Los Angeles World Airports
PLANNING & DEVELOPMENT GROUP

LAWA Utility As-Built Survey Standards:

Data Collection and Recording Requirements for New & Existing Utility Infrastructure

June 2017

PAGE INTENTIONALLY LEFT BLANK

Table of Contents

PAGE INTENTIONALLY LEFT BLANK

1 SUBSURFACE UTILITIES DATA REQUIREMENTS & STANDARDS

1.1 Requirements for Subsurface Utility Data

Los Angeles World Airports (LAWA) has embarked on a robust program to collect sub-surface utility engineering surveys for all airport construction projects. All construction projects that place new or expose the location of sub-surface utilities are required to accurately capture the location and provide the data to LAWA Planning & Design Group. Construction plans should indicate when sub-surface utilities are to be uncovered and/or new utilities installed and coordinate with the Los Angeles World Airports Survey Department for the collection of all utility data prior to being covered. The contractor will be responsible for the collection of utility data including any associated potholing (re: Section 2.5), but notification to the LAWA Project Manager and Airport Survey Office is required by contractor three business days before items are uncovered. As-built CADD and GIS data submitted to LAWA shall contain all sub-surface utility locations and attributes in CADD and GIS format as outlined in this document.

1.2 Purpose

The purpose of the LAWA Utility As-Built Survey Standards is to set a standard practice of survey work throughout all LAWA CIP and Tenant Acquisition projects. This includes survey control and maintenance, updated data dissemination, data collection and reference standards. The Data Collection and Recording Requirements for Utility Infrastructure Standard focuses on the requirements for collecting and recording underground utility data – a major component of LAWA's overall standardized survey strategy. It represents what LAWA believes to be industry's best practices, but intends to maintain and update those best practices as technologies and standards are updated and accepted.

1.3 Standards Approach for Existing Conditions and New Installation

To enable best practices for damage prevention, risk mitigation, proactive and predictive design, planning and coordination, as well as emerging 3-D digital applications for visualization, conflict analytics, building infrastructure management (BIM), virtual design and construction (VDC), machine control, etc., LAWA is systematically collecting and managing standardized 3-D digital data on all utility infrastructure located within their property boundaries. Accordingly, LAWA is requiring utility installation data to be collected and submitted in accordance with related standards and frameworks supported by the American Society of Civil Engineers (ASCE) Utility Engineering and Surveying Institute (UESI) and Construction Institute (CI), in particular the *Standard Guidelines for the Collection and Depiction of Subsurface Utility Data* (ASCE 38) and the data framework developed by the Committee for the *Standard for Recording and Exchanging Utility Infrastructure Data** (also referred to as the ASCE "as-built" standard committee).

*Note: ASCE anticipates completing the committee balloting, review and approval of a utility “as-built” standard late in 2017; the “as-built” spatial, feature, and attribute data framework presented within these LAWA requirements stems from the current ASCE standard development activity that is expected to be adopted into the standard. It is the intent of LAWA to adopt the *ASCE Utility “As-Built” Standard* following its publication.

Opportunities to capture standardized utility data occur during project development (design), project delivery (construction), and during permitted utility infrastructure installation and maintenance activities. Utility networks are used for generation, transmission, or distribution of traffic, communication, electric, gas, petroleum, water, reclaimed water, steam, sanitary sewer, storm drainage, and similar. Utility features include, but are not limited to, pipes, cables and related device and appurtenance facilities such as boxes, poles, conduits, vaults, ducts, casings, cabinets, guy wires, and structural supports.

“As-built” data for infrastructure, both newly installed and exposed, during construction activities **shall** be collected to the highest accuracy level (1, 2, 3, 4, 5, 6, or 9 - see Table 1) set forth in LAWA contract and permit agreements. Likewise, all utility feature types and attributes **shall** be documented with at least the mandatory (“M”) attributes and using the standardized domain values as listed in the tables in Appendix A.

All data on existing subsurface utilities for preconstruction purposes (e.g., project design, conflict analytics and resolution engineering, utility coordination, and construction planning) **shall** be acquired in accordance with the ASCE 38 standard guideline, using a qualified professional engineer, surveyor, and/or geophysicist as dictated by California state statute. The ASCE 38 standard shall be applied with the intent of achieving at a minimum of quality level (QL) B within the project footprint as is pragmatic and appropriate for risk mitigation and public welfare interests.

This standard shall be used by the Designer (for project development), Contractor (for project delivery), all sub-contractors, consultants, and utility owners performing work on the project. It is the responsibility of the Designer (for project development) or Contractor (for project delivery) to ensure that these parties adhere to all relevant processes, workflow, standards, and provisions stated in this specification.

