# FACILITY DESIGN GUIDELINES

## DIVISION 27 05 43 - COMMUNICATIONS UNDERGROUND PATHWAYS & SPACES

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<tr>
<th>FDG ISSUE NO.</th>
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<td>1</td>
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PURPOSE:
1. This document describes Stanford University’s (SU) Facility Design Guideline (FDG) for Communications Underground Pathways & Spaces (CUPS).
2. The FDG-CUPS applies to anyone involved in the design, construction and maintenance of Communications Underground Pathways and Spaces.
3. Adherence to the FDG-CUPS will satisfy Stanford University IT - Information Technology Services’ (SUIT-ITS) requirements for communications underground pathways.

DEFINITIONS – COMMUNICATIONS UNDERGROUND PATHWAYS & SPACES:
1. Communications Underground Pathways & Spaces (CUPS) is the network of conduit/duct, maintenance holes, service boxes, and hand holes that form an integrated underground system.
   - The common term used to describe underground “Pathways” is conduit or duct. The term “conduit” refers to the individual tube designed to carry communications cable. The term duct refers to the complete cable-carrying installation comprised of one or more conduits.
   - The common terms used to describe underground “Spaces” is maintenance holes or vaults (MH’s), service boxes or splice boxes (SB’s), and hand holes (HH’s).
2. CUPS support communications cables, placed between buildings and other facility structures that provide voice, data, video, telemetry and building automation services on the Stanford Campus.
3. CUPS are categorized as follows:
   - Main Underground Pathway: A main underground pathway supports communication cables that serve all buildings or service locations in a service route area. Main Underground Pathways typically begin at an Electronic Communication Hub (ECH) Building and radiate out along streets to serve buildings and service locations along the route or to connect to another ECH Building. It contains a large number of underground multiple conduit or duct, installed between maintenance holes (MH’s) and Service Boxes (SB’s) along the route.
   - Lateral Underground Pathway: A lateral underground pathway is a branch off the main underground pathway that supports communication cables serving one or more buildings or service locations in a service area. It contains a small number of multiple underground conduit or duct that extends from a main underground pathway to succeeding maintenance holes (MH), service boxes (SB) or hand holes (HH) along the lateral run.
   - Building Entrance Pathway: A building entrance pathway is two to six underground conduit or duct extended from a maintenance hole (MH) or service box, directly into a building’s entrance facility space (EFS) or main telecommunications room (MTR).

SU-ITS CUPS RESPONSIBILITIES
1. The Information Technology Services’ Facility Engineering group has overall responsibility to plan, design, construct and maintain the Communications Underground Pathways & Spaces (CUPS) on and off the main Stanford Campus in University owned facilities.

2. An approved and funded Project is required for all undertakings that move, add or change the Communications Underground Pathways & Spaces (CUPS) network.

CUPS DESIGN AND PROJECT MANAGEMENT ALTERNATIVES (ITSFE, DPMDC)

1. A CUPS Project that is not associated with a Department of Project Management (DPM) Project shall be designed and project managed by SUIT-ITS as follows:
   - An Information Technology Services Facility Engineer (ITSFE) designs the project, prepares the detailed construction drawings and written specifications.
   - The ITSFE develops the detailed design and the Construction Logistics Plan and coordinates the design review and approval process. The final design and construction schedule requires review and approval via the Facilities Operations Plans Review process.
   - The ITSFE coordinates, with Contracts & Procurement, the preparation of an invitation for bid (IFB) and bid award to qualified construction contractors (CC).
   - The ITSSFE will, upon bid award, provide field project management and ongoing inspections of the CC’s work.

2. A CUPS Project that is associated with an SU Department of Project Management (DPM) Project may be designed and project managed as follows:
   2.1. Main Underground and Lateral Underground Pathway – Building Project site requiring new or relocated CUPS:
      - An Information Technology Services Facility Engineer (ITSFE) is assigned to provide general design requirements to the DPM Project Manager (DPMPM).
      - DPMPM may engage a qualified DPM Design Consultant (DPMDC) to detail design the pathway.
      - The ITSFE will provide the DPMPM with the general pathway design requirements (e.g. general route; number and size of conduit/ducts; approximate location and size of MH’s or SB’s, etc.) to facilitate the DPMDC’s completion of the detail pathway design.
      - DPMDC develops the detail design and Construction Logistics Plan for approval by the ITSFE’s. The DPMDC coordinates the final design review and approval process and the construction schedule. The final design and construction schedule requires review and approval via the Facilities Operations Plans Review process.
      - DPMPM coordinates the preparation of a construction contract for bid and award to a qualified construction vendor.
      - DPMPM project manages the field construction work to completion.
      - The ITSFE, or assigned delegate, will provide inspections at any or all phases of conduit installation to ensure that conduits are properly placed, supported, encased and connected to new or existing service vaults. UIT/ITS reserves
the right to request construction be stopped and deficiencies corrected at any point during the construction process. The installing contractor must contact the designated FE two (2) business days prior to scheduling concrete encasement of underground conduits. The ITSFE must be present for all mandrel testing of installed conduits.

2.2 Building Entrance Pathway – new or remodel building projects:

- An Information Technology Services Facility Engineer (ITSFE) is assigned to provide the general design requirements to the DPMPM.
- DPMPM may engage a qualified DPM Design Consultant (DPMDC) to detail design the pathway.
- The ITSFE will provide DPMPM with the general pathway requirements (e.g. main underground conduit/duct system access point; building entrance location; route, number and size of conduit/ducts; location, number, and size of MH’s or SB’s as required) to facilitate the DPMDC’s completion of a detail design.
- DPMDC develops the detail design and Construction Logistics Plan for approval by the ITSFE’s. If required, the DPMDC coordinates the final design review and approval process and the construction schedule. The final design and construction schedule requires review and approval via the Facilities Operations Plans Review process.
- DPMPM coordinates the preparation of a construction contract for bid and award to a qualified construction vendor.
- DPMPM project manages the field construction work to completion.
- The ITSFE, or assigned delegate, will provide inspections at any or all phases of conduit installation to ensure that conduits are properly placed, supported, encased and connected to new or existing service vaults. UIT/ITS reserves the right to request construction be stopped and deficiencies corrected at any point during the construction process. The installing contractor must contact the designated FE two (2) business days prior to scheduling concrete encasement of underground conduits.

PATHWAY DESIGNER’S RESPONSIBILITIES (ITSFE, DPMDC)

1. The ITSFE or the DPM Design Consultant (DPMDC) shall:

- Provide complete and accurate design specifications, on the Project’s Construction Drawings and Specifications, for construction of the communications underground pathways and spaces.
  - Design drawings shall depict (a) the communications conduit/duct layout in plan and profile, (b) “butterfly” details of all maintenance holes (MH), service boxes (SB) and hand holes (HH) showing the exact locations of conduit/duct(s) entry points on each wall.
Identify from Stanford Maps & Records archives, all existing underground utilities, in the pathway route, for depiction on the construction drawings. The pathway designer shall coordinate for those conflicting utilities to be USA located and marked and subsequently potholed to confirm the exact location and size of the conflicting utility.

- Coordinate the final design review and approval process and the construction schedule.
- Facilities Operations Plans Review. Design review and approval is required to issued construction drawings (Maps & Records).

- Coordinate with Contracts & Procurement, the preparation of an invitation for bid (IFB) and bid award to qualified construction contractors (CC).
- Perform field Quality Assurance inspections and approvals.
- Field review and approve design changes and subsequent work change authorizations.

2. The Pathway Designer may also provide or arrange for the following:

- Coordinate line and grade field construction staking, at the request of the Contractor, for USA locating and marking of existing underground utilities and for subsequent project construction.
- Engage the services of an Independent Testing Agency to perform required tests, e.g. compaction tests, sampling and testing of materials, etc.

