidence level)	H ≤ 0.06 ft V ≤ 0.06 ft	H ≤ 0.10 ft V ≤ 0.10 ft	H and V See Note 5
Maximum post-processed baseline length	10 miles		15 miles
Minimum number of common healthy satellites in view for GNSS base stations and mobile scanner	See notes 1 thru 4		
Maximum PDOP during TML data acquisition	5		
Allow sufficient time between overlapping collection passes to ensure change in satellite constellation. Recommend at least 3 different satellites in view.	Each overlapping pass		
Minimum overlapping coverage between adjacent runs (For Type A and B surveys)	20%		See note 10
Minimum orbit ephemeris for kinematic post-processing	Broadcast		
Observations – sufficient point density to model objects	Each pass		
Vehicle speed – limit to maintain required point density	Each pass		
Minimum number of project transformation points required	4		
LiDAR point density requirements (see note 8)	(≥ 20 pts/ft²)	(≥ 10 pts/ft²)	See note 9
Recommended maximum spacing for project control point pairs along the project corridor. project control points should be located on each side of scanned roadway.	1000 ft intervals See note 5	1500 ft intervals See note 5	See note 5
Recommended maximum checkpoint spacing along the project corridor for QA purposes as safety conditions permit. (See Note 3)	1000 ft intervals See note 5	1000-2500 ft intervals See note 5	See note 5

Operation/Specification	TML Survey		
	Type A	Type B	Type C
Minimum NSSDA Horizontal and Vertical Check Points	20 points - see note 7		See note 10

TML survey specifications notes:

1. Areas in the project that have poor satellite visibility should be identified and a plan to minimize the effect on the data developed.
2. If necessary, project area shall be reconnoitered to determine the best time to collect the data to minimize GNSS outages and excessive artifacts in the data collection from surrounding traffic or other factors.
3. If safety conditions permit, additional checkpoints should be added in challenging GNSS environments such as urban canyons.
4. GNSS coverage of less than 5 satellites in view must not exceed the uncorrected position time or distance travelled capabilities of the TML system IMU.
5. Since all projects are different, these are only recommendations. The PSM in responsible charge of the TML must choose the appropriate accuracy and geometry of the project control points and checkpoints to insure the TML survey data and products meet or surpass accuracy requirements of the project.
6. Manufacturer's specifications for precision must be sufficient for TML system to meet or surpass accuracy requirements of the project.
7. If critical areas of the point cloud are to be used outside of the locations of the checkpoints, then additional checkpoints will be needed in those areas to meet this requirement.
8. The PSM in responsible charge must ensure the mobile LiDAR collection achieves sufficient point density to support the required detail and accuracy of TML survey data and products. Point density should be verified through sample point spacing analysis using the formula:

$$Sample\ spacing = \sqrt{1/point\ density}$$

National Cooperative Highway Research Program (NCHRP): Report 748. (2013). *Guidelines for the Use of Mobile LIDAR in Transportation Applications,* Research Board of the National Academy of Sciences.

9. Large surveys requiring less accuracy, that do not have designated project control, may use other appropriate published control upon approval by Department.

10. Specific requirements will be set in the Scope of Services.

39.7. ACCURACY ANALYSIS

The accuracy analysis of TML point cloud data shall conform to the NSSDA requirements for geospatial data classification as published by the FGDC in document FGDC-STD-007.3-1998 titled *Geospatial Positioning Accuracy Standards Part 3: National Standard for Spatial Data Accuracy*. A minimum of 20 independent horizontal and vertical check points shall be measured and distributed to reflect the geographic area of interest and expected distribution of error in the data sets. The resulting comparisons shall meet or surpass the positional accuracy requirements for the survey at the 95% confidence level based on the NSSDA and shall be included in the survey report.

39.8. QUALITY ASSURANCE/QUALITY CONTROL

Engineering design survey data points collected using TML are checked by various means including comparing scan points to check points, reviewing the digital terrain model, reviewing independent cross section data to scan surfaces, and redundant measurements. Redundant measurements with TML can only be accomplished by multiple scan runs or passes that offer overlapping coverage.

The TML data provider shall provide a Quality Assurance/Quality Control plan that includes descriptions of the proposed quality control and quality assurance plan. The plan shall address the requirements set forth in this document as well as other project specific QA/QC measures.

See ***Section 10.3*** for more information on Quality Assurance/Quality Control.

40. TML DELIVERABLES AND DOCUMENTATION

As stated earlier the origin and accuracy of the point cloud data must be supported by a survey report for it to be used with confidence, and to ensure the survey information and any byproducts are not misused.

Documentation of project TML survey(s) is an essential part of surveying work. The documentation of a scanning project must show a clear data lineage from the published primary control to the final deliverables. All project deliverables and documentation shall be included or clearly identified by reference in the survey report.

40.1. ALL TML TYPE DELIVERABLES

The first product deliverable for all TML Type surveys is an original post-processed geo-referenced point cloud in the latest (unless otherwise directed) ASPRS published LAS binary format file. Supporting documentation required but not limited to:

- Statistical system reports
- PDOP values during the survey
- Separation of forward and reverse solution (difference between forward and reverse post-process roll, pitch, yaw and XYZ positions solution).
- Areas of the project that the data collected exceeded the maximum elapsed time or distance traveled of uncorrected IMU drift due to GNSS signal loss or obstruction.
- Comparison of elevation data from overlapping (side lap) runs
- Comparison of points at the area of overlap (end lap) if more than one GNSS base is used.
- NSSDA report comparison
- Excel or file of control points with the following information: point name, geodetic coordinates (latitude/longitude and ellipsoid height), state plane coordinates, elevations, and point descriptions.

The most developed TML point cloud data has been adjusted, verified, and classified by subject type. A classified point cloud has the added value of having the individual points within it identified by class. All required classes should be specified in the contract scope as this task can be very time consuming.

40.1.1. LiDAR POINT CLASSES

ASPRS Standard LIDAR Point Classes	
Classification Value	Meaning
0	Created, never classified
1	Unclassified
2	Ground
3	Low Vegetation
4	Medium Vegetation
5	High Vegetation
6	Building
7	Low Point (noise)
8	Reserved
9	Water
10	Rail
11	Road Surface
12	Reserved
13	Wire-Guard (Shield)
14	Wire-Conductor (Phase)
15	Transmission Tower
16	Wire-structure Connector (e.g. Insulator)
17	Bridge Deck
18	High Noise
19-63	Reserved
64-255	User definable

Note: The Department continues to review classifications for TML surveys on transportation projects. The DSMO should be consulted before point classification begins.

The only required class at this time is “Erroneous” used for points with compromised accuracies. The ASPRS Classification Value of 64 should be used for this class

64	Erroneous



Whenever possible the current ASPRS classifications should be followed at this time.

The project digital products shall be submitted to the Department on a portable external USB or firewire computer drive accompanied by an itemized transmittal letter. All digital products submitted, along with any digital and hardcopy media shall become the property of the FDOT. The digital media drive shall be labeled on the outside with the following information:

- Project title
- Survey report title
- Date of survey

- Financial Management Number
- Consultant name
- Name of PSM in responsible charge
- Central Office Image Tracking Number (MSTS)

The LAS file deliverable for TML Types A and B is the resulting original post processed point cloud from the sensor. The next form of the TML point cloud data is the transformed/adjusted point cloud also saved in an LAS specific binary format.

Supporting documentation required but not limited to:

- Statistical comparison of point cloud data and finished products to check points.
- Statistical comparison of at least 5 cross sections showing differences between the surfaces created from adjusted point cloud data to cross sections collected from independent measurements of equal or higher accuracy.

The point cloud data is now ready to be imported into various software packages for further data analysis and feature extraction as well as fusing with other types of data and analytical tools creating a variety of value-added products.

The following digital products related to TML surveys that are applicable to the project shall be included:

- Binary LAS files of point cloud data from original scans
- Binary LAS files of adjusted and classified point cloud data
- Digital video or photo mosaic files
- FGDC compliant metadata files

Additional digital CADD products as covered in the current ***CADD Manual, Topic No. 625-050-001***.

- Topographic design files
- Surface / TIN files

40.2. TML SURVEY REPORT

The documentation of a mobile scanning project must show a clear data lineage from the published primary control to the final deliverables. The data path of the entire process must be defined, documented, assessable, and allow for identifying adjustment or modification. 3D data without a documented lineage is susceptible to imbedded mistakes, difficult to validate, and offers little or no reliability.

General Survey Report Content Minimum Requirements:

- Project name & identification: MSTS number, FM number, County, Route, Section, etc.
- Survey date, limits, and purpose
- Datum, epoch, and units
- Control found, held, and set for the survey
- Personnel, equipment, and surveying methods used
- Problems encountered
- Declare what TML Type A, B, or C accuracy was achieved
- Project base stations occupied
- Identification of control target points (transformation and validation)
- Results of constrained adjustment of TML data to project transformation control points
- QA/QC reports as described in ***Section 39.8*** portion of this handbook
- NSSDA analysis of checkpoints from ***Section 39.7*** portion of this handbook
- Type, shape, dimensions and graphic of target(s).
- Digital signature and seal

All TML Surveying and Mapping products submitted shall be supported by a survey report containing at a minimum all information necessary to support the precision and accuracy of TML measurements and products, and meets the ***Standards of Practice*** adopted by the Florida State Board of Professional Surveyors and Mappers. To this end the survey report shall include but is not limited to the documentation and references to digital reports, products and media, identified in this document.

APPENDIX A – NOTES, DATA COLLECTION AND DATA PROCESSING

1. NOTES AND NOTEKEEPING

Whether recorded electronically or by hand, field notes may be used by persons who are not familiar with the area, and who must rely on what is recorded in the notes. For this reason, the notes must contain all necessary information and they must be recorded in a form that will allow for easy interpretation. All field notes must be recorded in the field. Sketches may be invaluable in clarifying electronically collected data.

The current practice for the Department is to collect survey data electronically. Topography, cross-section, terrain, and other similar data can be collected and stored this way. After processing and field verification, the database is exported to Department approved design software.

The method of collecting data should be reviewed with the Department before the project is begun to assure compatibility of the digital data with Department approved formats, notation and other essentials.

Electronic data may be supplemented by notes and sketches in traditional, bound field books. If field books are submitted as part of the survey record, the following guidelines apply:

- At the discretion of the DSMO, on the front cover of each field book, indicate in ink: the project number, the county in which the survey is made, and the contents of the book, e.g. *Bench Levels and Cross Sections*. On the back edge, in ink, indicate the book number and project number. See ***Figure 1*** below.

- Sample field book certification. See ***Figure 2*** below.

- Pages will not be removed from a field book. Incorrect or obsolete notes should be marked *VOID*, dated, and initialed. Numerical data will not be erased. If a number is in error, a single line should be drawn through it, and the correct number written above.

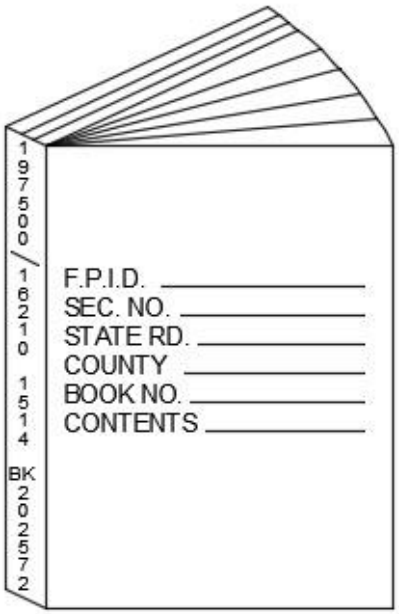
- On the inside fly sheet of each standard bound field book will be a pre-stamped form with the book number and spaces for other essential identification information which the user is required to fill in, including the job description exactly as it appears in the Department's Financial Management System. See ***Figure 1*** below.

- The next page after the identification information will be *Page 1*. To assure adequate space, pages 1-5 should be reserved for indexing and other information. The numbering of the pages is continued from page 1 throughout the field book, numbering the upper right-hand page only.

- Cross reference all incomplete items when revisions or continuations are made. Make all subsequent corrections and additions to notes in red.

- At the completion of the survey, all field books containing data for the project will be collected, organized, and delivered to the DSMO.

FIELD BOOK COVER



INSIDE COVER

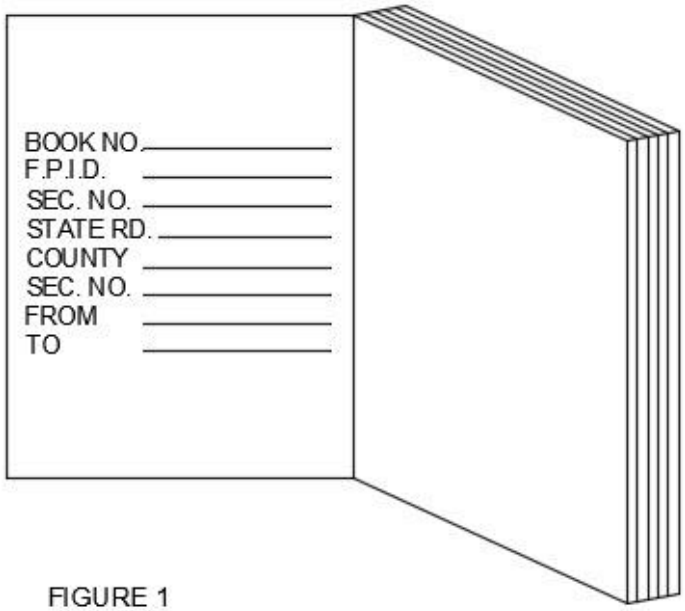


FIGURE 1

CERTIFICATION

I hereby certify that as of the date shown below, all data recorded in field book number _____ is a true representation of the field survey made under my responsible charge and that to the best of my knowledge said field survey is in compliance with the Standards of Practice adopted by the Florida Department of Agriculture and Consumer Services, Board of Professional Surveyors and Mappers.

CERTIFIED

Sign _____

Print Name _____

Florida Professional Surveyor and Mapper No. _____

Page(s) _____ Date _____

FIGURE 2

1.1. CERTIFIED FIELD BOOK

A certified field book may be kept recording the following information:

- Baseline alignment and references
- Bench levels and benchmark index
- DTM check cross sections

1.2. FIELD WORKBOOK

A segment/project field workbook may be kept to record the following information. This information includes but is not limited to the following:

- Project network control, DTM survey, R/W control survey axis test repetitions, network/traverse repetitions, and control point index/references
- Height of instrument and height of target for each setup
- A sketch of the topography chains, including DTM break line chains, with labels and pertinent point names to store the chains
- A list of chains containing chain point lists as an aid in the chain revision during post processing
- Notes to aid in post processing such as modifications to a series of points

2. ELECTRONIC SURVEY DATA COLLECTION

Electronic survey data collection applies to all methods of field survey that utilize electronic means to record measurements relating to land information, including storing, analyzing, processing, and archiving of that information. This commonly involves the use of GNSS, total stations, data collectors, and software such as, but not limited to, Access, Captivate, FieldGenius, GeoPro, Magnet, SurvCE, SurvPC, TerrSync, X-PAD, MicroStation, and Civil 3D.

2.1. CALIBRATION

Axis tests will be performed when using traditional measurement equipment (theodolite or total station).

2.2. CONTROL CHECK-IN

Control should be re-observed in direct and reverse telescope, recording horizontal angle, zenith angle, and slope distance as a check. To ensure that the setup is not disturbed, checking into the control must be done at a minimum of the beginning and end of each setup, but may need to be done more frequently in high risk areas.