2 QUALITY & ACCURACY REQUIREMENTS

2.1 Utility Quality Level Attributes

The American Society of Civil Engineers (ASCE) developed standard guidelines for the collection and depiction of existing subsurface utility information, *Standard Guidelines for the Collection and Depiction of Existing Subsurface Utility Data (ASCE/C-I 38-02),* by the civil engineering profession, the FHWA, ASCE, AGC, and other national organizations*.* The guideline breaks down utility collection into four separate levels of confidence. The initial field collection and mapping for most airports is Quality Level (QL) D. These four separate levels of confidence are as follows:

2.1.1 Quality Level "D" - Existing Records:

Results from review of available records: It gives overall "feel" for congestion of utilities, but is highly limited in terms of comprehensiveness and accuracy. For projects where route selection is an option, this Quality Level is useful when combined with cost estimates for utility relocations following applicable "clear zone" and other accommodation policies.

2.1.2 Quality Level "C" - Surface Visible Feature Survey:

QL "D" information for existing records is augmented using surface visible feature survey and digitizing data into Computer-Aided Drafting and Design (CADD) drawings. The danger here is that much of the data is "digitized fiction." There may be as much as a 15-30% error and omission rate in QL "C" information.

2.1.3 Quality Level "B" - Designating:

Two-dimensional horizontal mapping: Obtain this information through surface geophysical methods. It is highly useful for design basis information for conceptual design and for proceeding prudently to QL "A". Do not use this level for design basis vertical information or where exacting horizontal tolerances are expected.

2.1.4 Quality Level "A" - Locating:

Three-dimensional points of conflict: This is the highest level of accuracy of subsurface utility engineering data. It provides horizontal and vertical design basis information for engineering, construction, maintenance, remediation, condition assessment, and related efforts.

2.2 Existing Condition/As-Built Survey

To keep an accurate record of utilities installed and exposed during the project, a complete “as-built” record must be submitted by the end of the project. This is essential for documenting the location and other important attributes of installed, abandoned, and discovered underground and above ground utility infrastructure. The “as-built” record will be collected during the entire construction phase to capture all exposed, changed, or newly installed features within the project footprint on both above and below grade installations and will be submitted iteratively to LAWA bi-weekly or as defined by the project scope.

Include the following utility survey information in the as-built:

- Existing utilities that are exposed below grade (including potholes).
- Installed and abandoned utilities included in the design files
- Discovered utilities exposed during construction.
- Supplemental features as determined by LAWA.

2.3 Utility Research

Utility Research is important before setting out to capture utility data. Prior to beginning the designation work, the contractor should contact the utility known to be within the project limits. The contractor should ask for all record information within the project limits and specifically ask to speak to the Planning & Development Division to identify utility projects completed but not depicted in the utility owners' records section. The contractor is to prepare a utility record log per ASCE standards, and maintain records for future reference. Review the record information for the following:

- Material type joining procedures that will influence equipment selection.
- Amount of utilities to be expected, which will influence number and phasing of personnel assigned to the project.
- Local geology/soil conditions if data is available, which may influence equipment selection.
- Number and type of access points, such as manholes, etc., which will influence safety procedures.
- Expected depth of utilities, which will influence equipment selection. Presence of rebar or other paving characteristics, affecting the methods/procedures/equipment.
- Advise the project owner regarding potential effects that the project may have on existing subsurface utilities.
- Inform the project owner regarding utility quality levels and reliability of data for each quality level. Such information may include a discussion of costs and benefits associated with obtaining quality levels.
- Recommend a scope for utility investigations dependent on project needs. This may include a list of the types of utilities for detection and depiction and the desired utility data quality level. It may include certain systems to be investigated and depicted at a lower quality level. It may include geographic sections of the project to have utilities investigated and depicted at various quality levels.
- Discuss and recommend formatting of deliverables to clearly distinguish quality levels.
- Discuss the sequence of acquiring appropriate quality level data throughout the planning and design process. This is dependent on project design elements, design timetables, the type of project, the criticality of utility service, and so forth.
- Prepare a utility composite drawing or file with appropriate supporting documents, in accordance with owner specification, that clearly identifies utilities at their desired quality levels at the appropriate time within project development. The deliverable may contain utilities depicted at quality levels A, B, C, and/or D.
- Review data with utility owners.
- Review plans as design develops to analyze the effects of design changes to current utility information.

- Recommend areas or particular utility systems for a “quality level” upgrade after review. Such an upgrade may be to quality level C, B, or A.
- Follow applicable one-call statutes or other applicable laws.
- Place a note on the plans explaining the different utility “quality levels.”
- Affix an engineer’s stamp on the plans that depict existing subsurface utility data at the indicated quality levels.
- Discuss utility accommodation and utility relocation policies.

2.3.1 Field Utility Locates

Conducting field utility locates require geophysical locating equipment and methods (combined with existing utility records and field observations), the marks that designate the utility on the surface of the ground can be performed. If the utility changes horizontal direction, but has no physical aperture at that point, every standard of care of the subsurface utility engineering profession will be taken to designate the point at which the utility ‘bends’ or changes direction. While the utility designating is taking place, the survey crew will simultaneously be collecting data for the utility features and the temporary paint marks over the utility line.