**DPM DESIGN CONSULTANT AND CONTRACTOR SUBMITTALS:**

1. Design Drawings:

- The DPM Design Consultant (DPMDC) shall provide detailed design drawings that depict (a) the communications conduit/duct layout in plan and profile, (b) “butterfly” details of all maintenance holes (MH), service boxes (SB) and hand holes (HH) showing the exact locations of conduit/duct(s) entry points on each wall.

2. Shop drawings and Project Data:

- The DPM Construction Contractor shall submit six (6) copies of shop drawings, manufacturers data, and materials list to the ITSFE for compliance review before purchase of such materials.
- All material and equipment shall be new and shall bear the manufacturers name, stamp and rating. If the contractor proposes to use substitute materials for an item where a particular manufacturers product is specified followed by the phrase “or approved equivalent”, the Contractor must submit six (6) copies of the manufacturers product data for the proposed substitution.

3. As-built Drawings (See Page 26 of 27 for additional details):

- The DPM Construction Contractor shall submit as-built drawings showing the actual installed location and depth of all structures and conduit/duct runs. Wall to wall footages shall be provided for all conduit/duct sections.
- Locations shall be referenced to the California Stated Plane Coordinate System or be specific as to offset distance from permanent improvements such as building foundations, concrete curbs, street centerlines, etc.

- As-built drawings shall include the location and depth of any discovered underground utility that were not indicated on the original plans or is in a location different than what was indicated on the original plans.

**DESIGN STANDARDS AND GUIDELINES**

1. GENERAL SPECIFICATIONS.

SU’s underground communications pathway design standards and guidelines are primarily based upon the following reference documents:

- California Public Utilities Commission – General Order Number 128 (CPUC GO-128)

- Telecommunications Industry Association/Electronic Industry Alliance (TIA/EIA) – Customer-Owned Outside Plant Telecommunications Cabling Standard – 758


The reference standards and codes, shown below in Table 1 and SU's Facilities Design & Construction Standards (FDCS), shown below in Table 2; are applicable to the SU CUPS design.

- It is required that the Pathway Designer be thoroughly familiar with the content and intent of these reference standards and codes, and be capable of applying the content and intent of these reference standards and codes to the design of the underground communications pathway.

- If questions arise as to which reference standard or code should apply in a given situation, the more stringent shall prevail. As each of these documents are modified over time, the latest edition and addenda to each of these documents is considered to be definitive.
### TABLE 1 – REFERENCE STANDARDS AND CODES

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<td>AASHTO</td>
<td>American Association of State Highway and Transportation Officials (AASHTO). Applicable standards.</td>
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<tr>
<td>ACI</td>
<td>American Concrete Institute. Applicable standards.</td>
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<tr>
<td>BICSI TDMM</td>
<td>Building Industries Consulting Services International (BICSI) – Telecommunications Distribution Methods Manual (TDMM)</td>
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<tr>
<td>NEMA</td>
<td>National Electrical Manufacturer’s Association (NEMA).</td>
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<tr>
<td>TIA/EIA – 758</td>
<td>Telecommunications Industry Association/Electronic Industry Alliance (TIA/EIA) – Customer-Owned Outside Plant Telecommunications Cabling Standard –758</td>
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<tr>
<td>TIA/EIA – 569</td>
<td>Telecommunications Industry Association/Electronic Industry Alliance (TIA/EIA) – Commercial Building Standard for Telecommunication Pathways &amp; Spaces – 569</td>
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<tr>
<td>TIA/EIA – 607</td>
<td>Telecommunications Industry Association/Electronic Industry Alliance (TIA/EIA) – Commercial Building Grounding and Bonding Requirements for Telecommunications – 607</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriter’s Laboratories (UL): Applicable listings and ratings.</td>
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### TABLE 2 – FACILITY DESIGN & CONSTRUCTION STANDARDS

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<tr>
<td>FDCS Section 01.35.00</td>
<td>Environmental Health &amp; Safety</td>
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<td>FDCS Section 01.56.39</td>
<td>Tree and Shrub Protection</td>
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<td>FDCS Section 01.56.00</td>
<td>Construction Signs &amp; Fencing</td>
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<td>FDCS Section 31.23.33</td>
<td>Trenching, Backfilling, and Compaction</td>
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<td>FDCS Section 32.11.00</td>
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<td>FDCS Section 32.12.00</td>
<td>Asphalt Concrete Paving</td>
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<td>FDCS Section 32.13.13</td>
<td>Concrete Paving, Curbs, and Ramps</td>
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<td>FDCS Section 32.17.00</td>
<td>Traffic Striping, Pavement Markers, Pavement Markings</td>
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<td>FDCS Section 32.01.00</td>
<td>Site Restoration and Rehabilitation</td>
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<tr>
<td>FDCS Section 27.05.28</td>
<td>Communications Interior Pathways</td>
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<td>FDCS Section 27.05.43</td>
<td>Communications Underground Pathways And Spaces</td>
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<td>Special Conditions For Storm Pollution Prevention.</td>
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<td>Managing Hazardous Material</td>
<td><a href="https://ehs.stanford.edu/">https://ehs.stanford.edu/</a></td>
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<tr>
<td>Construction Project Temporary Facilities Siting Policy</td>
<td><a href="https://lbre.stanford.edu/">https://lbre.stanford.edu/</a></td>
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The Facilities Design Guidelines (FDGs) listed in Table 2 can be accessed on the Internet at http://maps.stanford.edu/fdg_main

2. Maintenance Hole (MH), Service Box (SB), Hand Hole (HH) Design Standards.

2.1. General Specifications:

- The ITSFE will specify the size and location of MH's, SB's and HH's.
  - MH/SB's shall be sized to meet the ultimate number of conduit/ducts required in the pathway route.
  - Locations shall be based on the optimum use of associated main, lateral and reviewed and approved via the Facilities Operations Plans Review process.
- Precast MH's, SB's and HH's shall be used whenever possible. Field-cast shall only be used when precast does not meet requirements.
- SUIT-ITS has adopted the general specifications for MH's and SB's as used by AT&T. These standardized vaults are commonly available from multiple manufacturers.
- MH/SB/HH shall be designed in accordance with the California CPUC General Order Number 128, Requirements For Communication Systems, Section IV.

2.2. MH Types & Sizes:

- The following precast MH products are used in various landscape, pedestrian, incidental traffic and full traffic areas e.g. Oldcastle, Jensen Precast or equivalent manufacturer:
  - 4.5’W x 8.5’L x 6.5’HR (e.g. Jensen PTS-65). Maximum 8-4” main conduit/ducts in/out and a maximum of 2-4” lateral conduit/ducts out.
  - 6.0’W x 12.0’L x 7.0’HR (e.g. Jensen 38Y-4046-1). Maximum 18-4” main conduit/ducts in/out (27-4” when equipped with 38Y-4049 extension) and a maximum of 6-4” lateral conduit/ducts out.
  - 7.0’W x 16.0’L x 10.0’HR (e.g. Jensen 38Y-4048). Maximum 24-4” main conduit/ducts in/out (33-4” when equipped with 38Y-4051 extension) and a maximum of 8-4” lateral conduit/ducts out.
  - The ITS-FE will have the final decision on MH type and configuration based on location, future growth needs, and configuration of the conduit structures being installed.

2.3. SB Types & Sizes:

- The following precast SB products are used in pedestrian and incidental traffic areas e.g. Oldcastle, Jensen Precast or equivalent manufacturer:
  - 3.0’W x 5.0’L x 4.0’D (e.g. Jensen PTS-3660). Maximum 2-4” conduit/ducts in/out.
  - 4’.0”W x 6’-6”L x 3’-7”D (e.g. Jensen PTS-4878). Maximum 4-4” conduit/ducts in/out.
2.4 HH Types & Sizes:

- The following precast HH products are used in pedestrian or landscaped areas only e.g. Christy Concrete Products or equivalent manufacturer:
  - 17-3/4"W x 30"L x 24"D (PTS1730). Maximum 1-2” conduit/duct in/out. Use as a pull box only, no planned splicing.
  - 30-1/4"W x 48-1/4"L x 34"D (PTS3048). Maximum 1-4” conduit/duct in/out. Use as a pull box only, no planned splicing.