2.3. ELECTRONIC MEASUREMENT METHODS

2.3.1. TOPOGRAPHY, DTM, AND R/W CONTROL SURVEY DATA

Right of way control surveys may be collected in HVD or HD mode.

2.3.2. HD MODE

Mode of measurement, normally with a total station, in which the horizontal circle reading (H) and the horizontal distance (HD) are recorded. Height of instrument, unnecessary for producing the horizontal position of the setup point, is still measured and recorded in case more than one measurement mode is used on a particular setup. Height of target is not measured and is not used in the processing.

2.3.3. HVD MODE

Mode of measurement, normally with a total station, in which the horizontal circle reading (H), the zenith circle reading (V), and the slope distance (D) are recorded. Horizontal angles are measured clockwise to the right. Zenith angles are measured from the zenith at zero degrees. Height of instrument (HI) and the height of the target (HT) are also measured and recorded. These measurements combine to process the horizontal and vertical position of a point or a series of points.

2.3.3.1. HVD OBSERAVTIONS

Refer to the Appendix F for feature coding and attributing of points and chains.

2.3.4. SOR MODE

Mode of measurement, normally with a level, level rod, and tape, in which an alignment station value (S), offset right or left of the alignment (O), and the level rod reading (R) are recorded. The horizontal and vertical position of a point or a series of points is processed based on the alignment position and a controlling elevation.

2.3.4.1. SOR OBSERVATIONS

Setup the level and record an observation to a BM or TBM. Measure and record the required stations, offsets and the corresponding level rod readings.

SOR observations are useful when locating topographic features and taking traditional cross-sections on small special purpose projects and on resurface projects where large cross-section intervals are employed and a DTM will not be computed.

3. TOPOGRAPHY

All topographic features such as roadbeds, asphalt aprons, curbs and gutters, utility poles, trees, etc. should be observed in HVD mode. All points and chains relating to the ground surface model have a ground (*G*) attribute. Only those points and chains on the ground surface are used in computing the DTM. Topography and DTM surveys should be performed in HVD or SOR mode. Horizontal angle, zenith angle, slope distance (HVD) observations should not be made for distances greater than 500 feet to ensure accurate trigonometric elevations.

3.1. CHAINS

A chain is the ordered connection of points that define the boundary of an object. The first step in collecting DTM data is locating all ground topographic chains. This is accomplished by radially observing all points along each chain (see ***Section 3.2.1. of Appendix A***). Each point along a specific chain is observed, recording the horizontal and vertical position. These points are the horizontal and vertical breaks along the chain and contain point (P) geometry or curve (C) geometry.

3.1.1. GROUND

Ground survey chains are all those break lines, as defined above, that lie on the ground surface. Ground chains are the profiles along the distinct breaks in the ground surface model. Ground chains will contain only ground points.

3.1.2. BREAK LINES

A break line is a profile line along a distinct topographic feature or along a distinct interruption in the continuity of the ground surface. The ground topographic chains are 3-D break lines for the DTM. Some examples include roadbeds, curbs and gutters, sidewalks, shoulders, tops of endwalls, tops of slopes, ditch bottoms, etc.

3.2. POINTS

3.2.1. GROUND POINTS

Ground points are all those *X, Y, Z* positions that lie on the ground surface. Ground points include ground chain points as well as random ground positions needed to accurately generate a DTM. Once the chain points have been recorded, the random ground points are observed.

3.2.2. FEATURE

Feature survey points are those *X, Y, Z* positions that, in most cases, will not be used in the DTM generation. An example is a fire hydrant located by placing the target rod on top of the hydrant. The elevation of this point will not be used when computing the DTM although its elevation is determined during post processing.

3.2.3. SPOT ELEVATIONS

Spot elevations are the random ground surface observations needed to fill the remaining areas not covered by the ground chains. These observations should be made at the high and low points in the remaining areas. Spot elevations are critical in the generation of an accurate DTM. The location of these points is left to the judgment of the PSM in responsible charge based on the project requirements of the existing ground surface, and on knowledge of the data collection/DTM system.

3.3. CHECK CROSS-SECTIONS

To ensure an accurate DTM, independent check cross-sections should be taken. These check cross-sections may be recorded in the certified field book and may also be recorded electronically using HVD mode or SOR mode. The PSM in responsible charge should meet with the DSMO to set check cross-section requirements.

4. SEGMENTING

Survey projects involve many points, chains, etc. To keep the data set manageable, the project is divided into segments.

When creating and switching between various segments, avoid point naming conflicts. One method to avoid point naming conflicts on large projects employing multiple crews is to use a suitable crew designation, e.g., the party chief's initials, as a prefix to the segment names, point names, and chain names. If a crew is assigned a different project, end the segment by checking into control and downloading and archiving the partial segment. Download each crew's data at least daily.

5. GRAPHICAL ANALYSIS

The DTM breaklines are analyzed and edited to ensure accuracy. Intersecting break lines must have a common point. Other things to look for during survey chain edits are proper attributes, proper chain lists, and proper orientation.

The data should be viewed in 3D to confirm that the survey chains are oriented correctly in the vertical plane. For example, a vertical spike in an edge of pavement chain will not be apparent in plan view. If apparent discrepancies are noted, the project should be referred to the person in responsible charge for further action.

Once the survey chains have been verified and the DTM database has been created, the DTM triangles should be computed and then verified. The most common method of DTM verification is by comparing the computed cross-sections with the check cross-sections. Discrepancies must be investigated and corrected.

6. QUALITY CONTROL

See ***Section 10.3*** for information on the QA/QC Plan.

7. DELIVERABLES

Specific deliverables are defined in the scope. In general, the deliverables may include:

- The raw, unedited field data files
- The survey database
- CADD files as described in the Survey Report

After completion of the work, all files are transferred to the Department with an itemized transmittal letter. No project will be considered complete until all deliverables are received and approved by the DSMO.

7.1. CADD REQUIREMENTS

All CADD deliverables must meet CADD quality control requirements as follows:

7.1.1. SURVEY FEATURE TABLES

A Survey Feature Codes Table is provided inclusive of all Feature Codes with associated Levels/Layers, Linear/Point designation and Field Zone, accessible from the following link:

FDOT Survey Feature Codes Excel Spreadsheet

Note Features are not limited to one * Field Survey Zone.

7.1.2. SURVEY FIELD ZONES

Zone	Points/Chains	Description
Zone 1	Topo/DTM	Pavement, Sidewalks, Trees, Fences, Buildings, Signs, etc.
Zone 2	Drainage	Drainage Structures, Culverts, Inlets, End Walls, etc.
Zone 3	Utilities	Poles, Service Cabinets, Manholes, Aerial and Underground Utilities, etc.
Zone 4	Aerial Structure	Superstructures, Bridges and Railroad Overpasses
Zone 5	Primary-Secondary Control Baseline Control (BLC)	Horizontal and Project Vertical Control, Traverse Line and Points
Zone 6	Monumentation Reference Lines, Baseline Survey Field (BL)	Alignment, Property and Boundary Ties (Found or Set)
Zone 7	Cross Section	Check Cross Section Point and Chains to verify DTM
Zone 8	ITS	Intelligent Transportation System (Points and Chains)
Zone 9	Mapping Features	Featured Mapping Elements (Points or Chains)

7.1.3. APPLICATION FEATURE TABLES AND CADD RESOURCES

7.1.3.1. GEOPAK SURVEY AND OPEN ROADS SURVEY

The GEOPAK Survey application uses a feature table called *fdot_ss10.smd*. This feature table is installed into the x:\FDOTSS10\geopak\databases\ folder by the FDOTSS10 CADD Software Install routine ('x' is the drive letter where the CADD Software is installed). The *fdot_ss10.smd* should be used when processing field measurement OBS files, importing data files, reading GEOPAK Input files and visualizing features with the Survey Display dialogue box or the COGO Navigator. The *fdot_ss10.smd* is used for both Roadway Design Surveys and Right of Way Mapping files.

The Bentley Survey application uses an XML version of the GEOPAK SMD files named *Survey_Display.xml*. *The Survey_Display.xml* feature file can be found in the x:\FDOTSS10\geopak\databases\ folder and is imbedded in the *FDOT_SurveyFeatures_RD.dgnlib* and *FDOT_SurveyFeatures_RW.dgnlib*. It is NOT necessary to manually attach this feature file when working within the FDOT workspace.

Note AutoCAD Civil 3D DESCRIPTI0N KEYS for translating point objects are found imbedded in the individual templates provided in the Department's AutoCAD State Kit and are not separate resource files. The FIGURE PREFIX DATABASE for translating chains into AutoCAD figures is delivered as part of the Department's State Kit for AutoCAD.

The cell library (*survey.cel* for Roadway design and Right of Way) should be referenced from the x:\FDOTSS10\RESOURCES\Cell\ folder x:\FDOT20YY.C3D\DATA\BLOCKS\ for AutoCAD ('YY' is the year version of Civil 3D).

7.1.3.2. AutoCAD Civil 3D

Standard survey files developed for Autodesk workflows are created by using the FDOT20YY.C3D software in conjunction with the Department's standard surveying templates provided by the FDOT20YY.C3D software install routine. These standard surveying templates are installed into the x:\FDOT20YY.C3D\Data\Templates\ folder by the FDOT20YY.C3D software Install routine ('x' is the drive letter where the FDOT20YY.C3D software is installed).

The ***LandXMLGrouper*** is also provided by the FDOT20YY.C3D software install routine. The ***LandXMLGrouper*** routine presorts XML files exported from Data Collection software into point and figure groups that can be used for building standard surveying deliverables.

Note AutoCAD Civil 3D surveying deliverables must be developed within AutoCAD to be compatible with AutoCAD workflows. Surfaces and Alignments are specific formats within AutoCAD. Point objects and figures (chains) are also specific to AutoCAD. Converting Surveying deliverable MicroStation DGN files to DWG or vice versa will not necessarily create an acceptable deliverable in the current workflows for either MicroStation or AutoCAD products.

7.2. DESIGN SURVEY GUIDELINES

7.2.1. SURVRD CADD FILE

For 3D Design purposes, the SURVRD CADD file may serve as a complete survey database deliverable. For large projects, it may be prudent to split up the Survey into multiple SURVRD files. It is appropriate for the SURVRD file(s) to contain some or all, of the elements below:

7.2.1.1. NEW SURVRD FILES

New SURVRD files should always be created with the latest FDOTSS10 or FDOTConnect FDOT 3D Seed file. This file will have in it under the **Civil Standards or Open Roads Standards** tab of the Project Explorer, **Project Settings > Survey > FDOT Survey Settings**, properties that are tailored for FDOT projects, such as Adjustment Settings, Vba Macros, Data File Parsing, Symbology and Terrain Model settings. These settings can be adjusted as needed by the project surveyor.

7.2.1.2. GEOGRAPHIC COORDINATE PROJECTION

Design file Geographic Coordinates must be set to the appropriate projection as defined by the Project Specific Datum.

7.2.1.3. MODEL PROPERTIES

Design file Model Properties **Line Style Scale:** must be set to "**Annotation Scale**".

7.2.1.4. FILE COMPLIANCY

- Quick Check with QC Inspector file compliancy.
- File must check 90% compliant to meet FDOT CADD Standards.
- Reconcile flagged errors or create exceptions where necessary to reach 90% compliancy.

7.2.1.5. SURVEY REPORT REFERENCE

As per Rule Chapter 5J-17.051 (3) Surveys, Maps, and/or Survey Products Content, and the FDOT Surveying and Mapping Handbook (Appendix D), the digital design survey must contain:

- A reference to the Survey Report.
- Information as detailed in the Rule Chapter 5J-17.051 (3)(a)-(i)

7.2.1.6. TEXT

- All Fonts should be FDOT “True Type” fonts (do not use fonts 48 or 58).
- Point label text levels, also known as point decorations, (**TextPtLabel, TextElevLabel, TextSurveyLabel**) are for points only. Point feature label levels are for the surveyor’s analysis and not for final deliverable informational labeling purposes.
- If used, text for deliverable informational labeling of features must use the feature level itself or appropriate text level below, otherwise standard file level filters will not display properly:
    - **TextDrainInvElev_ep** – Invert Elevation Label
    - **TextDrainLabel_ep** – Drainage Feature Label
    - **TextTopoLabel_ep** – Topo Feature Label
    - **TextSubUtilLabel_ep** – Subsurface Utility Label
    - **TextUtilLabel_ep** – Above Ground Utility Label
- Along with feature point labels, stationing labels, and the above feature labels there are other text levels that will pass QC in the SURVRD file.

7.2.1.7. ALIGNMENT

- Must be a Horizontal Geometry featurized linear element for 3D design projects.
    - Horizontal Geometry alignments should contain “Rules” for dynamic adjustment of the components.

  - It is not necessary to show station annotation on a Horizontal Geometry alignment in the SURVRD for 3D design purposes however, station annotation is optional.
  - For 3D design projects, the ALGNRD creation is the responsibility of the Designer.

- All Horizontal Geometry alignments must be assigned an appropriate feature definition.

  - **BL, Baseline** – BaselineSurvey
  - **BLF** – BLSurveyField_ep
  - **BLSS** – BaselineSideStreet
  - **CLC, Centerline** – CLConst_dp
  - **RRCL** – RRBaseline

7.2.1.8. RIGHT OF WAY/PLAN VIEW ELEMENTS

- Should be included in the SURVRD file.
- May be a graphical element assigned to the appropriate level.
- May be a Horizontal Geometry element with an appropriate feature definition assigned.

7.2.1.9. GRAPHIC ELEMENTS & NON-SURVEY FEATURES

Aerial Photo and LiDAR extraction produces “graphic” elements such as cells and graphic lines. Also, graphic elements can be obtained from previous or legacy surveys. Although for design purposes It is not required for extracted features to become Survey Features that are housed in a Bentley Survey Open Roads Field Book, it is an option.

- If a graphic element is needed as a Terrain Model break line, it can be added to an existing Terrain Model with the “**Add Features**” Tool. This is not a Field Book survey feature.
- If a downstream customer such as a surveyor needs Survey Features in a Field Book, then convert the graphics to Survey Features using the **Load/Import Features from Current Graphics** option by right clicking on the Field Book.

7.2.1.10. TERRAIN MODEL

- Must be a Civil Terrain Model.
- Must have an appropriate Feature Definition assigned (do not manually assign a level).
- Non-contiguous areas of DTM data must have separate Terrain Models.
- Contiguous, adjacent/overlapping Terrain Models must be combined into a Complex Terrain Model.

- Terrain Models should contain Boundaries, Voids and Holes when appropriate.
    - Boundaries will limit the Terrain Model area.
    - Voids are areas with no data that will NEVER be filled.
    - Holes are areas with no data that may be filled later with new Terrain Models.
    - Natural ground should be represented by Soft Break lines.
    - Buildings and low porches/decks are usually Voids or Break Voids (if a contour is going to wrap around the building).
- A Complex Terrain Model may be exported as a single LandXML/TIN file and re-imported as a stand-alone Terrain Model that will cover the entire project limits.
- Linear and Curve Stroking is set before the Terrain Model is created and is exhibited only in the placement of the triangles in the Terrain Model after it has been created. MicroStation must be restarted before changes to stroking take effect.
    - Curve Stroking distance is the middle ordinate of the curve between the triangle line which is being created and the curve which is being modeled.
    - Short radius curves (5' or less) need to have a tight curve stroking of no greater than 0.01 feet. Checking for spikes, pits or crossing break lines around short radius curves such as curbing around drainage structures will help determine if curve stroking is sufficient. 0.01 feet is the default Survey setting in FDOTSS10. 0.07 feet is the default for FDOTConnect due to algorithms that increase triangulation around short radius curves.
    - For FDOT projects, triangulation along a straight break line historically has been held to measure no greater than 50 feet. However, linear stroking should be lowered as the density of shots increase. 50.0 feet is the default Survey setting for linear stroking.
    - There is no lower limit on linear and curve stroking. The lower the stroke tolerance the more triangles that will be created and the larger the file becomes. At some point, there is no need to have more and smaller triangles to sufficiently represent a DTM.
    - For Aerial Photo/LAMP and LiDAR projects there may be a large number of triangles that can be reduced by filtering out unnecessary points before the Terrain Model is created. Until a standard is created by FDOT, it is up to the Surveyor that creates the Terrain Model to use professional judgement to sufficiently reduce the number of points.
    - Run **Crossing Features Report** to check for crossing features.
    - Once an obscured area has received data and a Terrain Model has been built, the OBSC feature (obscured area chain) may be removed or have its level "Frozen" if needed for documentation/legacy purposes.