The temporary utility paint marks on the ground will follow the Utility Location and Coordination Council Uniform Color Codes as shown below:

	RED – Electric power lines, cables, conduit and Lighting cables
	YELLOW – Gas, Oil, Steam, Petroleum or Gaseous Materials
	ORANGE – Communications, Alarm or Signal lines, cables or conduits
	BLUE – Potable Water
	PURPLE – Reclaimed Water, Irrigation, or Slurry lines
	GREEN – Sewers and Drain lines
	PINK – Temporary Survey Markings

Figure 1 – Uniform Color Codes

2.4 Accuracy Attributes

All collected features shall be assigned a positional accuracy level attribute. The accuracy level specifications are provided in Table 1. All new installations, exposed or accessible will be surveyed to Level 1 accuracy. Specific circumstances (risk, practicalities, and costs) that may make it difficult to obtain Level 1 accuracy may be discussed with the LAWA. If LAWA agrees to consider accepting a lesser accuracy level the decision needs to be agreed upon and documented prior to conducting the survey. Datum, Projections, and Coordinate Systems will adhere to the requirements as set forth in this specification.

Accuracy Level	Positional Accuracy[1]	Applies to	Comment
1	±0.1 feet Vertical	Z data	Directly associated with ASCE 38 quality level A (QLA) requirements
	±0.2 feet Horizontal	X and Y data	
2	±0.2 feet	X, Y, and Z data	
3	±0.5 feet	X, Y, and Z data	
4	±1 foot	X, Y, and Z data	
5	±3+ feet	X, Y, and Z data	
6	±3+ feet	X and Y data	Positional accuracy of the Z data is unreliable or not available
9	Indeterminate		Positional accuracy of the X, Y, and Z data is indeterminate.

[1]At the 95% confidence level, using the root-mean-square error (RMSE) in accordance with FGDC-STD-007.3-1998

TABLE 1 - POSITIONAL ACCURACY SPECIFICATIONS

The positional accuracy level specifications in Table 1 correspond roughly with the following concepts:

- Level 1 matches specifically with quality level (QL) A as defined in ASCE 38.
- Level 2 is substantially identical to Level 1, but decreases the tolerance on vertical methods and can generally be achieved without survey bench leveling.
- Level 3 is usually achievable using GPS equipment and RTK methods.
- Level 4 is an intermediate point between levels 3 and 5.
- Level 5 is normally achievable using post-processed mapping grade GPS equipment.

Rigid aboveground features are subject to the same positional accuracy requirements as underground infrastructure. The positional accuracy of suspended aerial cables and wires is variable due to environmental factors and therefore shall be classified as Level 9, except at the points where they are anchored to support structures such as poles.

2.4.1 Effect of Horizontal or Vertical Curvature on Accuracy

As shown in Figure 2, when a lineal feature segment (e.g., cable or pipe) curves in either the horizontal or the vertical, a string line passed thru the collection of points will vary from the true location. The solid line represents the true location, while the dashed line indicates the line as determined from the discrete point collection and straight line linear interpolation.

To designate a specific accuracy level the error (A in Figure 2) due to chord offset must be less than the assigned accuracy level (Table 1).

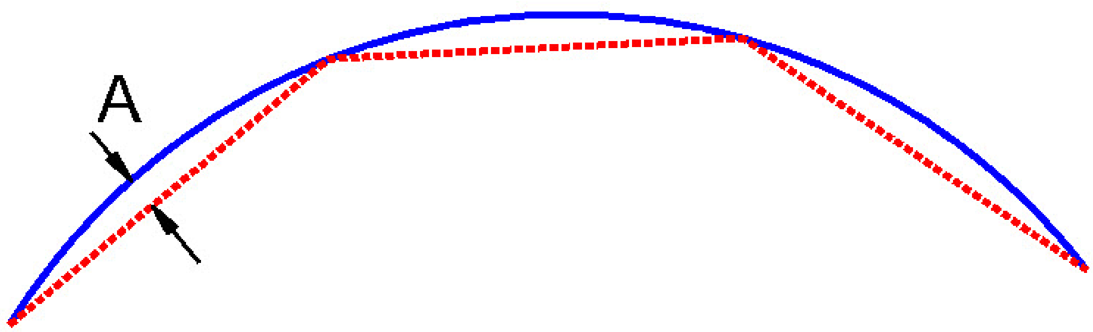

Figure 2 - Offset Error of Chorded Line String 1

2.4.2 Effect of Deflection on Accuracy

Figure 2 is a diagram illustrating how deflection combined with previously discussed curvature, can affect accuracy designation.