NOTE: HH’s shall not be installed in full or incidental traffic areas. The ITSFE may, on a case-by-case basis, approve installation of an AASHTO H-20 rated HH in a parking space area.

2.5 MH/SB in street areas, which are subject to vehicular traffic, shall be constructed to withstand a minimum of H-20-44 highway loading as designated by the American Association of State Highway Officials. Floors of manholes must meet the requirements of Public Utilities Code, Section 8054.

2.6 The strength of concrete used for MH/SB’s shall be at least 4,500 psi within 28 days.

2.7 The MH roof shall be a minimum 24” depth-of-cover in traffic areas to a maximum of 60” depth-of-cover. If greater depth-of-cover is required, use MH extensions or a Structural Engineer’s certified custom design.

2.8 MH’s shall be set on a graded level and compacted base of three (3) to six (6) inches of sand, gravel, drain rock or base rock. An approved flowable compactable mix shall be delivered by read-mix truck and backfill placed around the outside of the MH to the top of the roof slab (Do not use concrete above possible future bottom duct runs).

2.9 MH’s shall be fully equipped as follows:

- MH interior painted white.
- All hardware shall be galvanized steel metal.
Term-A-Duct terminators that accept PVC Schedule 40 conduit, minimum 4" inside diameter unless otherwise specified. The pathway designer must specify the location and spacing of terminators (minimum 8" horizontal and 10" vertical separation between conduits, measured centerline to centerline of conduits). It is recommended that the pathway designer specify additional row(s) of terminators, above and below those intended for use, to facilitate duct grade changes if conflicting utility crossings are in close proximity to the MH.

- Ground rod installed into earth through the provided knockouts in the floor of the enclosure. Copper, ¾” x 6’ in length.
- Bonding and grounding attachments and bonding ribbons installed.
- Uni-strut racking installed for cable support hanger attachments (racking package per current SBC – California (Pacific Bell) specifications.
- A minimum of four 7/8” diameter pulling irons shall be installed. On each duct entrance wall, install one pulling eye on the floor or lower wall and one on the upper wall. A Type ‘A’ MH with wall-centered duct banks shall be equipped with a minimum of 4 pulling irons. A Type ‘A’ MH with splayed duct banks shall be equipped with a minimum of 8 pulling irons.
- A 12” diameter by 4” depth sump located below each entry opening.
- An entry ladder in each entry opening. Ladder to be placed so that entry and exit is facing oncoming traffic (MH’s with centered access hole). MH’s that are between 12 feet and 20 feet long or between 6 feet and 12 feet width shall have two entry openings with covers. MH’s over 20 feet long must use three entry openings with covers.
- MH’s entry openings shall be thirty-six inch (36”) diameter clear opening at the center of the ceiling slab with thirty-six inch (36”) diameter extension rings installed as required for grade.
- MH Frame, Ring and Covers shall meet AASHTO HS-20-44 standards. The Frame shall be marked with the maintenance hole identification number on the top surface, facing North, with stamped letters not less than ½” high. The cover shall be a 30’ diameter Stanford Rosette-Design Cover labeled “Communications” in letters not less than two inches (2”) high, cast into the cover. The Stanford Rosette-Design Cover is available from D&L Foundry, 1-800-241-4766.
- The first MH step shall be placed on the top surface of the roof. Additional intermediate steps shall be placed at 12” intervals. The top step, just below the maintenance hole cover, shall be placed not less that six inches (6”) or not more than seventeen inches (17”) below the cover. Steps shall be ¾” galvanized steel and grouted between joints.
- All extension ring and collar seams in the MH neck shall be grouted smooth (prevention of water intrusion, debris collection, and snags) and painted white (increase light).

2.10 SB’s shall be set on a graded level and compacted base of three (3) to six (6) inches of sand, gravel, drain rock or base rock.
2.11 SB’s shall be fully equipped as follows:

- All metal hardware shall be galvanized steel.
- Term-A-Duct terminators that accept PVC Schedule 40 conduit, minimum 4” inside diameter unless otherwise specified. The pathway designer must specify the location and spacing of terminators (minimum 8” separation between conduits, measured centerline to centerline of conduits).
- Ground rod installed into earth through the provided knockouts in the floor of the enclosure. Copper, ¾” x 6’ in length.
- Bonding and grounding attachments and bonding ribbons installed.
- Uni-strut racking installed for cable support hanger attachments (racking package per current SBC – California (Pacific Bell) specifications.
- A minimum of two 7/8” diameter pulling irons shall be installed. On each duct entrance wall, install one pulling eye on the floor or lower wall. A Type ‘A’ SB with wall-centered duct banks shall be equipped with a minimum of 2 pulling irons. A Type ‘A’ SB with splayed duct banks shall be equipped with a minimum of 4 pulling irons.
- A 12” diameter by 2” depth sump located in the center of the floor.
- An adjustable frame and two-piece hinged cover assembly equipped with torsion assist opening and a slip-resistant steel cover. Cover to be furnished with a welded nameplate labeled “Communications” in letters not less than two inches (2”) high. Covers shall meet the design load criteria as applicable for the site location as follows:
  - Incidental traffic Loading: AASHTO H-20 (sidewalks & shared walkways).
  - Full Traffic Loading: AASHTO H-20 with 30% increase for impact (driveways, parking lots).

2.12 HH’s shall be set on a graded level and compacted base of three (3) to six (6) inches of sand, gravel, drain rock or base rock

2.13 HH’s shall be fully equipped as follows:

- Extensions to meet depth requirements (conduit/ducts shall enter the sides of HH, not bottom).
- Slab bottoms (unless otherwise noted).
- End knockouts for conduit/duct entries.
- Inserts and uni-strut racks for cable support hanger attachments.
- A slip-resistant cover. Cover to be embossed labeled “Communications” in letters not less than two inches (2”) high. Covers shall meet the pedestrian loading design criteria (300 lbs/sq.ft.)
2.14 Building Entry Boxes shall be Screw Cover Type 3R Enclosures, minimum sixteen (16) gauge galvanized steel (Hoffman or approved equivalent). The Enclosure shall provide protection in outdoor installations against rain, sleet, and snow and indoors against dripping water. The Contractor shall provide galvanized or cadmium plated nails, screws, clips or other means of securely anchoring boxes to buildings or other structures as required for a complete installation. Adequate provisions shall be taken to prevent dielectric action between dissimilar metals. Building entry boxes shall be painted to match existing building walls and/or trim where applicable.

The building entry box shall be sized based on the number and size of conduits entering and exiting the box and the size, number and type of cables to be installed thru the box.

2.15 Conduit penetrations into existing MH’s, SB’s or HH’s shall be by core drill hole or preformed breakout. Seal penetrations with waterproof grout. Conduits ends shall be placed flush to the inside surface of the wall.

3. MAIN & LATERAL UNDERGROUND PATHWAY – CONDUIT/DUCT DESIGN STANDARDS

3.1. General:

- The ITSFE will specify the conduit/duct route, the number and size of conduit/ducts, and the size and location of MH/SB’s.

  - Conduit/duct pathway locations shall be reviewed and approved via the Facilities Operations Plans Review process.

3.2. Clearance from other utilities:

- Conduit/duct shall not be placed in parallel, directly above or below, other utility lines (allow for maintenance access).

- Parallel lateral clearance to any other utility line shall be a minimum 24”.

- Crossing clearances to other non-steam utility lines shall be a minimum 12”.