7.2.1.11. PAVEMENT FEATURES

- **Pavement features:** Such as asphalt, brick, concrete pavement, concrete ditch, sidewalks, access ramps, bridge approach (AP, BRCK, CPVT, DTCHP, SWK+SWKB, RAMP, APRS) must be modeled for 3D Design and therefore should be located by the field crew in pairs
    - In 3D design the designer will close the ends of the pavement features, at the limits of the project if necessary, to make a polygon representing the sub-base of the pavement feature.
    - For projects that are not using 3D modeling, design tools look for corresponding pavement features to represent the sub-base in cross sections.
- **Adjoining pavement features:** That may or may not be located in pairs such as driveways, paved shoulders and miscellaneous pavement (DWY, SHLDR, MP) will also be turned into a polygon by the Designer for 3D modeling purposes.
    - Note that these adjoining features even if paved with the same type of material, such as asphalt, do not necessarily have the same sub-base thickness as AP and therefore should be modeled separately.
    - Usually, paved shoulders will cross driveways due to the way roads are constructed (paving machines usually do not skip driveways).
    - Driveways should use the DWY feature and should be appropriately labeled to denote the construction material (asphalt, concrete, gravel, etc.)
    - Adjoining pavement features should be located or extracted where they intersect at a coincident point. They should use the intersecting point of the two features so there will be no gap between models when creating Existing Feature Models.
- **Intersections:** Will almost always have an apparent primary and secondary roadbed when constructed. The primary roadbed will have parallel seam lines at the outer extent of the roadbed that will cross the secondary roadbed.
    - Note that it is the seam lines that defines the primary and secondary roadbeds, not the project work program ID.
    - These seam lines are usually, just in front of and coming off paved shoulders or curbing.
    - These seam lines should be feature coded appropriately as asphalt, brick, or concrete pavement (AP, BRCK, CPVT) to create the edge of the roadbed polygon.
    - Therefore, the primary roadbed will have one polygon created by the Designer, with separate polygons starting on each side of the primary that represents the secondary roadbed.
- **Medians:** Divided highways will have medians with or without curbing. Between the medians they will have cross over median breaks and turn lanes with the same sub-base thickness of the roadway. These cross overs and turn lanes are part of

the overall roadway feature polygon that is created by design and should not be model separately from the roadway.

  - Pavement features such as AP will surround a median like water surrounds an island.
  - Edge of pavement features (AP, BRCK, CPVT) will not extend from one median to another. For example, an AP feature will not extend across a cut through to another median. It must surround the median only.
  - Pavement slope breaks or seam lines may extend from one median to another. In most cases it would be appropriate to use the PAVBRK feature code as a break line.

- **Other pavement break lines:** Such as Asphalt Crown, Concrete Crown, Pavement Slope Breaks, (AC, CPVC, PAVBRK) denote slope breaks in the pavement and may be located parallel to each other multiple times. It is critical that all pavement slope breaks be located no matter how slight.
  - These break lines may or may not represent seam lines in the pavement
  - These break lines are for DTM purposes, not pavement markings.
  - These break lines may have pavement markings directly on top of them.
  - If a pavement break line or seam line is adjacent to or underneath a pavement marking, show both. For example, it is common for an AP and a LL to be inches away from each other at the edge of the roadway.
- **Pavement Markings:** There are only two linear pavement marking features. One for lane lines and one for all other pavement markings (LL, PMRK).
  - LL – Lane Lines delineate travel lanes.
  - PMRK – Pavement Markings are used for all other linear pavement marking features including but not limited to:
    - Stop Bars
    - Cross Walks
    - Gore areas
    - Hatching
    - Parking lines
  - Pavement markings are not considered “Critical Levels”. Therefore, color, weight and line style may be altered without adversely affecting the file compliancy. This gives a flexibility to the use of linear pavement markings.
    - Color may be altered. For example, from white to yellow.
    - Line weight may be raised or lowered.
    - Line style may be changed. For example, from dashed to continuous (solid) for bike lanes.
  - The Lane Line 10-20 foot skip may be altered by changing the scale of the line style itself. Note that Lane Lines do not change with the drawing scale.

- If a pavement marking is adjacent to a pavement break line or seam line, show both. For example, it is common for an LL and an AC to be inches away from each other in the center of a roadway.
- Best practice is to keep pavement markings and break lines separate.

7.2.1.12. FILE LEVEL FILTERS

- Use Standard File Filters in the level display dialogue to check for level integrity. Note that default point shot crosses and point labels (point decorations) should not show when using STANDARDS file filters
  - **ALGNRD**
  - **DREXRD**
  - **GDTMRD**
  - **TOPORD**
  - **UTEXRD**
- Use Existing feature levels and label levels to review features and labels.

7.2.1.13. MESSAGE ICONS

- Message Icons (Yellow triangles with an exclamation point) in a SURVRD file represent a problem that should be reconciled. Hovering on the icon (triangle) may display the issue. These issues may include but are not limited to:
  - Unrecognized or missing featured definitions.
  - Terrain Model issues, such as a necessary feature that has been removed.
  - Issues with corrupted survey chains or points (replace them if necessary).
  - Software version issues with older civil elements.

APPENDIX B – GNSS GUIDELINES

1. TYPES OF GNSS SURVEYS

- **Static GNSS (SGNSS)** - Carrier phase differencing technique where the integer ambiguities are resolved from an extended observation period through a change in satellite geometry. (Ionospheric model applied for baselines longer than 15 km)
- **Real-Time GNSS (RT)** – Uses measurements of the phase of the signal′s carrier wave, rather than the information content of the signal, and relies on a single reference station to provide real-time corrections.
- **Real-Time Network GNSS (RTN)** – A variation of RT GNSS surveying. Rather than setting up a base station on the project, several permanent and continuously operating base stations are set up providing the augmentation to the basic position as determined at the rover.

2. NETWORK DESIGN PLAN (NDP)

Every project that uses GNSS technology will have a NDP submitted, in open-source format, and be approved by the Department before the commencement of work.

2.1. REQUIREMENTS

Every NDP will include:

- Project Description
  - Horizontal Datum to be used
  - Vertical Datum to be used
  - Projection to be applied
  - Geoid Model to be applied
  - Ephemeris to be used
- Types of GNSS survey proposed
  - Sketch showing limits of each type of GNSS survey
- Identification, by make, model, and serial number of equipment to be used
- PPC:
  - Sketch showing project limits with PPC
- PSC:
  - Sketch showing project limits with PSC
- Network Design:
  - Sketch showing overall network design
  - Sketch showing each session design
  - Static session schedule
- Obstruction diagram for each PPC
- Datasheets for control to be used

2.2. DELIVERABLES

- Network Design Plan will be submitted in an open-source format, preferably PDF, and delivered electronically.
- A KML or KMZ file, preferably KML, can be delivered electronically to substitute for the required sketches.

3. GNSS EQUIPMENT

- Equipment for all GNSS survey activities will be multi-frequency, survey grade, carrier phase, geodetic receivers, and antennas unless prior written approval is obtained from the Department.
- A minimum of 3 GNSS receivers will be used for each session.

4. GNSS POINT TYPES

4.1. ACCURACY REQUIREMENTS

Accuracy requirements are point-type specific.

GNSS accuracy can be impacted by various error sources including obstructions, multipath, RF interference, and weather conditions, including ionospheric disturbances, tropospheric delays, heavy rain, and snow. GNSS observation times may need to be adjusted depending on error sources.

Manufacturer specific geospatial software can be used for GNSS processing and the final least squares network adjustment. All vectors used in the adjustment will be independent vectors.

See **Appendix C** for accuracy requirements for GNSS derived data.

4.2. STATEWIDE NETWORK CONTROL (FPRN)

The FPRN will serve as the Statewide Network Control for all Department projects. All newly established control will be constrained to the FPRN.

4.3. PROJECT PRIMARY CONTROL (PPC)

Local geodetic control supporting all project geospatial activities. All PPC shall have both Horizontal and Vertical components.

4.3.1. STATIC (SGNSS)

At least 2 Static GNSS observations of 1-hour, minimum, with at least a 2-hour differential is required for all Project Primary Control. Independent vectors shall be observed between newly established Project Primary Control during each session. All

independent vectors shall be occupied at least twice during the totality of sessions. Precise ephemeris shall be used for all processing. Vectors shorter than 800 M may require additional observations to achieve accuracy thresholds.

Table B1

Observation Method	Constellations	Minimum Occupation Time	Time differential	Minimum Observations
Static GNSS Observations	G	4 hours	4-hours	2
	G/R	2 hours	3-hours	2
	G/E	2 hours	3-hours	2
	G/C	2 hours	3-hours	2
	G/R/E	1.5 hours	2-hours	2
	G/R/C	1.5 hours	2-hours	2
	G/E/C	1.5 hours	2-hours	2
	G/R/E/C	1 hour	2-hours	2

4.3.2. VERTICAL COMPONENT

- Prior to performing leveling operations, a collimation shall be performed on the digital level and the results saved.
- The vertical component of Project Primary Control must be established using digital differential leveling equipment collecting redundant measurements and observations.

4.3.3. DELIVERABLES

- Raw data file, for newly established control, converted to RINEX format, open-source, and delivered electronically for each session.
- Raw data file, for FPRN stations, converted to RINEX format, open-source, and delivered electronically for each session.
- A Vertical collimation report shall be submitted in an open-source format and delivered electronically for each leveling session.
- The Vertical component of Project Primary Control data sets will be submitted in XML format, open-source, and delivered electronically for each session.

See ***Appendix C*** for accuracy requirements for GNSS derived data.

4.4. PROJECT SECONDARY CONTROL (PSC)

Local geodetic control supporting all project geospatial activities. All PSC shall have both Horizontal and Vertical components.

4.4.1. STATIC (SGNSS)

A minimum of 2 Static GNSS observations of 30-minutes with a 2-hour differential is required for all Project Secondary Control. During each session, Independent vectors shall be observed between newly established Project Primary Control. All independent vectors shall be occupied at least twice during the totality of sessions. Precise ephemeris shall be used for all processing.

Table B2

Observation Method	Constellations	Minimum Occupation Time	Time differential	Minimum Observations
Static GNSS Observations	G	4 hours	4-hours	2
	G/R	2 hours	3-hours	2
	G/E	2 hours	3-hours	2
	G/C	2 hours	3-hours	2
	G/R/E	1.5 hours	2-hours	2
	G/R/C	1.5 hours	2-hours	2
	G/E/C	1.5 hours	2-hours	2
	G/R/E/C	1 hour	2-hours	2

4.4.2. REAL-TIME (RT)

RT observations shall be used if the baseline distance (from FPRN Station) is less than 14 KM.

Table B3

Observation Method	Constellations	Minimum Occupation Time	Time differential	Minimum Observations
Real-Time (RT) GNSS Observations	G	120-epoch (0 to 14 km)	2-hour	2
	G/R	90-epoch (0 to 14 km)	2-hour	2
	G/E	90-epoch (0 to 14 km)	2-hour	2
	G/C	90-epoch (0 to 14 km)	2-hour	2
	G/R/E	60-epoch (0 to 14 km)	2-hour	2
	G/R/C	60-epoch (0 to 14 km)	2-hour	2
	G/E/C	60-epoch (0 to 14 km)	2-hour	2
	G/R/E/C	30-epoch (0 to 14 km)	2-hour	2

4.4.3. REAL-TIME NETWORK (RTN)

- Real-Time Network observations must use the Master Auxiliary Concept (MAX) solution. The Virtual Reference Station (VRS) network solution is not allowed on FDOT Projects.
- RTN observations shall be used if the baseline distance (from FPRN Station) is greater than 14 KM.

Table B4

Observation Method	Constellations	Minimum Occupation Time	Time differential	Minimum Observations
Real-Time Network (RTN) GNSS Observations	G	120-epoch (> 14 km)	2-hour	2
	G/R	90-epoch (> 14 km)	2-hour	2
	G/E	90-epoch (> 14 km)	2-hour	2
	G/C	90-epoch (> 14 km)	2-hour	2
	G/R/E	60-epoch (> 14 km)	2-hour	2
	G/R/C	60-epoch (> 14 km)	2-hour	2
	G/E/C	60-epoch (> 14 km)	2-hour	2
	G/R/E/C	30-epoch (> 14 km)	2-hour	2

4.4.4. VERTICAL COMPONENT

- Prior to performing leveling operations, a collimation shall be performed on the digital level and the results saved.
- The vertical component of Project Secondary Control must be established using digital differential leveling equipment collecting redundant measurements and observations.

4.4.5. DELIVERABLES

- Static raw data file, for newly established control, converted to RINEX format, open-source, and delivered electronically for each session.
- Static raw data file, for FPRN stations, converted to RINEX format, open-source, and delivered electronically for each session.
- RT or RTN raw data file, for newly established control, converted to GVX format, open-source, and delivered electronically for each session.
- A Vertical collimation report shall be submitted in an open-source format and delivered electronically for each leveling session.
- The Vertical component of Project Secondary Control data sets will be submitted in XML format, open-source, and delivered electronically for each session.

See ***Appendix C*** for accuracy requirements for GNSS derived data.

4.5. PROJECT VERTICAL CONTROL (PVC)

4.5.1. VERTICAL COMPONENT

- Prior to performing leveling operations, a collimation shall be performed on the digital level and the results saved.

- The vertical component of Project Vertical Control must be established using digital differential leveling equipment collecting redundant measurements and observations.

4.5.2. HORIZONTAL COMPONENT

A minimum of 1 observation using RT or RTN, using MAX solution, methods is required for all Project Vertical Control. The Virtual Reference Station (VRS) network solution is not allowed on FDOT Projects.

4.5.3. DELIVERABLES

- A Vertical collimation report shall be submitted in an open-source format and delivered electronically for each leveling session.
- Project Vertical Control data sets will be submitted in XML format, open-source, and delivered in electronic form for each session.
- RT or RTN raw data file, for horizontal portion, converted to GVX format, open-source, and delivered electronically for each session.
- Static raw data file, for FPRN station, converted to RINEX format, open-source, and delivered electronically for each session.

See ***Appendix C*** for accuracy requirements for GNSS derived data.

4.6. LOCATION / TOPOGRAPHY

4.6.1. POINT CHECK-IN

Location and topography data sets using RT or RTN, using the MAX solution, will check into Project Primary Control or Project Secondary Control before beginning each day's data collection, at a minimum of every 2 hours thereafter, and at the conclusion of the day's data collection. The Virtual Reference Station (VRS) network solution is not allowed on FDOT Projects.