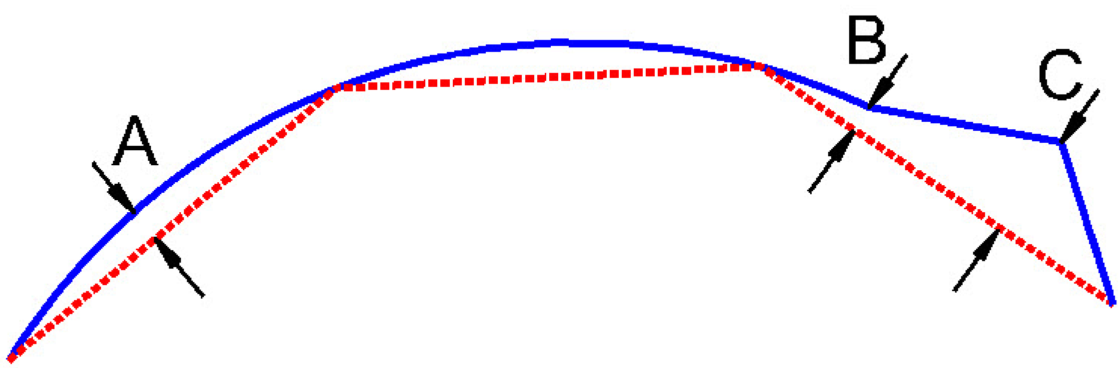

Figure 3 - Offset Error due to deflection

The offset error at A is the error due to curvature discussed in previous section. Errors at B and C in Figure 3 are due to deflection. These points of deflection introduce additional considerations for required point collection intervals. To designate the feature segment survey as meeting a specific accuracy level, additional points must be collected at B and C to ensure offset errors are less than the assigned accuracy level (Table 1). Points of deflection may occur in the horizontal or vertical planes, or both planes at a single point.

3 Collection of Feature Data

At the time of construction or at any time that an underground utility is subsequently exposed or visible and capable of measurement, the horizontal and vertical position and corresponding accuracy level shall be obtained and recorded as follows:

- For each distinct feature of the underground utility (e.g., valves, joints, junctions, risers, splices, etc.).
- For horizontal bends, vertical bends, and points of deflection.
- At specific points or intervals in accordance with the Data Collection Intervals Section.

3.1 Data Collection Intervals

Data collection intervals depend on the orientation and type of utility, site location, specific engineering requirements, and other requirements to meet the assigned point node and/or line segment accuracy levels defined above. Guidance for determining the data collection interval is provided below.

3.1.1 Above Ground Features and Wires

Rigid aboveground features are subject to the same positional accuracy requirements as underground infrastructure. The positional accuracy of suspended aerial cables and wires is variable due to environmental factors and therefore shall be classified as Level 9, except at the points where they are anchored to support structures such as poles. Collect sag vertical clearances with date, time, and temperature attributes.

3.1.2 Boxes, vaults, and enclosures

Collect information for boxes, vaults, and enclosures so that they can be accurately represented within the database. At a minimum, three (3) corners of a rectangular/square box will be collected along with a definition for the outside depth. It is preferred to collect all corners of the enclosure on the top and bottom. Lids and/or entry points will also be represented by a point collected in the center. All utility lines going into and out of the enclosure will also need to be collected so that their orientation is depicted correctly.

3.1.3 Trenchless Technology

Where all or part of the installation of the underground utility has been achieved by trenchless technology methods, collect the utility features at points of exposure, accurately measuring and recording positions in order to meet the requirements of this section.

Any portion of the trenchless feature that is not directly measured shall be designated in accordance with ASCE 38 and Positional Accuracy Level 9.

Where the underground utility cannot be exposed or designated (e.g., when it passes below a structure or body of water) its position should be measured where the utility was last observed when it enters and when it exits the obscured area. The portion of utility that is obscured shall be clearly indicated that it has not been measured.

Discrete boring logs shall be collected along the trenchless alignment and processed to absolute Z referenced to the project survey control.

3.2 Sub-Surface Utility Engineering Test Holes (Potholes)

Use of Sub-Surface Utility Engineering Test Holes are required of certain projects that require detailed high quality data such as vertical depths/elevations and condition assessments, complete Quality Level A test hole services. Digitally photograph the test pothole sites before and after the test hole operations. For Quality Level A data, provide a certification form in addition to the plotted position of the utility with additional information. This certification information includes:

- Horizontal and vertical location of top and/or bottom of utility referenced to project datum,
- Elevation of existing grade over utility at test hole referenced to project datum,
- Outside diameter of utility and configuration of non-encased, multi-conduit systems,
- Utility structure material composition, when reasonably ascertainable,
- Benchmarks and/or project control used to determine elevations,
- Paving thickness and type, where applicable,
- General soil type and site conditions, and other pertinent information as is reasonably ascertainable from each test hole site.

References to the project datum will maintain vertical tolerances to +/-0.05' based on benchmarks used or established with the base mapping deliverables and horizontal tolerances at +/- 0.25'.

3.3 Rule of Thumb for Minimal Observation Frequency

The surveyor will assess the identified error situations which can arise for any installation and increase observation frequency sufficiently to:

1. Provide adequate statistical accuracy and confidence for a least squares fit alignment or position depiction.
2. Mitigate risk of creating the framework for a distorted representation of the installation.