3.3. Concurrently installed joint duct systems (communication & power):

- Communication conduit/duct can be concurrently installed in joint trench with rigid power conduit/ducts if separated by a minimum 3” of concrete.

- Communication conduit/duct(s), in a joint trench configuration, shall be installed in a separate top layer(s) or a side-by-side configuration separated by a minimum 3” of concrete between communications and power conduit/ducts.

- Except where specifically shown otherwise, joint trench conduit/duct structures, containing power circuits above 600 volts, shall be encased in red concrete (5-sack cement mix, 3/4” maximum aggregate).

3.4 Size and number of conduit/ducts:

- The ITSFE will specify the number and size of conduit/ducts.

  - Minimum size of main conduit(s) is four-inch (4”) diameter. Five-inch (5”) diameter conduits may be specified by the ITSFE when bend radius specification allowances are exceeded.
• Minimum size of lateral conduit(s) is 4” diameter to serve buildings (MH > MH, MH > SB, SB > SB). Five-inch (5”) diameter conduits may be specified by the ITSFE when bend radius specification allowances are exceeded.

• Minimum size of a single lateral conduit to a blue tower, pay phones, other single use facility is generally a 2” diameter conduit (SB > HH, HH > HH, HH > utility base).

3.5 Conduit/duct route:

- First choice is immediately adjacent to the curb and gutter in the street pavement if clear of other parallel utility lines.
- Second choice is out into the street pavement area clear of parallel utility lines.
- Third choice is behind the sidewalk / planter area if clear of trees or other major obstructions.
- Last Choice is in the sidewalk / planter area if clear of trees or other major obstructions.

3.6 Conduit Material:

- PVC Schedule 40 type conduit. Fittings shall be the same manufacturer as conduit. All plastic conduit and fittings shall have solvent-weld connections and shall provide a watertight joint.
- Rigid galvanized steel conduit (wrapped or PVC coated) may be specified in special requirements, e.g. shallow depth, exposed structures, etc.

3.7 Multiple conduit/duct formations – duct bank configurations:

- Two to three - four-inch (4”) diameter” conduits = one layer
- Four – four-inch (4”) diameter conduits = two layers x two conduits wide
- Six – four-inch (4”) diameter conduits = two layers x three conduits wide (1st choice) or three layers x 2 conduits wide (2nd choice).
- Eight – four-inch (4”) diameter conduits = two layers x 3 conduits wide and one layer x 2 conduits wide
- More than eight = N layers x 3 conduits wide.

3.8 Conduit/duct Cover, Separation & Encasement:

- Unless future conditions require greater depth, the minimum cover over conduit/duct is 24” in street, driveway and sidewalk areas and 24” in landscaped areas. In areas where the minimum cover cannot be obtained, the conduit/duct shall be concrete encased (5-sack cement mix, 3/4” maximum aggregate).
- Install conduit/duct with a minimum downward slope of three (3) inches in each one hundred (100) feet away from building towards MH’s, SB’s and other necessary drainage facilities. Unless otherwise noted on the drawings, conduit/duct shall be run in a straight line except where a change in direction is necessary.
Conduit shall be supported in the trench with Carlon Snap-Lock Spacers and Rebar Holders or equivalent. The Carlon Snap-Loc Spacer support assemblies or equivalent shall not exceed eight feet (8') between support assemblies. Maintain no less that two inches (2") clearance between conduit/duct and earth on all sides and bottom. Conduits shall be separated by a minimum of two inches (2") clearance. In joint trench, power and communication conduit/ducts shall be separated by a minimum three inches (3") of concrete. Separation shall be maintained to enable conduit/ducts to be fully bedded and encased, as required, in a flowable cement sand slurry (1-1/2 sack cement-sand slurry mix) or concrete (5 sack cement mix, 3/4" maximum aggregate). The conduit/duct structure shall be tied together at the separators with wire and rebar and securely anchored to the bottom of the trench to prevent any movement or floating while pouring encasement.

Conduit shall be encased in flowable 1-½ sack cement – sand slurry mix, or if required by design specifications, concrete encased (5-sack cement mix, ½" maximum aggregate) to a minimum 3” above the conduit structure. A concrete vibration tool must be used to ensure that voids are not created around duct structures.

- In asphalt street and walkway pavement areas, the remainder of the trench shall be backfilled with Class II aggregate base @ 95% compaction to the bottom level of the existing pavement. The trench shall be final paved to match the existing pavement material (minimum 3” asphalt).
- In landscaped areas, the remainder of the trench shall be backfilled with native material @ 90% compaction and planting topsoil mix, to existing landscape grade (removed sod, plants and/or decorative materials shall be replaced in kind).

All bends and sweeps less than eighty feet (80") radius and all shallow depth conduit/ducts shall be concrete encased (5-sack cement mix, ¾” maximum aggregate).

3.9 Bends & Sweeps:

- Changes in direction of conduit/duct runs, exceeding a total of 10 degrees, shall be accomplished by long sweep bends.
- No more than two (2) 90 degree bends (180 degrees total) are allowed in a conduit/duct section without some form of pull-point (e.g. MH or SB as applicable).
- The minimum inside radius of long sweep conduit/duct bends shall not be less than 25 feet. All bends and sweeps less than eighty feet (80’) radius shall be concrete encased (5-sack cement mix, ¾” maximum aggregate). Nothing less than 25’ shall be used unless pre-approved in writing by the ITSFE.
- Straight sections of single bore PVC Schedule 40 conduit can be manually bent to form curves with a radius 40 feet or greater. All field formed long radius bends must be able to pass a 12” long by 3 5/8” wide solid ‘slug’ mandrel.
All bends and sweeps less than eighty feet (80") radius shall be concrete encased (5-sack cement mix, ¾” maximum aggregate).
3.10 Mandreling, Brushing, Pull Tapes, Plugging:

- Each conduit shall be mandreled immediately following backfill and compaction. The mandrel shall be pulled in both directions. It shall be preceded by a stiff brush pulled in both directions or until the conduit is clear of all material particles (earth, sand, gravel). The brush shall be sized to match the diameter of the conduit. A bend radius of 60” or less shall pass a rigid mandrel not less than 6” long with a diameter 3/8” less than the interior size of the conduit (4” diameter conduit requires a 3-5/8” diameter mandrel). A bend radius greater than 60” shall pass a 12” long rigid mandrel with a diameter 3/8” less than the interior size of the conduit. Conduit through which the mandrel cannot pass will be judged defective and shall be repaired immediately. The ITSFE shall witness the mandrel proving process.

- Install a ¾” polyester woven pre-lubed measuring / pull-tape (2500 lbs tensile strength, flat design with footage measurements, Neptco WP2500P or equivalent) in each conduit. The pull tape shall be new and free of splices. The wall-to-wall footage length, for each section, shall be provided to the ITSFE and noted on the “as-built” drawings. The pull tape shall be securely fastened at both conduit ends to compression conduit plug fittings. Install one (1) #18 AWG, stranded, jacketed copper wire, with the pull-tape, in one upper conduit of each duct structure, to enable future electronic locating and marking of the conduit/duct structure.

- Upon completion of mandreling, brushing and pull tape placement; each conduit shall be plugged at both ends, using compression type conduit plug fittings.

4. BUILDING ENTRANCE PATHWAY – CONDUIT/DUCT DESIGN STANDARDS

4.1 General:

- The ITSFE will specify the conduit/duct route, the number and size of conduit/ducts, and the size and location of MH/SB’s (if required), to connect new or remodeled buildings with the existing underground pathway system.

- For service security reasons, certain buildings may require dual building entrance facilities (separate entrance structures). If required the number of entrance conduit/ducts will be duplicated in each separate entrance structure.

- The DPM Project may need to install a vault or pull box, on the building site, to meet bend radius, slope or maximum cable length requirements to the existing pathway system.