4.6.2. OBSERVATIONS

Typical observations are RT or RTN, using the MAX solution, single epoch. This will be the acceptable procedure for both data collection and validation point check-in.

4.6.3. DELIVERABLES

- RT or RTN location and topography data sets shall not exceed 24 hours in length and shall be converted to GVX format, open-source, and delivered electronically for each session.
- Static raw data file, for FPRN stations, converted to RINEX format, open-source, and delivered electronically for each session.

See **Appendix C** for accuracy requirements for GNSS derived data.

5. SGNSS PROCESSING

Session processing is the only acceptable method for PPC Static GNSS processing. Single Point Positioning is not allowed. Independent vectors between newly established PPC must be observed during each session. All independent vectors shall be occupied at least twice during the totality of sessions. Precise ephemeris shall be used for all baseline processing.

5.1. SETTINGS

Table B5

Cut-Off Angle	10°
Sampling Rate	1 second or Use All
Used Satellites	Use All
Ephemeris	Precise
Antenna Calibration	NGS Absolute
Minimum Observations Used	> 80%
Minimum Fixed Ambiguities	> 80%
Solution Type	Phase Fixed
(Tropospheric) Solution Optimization	Automatic
Tropospheric Model	VMF with GPT2 model
Ionospheric Model	Automatic

5.1.1. DELIVERABLES

- Session Processing Reports (1 for each Session)
- Baseline Report (1 for each Session)
- Point Quality Report (1 for each PPC)
- Point History Report (1 for each PPC)
- Network Adjustment Report
- Final Adjusted Coordinates Spreadsheet

6. LOCALIZATION / TRANSFORMATION

When using Static observations, after completion of the final least squares adjustment of the PPC a localization / transformation file and report shall be created. The raw GNSS data shall be transformed to the final adjusted coordinates of the PPC. The localization / transformation file shall be saved and applied to all GNSS measurements subsequent to the PPC adjustment. The localization / transformation file and/or the associated report shall be distributed and used by all entities involved with the project through completion.

6.1. DELIVERABLES

- The localization / transformation files will be provided in a XML file format and delivered electronically.
- The localization / transformation report will be provided in an open-source format, preferably PDF, and delivered electronically.

7. QA/QC

7.1. SGNSS

Submit to observation files to OPUS or FPRN Computation Service.

7.2. RT or RTN

Observe 20% (at least 3) stations with 30-epoch RT or RTN, using the MAX solution, observations. The Virtual Reference Station (VRS) network solution is not allowed on FDOT Projects.

7.3. DELIVERABLES

Comparison spreadsheet showing coordinate differences between final adjusted coordinates and QA/QC coordinates.

8. SURVEY REPORT

When GNSS is used on a project, the survey report should contain standard content:

- Manufacturer specific geospatial software programs are acceptable for GNSS processing. When these programs are used, a least squares network adjustment must be applied, and a statistical analysis included in the survey report. See ***Section 9*** and ***Appendix E*** for information on survey reports.

APPENDIX C – ACCURACY REQUIREMENTS

1. BACKGROUND

Historically, surveying & mapping for Florida's transportation system rarely needed to trace the propagation of absolute (global) accuracy for the locations of its infrastructure assets. However, this began to change over two decades ago with the advent of geodetic survey measurements collected using the Global Navigation Satellite Systems (GNSS). Today survey measurements are being performed increasingly by remote sensing from mobile platforms using GNSS as part of their onboard Inertial Navigation System (INS). Even more importantly, transportation systems are connecting worldwide to support connected and self-navigating vehicles on land, sea, and air as well as transportation resiliency efforts to mitigate risks from natural phenomena throughout Florida and the world. These systems rely on Global Navigation Satellite Systems GNSS and therefore have global accuracy requirements.

2. PURPOSE

The purpose of this section is to establish the terminology and standards for establishing geodetic control supporting FDOT transportation projects. These standards are based on ***The Federal Geographic Data Committee Draft Geospatial Positioning Accuracy Standards Part 2, Standards for Geodetic Networks***.

2.1. APPLICABILITY

Geodetic network surveys are often employed when large geopolitical area (e.g., county-level or larger) mapping control is required, and where seamless connection with adjacent political areas is critical. Accurate network control may also be required for controlling interstate transportation corridors (highways, pipelines, railroads, etc.); long-span bridge construction alignment; geophysical studies; structural deformation monitoring of dams, buildings, and similar facilities.

2.2. ACCURACY DETERMINATION

The classification standard for NSRS is based on Table 2.1. The procedure leading to classification involves four steps:

1. The survey measurements, field records, sketches, and other documentation are examined to verify compliance with the specifications for the intended accuracy of the survey. This examination may lead to a modification of the intended accuracy.

2. Results of a minimally constrained, least squares adjustment of the survey measurements are examined to ensure correct weighting of the observations and freedom from blunders.

3. Local and network accuracy measures computed by random error propagation determine the provisional accuracy. In contrast to a constrained adjustment where coordinates are obtained by holding fixed datum values of the existing network control, accuracy measures are computed by weighting datum values in accordance with the network accuracies of the existing network control.

4. The survey accuracy is checked by comparing minimally constrained adjustment results against established control. The result must meet a 95 percent confidence level. This comparison takes into account the network accuracy of the existing control, as well as systematic effects such as crustal motion or datum distortion. If the comparison fails, then both the survey and network measurements must be scrutinized to determine the source of the problem.

When control points in a survey are classified, they have been verified as being consistent with all other points in the network, not merely those within that particular survey. It is not observation closures within a survey that are used to classify control points, but the ability of that survey to duplicate already established control values. This comparison takes into account models of crustal motion, refraction, and any other systematic effects known to influence survey measurements.

By supporting both local accuracy and network accuracy, the diverse requirements of NSRS users can be met. Local accuracy is best adapted to check relations between nearby control points. For example, a surveyor checking closure between two NSRS points is mostly interested in a local accuracy measure. On the other hand, someone constructing a Geographic or Land Information System (GIS/LIS) will often need some type of positional tolerance associated with a set of coordinates. Network accuracy measures how well coordinates approach an ideal, error-free datum.

2.2.1. ACCURACY REPORTING

When providing geodetic point coordinate data, a statement should be provided that the data meets a particular accuracy standard for both the local accuracy and the network accuracy.

3. SURVEY PROJECT CONTROL HIERARCHY

Currently the official datum of the United States is the NAD83 (2011). The control points used for referencing the latest 2011 realization of NAD83 are the Continuous Operating Reference Stations (CORS) that are the backbone of the National Spatial Reference System (NSRS) which is maintained by the National Geodetic Survey (NGS). The Florida Permanent Reference Network (FPRN) is aligned with the NSRS CORS stations through continuous GNSS measurements and is the basis for providing geodetic control for all FDOT survey projects. This allows for positional accuracies to be established on all transportation system assets when surveyed before and after construction.

All Project Primary Control (PPC) shall be referenced to the FPRN. The typical positional accuracy hierarchy for transportation projects can be described as follows:

1. FPRN Network Accuracy is an estimate of accuracy for the FPRN stations based on continuous GNSS measurements to the NSRS CORS stations and to each other.
2. Local Network Accuracy is an estimate of accuracy for the Project Primary Control (PPC) stations based on redundant static GNSS measurements to each nearest PPC mark and to at least three FPRN stations and computed by a properly weighted least squares network adjustment.

To compute positional accuracy for any geodetic control network requires independent measurements and a closed geometric figure. Independent meaning more than one set/group of precise measurements are made to the point or object, preferably by different observers, with different sensor setup, under different conditions, and at different observation times. Remember while sensors may differ, they must be able to measure with equal or better precision, otherwise the positional accuracy will be reduced. How many conditions must differ between sets of relative measurements to make them independent varies considerably, and therefore it falls to the expertise of the surveyor in responsible charge to determine, measure, and record results verifying accuracies have been met.

Project Relative Survey Accuracy is an estimate of how close surveyed objects within the project relate to their true position relative to the project control. This is the principal accuracy standard for project survey deliverables and will vary by product. Typical product accuracies can be found in the appropriate sections of the Surveying & Mapping Handbook. If the desired product is not covered, or a specific non-typical accuracy is required, then this should be stated clearly in the project scope.

4. Table C1 – FPRN Accuracies (Network Accuracies)

Control Type	Purpose	Method	Horizontal Positional Accuracy	Relative Horizontal Accuracy	Vertical Positional Accuracy	Relative Vertical Accuracy	Recommended Minimum Spacing
FPRN	Statewide Geodetic basis for all geospatial measurements	Continuous GNSS observations	1 cm	N/A	3 cm	N/A	N/A

5. Table C2 – Project Primary Control (PPC) Accuracies (Local Accuracies)

Control Type	Purpose	Method	Horizontal Positional Accuracy	Relative Horizontal Accuracy	Vertical Positional Accuracy	Relative Vertical Accuracy	Recommended Minimum Spacing
Project Primary Control (PPC)	Local geodetic horizontal and vertical control - basis for all project survey measurements	Static GNSS observations	1 cm ~ 0.033'	10 ppm	0.01 m ~ 0.033'	9 mm x √ (kilometers)	800 m ~ 2600'

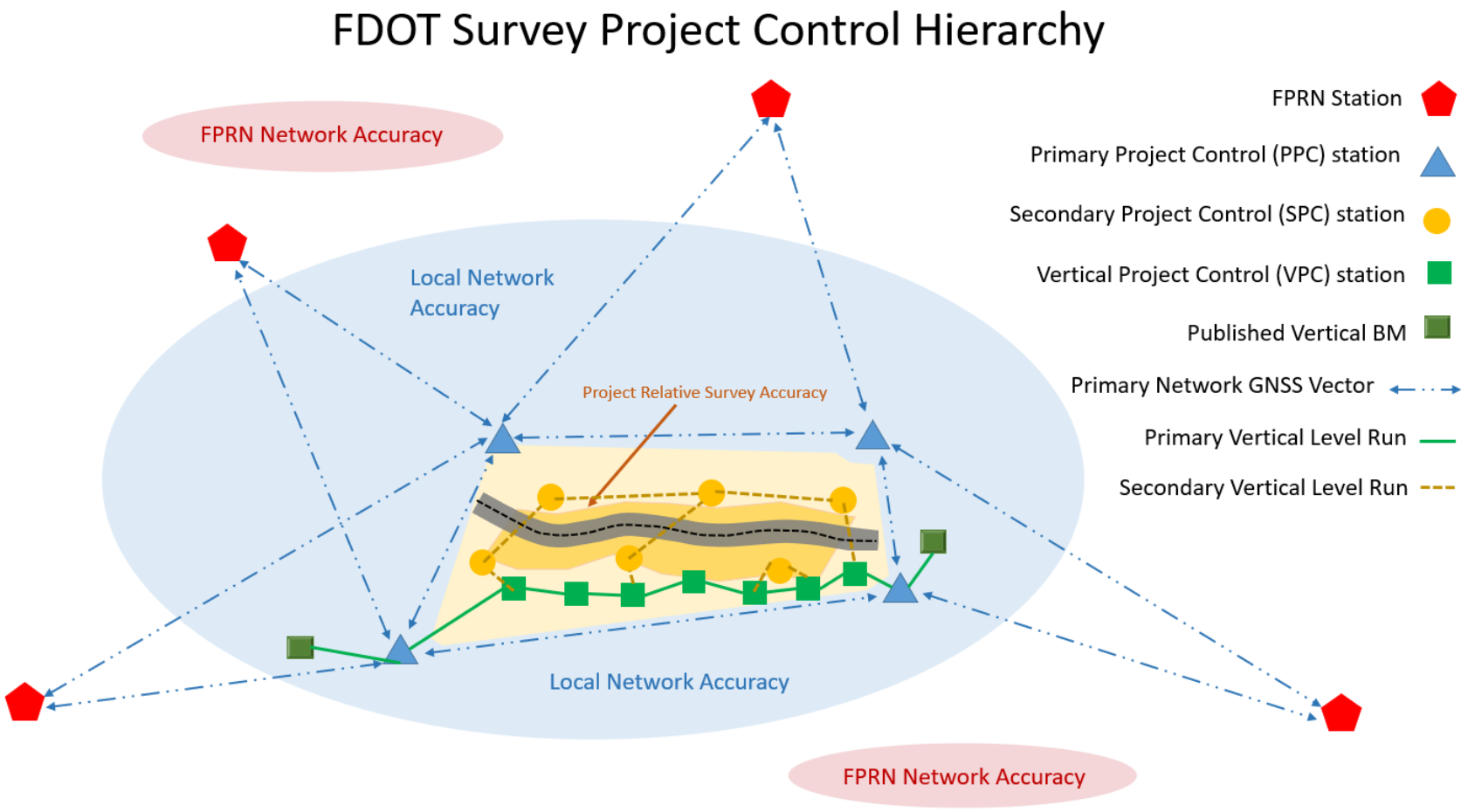
6. Table C3 – Project Secondary Control (PSC) Accuracies (Local Accuracies)

Control Type	Purpose	Method	Horizontal Positional Accuracy	Relative Horizontal Accuracy	Vertical Positional Accuracy	Relative Vertical Accuracy	Recommended Minimum Spacing
Secondary Project Control (PSC)	Local geodetic horizontal and vertical control - basis for all project survey measurements	*GNSS or terrestrial observations	2 cm ~ 0.066’	50 ppm	0.02 m ~ 0.066’	12 mm x √ (kilometers)	150 m ~ 500’

*Static, RT, RTN, and/or by 3D traverse

7. Table C4 – Project Vertical Control (PVC) Accuracies

Control Type	Purpose	Method	Horizontal Positional Accuracy	Relative Horizontal Accuracy	Vertical Positional Accuracy	Relative Vertical Accuracy	Recommended Minimum Spacing
Project Vertical Control (VPC)	Local vertical control	GNSS RT or RTN observations	1 m ~ 3.281'	1000 ppm	0.01 m ~ 0.033'	9 mm x √ (kilometers)	300 m ~ 1000'


FDOT Survey Project Control Hierarchy
FPRN Network Accuracy
Local Network Accuracy
Project Relative Survey Accuracy
Local Network Accuracy
FPRN Network Accuracy
FPRN Station
Primary Project Control (PPC) station
Secondary Project Control (SPC) station
Vertical Project Control (VPC) station
Published Vertical BM
Primary Network GNSS Vector
Primary Vertical Level Run
Secondary Vertical Level Run

8. Table C - NOTES

1. Project Primary Control must be established using static GNSS observations.
2. The vertical component of Project Primary Control must be established using digital differential leveling equipment collecting redundant measurements and observations.
3. All Horizontal and Vertical control are derived from properly weighted least squares network adjustments, and all associated accuracies shall be presented at the 95% confidence level.
4. Positional accuracies of control can be improved through additional independent measurements of equal or higher confidence. This is especially desirable when minimum control point spacings cannot be met.
5. Secondary Project Control must be referenced to the Project Primary Control Network.
6. Secondary Project Control shall be established by GNSS static, GNSS RTK, GNSS RTN and/or by closed 3D traverse.
7. The vertical component of Secondary Project Control must be established using digital differential leveling equipment collecting redundant measurements. Single observations are permitted, however redundant observations are preferred.
8. R/W control and monumentation shall be established (or located) through redundant measurements using GNSS static, GNSS RTK, GNSS RTN and/or by 3D traverse and must be referenced to the Project Primary and/or Secondary Project Control Networks.
9. Location and Topography can be performed by all appropriate static and mobile survey methods and must be referenced to Primary or Secondary Project Control.

