

PART 1 - GENERAL

This section of the Telecommunications Construction Guide Specification has references, products, procedures, processes, and work descriptions/summaries that are common to many Washington State University Pullman (WSUP) campus telecommunications projects. This information is provided in specification format to serve as a guide to the Designer in producing a CSI-compliant specification that will meet the unique requirements of WSUP Telecommunications projects. However, this document is not intended to be a Master Specification. The information included in this section is not intended to be all-inclusive for any given project.

The Designer shall edit this section (adding and/or removing content where required) to meet the requirements of a given project.

Prior to publishing the specifications for bid or construction purposes, all edits shall be made using the MS Word Tracking Changes feature. **When submitting the specifications for review at each progress milestone, print the specifications showing the revision markings.**

Text in shaded boxes (such as this text) is included to aid the Designer in understanding areas of this section that may require modification for a particular circumstance. Although this text is generally written in declarative form, the Designer shall consider it guidance only. The Designer shall not assume that the content of this specification section is suitable or sufficient for any given project in its current form, and shall remain responsible for developing a thorough and complete specification that meets the requirements of the project being designed.

1.1 SUMMARY

Review and edit the following list of generic type products and work for relevance to this project. This listing should not include procedures or processes, preparatory work, or final cleaning.

- A. Provide all materials and labor for the installation of a pathway system for outside plant communications circuits. Work in this section includes excavation and trenching, conduit (raceway) construction, cutting and patching, concrete, maintenance hole and handhole construction, and landscaping.

Include this paragraph only if products will be furnished under this section but installed under other sections or by the Owner. WSUP frequently has the Contractor furnish patch cords, but uses their IT staff to install. When installations are "By Owner" consider referencing the installation to Division 1 Section 01010 (or equivalent) - Summary of Work (Owner- Installed Items). If this paragraph is required for the project, the Designer must take care to clearly define any product warranty issues associated with the split responsibility.

- B. Products installed (but not furnished) under this section -

Include this paragraph only if products will be installed under this section but furnished under other sections or by the Owner. For example, WSUP may pre-purchase fiber, but have the Contractor install. When products are furnished "By Owner" consider referencing the installation to Division 1 Section 01010 (or equivalent) - Summary of Work (Owner-Furnished Items). If this paragraph is required for the project, the Designer must take care to clearly define any product warranty issues associated with the split responsibility.

1. Grounding Conductor

1.2 STANDARDS AND CODES

Review and edit the following list of references. Check for completeness, currency and applicability to this project. The Designer shall verify with the WSUP Project Manager and/or the WSUP IT Project Manager assigned to the project whether the latest edition and/or addenda of each required reference is appropriate and specify the edition and addenda below accordingly.

- A. Incorporate by reference the applicable portions of the following specifications, standards, codes into this specification section.
1. General:
 - a. WSDOT/APWA 2008 Standards Specifications for Road, Bridge and Municipal Construction (APWA Standard Specifications)
 2. Concrete:
 - a. Reinforcement:
 - 1) ACI 301: Structural Concrete for Buildings
 - 2) ACI SP-66: American Concrete Institute - Detailing Manual
 - 3) ANSI/ASTM A82: Cold Drawn Steel Wire for Concrete Reinforcement
 - 4) ANSI/AWS D1.4: Structural Welding Code for Reinforcing Steel
 - 5) ANSI/AWS D12.1: Reinforcing Steel Welding Code
 - 6) ASTM A615: Deformed and Plain Billet Steel Bars for Concrete Reinforcement
 - 7) AWS D12: Welding Reinforcement Steel, Metal Inserts and Connections in Reinforced Concrete Construction
 - b. Cast-in-Place:
 - 1) ACI 212.3R: Chemical Admixtures for Concrete
 - 2) ACI 301: Structural Concrete for Buildings
 - 3) ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
 - 4) ACI 305R: Hot Weather Concreting
 - 5) ACI 306R: Cold Weather Concreting
 - 6) ACI 347: Guide to Formwork for Concrete
 - 7) ASTM C33: Concrete Aggregates
 - 8) ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - 9) ASTM C94: Ready-Mixed Concrete
 - 10) ASTM C150: Portland Cement
 - 11) ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete
 - 12) ASTM C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
 - 13) ASTM C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 - 14) ASTM C260: Air Entraining Admixtures for Concrete
 - 15) ASTM C309: Standard Specifications for Liquid Membrane Forming Compound for Curing Concrete
 - 16) ASTM C494: Chemical Admixtures for Concrete
 - c. Pre-Cast:
 - 1) ASTM C478: Standard Specification for Precast Reinforced Concrete Manholes Sections
 - 2) ASTM C857: Standard Practice for Minimum Structural Design Loading for Underground Precast Utility Structures
 - 3) ASTM C858: Standard Specification for Underground Precast Concrete Utility Structures
 - 4) ASTM C891: Standard Practice for Installation of Underground Precast Concrete Utility Structures

- 5) ASTM C1037: Standard Practice for Inspection of Underground Precast Concrete Utility Structures
 - 6) ASTM D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
3. Trenching and Backfill:
- a. ASTM D1557: Test Method for Laboratory Compaction Characteristics Using Modified Effort

1.3 DEFINITIONS

Review and edit the following list of definitions for applicability to this project. Add and/or remove definitions for unusual terms that are not explained in the conditions of the Contract and that are used in ways not common to standard references.