4.2 The DPM Project shall provide entrance conduit/ducts from the designated exterior conduit/duct stub-out point, to and through the building wall, to the Entrance Facility Room (EFR) or Main Telecommunications Room (MTR) inside the building.
Clearance from other utilities:

- Conduit/duct shall not be placed in parallel, directly above or below, other utility lines (allow for maintenance access).
- Parallel lateral clearance to other utilities is a minimum 24”.
- Crossing clearances to other non-steam utility lines is a minimum 12”.

4.3 Concurrently installed joint duct systems (communication & power):

- Communication conduit/duct can be concurrently installed in joint trench with rigid power conduit/ducts if separated by a minimum 3” of concrete.
- Communication conduit/duct(s), in a joint trench configuration, shall be installed in a separate top layer(s) or a side-by-side configuration separated by a minimum 3” of concrete between communications and power conduit/ducts.
- Except where specifically shown otherwise, joint trench conduit/duct structures, containing power circuits above 600 volts, shall be encased in red concrete (5-sack cement mix, 3/4” maximum aggregate).

4.4 Size and number of conduit/ducts:

- A minimum of two (2) four inch (4” diameter), to a maximum of six (6) four inch (4” diameter) entrance conduit/ducts shall be placed (ITSFE will specify the required size and number). 5” conduits may be specified, at the discretion of the ITSFE, if the radius into the structure is 60” or less.

4.5 Underground Conduit Material:

- PVC Schedule 40 type conduit. Fittings shall be the same manufacturer as conduit. All plastic conduit and fittings shall have solvent-weld connections and shall provide a watertight joint.
- Rigid galvanized steel conduit (wrapped or PVC coated) may be specified in special requirements, e.g. shallow depth, exposed structures, etc.

4.6 Above Grade Communication Conduit Material:

- All exposed conduit rising more than one foot (1’) above the adjacent grade shall be rigid steel conduit, full weight, pipe size, finished inside and outside by a hot dipped galvanized method. The weight of zinc coating on the interior and exterior surfaces shall not be less than 2.0 ounces per square foot of total coated surface. The interior of the conduit shall be free of blisters, projections, and other defects. The conduit shall have threaded type couplings and fittings with insulated end bushings. Rigid steel conduit shall extend a minimum of twenty-four inches (24”) below grade before transition to PVC conduit.
- The Contractor shall provide galvanized or cadmium plated nails, screws, clips, or other means of securely anchoring the conduit to buildings or other structures as required for a complete installation. Adequate provisions shall be made to prevent dielectric action between dissimilar metals.

4.7 Multiple conduit/duct formations – duct bank configurations:
- Two to three (3) – four-inch (4") diameter conduits = one layer
- Four – four-inch (4") diameter conduits = two layers x two conduits wide.
- Six – four-inch (4") diameter conduits = two layers x three conduits wide (or three layers x 2 conduits wide)

4.8 Conduit/duct Cover, Separation & Encasement:

- Unless future conditions require greater depth, the minimum cover over conduit/duct is 24" in street, driveway and sidewalk areas and 24" in landscaped areas. In areas where the minimum cover cannot be obtained, the conduit/duct shall be concrete encased (5-sack cement mix, 3/4" maximum aggregate).
- Install conduit/duct with a minimum downward slope of three (3) inches in each one hundred (100) feet away from building towards MH's, SB's and other necessary drainage facilities. Unless otherwise noted on the drawings, conduit/duct shall be run in a straight line except where a change in direction is necessary.
- Conduit shall be supported in the trench with Carlon Snap-Lock Spacers and Rebar Holders or equivalent. The Carlon Snap-Loc Spacer support assemblies or equivalent shall not exceed eight feet (8') between support assemblies. Maintain no less that two inches (2") clearance between conduit/duct and earth on all sides and bottom. Conduits shall be separated by a minimum of two inches (2") clearance. In joint trench, power and communication conduit/ducts shall be separated by a minimum three inches (3") of concrete. Separation shall be maintained to enable conduit/ducts to be fully bedded and encased, as required, in a flowable cement sand slurry (1-1/2 sack cement-sand slurry mix) or concrete (5 sack cement mix, 3/4" maximum aggregate). The conduit/duct structure shall be tied together at the separators with wire and rebar and securely anchored to the bottom of the trench to prevent any movement or floating while pouring encasement.
- Conduit shall be encased in flowable 1-½ sack cement - sand slurry mix, or if required by design specifications, concrete encased (5-sack cement mix, ½" maximum aggregate) to a minimum 3" above the conduit structure. A concrete vibration tool must be used to ensure that voids are not created around duct structures.
  - In asphalt street and walkway pavement areas, the remainder of the trench shall be backfilled with Class II aggregate base @ 95% compaction to the bottom level of the existing pavement. The trench shall be final paved to match the existing pavement material (minimum 3" asphalt
  - In landscaped areas, the remainder of the trench shall be backfilled with native material @ 90% compaction and planting topsoil mix, to existing landscape grade (removed sod, plants and/or decorative materials shall be replaced in kind).
- All bends and sweeps less than eighty feet (80") radius shall be concrete encased (5-sack cement mix, 3/4" maximum aggregate).
4.9 Bends & Sweeps (if required):

- Changes in direction of conduit/duct runs, exceeding a total of 10 degrees, shall be accomplished by long sweep bends.

- No more than two (2) 90 degree bends (180 degrees total) are allowed in a conduit/duct section without some form of pull-point (e.g. MH, SB, etc).

- The minimum inside radius of building entrance long sweep conduit/duct bends shall not be less than 60". The ITSFE shall specify longer sweep bends, greater than 60" radius, or 5" conduits, if large pair-count copper cables are planned for placement.

- Straight sections of single bore PVC Schedule 40 conduit can be manually bent to form curves with a radius 40 feet or greater.

- All bends and sweeps shall be concrete encased (5-sack cement mix, 3/4" maximum aggregate).

4.10 Mandreling, Pull Tapes, Plugging:

- Each conduit shall be mandreled immediately following backfill and compaction. The mandrel shall be pulled in both directions. It shall be preceded by a stiff brush pulled in both directions until the conduit is clear of all material particles (earth, sand, gravel). The brush shall be sized to match the diameter of the conduit. A bend radius of 60" or less shall pass a rigid mandrel not less than 6" long with a diameter 3/8" less than the interior size of the conduit (4" diameter conduit requires a 3-5/8" diameter mandrel). A bend radius greater than 60" shall pass a 12" long rigid mandrel with a diameter 3/8" less than the interior size of the conduit. Conduit though which the mandrel cannot pass will be judged defective and shall be repaired immediately. The ITSFE shall witness the mandrel proving process.

- Install a 3/4" polyester woven pre-lubed measuring / pull-tape (2500 lbs tensile strength, flat design with footage measurements, Neptco WP2500Polor equivalent) in each conduit. The pull tape shall be new and free of splices. The wall-to-wall footage length, for each section, shall be provided to the ITSFE and noted on the "as-built" drawings. The pull tape shall be securely fastened at both conduit ends to compression conduit plug fittings. Install one (1) #18 AWG, stranded, jacketed copper wire, with the pull-tape, in one upper conduit of each duct structure, to enable future electronic locating and marking of the conduit/duct structure.

- Upon completion of mandreling, brushing and pull tape placement; each conduit shall be plugged at both ends, using compression type conduit plug fittings. Blank conduit plugs shall be removable, reusable, corrosion proof, water/air/gas-tight, and equipped with an attachment to secure the pull tape inside the conduit.
5. SITE CONSTRUCTION:

5.1. Surface excavation work shall be performed in accordance with applicable Stanford Facilities Design and Construction Standards: Division 01 – General Requirements and Division 02 – Site Construction. The applicable standards can be accessed on the Stanford website http://maps.stanford.edu/fdg_main

5.2. In asphalt street pavement areas, asphalt in the trench and maintenance hole excavation areas will be cutback 6" from excavation edge for final pavement placement. Final asphalt pavement shall match existing pavement but shall not be less than 3" asphalt over a minimum of: (a) 9" of Class 2 aggregate base @ 95% compaction. If a longitudinal pavement joint or edge of pavement is located within three (3) feet of the limit of excavation, all intervening pavements shall be removed and replaced.