APPENDIX D – FORMS AND TEMPLATES

For standardization, this section contains sample forms to be used for survey project submittals. However, there may be other District specific forms that are required in addition to the forms shown in this section. See the DSMO for District specific forms.

Right of Way Requirement Changes Tracking Form

FDOT Project Log

Percentage of Field Work Complete Form

Percentage of Control Map Complete Form

Percentage of Right of Way Map Complete Form

Weekly Report of Survey Activities

Right of Way Requirement Changes Tracking Form

Form Created: June 07, 2004; Updated; June 05, 2009, April 24, 2012, October 07, 2013, August 6,2015

FPN:	Section:	Project Description:		FDOT PM:
Design Firm:		EOR Name:	Signature:	Date:
60% Phase II Plans Approved/Comment Resolution Date:		R/W Req. & LOC to S&M (start 60% Map) Date:		60% Mapping Team Meeting (Parcel by Parcel Review) Date: Initial No. of Parcels:
100% R/W Map Complete Date:		DOC's to R/W Date:		Final No. of Parcels:
List Dates for Each Time Form is Updated With Changes:				

(1) All dates are actual, not scheduled dates.
(2) All rows are expanding, so please provide sufficient detail as required. To insert a row go to Table, Insert, Rows (this allows the form to be kept in Parcel No. order).
(3) The first four (4) columns below will be completed for all requirements/parcels with the initial date added being the same date r/w requirements are delivered to the R/W Surveyor to start 60% R/W Map stage. The initial form is required to be submitted both electronically and signed hard copy.
(4) The initial form will be completed during the 60% Mapping Team Meeting (parcel by parcel review) which will be held as soon as possible after delivery of the requirements.
(5) The remaining columns will be completed for only those parcels that are proposed for changes after the Mapping Team Meeting through right of way certified clear.
(6) Any issue that can not be resolved during the parcel by parcel review and proposed changes occurring after the parcel by parcel review will be submitted to the Department Heads for review and decision on the direction to take.
(7) Code:
01 Design Change to Scope (i.e. typical section, drainage design)
02 Variance or Exception Granted
03 Permitting Issue
04 Utility Design Issue
05 Local Agency (JPA) Delay or Default
06 Design Accommodation versus R/W Take (i.e. wall vs. slope easement)
07 Design Mistake
08 Survey Mistake
09 Property Changes Resulting from Complete Title Work (i.e. property split)
10 Tweaking of Design Due to Final Geometry Calcs on Property Lines
11 Avoid Impacts to Real Estate Improvements
12 Reduce Damages to Remainder Property
13 Development of the Property
14 Real Estate Costs
15 Real Estate Interest Change (i.e. fee to easement)
16 Property Owner's Request
17 Uneconomic Remnant
18 Other

Approximate Survey Line Station Lt. / Rt.	Parcel No. (Assigned By S&M)	Fee, PE,TE, LA	Date Parcel Added	Date of Request to Change Parcel	Discipline Requesting Change (Design, R/W, S&M)	Code	Reason for Change	Date Change Approved GR,JA,FL,AB

FDOT Project Log

State Road No: _____
From: _____
To: _____
Financial Profect No: _____
County: _____
Road Section/Roadway ID No: _____
Name of Reporting Consultants _____

Begin Reporting Period Log

Reporting Period: From _____ To _____

Major Project Milestones

(Use N/A if not applicable. Add tasks if not shown. **Do not delete tasks/actions**)

FDOT Staff Hour Tab # 27, 28 or 30

		% Complete
27.1	Horizontal Project Network Control (by XXX)	
27.2	Project Vertical Control/Bench Run (by XXX)	
27.3	Alignment and Existing R/W Ties	
27.4	Aerial Targets (by XXX)	
27.5	Reference Points	
27.6	Topography/DTM (3D)	
27.7	Planimetric (2D)	
27.8	Roadway Cross-Sections/Profiles	
27.9	Side Street Surveys	
27.10	Underground Utilities (by XXX)	
27.11	Outfall Surveys	
27.12	Drainage Surveys (by XXX)	
27.13	Bridge Surveys	
27.14	Channel Surveys	
27.15	Pond Site Surveys	
27.16	Mitigation Surveys	
27.17	Jurisdictional Surveys	
27.18	Geotechnical Surveys	
27.19	Sectional/Grant Surveys	
27.20	Subdivision Location	

27.21	Maintained R/W	
27.22	Boundary Surveys	
27.23	Water Boundary Surveys	
27.24	R/W Staking/R/W Line	
27.25	R/W Monumentation	
27.26	Line Cutting	
27.27	Work Zone Safety	
27.28	Miscellaneous Surveys	
27.29	Supplemental Surveys	
28.01	Flight Preparation (by XXX)	
28.02	Control Point Coordination (by XXX)	
28.03	Mobilization (by XXX)	
28.04	Flight Operations (by XXX)	
28.05	Film Processing (by XXX)	
28.06	Photo Products (by XXX)	
28.09	Aerial Triangulation (by XXX)	
28.10	Digital Terrain Model (3D) (by XXX)	
28.16	Planimetrics (2D) (by XXX)	
28.18	CADD Edits (by XXX)	
28.19	Data Merging (by XXX)	
28.21	Field Review (by XXX)	

	Scheduled Date	Actual Date
Alignment Review Submittal		
30% Control Survey Map Submittal		
Mainline Design Survey Submittal		
60% Control Survey Map Submittal		
90% Control Survey Map Submittal		
Updated Design Survey Submittal		
30% R/W Map Submittal		
60% R/W Map Submittal		
100% Control Survey Submittal		
90% R/W Map Submittal		
100% R/W Map Submittal		
Certified Design Survey Deliverables		

Actions for Current Reporting Period: _____

Actions Expected for Next Reporting Period: _____

This report needs to reflect the present status (in percent complete) of the project when compared to the scoped tasks. This report needs to show all actions applicable to each reporting period and must be submitted no later than the last Tuesday of every month or as otherwise requested.

PERCENTAGE OF FIELD WORK COMPLETE FORM

0

FIRM NAME

0

SURVEYOR IN CHARGE

SURVEYOR IN CHARGE SIGNATURE

INVOICING PERIOD DATES: 1/0/1900 to 1/0/1900 NTP DATE: 1/0/1900

FINANCIAL PROJECT # : 0 DATABASE # : 0

PROJECT LIMITS: 0

Limiting Amount

PERCENTAGE COMPLETE

WORK ITEMS	CONTRACT DAYS/HOURS	TOTAL DAYS/HOURS USED	PERCENT OF TASK FIELD SURVEY	NOTES:
Horizontal PNC	2	1	50%	
Vertical PNC/Bench line	2	1	50%	
Alignment and/or Existing R/W lines	2	1	50%	
Reference Points	2	1	50%	
Topography (2D)	2	1	50%	
Digital Terrain Model (DTM)	2	1	50%	
Roadway Cross-Sections/Profile	2	1	50%	
Underground Utilities Designates	2	1	50%	
Underground Utilities Locates	2	1	50%	
work Zone Safety	2	1	50%	
Supplemental Surveys	2	1	50%	
TOTAL	22	11	**TOTAL FIELD WORK PERCENT:**	50%

I APPROVE / DISAPPROVE THE PERCENTAGE OF WORK COMPLETED.

SIGNATURE: **DATE:**

Surveying & Mapping Consultant Management Department

PERCENTAGE OF CONTROL MAP WORK COMPLETE FORM

0

FIRM NAME

0

SURVEYOR IN CHARGE

SURVEYOR IN CHARGE SIGNATURE

INVOICING PERIOD DATES: 1/0/1900 to 1/0/1900 NTP DATE: 1/0/1900

FINANCIAL PROJECT # : 0 DATABASE # : 0

PROJECT LIMITS: 0

PERCENTAGE COMPLETE

WORK ITEMS	CONTRACT HOURS	TOTAL HOURS USED	PERCENT OF TASK CONTROL MAP	NOTES:
COVER SHEET	2	1	50%	
KEY SHEET(S)	2	1	50%	
DETAIL SHEET(S)	2	1	50%	
REFERENCE SHEET(S)	2	1	50%	
QA/QC	2	1	50%	
TOTAL	10	5	**TOTAL CONTROL MAP PERCENT:**	50%

I APPROVE / DISAPPROVE THE PERCENTAGE OF WORK COMPLETED.

SIGNATURE: **DATE:**

District Right of Way Surveyor

PERCENTAGE OF RIGHT OF WAY MAP WORK COMPLETE FORM

0

FIRM NAME

0

SURVEYOR IN CHARGE

SURVEYOR IN CHARGE SIGNATURE

INVOICING PERIOD DATES: 1/0/1900 to 1/0/1900 NTP DATE: 1/0/1900

FINANCIAL PROJECT # : 0 DATABASE # : 0

PROJECT LIMITS: 0

PERCENTAGE COMPLETE

WORK ITEMS	CONTRACT HOURS	TOTAL HOURS USED	PERCENT OF TASK RIGHT OF WAY MAP	NOTES:
COVER SHEET	2	1	50%	
KEY SHEET(S)	2	1	50%	
DETAIL SHEET(S)	2	1	50%	
TABLE OF OWNERSHIPS SHEET(S)	2	1	50%	
LEGAL DESCRIPITIONS	2	1	50%	
QA/QC	2	1	50%	
TOTAL	12	6	**TOTAL RIGHT OF WAY MAP PERCENT:**	50%

I APPROVE / DISAPPROVE THE PERCENTAGE OF WORK COMPLETED.

SIGNATURE: **DATE:**

District Right of Way Surveyor



WEEKLY REPORT OF SURVEY ACTIVITIES

FIELD CREW HOURS SHOWN HEREON ARE FROM THE TIME THE FIELD CREW LEAVES THE CONSULTANT'S OFFICE IN THE MORNING TO THE TIME THEY RETURN TO THE OFFICE IN THE AFTERNOON, EXCLUDING TIME SPENT FOR LUNCH.

Contract No.: 0 Authorization No. 0 FM No.: 0 Database No. 0

CONSULTANT:	Project Description:	**Based on a 4 Man 8 Hour day F.C.**
0	0	

Date: 1/0/1900		Date: 1/1/1900		Date: 1/2/1900		Date: 1/3/1900		Date: 1/4/1900		Date: 1/5/1900		Date 1/6/1900	
Crew Name	Hours	Crew Name	Hour	Crew Name	Hours	Crew Name	Hours	Crew Name	Hour	Crew Name	Hours	Crew Name	Hours
TASK:		TASK:		TASK:		TASK:		TASK:		TASK:		TASK:	
Office Name	Hours	Office Name	Hour	Office Name	Hours	Office Name	Hours	Office Name	Hour	Office Name	Hours	Office Name	Hours
Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:		Sr Surveyor & Mapper:	
Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper		Surveyor and Mapper	
CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech		CADD/Survey Tech	
Clerical:		Clerical:		Clerical:		Clerical:		Clerical:		Clerical:		Clerical:	
TASK:		TASK:		TASK:		TASK:		TASK:		TASK:		TASK:	

APPENDIX E – SURVEY REPORT

This section contains a standard format for survey reports that will be submitted to the Department. This format may not cover all necessary information for every survey report, as all projects and types of surveys are different. Because of this, some projects may require more information to be included in a survey report than what is outlined herein. It is always appropriate to include as much information as necessary when preparing a survey report.

1. PROJECT INFORMATION

1.1. Firm
1.2. Financial Project Number
1.3. Project name
1.4. State Road Number
1.5. Roadway Section Identification Number
1.6. Project limits, e.g. *This project is along SR 10 (US 90) between Magnolia Drive and Capital Circle NE in Leon County, FL.*
1.7. Survey date (give the start and end dates)
1.8. Units of measure

2. TYPE OF SURVEY

State the type of survey in accordance with Rule Chapter 5J-17.050, Florida Administrative Code. If the survey is a specific purpose survey, state the purpose.

3. METHODOLOGY

This section should explain the method(s) used in the survey process. If this is a topographic survey, give a description of the procedure(s) used to collect topographic information; if it is a control survey, state the procedure used in setting or locating monumentation.

The statistical analysis of the least squares network adjustment generated by the Manufacturer specific geospatial software program should be included in this section.

The localization / transformation report parameters should be included in this section.

Also, this is the place to explain the procedures used in the development of the Digital Terrain Model (DTM).

4. PROJECT CONTROL

4.1. Horizontal Datum

4.2. Horizontal Control Points – list all control points set and/or used. If the list is long, attach it as an appendix.

4.3. Vertical Datum

4.4. Vertical Control Points – list all control points set and/or used. If the list is long, attach it as an appendix**.**

5. SOURCES

Identify any sources used in the preparation of the survey, e.g. right of way maps, plats, legal descriptions, aerial imagery, abstracts of title, jurisdictional areas, ordinary high-water lines, mean high water lines.

6. GENERAL NOTES

This section should include any survey notes that typically appear on the face of a survey map, e.g. *This survey is not valid without the signature and original seal of a Florida licensed surveyor and mapper.*

7. LEGEND AND ABBREVIATIONS

This section should include all abbreviations, symbols and line types used in the digital file(s).

8. COMPILATION OF SURVEYS

When a survey project involves multiple surveyors or firms, a lead surveyor will be identified. A comprehensive survey report will be prepared by the lead surveyor and should detail the total survey, describing the roles and responsibilities of each surveying entity and will reference and include as attachments, all survey reports prepared by the other surveyors involved in the project.

9. FILES LIST

List all files that are part of the deliverables.

10. CERTIFICATION

I hereby certify that this survey and all files herein are a true and accurate representation of a field survey made under my responsible charge, and that to the best of my knowledge meets the Standards of Practice as set forth by the Board of Professional Surveyors and Mappers in Rule Chapter 5J-17 of the Florida Administrative Code.