Survey observations will include:

- **All inflection points** (vertical and horizontal),
- **All joints** (noting that the collection point is at a joint and at maximum geometric deviations such as flairs for bell joints), and at **locations where facilities join or diverge**, such as at tees, “Y”s, splice joints, valves, etc.,
- **All feature nodes and point features**.

The observation frequencies must be sufficient so that the digital rendition yielded through the 3-D modeling application and based on the observation points, creates a virtual representation with spatial accuracy to the required published datum (typically the National Geodetic Survey’s National Spatial Referencing System – NGS NSRS) that is practically identical geometrically to the actual utility and spatially within the assigned accuracy level (a.k.a. error tolerance).

Beyond those observation criteria, the following are minimal observation frequencies for feature segments:

- Rigid Feature Segments (e.g., reinforced concrete pipe installed at fixed grades) - 20 feet intervals
- Flexible Feature Segments (e.g., direct bury fiber optic) – 10 feet intervals

4 Utility Survey Deliverables

Items that are required in the as-built submittal include, but are not limited to, all utilities that are newly installed, exposed below grade, and remaining above grade after construction (e.g. communications, gas, water, electric, sanitary sewer, storm drainage, boxes, poles, cables, wires, cabinets, and other pertinent features as determined by LAWA). This includes everything that is included in the design files, added supplemental items, and any apparent or potential utility infrastructure feature that was discovered during construction.

4.1 Subsurface Utility Engineering (SUE)

Subsurface Utility Engineering (SUE) services inherently require some surveying activities that fall under the purview of this specification.

The SUE professional (or their subcontracted land surveyor) shall certify horizontal and vertical accuracies of utility locations at Accuracy Level 1 (Table 1) when performing QL A utility locate (e.g., test hole) activities per ASCE 38. To obtain these accuracies on a project the SUE professional (or their subcontracted land surveyor) shall tie to the project survey control and appropriately certify the test hole observations in accordance with ASCE 38. These ties to the project survey control network or a LAWA authorized published datum (e.g., NGS NSRS) shall conform to industry surveying standards and procedures, and related statutory mandates.

The SUE professional shall certify quality levels of utility depictions when performing Quality Level B utility designating.

Coordinate with the Contractor to obtain horizontal and vertical data from appropriate project control, or to request supplemental control in the vicinity where SUE investigative activities are planned.

Refer to CI/ASCE 38- current edition, *Standard Guideline for the Collection and Depiction of Existing Subsurface Utility Data*, for procedures to perform D, C, B and A quality level services to obtain horizontal and vertical data, including designating and locating subsurface utilities.

APPENDIX A

1 Feature Types

TABLE 1 - FEATURE TYPE DEFINITIONS

Feature Type	Definition
Line	A linear utility feature such as water pipe or electric cable, represented by a series of connected points.
Device	A discrete utility feature such as valve, splice, or a transformer that is directly involved with the conveyance, control, or distribution of a particular utility service.
AccessPoint	An opening that provides access to utility devices or into utility lines.
SupportStructure	A pole, tower, thrust block, or other structure used to support utility lines and devices.
ContainingStructure	A large structure or chamber that houses utility devices and/or provides a juncture area for multiple utility lines.
SecuredUtilityArea	An area typically fenced off to restrict access to utility facilities.
Encasement	A duct, tunnel, trench, conduit, or other linear chamber that conveys and protects utility facilities and/or individuals from the surrounding environment.
Marker	A visible or remotely detectable marker used to indicate the location of a utility asset.
Tracer	A wire or tape used to indicate the location of a linear utility asset.
CustodyTransferLocation	A location along a utility line where ownership, custody, or responsibility of the material being conveyed and/or the utility infrastructure is transferred from one entity to another.
OtherPoint	Other point features not elsewhere classified
OtherLine	Other line features not elsewhere classified
OtherPolygon	Other point features not elsewhere classified

1.1 Feature Attributes

Table 2 shows data that will be used for each feature type included in Table 1. Data attributes are grouped into four categories: general, geometry and configuration, spatial data, and status and certification.