5.3. In existing concrete sidewalks, excavations for the trench or to a full depth in straight lines either parallel to the curb or at right angles to the alignment of the sidewalk. No concrete sidewalk to be replaced shall be smaller than thirty inches (30") in either length or width. If the saw cut would fall within thirty inches (30") of a construction joint, expansion joint, or edge or within twelve (12) inches of a score mark, the concrete shall be removed to the joint, edge, or mark.

6. CONCRETE CONSTRUCTION SPECIFICATIONS:

6.1. Concrete construction work shall be performed in accordance with applicable Stanford Facilities Design and Construction Standards: Division 01 – General Requirements and Division 02 – Site Construction. The applicable standards can be accessed on the Stanford website: http://maps.stanford.edu/fdg_main

6.2. Concrete for duct encasement shall be Class B, 470 lbs. (5 sack) of Portland cement per cubic yard. The combined aggregate grading for each batch of concrete shall conform to ¾” maximum as described in Section 73.106 of the CDT Standard Specifications.

6.3. Concrete encasement for communication ducts shall be normal color except when placed integrally with concrete encasement for electrical power ducts, in which case the concrete shall be red.

CONSTRUCTION CONTRACTOR’S RESPONSIBILITIES:

1. The construction contractor shall construct the communications underground pathway per the design specifications, as shown on the Project’s Construction Drawings and Specifications, all applicable Stanford Facilities Design and Construction Guidelines http://maps.stanford.edu/fdg_main and all applicable governing laws, rules and regulations.

2. Thoroughly review and verify that all work required in the field is adequately described in the construction drawings. All discrepancies and omissions shall be brought to the immediate attention of the pathway designer (ITSFE).

3. Submit for approval in writing the names of all proposed Sub-contractors with a detailed description of their Work responsibilities.

4. Submit a detailed Construction Schedule for the overall project.
5. Submit a report detailing the Contractor’s management structure including the names, titles and phone numbers for emergency contacts and call-outs. The Contractor’s emergency call list shall be kept current during the construction period.

6. Shop drawings and Project Data:
   - The DPM Construction Contractor shall submit six (6) copies of shop drawings, manufacturers data, and materials list to the ITSFE for compliance review before purchase of such materials.
   - All material and equipment shall be new and shall bear the manufacturers name, stamp and rating. If the contractor proposes to use substitute materials for an item where a particular manufacturers product is specified followed by the phrase “or approved equivalent”, the Contractor must submit six (6) copies of the manufacturers product data for the proposed substitution.

7. Submit for approval, in writing, all requests for compensation adjustments prior to execution.

CONSTRUCTION STANDARDS AND GUIDELINES

1. GENERAL SPECIFICATIONS
   1.1. All work contained herein shall conform to the construction drawings, specifications and all applicable Federal, State, County, City, Local laws, ordinances, rules, permits and regulation of Rights-of-Way Owners or authorities having jurisdiction. The aforementioned laws, ordinances, rules, permits and regulations are hereby incorporated and become a part of the Contract Documents as though they were written herein.
   1.2. The contractor shall provide labor, materials apparatus, tools, equipment, transportation, temporary construction, and special or occasional services as required to construct a complete communications facility as shown on the drawings and described in the specifications.
   1.3. Contractor shall secure all permits, clearances and agreements not furnished by Owner.
   1.4. Contractor shall obtain and pay for all work permits required by governmental authorities and other permits required for Contractor’s construction operations including but not limited to Contractor’s licenses, construction bonds, transportation, equipment, labor and or other general permits.
   1.5. Properly trained and skilled workers shall perform all work. The Contractor shall provide full-time supervision to ensure that all work is performed in a safe and quality manner in accordance with all applicable standards, specifications, methods and procedures.
   1.6. The reference standards and codes, shown in Table 1 (see page 4), and the Stanford Facilities Design Guidelines, shown in Table 2 (see page 4), are applicable to the construction of SU’s Underground Communications Pathways.
      - The Contractor shall be thoroughly familiar with the content and intent of these reference standards and codes and be capable of applying the content and intent of these reference standards and codes.
If questions arise as to which reference standard or code should apply in a given situation, the more stringent shall prevail. As each of these documents are modified over time, the latest edition and addenda to each of these documents is considered to be definitive.

The Facilities Design Guidelines listed in Table 2 (see page 4) can be accessed on the Stanford website: https://lbre.stanford.edu/maps/what-we-do/construction-services/facility-design-guidelines/fdg-available-documents

2. QUALITY CONTROL

2.1. Materials: All materials shall be new and the best of their respective kinds, free from all defects and as specified on the plans and the specifications or as accepted by the SUIT-ITSFE. Whenever, under the contract, it is provided that the Contractor shall furnish materials or manufactured articles or shall do work for which no detailed specifications are set forth, the materials or manufactured articles shall be of the best grade in quality and workmanship obtainable on the market from firms of established good reputation, or if not ordinarily carried in stock, shall conform to the usual standards of first-class materials or articles of the kind required, with due consideration of the use to which they are to be put. In general, the work performed shall be in full conformity and harmony with the intent to secure the best standard of construction and equipment of the work as a whole or in part.

2.2. Manufacturer's recommendations: Whether specifically mentioned or not in the Specifications, all materials, equipment, devices, etc., shall be installed in a manner meeting the approval of the manufacturer of the particular item. The Contractor shall obtain all installations manuals, brochures, and procedures that the manufacturer issues for the equipment and materials. The particular manufacturer shall certify any reason for deviation from the manufacturer’s recommendations in writing. The Contractor shall be held responsible for all installations contrary to the accordance with the manufacturer’s recommendations, the Contractor shall make all necessary changes and revisions to achieve such compliance.

3. CONSTRUCTION SAFETY

3.1. All construction shall be performed in a safe manner in accordance to all applicable Cal-OSHA construction safety orders.

3.2. Confined space work activities shall be planned and performed in adherence with

- California Code of Regulations, Title 8, Sections 5156 and 5158 of the General Industrial Safety Orders and Sections 8604 and 8616 of the Telecommunications Safety Orders.
Stanford University Safety Manual, Section 3.8 defines the Confined Space Safety Procedures. Stanford Environmental Health & Safety (EH&S) has prepared a separate safety guide that incorporates the most recent standards concerning confined space entry and operation. The actual regulations are contained in Title 8, Sections 5156-59 of the General Industry Safety Orders and Section 8616 of the Telecommunication Safety Orders of the California Code of Regulations. For a copy of the Confined Space Safety Guide please contact the General Safety Office at 725-1472.

4. CONSTRUCTION LOGISTICS PLAN

4.1. The contractor shall adhere to the project’s Construction Logistics Plan (Construction Project – Temporary Facilities Siting Policy) at all times. The Construction Logistics Plan defines the following requirements:
- Access routes by vehicle type into campus and to the construction site
- Areas designated as lay down and storage
- Proposed routes for pedestrians, bicycles, vehicles, and public transportation, with sign locations indicating detours
- Tree protection fencing
- Project limit fencing, curbing and vehicle control devices
- Sanitary facilities location
- Number of employees that will use the site
- Proposed hours and dates of work
- Start and finish dates for the construction project
- Parking, and access routes from contractor parking to the construction site

4.2. The contractor is required to perform their work in a manner that does not cause collateral damage to existing property, features, or facilities, and that all disturbed work areas are returned to their original or better condition. As such, it is recommended that the contractor photograph or video all construction work sites prior to the start of the work.