_____ _____

Name Date

Florida Professional Surveyor and Mapper

License Number _____

APPENDIX G – SURVEY FEATURE CODES

FDOT Survey Feature Codes Excel Spreadsheet

Feature Code	LEVEL NAME	Level Description	Point / Line	ZONE
AC	PavtAsphaltCrown_ep	Asphalt Pavement Crown (Existing)	L	1
AGF	AgricultField_ep	Agricultural Field or Farmland (Not Groves or Orchards) (Existing)	L	1
AGV	VaultsAG_ep	Vaults Above Grade (Existing)	L	3
AP	PavtAsphalt_ep	Asphalt Pavement Edge (Existing)	L	1
APRS	Bridge_ep	Bridge Approaches and Slabs (Existing)	L	1
ARST	ArchSite_ep	Archeological Site (Existing)	L	1
ATTN	Attenuator_ep	Attenuator Systems (Existing)	L	1
BARW	WallBarrier_ep	Barrier Wall Dividing Traffic (All Types) (Existing)	L	1
BAS	Basins_ep	Sediment Basins, Retention Ponds (Existing)	L	2
BCATVA	CATVBurA_ep	Cable TV Line Quality Level A Locate (Buried) (Existing)	L	3
BCATVB	CATVBurB_ep	Cable TV Line Quality Level B Designate (Buried) (Existing)	L	3
BCATVC	CATVBurC_ep	Cable TV Line Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
BCATVD	CATVBurD_ep	Cable TV Line Quality Level D Existing Records (Buried) (Existing)	L	3
BGV	VaultsBG_ep	Vaults Below Grade (Existing)	L	3
BL	BaselineSurvey	Baseline Survey	L	6
BLC	BLSurveyCntrl_ep	Baseline Survey Control (Traverse Line)	L	5
BLDG	Building_ep	Buildings (Existing)	L	1
BLF	BLSurveyField_ep	Baseline Survey Field (Calculated from BLC)	L	6
BLSS	BaselineSideStreet	Baseline Side Street	L	6
BNK	BankMent_ep	Embankment (Manmade, Top or Bottom) (Existing)	L	1
BOH	BuildingOH_ep	Building Roof Overhangs (Encroachments) (Existing)	L	1
BPWRA	ElecBurA_ep	Electrical Quality Level A Locate (Buried) (Existing)	L	3
BPWRB	ElecBurB_ep	Electrical Quality Level B Designate (Buried) (Existing)	L	3
BPWRC	ElecBurC_ep	Electrical Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
BPWRD	ElecBurD_ep	Electrical Quality Level D Existing Records (Buried) (Existing)	L	3
BRCK	PavtBrick_ep	Brick Pavement Edge (Brick Roadways and Sidewalks) (Existing)	L	1

BRDG	BridgeEle_ep	Bridge Elements (Existing)	L	4
BSECA	ElecBurSecA_ep	Conductor (Secondary Distribution) Quality Level A Locate (Buried) (Existing)	L	3
BSECB	ElecBurSecB_ep	Conductor (Secondary Distribution) Quality Level B Designate (Buried) (Existing)	L	3
BSECC	ElecBurSecC_ep	Conductor (Secondary Distribution) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
BSECD	ElecBurSecD_ep	Conductor (Secondary Distribution) Quality Level D Existing Records (Buried) (Existing)	L	3
BSTP	BusStop_ep	Bus Stop (Chain for Larger Structures) (Existing)	L	1
BTA	TeleBurA_ep	Telephone (All Sizes) Quality Level A Locate (Buried) (Existing)	L	3
BTB	TeleBurB_ep	Telephone (All Sizes) Quality Level B Designate (Buried) (Existing)	L	3
BTC	TeleBurC_ep	Telephone (All Sizes) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
BTD	TeleBurD_ep	Telephone (All Sizes) Quality Level D Existing Records (Buried) (Existing)	L	3
BTDA	TeleBurDA_ep	Telephone, DUCT (All Sizes) Quality Level A Locate (Buried) (Existing)	L	3
BTDB	TeleBurDB_ep	Telephone, DUCT (All Sizes) Quality Level B Designate (Buried) (Existing)	L	3
BTDC	TeleBurDC_ep	Telephone, DUCT (All Sizes) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
BTDD	TeleBurDD_ep	Telephone, DUCT (All Sizes) Quality Level D Existing Records (Buried) (Existing)	L	3
BTTA	TeleBurTA_ep	Telephone, TOLL (All Sizes) Quality Level A Locate (Buried) (Existing)	L	3
BTTB	TeleBurTB_ep	Telephone, TOLL (All Sizes) Quality Level B Designate (Buried) (Existing)	L	3
BTTC	TeleBurTC_ep	Telephone, TOLL (All Sizes) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
BTTD	TeleBurTD_ep	Telephone, TOLL (All Sizes) Quality Level D Existing Records (Buried) (Existing)	L	3
BXC	BoxCulvert_ep	Box Culvert (Existing)	L	2
CAN	Canal_ep	Canal, Lock (Existing)	L	1
CAPA	ElecCAPA_ep	Capacitors (Above Ground) (Existing)	L	3
CAPB	ElecCAPB_ep	Capacitors (Buried) (Existing)	L	3
CATV	CATVAer_ep	Cable TV Line (Aerial) (Existing)	L	3
CATVCA	CATVCondBurA_ep	Cable TV Conduit System Quality Level A Locate (Buried) (Existing)	L	3
CATVCB	CATVCondBurB_ep	Cable TV Conduit System Quality Level B Designate (Buried) (Existing)	L	3
CATVCC	CATVCondBurC_ep	Cable TV Conduit System Quality Level C Above Ground Evidence (Buried) (Existing)	L	3

CATVCD	CATVCondBurD_ep	Cable TV Conduit System Quality Level D Existing Records (Buried) (Existing)	L	3
CB	CatchBasin_ep	Catch Basins (Existing)	L	2
CBR	CableBarrier_ep	Cable Barrier (Existing)	L	1
CCR	CurbRamp_ep	Curb Cut Ramp (Existing)	L	1
CEM	Cemetery_ep	Cemetery, Grave Outlines (Existing)	L	1
CG	CGep_ep	Curb / Curb and Gutter (at EP & FL) (Existing)	L	1
CGB	CGBack_ep	Curb and Gutter (Back) (Existing)	L	1
CGF	CGFace_ep	Curb and Gutter (Face) (Existing)	L	1
CINL	InletCurb_ep	Curb Inlets (Existing)	L	2
CLC	CLConst_dp	Centerline Construction	L	6
CNPY	Canopy_ep	Shelters of All Kinds (Gas Station, Toll Plaza, etc.) (Existing)	L	1
COE	WetlandCOE_ep	Unitied States Army Corps of Engineers (COE) Wetlands (Marsh or Swamp) (Existing)	L	1
COL	GovCountyLine_ep	Government: County Line (Existing)	L	9
CONV	Conveyor_ep	Conveyor Belt Systems (All Types) (Industrial, Agricultural, etc.) (Existing)	L	1
CPVC	PavtConcreteCrown_ep	Concrete Pavement (Crown) (Existing)	L	1
CPVJ	PavtConcJoints_ep	Concrete Pavement (Joints) (Existing)	L	1
CPVT	PavtConcrete_ep	Concrete Pavement (Edges) (Existing)	L	1
CRW	CurbRampWarning_ep	Detectable Warnings on Curb Ramps (Existing)	L	1
CSL	ConcSlabs_ep	Concrete Slabs (Existing)	L	1
CYL	GovCityLimitLine_ep	Government: City Limit Line (Existing)	L	9
DECK	Deck_ep	Deck / Porch (Existing)	L	1
DEP	WetlandDEP_ep	Water Management Districts (WMD) & Florida Department of Environmental Protection (DEP) Wetlands (Existing)	L	1
DFL	FlowLine_ep	Ditch Flow Line Direction (Ditches, Swells, etc.) (Existing)	L	2
DOCK	Docks_ep	Docks and Wharfs (Existing)	L	1
DRIP	TreeDripLine_ep	Tree Drip Line for Delineating Root Systems (Existing)	L	1
DRNB	InletBottom_ep	Drainage Structure Bottoms (Existing)	L	2
DRNP	DrainPipes_ep	Drainage Pipes and Spouts (Existing)	L	2
DTCH	Ditch_ep	Ditch (Top, Bottom and Flow Lines) (Existing)	L	2
DTCHI	InletDBI_ep	Ditch Bottom Inlet (Existing)	L	2
DTCHP	DitchPavt_ep	Ditch Pavement (Existing)	L	2
DUCTA	ConduitA_ep	Utility Conduit & Encasements Quality Level A Locate (Existing)	L	3
DUCTB	ConduitB_ep	Utility Conduit & Encasements Quality Level B Designate (Buried) (Existing)	L	3
DUCTC	ConduitC_ep	Utility Conduit & Encasements Quality Level C Above Ground Evidence (Buried) (Existing)	L	3

DUCTD	ConduitD_ep	Utility Conduit & Encasements Quality Level D Existing Records (Buried) (Existing)	L	3
DUMB	DummyChains_ep	Dummy Chains (Existing)	L	1
DWY	Driveway_ep	Driveway (Drive, Lane, Turnouts) (Existing)	L	1
ECP	ElecMultiCtrl_ep	Electric Control Panel with Multiple Controls (Existing)	L	3
ELECS	ElecServBox_ep	Electric Service Box (Large) (Existing)	L	3
EM	WetlandEM_ep	Edge of Mangrove (Existing)	L	1
ESL	EndangeredL_ep	Endangered Species Line	L	1
ESMT	EaseLine_ep	Easement Lines (Existing)	L	9
ESMTP	EasePerpLine	Easement Lines Perpetual (Proposed)	L	9
EXIST	DTMBoundary_ep	Digital Terrain Model (DTM) Boundary (Existing)	L	1
FES	EndTreatFES_ep	Flared End Section (Existing)	L	2
FMA	SanitaryFM_A_ep	Force Main (All Sizes) Quality Level A Locate (Existing)	L	3
FMB	SanitaryFM_B_ep	Force Main (All Sizes) Quality Level B Designate (Buried) (Existing)	L	3
FMC	SanitaryFM_C_ep	Force Main (All Sizes) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
FMD	SanitaryFM_D_ep	Force Main (All Sizes) Quality Level D Existing Records (Buried) (Existing)	L	3
FNC	Fence_ep	Fence (All Types) (Existing)	L	1
FO	FOTAer_ep	Fiber Optics Telephone (Aerial) (Size Unknown) (Existing)	L	3
FOC	FOCAer_ep	Fiber Optics Cable (Aerial) (Existing)	L	3
FOCUA	FOCBurA_ep	Fiber Optics Cable Quality Level A Locate (Buried) (Existing)	L	3
FOCUB	FOCBurB_ep	Fiber Optics Cable Quality Level B Designate (Buried) (Existing)	L	3
FOCUC	FOCBurC_ep	Fiber Optics Cable Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
FOCUD	FOCBurD_ep	Fiber Optics Cable Quality Level D Existing Records (Buried) (Existing)	L	3
FOP	FOEAer_ep	Fiber Optics Electrical (Aerial) (Existing)	L	3
FOPUA	FOEBurA_ep	Fiber Optics Electrical Quality Level A Locate (Buried) (Existing)	L	3
FOPUB	FOEBurB_ep	Fiber Optics Electrical Quality Level B Designate (Buried) (Existing)	L	3
FOPUC	FOEBurC_ep	Fiber Optics Electrical Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
FOPUD	FOEBurD_ep	Fiber Optics Electrical Quality Level D Existing Records (Buried) (Existing)	L	3
FOTVUA	FOTVBurA_ep	Fiber Optics Television Quality Level A Locate (Buried) (Existing)	L	3
FOTVUB	FOTVBurB_ep	Fiber Optics Television Quality Level B Designate (Buried) (Existing)	L	3
FOTVUC	FOTVBurC_ep	Fiber Optics Television Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
FOTVUD	FOTVBurD_ep	Fiber Optics Television Quality Level D Existing Records (Buried) (Existing)	L	3
FOUA	FOTBurA_ep	Fiber Optics Telephone Quality Level A Locate (Buried) (Existing)	L	3

FOUB	FOTBurB_ep	Fiber Optics Telephone Quality Level B Designate (Buried) (Existing)	L	3
FOUC	FOTBurC_ep	Fiber Optics Telephone Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
FOUD	FOTBurD_ep	Fiber Optics Telephone Quality Level D Existing Records (Buried) (Existing)	L	3
FUSE	ElecFuse_ep	Fuses (Existing)	L	3
GASA	GasA_ep	Gas Line (All Sizes) Quality Level A Locate (Existing)	L	3
GASB	GasB_ep	Gas Line (All Sizes) Quality Level B Designate (Buried) (Existing)	L	3
GASC	GasC_ep	Gas Line (All Sizes) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
GASD	GasD_ep	Gas Line (All Sizes) Quality Level D Existing Records (Buried) (Existing)	L	3
GBRK	GroundBrkLine_ep	Ground Break Line (Not Slopes or Embankments) (Existing)	L	1
GI	InletGutter_ep	Gutter Inlets (All Types) (Existing)	L	2
GOLF	Golf_ep	Golf Course Features (All Types) (Existing)	L	1
GRDBL	GuardrailDbl_ep	Guardrail Double Face (Existing)	L	1
GRL	GuardrailLt_ep	Guardrail Left (Existing)	L	1
GRR	GuardrailRt_ep	Guardrail Right (Existing)	L	1
GRT	DrainGrate_ep	Metal Drainage Grate within Concrete Structure (Existing)	L	2
GRTL	GovGrantLine_ep	Government: Grant Line (Existing)	L	9
GRV	TreeLineGrove_ep	Groves & Orchards (Boundary) (Existing)	L	1
GT	Gates_ep	Gates (Existing)	L	1
GTM	GasTestMisc_ep	Gas Test & Miscellaneous (Existing)	L	3
GYS	GuyWireSpan_ep	Span Guys (Existing)	L	3
HED	ShrubHedge_ep	Hedges and Shrubs (Boundary) (Existing)	L	1
HNDRL	Railing_ep	Railings (All Types); Piperail, Guiderail, Handrail Used for Pedestrian and Bicycles (Existing)	L	1
HVL	ElecAerHVL_ep	High Voltage Transmission Line (Existing)	L	3
ITFCA	ITSFiberCableA_ep	Intelligent Transportation System (ITS) Fiber Cable Quality Level A Locate (Buried) (Existing)	L	8
ITFCB	ITSFiberCableB_ep	Intelligent Transportation System (ITS) Fiber Cable Quality Level B Designate (Buried) (Existing)	L	8
ITFCC	ITSFiberCableC_ep	Intelligent Transportation System (ITS) Fiber Cable Quality Level C Above Ground Evidence (Buried) (Existing)	L	8
ITFCD	ITSFiberCableD_ep	Intelligent Transportation System (ITS) Fiber Cable Quality Level D Existing Records (Buried) (Existing)	L	8
JB	DrainJnctBox_ep	Drainage Junction Box (Existing)	L	2
LARW	LARWLine_ep	Limited Access Right of Way Lines (Existing)	L	9
LARWP	LARWLine	Limited Access Right of Way Lines (Proposed)	L	9

LICAG	EaseLicLine	Easement License Agreement Line	L	9
LL	LaneLine_ep	Pavement Marking - Lane Lines, Delineates Travel Lanes (Existing)	L	1
LMB	LowBrdgMemb_ep	Low Members of the Bridge (Existing)	L	4
LOC	ConstLimits	Construction Limits	L	9
LOTLN	GovLotLine_ep	Government: Lot Line (Existing)	L	9
LV	SlopesLevee_ep	Levees, Dikes, or Dams (Top or Bottom) (Existing)	L	1
MAINT	MaintLine	Maintenance Line	L	9
MAR	WetlandMAR_ep	Edge of Wetlands (Marsh or Swamp) (Existing)	L	1
MEDI	InletMedian_ep	Median Inlets (Existing)	L	2
MEDRL	GovMeanderLine_ep	Government: Meander Line (Existing)	L	9
MES	EndTreatMES_ep	Mitered End Section (Existing)	L	2
MHWL	MHWL_TIITF_Line	TIITF:Mean / Ordinary High Water Lines	L	9
MISC	TopoMisc_ep	Topography (Miscellaneous) (Existing)	L	1
MP	PavtMisc_ep	Pavement Parking Lot/Guardrail/Miscellaneous Pavement (Existing)	L	1
MS	SignMulti_ep	Multi-column Sign (Large Sign) (Existing)	L	1
MURPHY	Murphy_TIITF_Line	TIITF: Upland TIITF:Murphy Reservations Lines	L	9
NPWLA	WaterNP_A_ep	Non-potable Water Line (All Sizes) Quality Level A Locate (Existing)	L	3
NPWLB	WaterNP_B_ep	Non-potable Water Line (All Sizes) Quality Level B Designate (Buried) (Existing)	L	3
NPWLC	WaterNP_C_ep	Non-potable Water Line (All Sizes) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
NPWLD	WaterNP_D_ep	Non-potable Water Line (All Sizes) Quality Level D Existing Records (Buried) (Existing)	L	3
NSPF	GovParkLine_ep	Government: National or State Park or Forest Line (Existing)	L	9
NVAL	NonVehcLine_ep	Existing:Non-Vehicular Access Line	L	9
OBSC	AreaObscured_ep	Obscured Area (Existing)	L	1
PAVBRK	PavtBreak_ep	Pavement Slope Break Line (Existing)	L	1
PCULV	PipeCulvert_ep	Pipe Culvert (Existing)	L	2
PETROA	Oil_A_ep	Oil Line (All Sizes) Quality Level A Locate (Existing)	L	3
PETROB	Oil_B_ep	Oil Line (All Sizes) Quality Level B Designate (Buried) (Existing)	L	3
PETROC	Oil_C_ep	Oil Line (All Sizes) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
PETROD	Oil_D_ep	Oil Line (All Sizes) Quality Level D Existing Records (Buried) (Existing)	L	3
PILE	PilingColumn_ep	Pilings and Columns (All Types) (Existing)	L	1
PIPENA	PipeEncaseA_ep	Pipe Encasements Quality Level A Locate (Existing)	L	3
PIPENB	PipeEncaseB_ep	Pipe Encasements Quality Level B Designate (Buried) (Existing)	L	3