TABLE 2 - FEATURE ATTRIBUTES

Feature Type	Feature Attribute																																				
	General					Geometry and Configuration															Spatial Data										Status and Certification						
	ID	Owner	UtilityType	DeviceType	ConveyancePurpose	Material	IsCathodicProtected	IsEncased	EncasementMaterial	ConveyanceMethod	CrossSectionShape	InsideDiameter	OutsideDiameter	DiameterUnit	Length	Width	Height	LengthWidthHeightUnit	NumberConduits	GroundRelation	XYZ	XYRelativePosition	ZRelativePosition	XYZObserved	XYZAnchorPoint	HorizontalSpatialReference	VerticalSpatialReference	OffsetTo	QualityLevel	AccuracyLevel	Status	ReplacementCost	LinkedFile	DateDataCollected	DataSensitivityLevel	IsCertified	CertificationSummary
Line	M	M	M		M	O	O	O	O	O	O	O	O	O		O	O	C	O	O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
Device	M	M	M	M	M					O							O			O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
AccessPoint	M	M	M	M											O	O	O			O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
SupportStructure	M	M	M	M		O	O						O		O	O	O			O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
ContainingStructure	M	M	M												O	O	O			O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
SecuredUtilityArea	M	M	M												O	O	O			O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
Encasement	M	M	M			O	O	O	O			O	O		O	O				O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
Marker	M	M	M	M																O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
Tracer	M	M	M	M		O	O	O	O						O					O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
CustodyTransferLocation	M	M	M																	O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
OtherPoint	M	M	M	M																O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
OtherLine	M	M	M			O	O	O	O						O					O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M
OtherPolygon	M	M	M																	O	M	M	C	O	C	M	M	O	M	M	M	O	O	M	M	M	M

M = Minimum requirement
O = Optional
C = Conditional
Blank = Does not apply

1.2 Feature Attribute Definitions

TABLE 3 - DEFINITIONS OF FEATURE ATTRIBUTES SHOWN IN TABLE 2

Attribute	Definition	Domain (Table 4)
ID	Alphanumeric utility feature identifier	
Owner	Name of the organization that owns and/or operates the utility feature	
UtilityType	Type of utility feature	CodeUtility
DeviceType	Type of device (does not apply to linear features)	CodeDevice
ConveyancePurpose	Primary purpose of service of the utility feature	CodePurpose
Material	Predominant material of which the utility feature constructed. For communication and electric lines, material refers to the conductor material.	CodeMaterial
IsCathodicProtected	Indicator of the presence of a cathodic protection	CodeBoolean
IsEncased	Indicator of the presence of encasement to insulate or protect the utility feature	CodeBoolean
EncasementMaterial	Indicator of the presence of a material to fill the space between a utility feature and its encasement	CodeMaterial
ConveyanceMethod	Method to move or convey matter through the utility feature	CodeMethod
CrossSectionShape	Shape of the cross section of the utility feature	CodeShape
InsideDiameter	Inside diameter of the utility feature cross section. It does not apply for cross sections that are not circular in shape. For electric lines, the inside diameter indicates the gauge of the conductor.	
OutsideDiameter	Outside diameter of the utility feature cross section. It does not apply for cross sections that are not circular in shape.	
DiameterUnit	Unit of measurement for diameters	
Length	Three-dimensional length of linear utility feature	
Width	Width of utility feature, measured at the widest point of the feature	
Height	Height of utility feature, measured from the highest to the lowest elevation of the feature along the line of gravity (i.e., plumb line)	
LengthWidthHeightUnit	Unit of measurement for length, width, and height dimensions	
NumberConduits	Number of conduits within a pipe or duct bank	
GroundRelation	Indicator of whether the utility feature is predominantly underground, on or effectively on the ground, or suspended aboveground.	CodeGroundRel
XYZ	X, Y, and Z coordinates of the utility feature for data exchange purposes. Depending on the implementation, the X, Y, and Z coordinates may be stored as separate fields in a table or as part of an array that contains spatial data in a single field.	
XYRelativePosition	Relative position of xyz with respect to the horizontal alignment of the utility feature.	CodeXYAt
ZRelativePosition	Relative position of xyz with respect to the elevation of the utility feature.	CodeZAt

Attribute	Definition	Domain (Table 4)
XYZObserved	X, Y, and Z coordinates of the utility feature as measured in the field. Depending on the implementation, the X, Y, and Z coordinates may be stored as separate fields in a table or as part of an array that contains spatial data in a single field.	
XYZAnchorPoint	X, Y, and Z coordinates of the anchor point used to depict and represent a utility feature as a 3D object. Depending on the implementation, the X, Y, and Z coordinates may be stored as separate fields in a table or as part of an array that contains spatial data in a single field.	
HorizontalSpatialReference	Coordinate system and datum associated with the X and Y coordinates	
VerticalSpatialReference	Coordinate system and datum for the Z coordinate	
OffsetTo	Reference point or object and distance to the utility feature. Example: 10 feet east of the edge of pavement.	
QualityLevel	Quality level associated with the utility feature, in accordance with ASCE 38.	CodeQualityLevel
AccuracyLevel	Numerical code describing the positional accuracy of the utility feature, as described in **Error! Reference source not found.**.	1-9
Status	Operational status of the utility feature	CodeStatus
ReplacementCost	Estimated cost, including both construction and engineering costs, to replace the feature at the time of installation. For linear feature installations, it is the replacement cost for the length of the feature. For device features, it is the discrete cost to replace the individual device.	
LinkedFile	Name of file or files that contain information about the utility feature. Examples of files include photographs, CAD files, sketches, video, and other supporting information. Depending on the implementation, the file names may be stored as separate field entries in a table or as part of an array that contains file names in a single field.	
DateDataCollected	Date when the data describing a utility feature was first collected	
DataSensitivityLevel	Indicator of the sensitivity level of the data recorded for a utility feature. If the data is considered sensitive security information (SSI), the data must be labelled on any output produced and handled in accordance with 49 CFR 1520.	CodeSensitivity
IsCertified	Indicator of whether the data has been certified	CodeBoolean
CertificationSummary	Name and credentials of the party that certified the data	