4.3. Site work shall not begin until temporary fences; barricades, warning signs and other pedestrian control devices are installed. If peripheral fencing is used, it shall be provided with reflectors, flashers, signs, dangles or barricades as the fence is being built. The Contractor shall furnish, erect, conduct and maintain such temporary fences, barriers, lights, reflectors, cones, signs, ramps, etc., as may be needed to adequately provide separation and warn the public of work in progress and of any existing dangerous conditions. This requirement shall apply continuously and shall not be limited to normal working hours.

4.4. The Contractor shall conduct their work operations and in a manner that causes the least possible obstruction and inconvenience to adjacent properties, cyclists, pedestrians and vehicular traffic. The work site shall be maintained in an orderly and safe manner.
4.5. The Contractor’s traffic control plan shall be approved before any work affecting roads or pathways commences.

- Full or partial closures of roads or pathways are not permitted without prior approval.
- The Contractor is responsible for coordinating and obtaining approvals of temporary barricades and/or detours of traffic from the Police Department, Fire Department and/or any other Authority Having Jurisdiction (AHJ).
- If traffic is reduced to one way, the Contractor shall provide flag persons. A minimum of one lane shall be maintained open to traffic at all times.
- When entering or leaving roadways carrying public traffic, the Contractor’s equipment, whether empty or loaded, shall in all cases yield to public traffic.
- The Contractor shall maintain continued access to parking areas, roads, abutting properties, and other facilities that the construction will cross.
- Cone placements for traffic detours and signing shall conform to the most current edition of the Caltrans Traffic Manual. The Contractor shall supply and maintain cone placements at their expense.
- All traffic signs which fall within the line if construction or are obstructed by the Contractor’s equipment or operations shall be temporarily relocated to an unobstructed area. At no time shall hospital “EMERGENCY” signs be blocked or removed. Temporarily relocated traffic signs shall be returned to their original location at the end of construction.
- When working in Stanford Hospital zone follow the Stanford Hospital Facilities Guidelines applicable to the work.
- The CC shall closely coordinate their MH/SB excavation work with the manufacturer’s site delivery and placement of precast MH/SB’s so that street access disruptions are minimized.

4.6. All shrubs and trees in the project area shall be protected from damage and shall be replaced if damaged. Contractor to contact the Stanford Architect / Planning Office prior to digging under root zones to determine the method of excavation to minimize or eliminate the cutting of roots. Any other significant plantings should be protected or replaced if damaged (lawns, flower beds, ground covers, etc.).

4.7. Contractor will make every effort to prevent the pollution of surface water runoff from the construction project by keeping pollution out of storm drains, by reducing the exposure and discharge of materials and wastes to storm water, and by reducing erosion and sedimentation (Reference: Special Conditions For Storm Pollution Prevention).
4.8. Prior to saw cutting of pavement and excavation of trench, all storm drains shall be protected from saw cut slurry and all construction debris. Saw cut slurry and debris shall be swept up and vacuumed as required and at the end of each workday (Do not hose down pavement). Contractor shall ensure that slurry does not enter storm drains (Contractor may be fined $5,000 for violation). At the completion of all project work, remove storm drain protection and clean out basins if necessary.

4.9. In the event that the Contractor encounters toxic or hazardous materials in the performance of the Work, which are not caused by the Contractor’s fault or through its negligence, Contractor shall immediately contact Owner and the governing authority for direction on how to proceed.

4.10. Contractor shall be responsible for any and all costs for the removal and corrective measures associated with toxic materials or hazardous materials caused by the Contractor fault or through its negligence. Owner and governing authority shall determine corrective action.

5. CONSTRUCTION STAKING

5.1. The Contractor shall notify the Design Engineer in writing at least seventy-two (72) hours prior to the time when specific staking services are desired and shall stipulate at that time the particular stakes required, giving the specific location or limiting stations, kind stakes, off-sets, and other pertinent information. The Design Engineer will provide staking order forms.

5.2. The Design Engineer shall furnish the stakes and reference marks necessary for the construction of the improvements covered by the Contract. One set of construction stakes shall be furnished without charge to the Contractor. Additional staking or re-staking shall be requested in writing and will be paid for by the Contractor.

5.3. Control stakes, which constitute reference points for all construction work, will be conspicuously marked with orange flagging tape/paint. It shall be the responsibility of the Contractor to inform his or her employees and his or her Subcontractors of the stakes’ importance, and the necessity for their preservation. The cost of replacing such controls, should it become necessary for any reason whatsoever, shall be at the Contractor’s expense. If the removal of a control stake is required by construction operations of the Contractor or his or her Subcontractors, advance notice of at least forty-eight (48) hours shall be given to the Design Engineer, who will reference and remove said stake at no cost to the Contractor or his or her Subcontractor.

5.4. Should occasion arise where the validity of a stake is questionable either as to its location or the offset marked thereon or as to the elevation of cut or fill marked thereon, the Contractor shall notify the Design Engineer, who will check the stake or stakes in question. It shall be the Contractor’s responsibility to examine the stakes before commencing operations. Any stakes found to be in error would be reset. There will be no charge to the Contractor for this service if the stake is found to be in error: it is understood that the Design Engineer will not be charged for any standby or “down time” as a result of such checking or resetting procedure.
6. UNDERGROUND UTILITY LOCATING AND MARKING

6.1. The construction drawings are generally diagrammatic and may not depict the exact location of the identified underground utilities. Unless potholed during design, the existing underground utilities shown on the construction drawing are based on the available records information. The Contractor is responsible for locating all underground utilities whether on the plans or not. The Contractor assumes liability for any damage to underground utilities.

6.2. Prior to excavation commencement, the Contractor shall call USA North (1-800-227-2600) to request locating and marking of underground utilities (48 hours prior to construction start). The Contractor shall also notify all existing utility owners not participating in the USA North - One Call Service, if located in the excavation area. The Contractor shall document and maintain records that evidence the notification of USA North and other utility owners as required.

6.3. The Contractor shall meet with the approved utility representative to resolve any depth or construction line conflicts prior to the start of construction. Where existing utilities are present, the Contractor will be responsible for exposing the existing utilities by hand digging prior to working in the area. If the Contractor discovers underground facilities not indicated on the plans or in a location different from what is indicated on the plans, the Contractor shall protect such facilities, notify the Owner’s Representative and the ITSFE, and record actual conditions found onto the record drawing.

7. SITE CONSTRUCTION

7.1. Surface excavation work shall be performed in accordance with applicable Stanford Facilities Design Guidelines: Division 01 – General Requirements and Division 02 – Site Construction. The standards can be accessed on the Stanford website: https://lbre.stanford.edu/maps/what-we-do/construction-services/facility-design-guidelines/fgd-available-documents

7.2. In asphalt street pavement areas, asphalt in the trench and maintenance hole excavation areas will be cutback 6” from excavatin edge for final pavement placement. Final asphalt pavement shall match existing pavement but shall not be less than 3” asphalt over a minimum of: (a) 9” of Class 2 aggregate base @ 95% compaction. If a longitudinal pavement joint or edge of pavement is located within three (3) feet of the limit of excavation, all intervening pavements shall be removed and replaced.

7.3. In existing concrete sidewalks, excavations for the trench or to a full depth in straight lines either parallel to the curb or at right angles to the alignment of the sidewalk. No concrete sidewalk to be replaced shall be smaller than thirty inches (30”) in either length or width. If the saw cut would fall within thirty inches (30”) of a construction joint, expansion joint, or edge or within twelve (12) inches of a score mark, the concrete shall be removed to the joint, edge, or mark.

8. MAINTENANCE HOLE (MH), SERVICE BOX (SB), HAND HOLE (HH) CONSTRUCTION
8.1. MH’S, SB’s, and HH’s shall be constructed in accordance with the approved Construction Drawings and the applicable design specifications as outlined in Section 2 of this FDCS-CUPS document.