PIPENC	PipeEncaseC_ep	Pipe Encasements Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
PIPEND	PipeEncaseD_ep	Pipe Encasements Quality Level D Existing Records (Buried) (Existing)	L	3
PLNT	LandscapeBordr_ep	Landscape Planter Structures and Areas (Existing)	L	1
PMPIS	PumpIsland_ep	Pump Island (Existing)	L	1
PMRK	PMRK_ep	Pavement Marking - Line Markings (Exclude Travel Lanes) (Existing)	L	1
POOL	Pools_ep	Pools and Fountains (Not Ponds) (All Types) (Existing)	L	1
PRI	ElecAerPri_ep	Conductors (Primary Distribution) (Aerial) (Existing)	L	3
PROP	PropertyLine_ep	Property Lines / Lot Lines (Existing)	L	9
PWR	ElecAer_ep	Electrical Conductors (Distribution & Transmission) (Aerial) (Existing)	L	3
QQTRS	GovQtrQtrLine_ep	Government: Quarter / Quarter Section Line (Existing)	L	9
QTRS	GovQuarterLine_ep	Government: Quarter Section Line (Existing)	L	9
RAMP	AccessRamp_ep	Accessible Ramp (For Buildings, Docks, Sidewalks, etc.) (Not Curbs) (Existing)	L	1
RD	Trail_ep	Roadway,Trail (Unpaved) (Existing)	L	1
REFL	RefPtLine	Survey Reference Point Line / Detail (Miscellaneous)	L	6
RETW	WallRetainEarth_ep	Wall Holding Earth (All) (Existing)	L	1
RIP	RipRap_ep	Rip Rap, Rubble (Existing)	L	1
ROW	RWLine_ep	Right of Way Lines (Existing)	L	9
ROWP	RWLine	Right of Way Lines (Proposed)	L	9
RR	RailroadTracks_ep	Railroad Tracks (Rail, Bed) (Existing)	L	1
RRCL	RRBaseline	Baseline:Rail Road Centerline	L	6
RRX	RailroadXing_ep	Railroad Crossing (Roadway Platforms), Railroad Signal w/ Gate (Existing)	L	1
SCT	TreeLineScatter_ep	Scattered Trees (Boundary) (Existing)	L	1
SE	SanitarySewerEff_ep	Sanitary Effluent (Open Channel) (Existing)	L	3
SEAW	WallSea_ep	Sea Walls (Existing)	L	1
SEC	ElecAerSec_ep	Conductors (Secondary Distribution) (Aerial) (Existing)	L	3
SECT	GovSectionLine_ep	Government: Section Lines (Existiing)	L	9
SEW	EndTreatSEW_ep	Straight Endwall (Existing)	L	2
SGNT	SignTrussOH_ep	Trusses and Cantilevers for Overhead Signs (Existing)	L	1
SHLDR	ShldrPaved_ep	Shoulder Edge (Paved) (Existing)	L	1
SLC	LiteCond_ep	Street Lighting Conduit (Existing)	L	3
SLP	Slopes_ep	Natural Slopes (Top or Bottom) (Existing)	L	1
SLV	SubVacOrigLotLine	Subdivision Vacated or Original Lot Line (Existing)	L	9
SMAE	SignalSupportExt_ep	Signal Support Mast Arm Extension (Existing)	L	1
SPD	DrainSpecial_ep	Special Drainage Feature (Describe) (Existing)	L	2
SPEW	EndTreatSPEW_ep	Special Endwall (Existing)	L	2

SPL	DrainSpillwy_ep	Spillways, Flumes or Scuppers (Existing)	L	2
SSA	SanitarySewerA_ep	Sanitary Sewer (All Sizes) Quality Level A Locate (Existing)	L	3
SSB	SanitarySewerB_ep	Sanitary Sewer (All Sizes) Quality Level B Designate (Buried) (Existing)	L	3
SSC	SanitarySewerC_ep	Sanitary Sewer (All Sizes) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
SSD	SanitarySewerD_ep	Sanitary Sewer (All Sizes) Quality Level D Existing Records (Buried) (Existing)	L	3
SSW	SpanWire_ep	Signal / Span Wire (Existing)	L	1
STCKP	StockPile_ep	Stock Piles (All Types) (Dirt, Gravel, Sand, etc.) (Existing)	L	1
STEAMA	SteamA_ep	Steam Line Quality Level A Locate (Existing)	L	3
STEAMB	SteamB_ep	Steam Line Quality Level B Designate (Buried) (Existing)	L	3
STEAMC	SteamC_ep	Steam Line Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
STEAMD	SteamD_ep	Steam Line Quality Level D Existing Records (Buried) (Existing)	L	3
STL	GovStateLine_ep	Government: State Line (Existing)	L	9
STP	Stairs_ep	Stairways, Steps (Existing)	L	1
STRM	StreamEdge_ep	Stream Edge (Existing)	L	1
STRMC	StreamCtr_ep	Stream Center (Existing)	L	1
STS	StormSewer_ep	Storm Sewer (All Sizes) (Drain Pipes and Spouts) (Existing)	L	2
SUBL	SubDivLine	Subdivision Line (Existing)	L	9
SUEL	SUEL_TIITF_Line	DEP:TIITF:Safe Upland Elevation Lines or Jurisdictional Lines established by DEP methodology	L	9
SW	Switchgear_ep	Switchgear & Appurtenances (Existing)	L	3
SWK	SidewalkFront_ep	Sidewalk (Fronts) (Existing)	L	1
SWKB	SidewalkBack_ep	Sidewalk (Backs) (Existing)	L	1
TEL	TeleAer_ep	Telephone Line (Aerial) (Existing)	L	3
TELS	TeleServBox_ep	Telephone Service Box (Large) (Existing)	L	3
TESMT	EaseTempLine_ep	Easement Lines Temporary (Existing)	L	9
TESMTP	EaseTempLine	Easement Lines Temporary (Proposed)	L	9
TFD	SignalLoop_ep	Traffic Detector Loops (Existing)	L	1
TFSP	TrafSeparator_ep	Traffic Separator (Existing)	L	1
TMPW	TempBarrier_ep	Temporary Barrier Dividing Traffic (All) (Existing) (Temporary)	L	1
TRANSA	ElecBurPriA_ep	Conductors (Primary Distribution) Quality Level A Locate (Buried) (Existing)	L	3
TRANSB	ElecBurPriB_ep	Conductors (Primary Distribution) Quality Level B Designate (Buried) (Existing)	L	3
TRANSC	ElecBurPriC_ep	Conductors (Primary Distribution) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3

TRANSD	ElecBurPriD_ep	Conductors (Primary Distribution) Quality Level D Existing Records (Buried) (Existing)	L	3
TRD	Treadle_ep	Treadle, Axle Sensor (Existing)	L	1
TWP	GovTwpRgeLine_ep	Government: Township and Range Government Survey Line	L	9
TX	PavtTractorXing_ep	Tractor Crossings (Existing)	L	1
UD	UnderDrain_ep	Underdrains and Cross Drains (Existing)	L	2
UEW	EndTreatUEW_ep	U-Type Endwall (Existing)	L	2
UMISC	UtilMisc_ep	Utility Items (Miscellaneous) (Existing)	L	3
UNPS	ShldrUnpaved_ep	Shoulders (Unpaved) (Existing)	L	1
VOID	VoidArea_ep	Void Area (No Locations Collected) (Existing)	L	1
WALL	Wall_ep	Walls (Existing)	L	1
WDL	TreeLineWoods_ep	Woods Line (Existing)	L	1
WEDG	WaterEdge_ep	Edge of Water (Existing)	L	1
WEW	EndTreatWEW_ep	Winged Endwall (Existing)	L	2
WLA	WaterA_ep	Water Line (All Sizes) Quality Level A Locate (Existing)	L	3
WLB	WaterB_ep	Water Line (All Sizes) Quality Level B Designate (Buried) (Existing)	L	3
WLC	WaterC_ep	Water Line (All Sizes) Quality Level C Above Ground Evidence (Buried) (Existing)	L	3
WLD	WaterD_ep	Water Line (All Sizes) Quality Level D Existing Records (Buried) (Existing)	L	3
XO	PavtXover_ep	Crossovers and Detours (Temporary) (Existing)	L	1
XSC	XSPatternlines_ep	Cross Section Chain (Existing)	L	7
YD	YardDrain_ep	Yard Drain (Existing)	L	2
25MPH	PM25MPH_ep	Pavement Marking Message - 25 MPH (Existing)	P	1
ACU	AirCondition_ep	Air Conditioning Unit (Existing)	P	1
AHEAD	PMAHEAD_ep	Pavement Marking Message - AHEAD (Existing)	P	1
ANT	Antenna_ep	Antenna (Existing)	P	3
AT	MonumentAT_ep	Control Monuments - Aerial Targets	P	5
BIKE	PMBIKE_ep	Pavement Marking Message - BIKE (Existing)	P	1
BIKELN	PMBikeLane_ep	Pavement Marking Symbol - Bicycle (Existing)	P	1
BKRK	BikeRack_ep	Bicycle Rack (All Sizes) (Existing)	P	1
BN	Beacons_ep	Beacons and Path Illumination (Existing)	P	3
BNCH	Bench_ep	Bench (Existing)	P	1
BOL	Bollard_ep	Bollards (Existing)	P	1
BUMP	PMBUMP_ep	Pavement Marking Message - BUMP (Existing)	P	1
BUOY	Buoy_ep	Buoy (Existing)	P	1
BUS	PMBUS_ep	Pavement Marking Message - BUS (Existing)	P	1
CALCPT	CalcPt	Mapping Calculated 2D Point	P	9

CATVS	CATVMisc_ep	Cable TV Service Box and Miscelleneous, Pole (Existing)	P	3
CCMON	MonumentCCC_ep	Control Monuments - Concrete (Cast)	P	5
CDH	MonumentCDH_ep	Control Monuments - Drill Hole, Plug	P	5
CDRM	MonumentCDR_ep	Control Monuments - Deep Rod Mark	P	5
CGD	CattleGuard_ep	Cattle Guard (Existing)	P	1
CIRC	MonumentCIRC_ep	Control Monuments - 5/8 Rod and Cap	P	5
CLMT	TowerTrans_ep	Transmission Tower (Single Column) (Existing)	P	3
CLNO	SanitarySewerCLNO_ep	Sanitary Sewer Cleanout (Existing)	P	3
CMON	MonumentCC_ep	Monuments - Concrete (Cast)	P	6
CMPST	Campstove_ep	Campstove, Grill, Firepit, BBQ (Existing)	P	1
CNL	MonumentCNL_ep	Control Monuments - Nail, Spike, Pin	P	5
COM	MonumentCOM_ep	Control Monuments - Other Marker?	P	5
CPIP	MonumentCPIP_ep	Control Monuments - Metal Pipe, Rod, Bar	P	5
CPMON	MonumentCCP_ep	Control Monuments - Concrete (Poured)	P	5
CPST	MonumentCPST_ep	Control Monuments - Post, Stake, Staub	P	5
CSH	Core_ep	Core Sample or Test Hole (Existing)	P	1
CSTMD	MonumentCSTD_ep	Control Monuments - Stamped Disk	P	5
CSTMP	MonumentCSTP_ep	Control Monuments - Stamped Plate	P	5
DEFAULT	PointLocator_ep	Point Locator Symbol (Existing) To Accommodate Bentley Default Output	P	1
DEFAULT_POINT	PointLocator_ep	Point Locator Symbol (Existing) To Accommodate Bentley Default Output	P	1
DF	Dolphins_ep	Dolphins and Fenders (Existing)	P	1
DH	MonumentDH_ep	Monuments - Drill Hole, Plug	P	6
DLP	DelineatorPost_ep	Delineator Post, Metal and Flexible (Existing)	P	1
DMP	Trash_ep	Dumpster, Trash Disposal (Existing)	P	1
DMPS	SanitarySewerDSta_ep	Sanitary Sewer Dump Station (SS) (Existing)	P	3
DRM	MonumentDR_ep	Monuments - Deep Rod Mark	P	6
EAST	PMEAST_ep	Pavement Marking Message - EAST (Existing)	P	1
ELEO	ElecOutlet_ep	Electrical Outlet (Existing)	P	3
EOI	SU_Interupt_ep	Subsurface Utility (End of Interuption) (Existing)	P	3
ESP	EndangeredP_ep	Endangered Species Point	P	1
FAU	WaterFct_ep	Faucet (Existing)	P	3
FC	TankUG_ep	Fill Cap (Buried Tank) (Existing)	P	1
FFE	FFElev_ep	Finished Floor Elevation (Existing)	P	2
FH	FireHydrant_ep	Fire Hydrant (Existing)	P	3
FLD	FloodLight_ep	Flood Light (Existing)	P	3
FP	FlagPole_ep	Flag Pole (Existing)	P	1
GA	Gauges_ep	Gauges (Existing)	P	3

GND	GroundShot_ep	Ground Shot for Digital Terrain Model (DTM) Densification (Hard Bottom Soundings) (Existing)	P	1
GYA	GuyWireAnchor_ep	Guy Anchor (Existing)	P	3
GYP	GuyWirePole_ep	Guy Pole (Dead-man) (Existing)	P	3
HML	Tower_ep	High Mast Lighting Poles (Existing)	P	3
HNDC	PMAccessible_ep	Pavement Marking Symbol - Accessible (Handicap) (Existing)	P	1
HOLE	Hole_ep	Hole (Existing)	P	1
HUMP	PMHUMP_ep	Pavement Marking Message - HUMP (Existing)	P	1
INCN	Furnace_ep	Incinerator, Boiler, or Furnace (Existing)	P	1
INV	FlowlineInvert_ep	Flow Line or Invert Elevations (Existing)	P	2
IRC	MonumentIRC_ep	Monuments - 5/8 Rod and Cap	P	6
ITCP	ITSCamera_ep	Intelligent Transportation System (ITS) Closed Caption TV Camera Pole (Existing)	P	8
ITPS	ITSPwrSupply_ep	Intelligent Transportation System (ITS) Closed Caption TV Power Supply (Wired, Solar, etc) (Existing)	P	8
ITVS	ITSVehSensor_ep	Intelligent Transportation System (ITS) Vehicle Sensor, Infared (Existing)	P	8
LANE	PMLANE_ep	Pavement Marking Message - LANE (Existing)	P	1
LEFT	PMLEFT_ep	Pavement Marking Message - LEFT (Existing)	P	1
LP	Luminaire_ep	Street Light / Pole (Existing)	P	3
MBX	Mailbox_ep	Mailbox(s) (Existing)	P	1
ME	MeterElec_ep	Meter (Electric) (Existing)	P	3
MERGE	PMMERGE_ep	Pavement Marking Message - MERGE (Existing)	P	1
MERGLT	PMMergeLeft_ep	Pavement Marking - Merge Left Arrow (Existing)	P	1
MERGRT	PMMergeRight_ep	Pavement Marking - Merge Right Arrow (Existing)	P	1
MEU	MeterElecBur_ep	Meter (Electric) (Buried) (Existing)	P	3
MG	MeterGas_ep	Meter (Gas) (Existing)	P	3
MH	ManholeUnknown_ep	Manhole (Unknown) (Existing)	P	3
MHCATV	ManholeCOMM_ep	Manhole (Communications) (Existing)	P	3
MHD	ManholeSW_ep	Manhole (Storm Water) (Existing)	P	2
MHE	ManholeElec_ep	Manhole (Electric) (Existing)	P	3
MHG	ManholeGas_ep	Manhole (Gas) (Existing)	P	3
MHS	ManholeSS_ep	Manhole (Sanitary Sewer) (Existing)	P	3
MHT	ManholeTel_ep	Manhole (Telephone) (Existing)	P	3
MHW	ManholeWater_ep	Manhole (Water) (Existing)	P	3
MON	MonConRW	Mapping Concrete Monument Right of Way (Annotation Cell)	P	9
MONRD	MonRodOpen	Mapping Rod Monument Open (Found) (Annotation Cell)	P	9
MONRDS	MonRodSolid	Mapping Rod Monument Solid (Set) (Annotation Cell)	P	9