TABLE 4 - DOMAIN VALUES FOR FEATURE ATTRIBUTES IN TABLE 3

Domain	Value	Comment
CodeBoolean	True	
CodeBoolean	False	
CodeDevice	Air Eliminator	
CodeDevice	Amplifier	
CodeDevice	Anchor	
CodeDevice	Anode	
CodeDevice	Anode Test Station	
CodeDevice	Antenna	
CodeDevice	Armor	
CodeDevice	Attenuator	
CodeDevice	Capacitor	
CodeDevice	Catch Basin	
CodeDevice	Clean Out	
CodeDevice	Culvert	
CodeDevice	Culvert End	
CodeDevice	Curb Inlet	
CodeDevice	Downspout	
CodeDevice	Drain	
CodeDevice	Drain Separator	
CodeDevice	Drop Inlet	
CodeDevice	Fill Point	
CodeDevice	Filter	
CodeDevice	Fire Connection Point	
CodeDevice	Generator	
CodeDevice	Glycol Recovery Pit	
CodeDevice	Grease Trap	
CodeDevice	Grit Chamber	
CodeDevice	Ground	
CodeDevice	Ground Point	
CodeDevice	Guy Anchor	
CodeDevice	Guy Wire	
CodeDevide	Guy Pole	
CodeDevice	Hand Hole	
CodeDevice	Head Bolt Outlet	
CodeDevice	Headwall	
CodeDevice	Hydrant	
CodeDevice	Impedance Matching Point	
CodeDevice	Inlet	
CodeDevice	Intake	
CodeDevice	Junction	
CodeDevice	Lift Station	
CodeDevice	Light	
CodeDevice	Lighting Circuit Point	
CodeDevice	Lighting Service Point	
CodeDevice	Line	
CodeDevice	Line Clean Out	
CodeDevice	Load Capacitor	
CodeDevice	Load Coil	
CodeDevice	Manhole	
CodeDevice	Marker Sign	
CodeDevice	Marker Post	

Domain	Value	Comment
CodeDevice	Media Converter	
CodeDevice	Meter	
CodeDevice	Motor	
CodeDevice	Network Systems Site	
CodeDevice	Neutralizer	
CodeDevice	Oil Water Separator	
CodeDevice	Outlet	
CodeDevice	Paging Device	
CodeDevice	Panel	
CodeDevice	Pedestal	
CodeDevice	Pig Launch Point	
CodeDevice	Pipe End	
CodeDevice	Pole	
CodeDevice	Pre-Conditioned Air Unit	
CodeDevice	Pressure Reducing Station	
CodeDevice	Pull Box	
CodeDevice	Pump	
CodeDevice	Pump Booster Station	
CodeDevice	Pump Ejector Station	
CodeDevice	Pump Station	
CodeDevice	Pump Station Ejector	
CodeDevice	Push Brace	
CodeDevice	Radio	
CodeDevice	Receptacle	
CodeDevice	Rectifier	
CodeDevice	Reducer	
CodeDevice	Regulator	
CodeDevice	Regulator Reducer	
CodeDevice	Relay	
CodeDevice	Repeater	
CodeDevice	Reservoir	
CodeDevice	RFID Marker	
CodeDevice	Riser	
CodeDevice	Sample Point	
CodeDevice	Satellite	
CodeDevice	Sensor	
CodeDevice	Service Loop	
CodeDevice	Service Point	
CodeDevice	Solar Panel	
CodeDevice	Speaker	
CodeDevice	Splice	
CodeDevice	Splice Box	
CodeDevice	Splitter	
CodeDevice	Sprinkler	
CodeDevice	Stilling Basin	
CodeDevice	Stormceptor	
CodeDevice	Storm Filter	
CodeDevice	Storm Gate	
CodeDevice	Stub Out	
CodeDevice	Switch	
CodeDevice	Tank	
CodeDevice	Tape	