8.2. If MH/SB/HH specifications are inadvertently missing on the construction drawings, the Construction Contractor shall contact the responsible pathway designer (ITSFE).

8.3. If construction-drawing specifications cannot be fulfilled due to field conditions encountered in performance of the work, the Construction Contractor shall resolve changes with the responsible pathway designer (ITSFE). Design changes confirmed in writing and noted on the “as built” drawings.

9. CONDUIT/DUCT CONSTRUCTION

9.1. Main, lateral and building entrance conduit/duct shall be constructed in accordance with the approved Construction Drawings and the applicable design specifications as outlined in Section 3 and 4 of this FDG-CUPS document.

9.2. If conduit/duct specifications are inadvertently missing on the construction drawings, the Construction Contractor shall contact the responsible pathway designer (ITSFE).

9.3. If construction-drawing specifications cannot be fulfilled due to field conditions encountered in performance of the work, the Construction Contractor shall resolve changes with the responsible pathway designer (ITSFE). Design changes confirmed in writing and noted on the “as built” drawings.

9.4. The exact routing of the trench shall be determined by field conditions encountered. Trench shall be excavated sufficiently ahead so that such changes may be made smoothly and avoid additional bends and offsets. All deviations from the drawings must be approved in advance by the responsible ITSFE.

10. CONCRETE CONSTRUCTION:

10.1. Concrete construction work shall be performed in accordance with applicable Stanford Facilities Design and Construction Standards: Division 01 – General Requirements and Division 02 – Site Construction. The applicable standards can be accessed on the Stanford website: https://lbre.stanford.edu/maps/what-we-do/construction-services/facility-design-guidelines/fdg-available-documents

10.2. Concrete for duct encasement shall be Class B, 470 lbs. (5 sack) of Portland cement per cubic yard. The combined aggregate grading for each batch of concrete shall conform to ¾” maximum as described in Section 73.106 of the CDT Standard Specifications.

10.3. Concrete encasement for communication ducts shall be normal color except when placed integrally with concrete encasement for electrical power ducts, in which case the concrete shall be red (four pound red dye per cubic yard).

10.4. Concrete shall not be dropped freely more than six feet (6’). Spouts, elephant trunks, of other approved methods shall be used to prevent segregation.
10.5. A mechanical vibrator shall be employed at each point of dump, and a standby vibrator machine, in good working condition, but not in use, shall be kept on the job site until all concrete is placed.

11. GRADE ADJUSTMENTS TO SURFACE STRUCTURES:

11.1. Frames, grates, and covers of all surface structures (maintenance holes, hand holes, etc.) shall be adjusted to proposed finish grade. Grade rings shall be supplied and installed as required.

11.2. Structures Within Paved Areas:

- A structure located in an area to be surfaced or resurfaced with asphalt or concrete, shall not be constructed to final grade unless grade stakes are provided by the Project’s responsible civil engineer or the adjacent pavement surface has been installed.
- The Contractor shall be responsible for referencing structures prior to paving and locating them after paving operations are complete.
- After asphalt concrete resurfacing is complete, the asphalt shall be cut out six inches (6") wider than the frames of all surface structures. Each frame shall then be raised to finished grade and supported by concrete as noted above. Refer to Stanford University Facilities Design and Construction Standards section 02585 for surface restoration requirements.

12. INSPECTION AND TESTING:

12.1. Compaction Testing:

- The Owner’s designated project manager (ITSFE) may provide the services of a Soils Engineer to review all excavations, fills, and compaction operations and to make such tests, as he or she may deem necessary to determine compliance with the specifications. The Contractor shall adhere in every detail to the requirements of the Soils Engineer in the prosecution of the work. The Soils Engineer shall be selected and paid by the Owner or Owner’s designated project manager.
- The Contractor shall notify the Owner’s designated project manager when compaction operations are completed, and soils are ready for testing. If excavation is required to provide access to compacted soil for testing, the Contractor shall perform the necessary excavation and subsequent re-backfill and compaction at no additional cost.

12.2. Field Cast Structure Testing:

- The Owner or Owner’s designated project manager may provide the services of a Structural Engineer to review all cast in place concrete structures and other structural support construction operations and to make such tests, as he/she may deem necessary to determine compliance with the specifications. The Contractor shall adhere in every detail to the requirements of the Structural Engineer in the prosecution of the work. The Structural Engineer shall be selected and paid by the Owner.
12.3. Field Inspections:

- The Owner's designated project manager (ITSFE) shall inspect the quality and progress of work.
  
  - Where workmanship or installation deficiencies are observed, the Owner's designated project manager (ITSFE) will prepare a written list of these deficiencies and discuss them immediately with the Contractor's Supervisor.
  
  - The Contractor shall then take measures to correct any discussed or written deficiencies without impacting the installation schedule.

- The Contractor shall quality inspect its work. The Contractor shall prepare a checklist of completed work items for inspection and schedule a joint review with the Owner's designated project manager (ITSFE).
  
  - The Owner's designated project manager (ITSFE) and Contractor will perform a joint inspection using the checklist as a guide.
  
  - Any work concealed before inspection by the Owner’s designated project manager (ITSFE) and/or authorities or agencies having jurisdiction (AHJ), shall be re-opened or uncovered. The exposure of the work and any required corrective modification shall be made at the Contractor's expense.
  
  - The Owner's designated project manager (ITSFE) shall prepare a punch-list that both the Owner’s designated project manager (ITSFE) and Contractor will sign, that documents all incomplete or non-standard work.

- The Contractor shall notify the Owner's designated project manager (ITSFE). The Contractor shall perform another acceptance inspection to ensure that all punch-list items have been corrected. The Owner's designated project manager (ITSFE) will initial each punch-list item to signify final acceptance.

13. SITE RESTORATION AND REHABILITATION:

13.1. Site restoration work shall be performed in accordance with applicable Stanford Facilities Design Guidelines: Division 01 – General Requirements and Division 02 – Site Construction. The applicable standards can be accessed on the Stanford website https://lbre.stanford.edu/maps/what-we-do/construction-services/facility-design-guidelines/fdg-available-documents

14. AS-BUILT DRAWINGS AND DOCUMENTATION:

14.1. The contractor shall, on a daily basis, update the “red line” drawings for the Owner to verify throughout the week. The Contractor shall submit a copy of the “red line” drawings to Owner along with any notes necessary for Owner to verify the “as-built” drawing set.

  - Field design changes, e.g. grade, cover depth, etc.
  
  - Tie-in footages to field locatable features.
MH/SB/HH butterfly drawings reflecting any changes in conduit entrance configurations, conduit orientation, conduit numbering and measurements.

- Conduit proofing documentation (mandreling results)
- Wall-to-wall, wall-to-end conduit section measurement footage's.

14.2. Contractor shall submit a final clean and legible set of “red line, as-built” drawings to the Project Engineer within seven (7) calendar days after completion of the work. As built documents to include:

REFERENCE DRAWINGS:

2. The following reference drawings are available on the Stanford website https://lbre.stanford.edu/maps/what-we-do/construction-services/facility-design-guidelines/fdg-available-documents:

- Typical maintenance hole – cutaway side view: Drawing CM-11
- PTS-65 MH (Utility Vault): Drawing CM-12
- 38Y-4046-1 MH (Utility Vault): Drawing CM-38
- Typical maintenance hole frame and cover: Drawing CM-13
- PTS-3660 SB (Utility Vault): Drawing CM-39
- PTS-4878 SB (Utility Vault): Drawing CM-40
- PTS1730 HH (Christy Concrete Products): Drawing CM-41
- PTS3048 HH (Christy Concrete Products): Drawing CM-42
- Typical MH butterfly drawing: CM-14
- Typical trench cross-section - Asphalt Street Area: Drawing CM-43
- Typical trench cross-section – Landscape/Sod/Dirt Area: Drawing CM-44