MONSQ	MonConcOpen	Mapping Concrete Monument Open (Found) (Annotation Cell)	P	9
MONSQS	MonConcSolid	Mapping Concrete Monument Solid (Set) (Annotation Cell)	P	9
MONW	WellMon_ep	Well Monitoring, Taps (Existing)	P	3
MPH	PMMPH_ep	Pavement Marking Message - MPH (Existing)	P	1
MU	MeterUnk_ep	Meter (Unknown) (Existing)	P	3
MW	MeterWater_ep	Meter (Water) (Existing)	P	3
NL	MonumentNL_ep	Monuments - Nail, Spike, Pin	P	6
NORTH	PMNORTH_ep	Pavement Marking Message - NORTH (Existing)	P	1
NOTE	TextFeatureLabel	Text - Feature Label	P	1
OM	MonumentOM_ep	Monuments - Other Marker?	P	6
ONLY	PMONLY_ep	Pavement Marking Message - ONLY (Existing)	P	1
OP	ShrubOrnamental_ep	Ornamental Plant (Existing)	P	1
PASS	PMPASS_ep	Pavement Marking Message - PASS (Existing)	P	1
PED	PMPED_ep	Pavement Marking Message - PED (Existing)	P	1
PHW	HazardWaste_ep	Potential Hazardous Waste Site (Old Gas Stations, Dry Cleaners, etc.) (Existing)	P	1
PIL	PilingPt_ep	Pilings, Piers, or Columns (Existing)	P	1
PIP	MonumentPIP_ep	Monuments - Metal Pipe, Rod, Bar	P	6
PKGM	ParkMeter_ep	Parking Meter (Existing)	P	1
PLEQ	Playground_ep	Playground Equipment (Existing)	P	1
PMON	MonumentCP_ep	Monuments - Concrete (Poured)	P	6
PMP	PumpNonPet_ep	Pump (Non Petroleum) (Existing)	P	3
PMPF	Pump_ep	Pump (Petroleum / Fuel) (Existing)	P	3
PMPST	SanitarySewerPSta_ep	Pump Station (Sanitary Sewer) (Existing)	P	3
POST	Post_ep	Post or Pole (Not Monuments) (Existing)	P	1
PP	PoleElec_ep	Electrical Pole (Existing)	P	3
PPT	PoleElecT_ep	Electrical Pole With Transformer (Existing)	P	3
PRWM	MonPermRW	Mapping Permanent Right of Way Monument (Annotation Cell)	P	9
PS	PedSignal_ep	Pedestrian Signal Unit, Signage (Existing)	P	1
PST	MonumentPST_ep	Monuments - Post, Stake, Staub	P	6
QDEL	SU_Delineator_ep	Subsurface Utility (Quality Level Delineator) (Existing)	P	3
QLA	SU_QLA_ep	Subsurface Utility Quality Level A Locate (Existing)	P	3
QLB	SU_QLB_ep	Subsurface Utility Quality Level B Designate (Existing)	P	3
QLC	SU_QLC_ep	Subsurface Utility Quality Level C Above Ground Evidence (Existing)	P	3
QLD	SU_QLD_ep	Subsurface Utility Quality Level D Existing Records (Existing)	P	3
QTREW	GovQtrSectCnrEW_ep	Government: 1/4 Section Corner E or W (Existing)	P	9
QTRNS	GovQtrSectCnrNS_ep	Government: 1/4 Section Corner N or S (Existing)	P	9

RAAL	PMRoundaboutApproachL_ep	Pavement Marking - Roundabout Approach Left Arrow (Existing)	P	1
RAALT	PMRoundaboutApproachLT_ep	Pavement Marking - Roundabout Approach Left-Thru Arrow (Existing)	P	1
RAFL	PMRoundaboutFishL_ep	Pavement Marking - Roundabout Fish-hook Left Arrow (Existing)	P	1
RAFLR	PMRoundaboutFishLR_ep	Pavement Marking - Roundabout Fish-hook Left-Right Arrow (Existing)	P	1
RAFT	PMRoundaboutFishT_ep	Pavement Marking - Roundabout Fish-hook Thru Arrow (Existing)	P	1
RAFTL	PMRoundaboutFishTL_ep	Pavement Marking - Roundabout Fish-hook Thru-Left Arrow (Existing)	P	1
RAFTLR	PMRoundaboutFishTLR_ep	Pavement Marking - Roundabout Fish-hook Thru-Left-Right Arrow (Existing)	P	1
RAFTR	PMRoundaboutFishTR_ep	Pavement Marking - Roundabout Fish-hook Thru-Right Arrow (Existing)	P	1
REDULT	PMLaneReduceLeft_ep	Pavement Marking Message - Lane Reduction Left Arrow (Existing)	P	1
REDURT	PMLaneReduceRight_ep	Pavement Marking Message - Lane Reduction Right Arrow (Existing)	P	1
RG	GasReg_ep	Gas Regulator (Existing)	P	3
RIGHT	PMRIGHT_ep	Pavement Marking Message - RIGHT (Existing)	P	1
RLS	PMRLS_ep	Pavement Marking Symbol - Restricted Lane (Existing)	P	1
RRMP	RailroadMP_ep	Railroad Milepost (Existing)	P	1
RRS	RailroadSwitch_ep	Railroad Switch (Existing)	P	1
RRWS	RailroadWarn_ep	Railroad Warning Sign (Existing)	P	1
RXR	PMRXR_ep	Pavement Marking Symbol - Railroad Crossing Symbol (Existing)	P	1
SAT	MonumentSAT_ep	Monuments - Hub and Tac	P	6
SATD	SateDish_ep	Satellite Dish Antenna (Existing)	P	3
SCHOOL	PMSCHOOL_ep	Pavement Marking Message - SCHOOL (Existing)	P	1
SGNC	SignColumn_ep	Cantilevered Sign Column (Large) (Existing)	P	1
SHARLN	PMSharedLane_ep	Pavement Marking Symbol - Shared Lane (with bicycles) (Existing)	P	1
SHP	PoleShared_ep	Shared Pole (Existing)	P	3
SHPT	PoleSharedT_ep	Shared Pole with Transformer (Existing)	P	3
SHR	Shrub_ep	Shrub, Bush (Existing)	P	1
SHRC	ShrubConiferous_ep	Coniferous Shrub (Existing)	P	1
SHRD	ShrubDeciduous_ep	Deciduous Shrub (Existing)	P	1
SHWM	WaterSeasHghMrk_ep	Seasonal High Water Mark (Bridges, Drainage Ponds and Trees as marked by Environmental) (Existing)	P	2
SIG	Signal_ep	Signal Head (Existing)	P	1
SIGC	SignalControl_ep	Signal Controller (Existing)	P	1
SIGNAL	PMSIGNAL_ep	Pavement Marking Message - SIGNAL (Existing)	P	1
SIGP	SignalPedestal_ep	Signal on Pedestal (Existing)	P	1
SILO	Silo_ep	Silo (Existing)	P	1
SILT	GroundShotSilt_ep	Top Elevation of Muck or Silt (Soft Bottom Soundings)	P	1
SLOW	PMSLOW_ep	Pavement Marking Message - SLOW (Existing)	P	1
SMA	SignalSupport_ep	Signal Supports (Including Mast Arm) (Existing)	P	1

SOUTH	PMSOUTH_ep	Pavement Marking Message - SOUTH (Existing)	P	1
SP	WaterStandpipe_ep	Standpipe (Existing)	P	3
SPH	Sprinkler_ep	Sprinkler Head (Existing)	P	3
SPLE	ITSFiberSpliceE_ep	Intelligent Transportation System (ITS) Fiber Spliced Enclosure (Existing)	P	8
SPLV	ITSFiberSpliceV_ep	Intelligent Transportation System (ITS) Fiber Spliced Vault (Buried) (Existing)	P	8
SPR	Tributary_ep	Spring (Water Source) (Existing)	P	1
SRVC	JunctBox_ep	Junction Box / Service Cabinet (Elec/Tel) (Existing)	P	3
SSP	SpanWireP_ep	Signal / Span Wire Pole (Existing)	P	1
SSS	SignSingle_ep	Sign (Single Pole Support) (Existing)	P	1
STAL	PMSTAL_ep	Pavement Marking - Straight and Turn Arrow Left (Existing)	P	1
STALR	PMTALRS_ep	Pavement Marking - Turn Arrow Left, Right and Straight (Existing)	P	1
STAR	PMSTAR_ep	Pavement Marking - Straight and Turn Arrow Right (Existing)	P	1
STAROW	PMSTAROW_ep	Pavement Marking - Straight Through Direction Arrow (Existing)	P	1
STM	Stump_ep	Stump (Existing)	P	1
STMD	MonumentSTD_ep	Monuments - Stamped Disk	P	6
STMP	MonumentSTP_ep	Monuments - Stamped Plate	P	6
STOP	PMSTOP_ep	Pavement Marking Message - STOP (Existing)	P	1
STTK	TankStor_ep	Storage Tank (Existing)	P	1
SUN	PMSUN_ep	Pavement Marking Message - SUN (Existing)	P	1
SWG	RailroadSgnalG_ep	Railroad Signal with Gate (Existing)	P	1
TAL	PMTAL_ep	Pavement Marking - Turn Arrow Left (Existing)	P	1
TALR	PMTALR_ep	Pavement Marking - Turn Arrow Left and Right (Existing)	P	1
TAR	PMTAR_ep	Pavement Marking - Turn Arrow Right (Existing)	P	1
TB	TeleBooth_ep	Telephone Booth (Existing)	P	3
TCALM	PMTrafCalm_ep	Pavement Marking Symbol - Traffic Calm Warning (Existing)	P	1
TELP	TelePole_ep	Telephone Pole (Existing)	P	3
TG	StreamGauge_ep	Stream or Tide Gauge (Existing)	P	1
THA	SU_QLATestHole_ep	Subsurface Utility Test Hole (QLA Only) (Existing)	P	3
TO	PMTO_ep	Pavement Marking Message - TO (Existing)	P	1
TPD	TelePed_ep	Telephone Pedestal / Service (Existing)	P	3
TREE	Tree_ep	Trees (Unknown) (Existing)	P	1
TREEC	TreeConiferous_ep	Coniferous Tree (Existing)	P	1
TREECI	TreeCitrus_ep	Citrus Tree (Existing)	P	1
TREECY	TreeCypress_ep	Cypress Tree (Existing)	P	1
TREED	TreeDeciduous_ep	Deciduous Tree (Existing)	P	1
TREEOA	TreeOak_ep	Oak Tree (Existing)	P	1

TREEPA	TreePalm_ep	Palm Tree (Existing)	P	1
TREEPC	TreePalmCluster_ep	Palm Tree Cluster (Existing)	P	1
TREEPI	TreePine_ep	Pine Tree (Existing)	P	1
TRNF	Transformer_ep	Transformer (Existing)	P	3
TURN	PMTURN_ep	Pavement Marking Message - TURN (Existing)	P	1
UDBX	UnderDrainBx_ep	Underdrain Box (Existing)	P	2
UMKR	UtilMarker_ep	Subsurface Utility Marker (Existing)	P	3
UTURN	PMUTurn_ep	Pavement Marking - U-Turn Arrow (Existing)	P	1
VB	ValveBox_ep	Valve Box (Existing)	P	3
VBG	ValveBoxGas_ep	Valve Box (Gas) (Existing)	P	3
VBNPW	ValveBoxWtrNP_ep	Valve Box (Non-potable Water) (Existing)	P	3
VBS	ValveBoxSwr_ep	Valve Box (Sewer) (Existing)	P	3
VBW	ValveBoxWtr_ep	Valve Box (Water) (Existing)	P	3
VC	ValveCover_ep	Valve Cover (Unknown) (Existing)	P	3
VCEF	ValveCvrEff_ep	Valve Cover (Effluent) (Existing)	P	3
VCG	ValveCvrGas_ep	Valve Cover (Gas) (Existing)	P	3
VCNPW	ValveCvrWaterNP_ep	Valve Cover (Non-potable Water) (Existing)	P	3
VCRW	ValveCvrWtrRaw_ep	Valve Cover (Raw Water) (Existing)	P	3
VCS	ValveCvrSewer_ep	Valve Cover (Sewer) (Existing)	P	3
VCW	ValveCvrWater_ep	Valve Cover (Water) (Existing)	P	3
VLV	Valve_ep	Valve (Unknown) (Existing)	P	3
VLVB	ValveBFP_ep	Valve (Back Flow Preventer), Valve Box (Existing)	P	3
VLVG	ValveGas_ep	Valve, Valve Box (Gas) (Existing)	P	3
VLVNPW	ValveWaterNP_ep	Valve, Valve Box (Water) (Non Potable) (Existing)	P	3
VLVS	ValveSewer_ep	Valve, Valve Box (Sewer) (Existing)	P	3
VLVW	ValveWater_ep	Valve, Valve Box (Water) (Existing)	P	3
VNT	Vent_ep	Vent (Unknown) (Existing)	P	3
VNTG	VentGas_ep	Vent (Gas) (Existing)	P	3
VNTS	VentSewer_ep	Vent (Sewer) (Existing)	P	3
WELL	Well_ep	Well (Any Size) (Existing)	P	3
WEST	PMWEST_ep	Pavement Marking Message - WEST (Existing)	P	1
WIFI	WIFI_ep	WIFI Pole (Existing)	P	3
WIM	WindMill_ep	Wind Mill (Existing)	P	1
WLPT	WetlandSym_ep	Wetland Point (Existing)	P	1
WPB	PullBox_ep	Wiring Pull Box (Existing)	P	3
WWAROW	PMWrongWayArrow_ep	Pavement Marking - Wrong Way Arrow (Existing)	P	1
XING	PMXING_ep	Pavement Marking Message - XING (Existing)	P	1

XS	XSPt_ep	Cross Section Point, Station	P	7
YIELD	PMYIELD_ep	Pavement Marking Message - YIELD (Existing)	P	1
YLDAHD	PMYieldAhead_ep	Pavement Marking - Yield Ahead Warning Triangle (Existing)	P	1
ZONE	PMZONE_ep	Pavement Marking Message - ZONE (Existing)	P	1