Domain	Value	Comment
CodeDevice	Telephone	
CodeDevice	Terminal	
CodeDevice	Terminator	
CodeDevice	Tower	
CodeDevice	Transformer	
CodeDevice	Treatment Unit	
CodeDevice	Undefined Utility Point	
CodeDevice	Valve	
CodeDevide	Valve Box	
CodeDevice	Vent	
CodeDevice	Wing wall	
CodeDevice	Wire	
CodeDevice	Other	
CodeDevice	Unknown	
CodeGroundRel	Underground	
CodeGroundRel	On Ground	
CodeGroundRel	Above Ground	
CodeGroundRel	Unknown	
CodeMaterial	Acrylonitrile Butadiene Styrene	
CodeMaterial	Aluminum	
CodeMaterial	Asbestos Cement	
CodeMaterial	Asphalt	
CodeMaterial	Block	
CodeMaterial	Brick	
CodeMaterial	Canvas	
CodeMaterial	Clay	
CodeMaterial	Coaxial Cable	
CodeMaterial	Composite	
CodeMaterial	Concrete	
CodeMaterial	Copper	
CodeMaterial	Earthen	
CodeMaterial	Fiberglass	
CodeMaterial	Fiber Optic (or Optical Fiber)	
CodeMaterial	Geotextile	
CodeMaterial	Glass	
CodeMaterial	Gravel	
CodeMaterial	High Density Polyethylene (HDPE)	
CodeMaterial	Iron	
CodeMaterial	Multiple	
CodeMaterial	Nickel	
CodeMaterial	Other	
CodeMaterial	Pitch Fiber	
CodeMaterial	Plastic	
CodeMaterial	Polyethylene	
CodeMaterial	Polypropylene	
CodeMaterial	Polystyrene	
CodeMaterial	Polyvinyl Chloride (PVC)	
CodeMaterial	Sand	
CodeMaterial	Steel	
CodeMaterial	Stone	
CodeMaterial	Styrofoam	

Domain	Value	Comment
CodeMaterial	Terracotta	
CodeMaterial	Tile	
CodeMaterial	Titanium	
CodeMaterial	Transite	
CodeMaterial	Twisted Pair Copper	
CodeMaterial	Wood	
CodeMethod	Gravity	
CodeMethod	Pressurized	
CodeMethod	Other	
CodeMethod	Unknown	
CodeMethod	Not Applicable	
CodePurpose	Control Monitoring	
CodePurpose	Data Transfer	
CodePurpose	Irrigation	
CodePurpose	Distribution	
CodePurpose	Fire	
CodePurpose	Gathering	
CodePurpose	Transmission	
CodePurpose	Traffic Control	
CodePurpose	Service	
CodePurpose	Lighting	
CodePurpose	Sign Illumination	
CodePurpose	Trace	
CodePurpose	Other	
CodePurpose	Unknown	
CodeQualityLevel	A	
CodeQualityLevel	B	
CodeQualityLevel	C	
CodeQualityLevel	D	
CodeSensitivity	Unrestricted	
CodeSensitivity	Restricted	
CodeSensitivity	SSI	
CodeShape	Arch	
CodeShape	Box Culvert	
CodeShape	Duct Bank	
CodeShape	High Profile Arch	
CodeShape	Horizontal Ellipse	
CodeShape	Low Profile Arch	
CodeShape	Pear	
CodeShape	Pipe Arch	
CodeShape	Rectangular	
CodeShape	Round	
CodeShape	Underpass	
CodeShape	Vertical Ellipse	
CodeStatus	Active	
CodeStatus	Inactive	
CodeStatus	Discontinued Use	
CodeStatus	Abandoned	
CodeStatus	Other	
CodeStatus	Temporary	
CodeUtility	Communication	Type of utility feature that carries data, voice, and/or video signals. Depending on the carrier

Domain	Value	Comment
		technology and other factors, a communication feature can include optical fiber, coaxial cable, or twisted pair copper.
CodeUtility	Compressed Air or Other Gas	Type of utility feature that carries compressed air or a gas other than natural gas
CodeUtility	Electric	Type of utility feature that carries electrical power
CodeUtility	Petroleum	Type of utility feature that carries raw or refined petroleum products in a liquid state
CodeUtility	Heat Cool	Type of utility feature that carries ________
CodeUtility	Chemical	Type of utility feature that carries chemical substances other than petroleum and natural gas
CodeUtility	Natural Gas	Type of utility feature that carries a flammable gas, mostly methane, that occurs naturally underground
CodeUtility	Disposal	Type of utility feature that carries disposal substances, typically in connection with the extraction of hydrocarbon products
CodeUtility	Non Potable Water	Type of utility feature that carries non potable water. Non potable water is water that has not been tested, treated, and approved for human consumption.
CodeUtility	Reclaimed (or Recycled) Water	Type of utility feature that carries water that has been reclaimed or recycled and can be used for new, usually non-drinking, purposes.
CodeUtility	Steam	Type of utility feature that carries pressurized steam
CodeUtility	Storm Water	Type of utility feature that carries storm water
CodeUtility	Wastewater	Type of utility feature that carries water that has been used at homes, businesses, and industrial processes
CodeUtility	Water	Type of utility feature that carries potable or drinking water
CodeUtility	Joint Use	Type of utility feature that carries more than one type of utility
CodeUtility	Other	
CodeUtility	Unknown	
CodeXYAt	Left Edge	
CodeXYAt	Center	
CodeXYAt	Right Edge	
CodeZAt	Barrel/Bottom	
CodeZAt	Invert Level	
CodeZAt	Geometric Center	
CodeZAt	Crown/Top	
CodeZAt	Soffit	