NOTE: Furnish, provide and install are used repeatedly throughout this specification. The Designer shall ensure that these terms are identified in the appropriate section of the project manual. The definitions of these terms shall be similar to the following:

Furnish - "Supply and deliver to the project site, ready for unloading, unpacking, assembly, installation and similar operations".

Install - "Operations at the project site including unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations".

Provide - "To furnish and install, complete and ready for the intended operation".

- A. Aggregate: Mineral materials such as sand or stone used in making concrete
- B. Backfill: Earth material used specifically for filling and grading excavations back to a finished state. Backfill is placed on top of the bedding surrounding encased ductbanks and direct-buried conduits.
- C. Base: Earth material used specifically to level and grade a subgrade for the subsequent placement of encased ductbanks, direct-buried conduit, maintenance holes and handholes. Base material is placed on top of the subgrade and beneath the bedding surrounding encased ductbanks, conduits, maintenance holes or handholes.
- D. Bedding: Earth material used specifically for filling excavations. Bedding is placed around encased ductbank, conduits, maintenance holes or handholes. Bedding is placed on top of the base and beneath the backfill.
- E. Fill: The collective term for base, bedding, and backfill.
- F. Handhole (HH): A structure similar to a small maintenance hole through which cable can be pulled, but not large enough for a person to fully enter to perform work.
- G. Maintenance Hole (MH): A vault located in the ground or earth as part of an underground conduit system and used to facilitate placing, connectorization, and maintenance of cables as well as the placing of associated equipment, in which it is expected that a person will enter to perform work.
- H. RNC: Rigid Non-Metallic Conduit (PVC)
- I. PSC: PVC Coated Rigid Steel Conduit.

J. RGC: Rigid Galvanized Steel Conduit

1.4 SYSTEM DESCRIPTION

Review and edit the following statement(s) for applicability to this project, restricted to describing performance, design requirements and functional tolerances of a complete system.

A. Furnish, install, and place into satisfactory and successful operation all materials, devices, and necessary appurtenances to provide a complete Outside Plant pathway system as hereinafter specified and/or shown on the Contract Documents. The Pathway system shall support an ANSI/TIA/EIA and ISO/IEC compliant communications Structured Cabling System (SCS) as specified in Section 33 82 00 — "Communications Distribution".

B. The work shall include materials, equipment and apparatus not specifically mentioned herein or noted on the plans but which are necessary to make a complete working ANSI/TIA/EIA and ISO/IEC compliant pathway system.

1.5 SUBMITTAL INFORMATION

Review and edit the following list of submittals as applicable to this project. Note that the submittals listed below are specific to this section only. Division 1, Section 01 30 00 (or equivalent) – Submittals should include general administrative requirements (e.g. schedule, number of copies, distribution, etc.). Either Section 01 30 00 or this section should include a statement similar to the following, "The Contractor shall apply Contractor's stamp, sign, or initial certifying that review, verification of required Products, and coordination of information is in accordance with the requirements of the work and Contract Documents.

Any deviations from the Contract Documents or specified product data shall be clearly noted, and must be approved by the Designer prior to start of construction. The Designer shall obtain approval from WSUP through the Standards Variance Request (SVR) process prior to approving a Contractor-submitted deviation.

If the deviation is not approved by the Designer it remains the Contractor's responsibility to provide what is required in the Contract Documents".

A. Quality Assurance/Control Submittals: Provide submittal information for review as follows:
1. Submit a copy of the delivery receipt for each concrete delivery. Include date, strength ordered, and location used.

1.6 SEQUENCING

State any requirements for coordinating work with potentially unusual or specifically required sequencing. WSUP may choose to construct a project under two bid packages - one for OSP Site Work as described in this specification section as well as other General Contractor specific work, and a second bid package for the Structured Cabling System. The Designer must coordinate with WSUP to determine if two bid packages will be used and include verbiage in the appropriate specification sections requiring the contractors to coordinate construction phasing and schedules. Coordinate this paragraph with the conditions of the contract and Division 1 requirements to ensure that no statements are made that will limit or void those conditions. A thorough understanding of the warranties applicable on this project is required. The Designer shall consider and account for unique warranty situations that may arise from owner furnished equipment, owner installed equipment, or other situations that may conflict with warranty requirements.

- A. Coordinate the installation of underground telecommunications ducts and maintenance holes with the installation of other underground utilities.
- B. Prior to concrete encasement of ductbanks, contact the Owner and Engineer to schedule observation of the conduits.

PART 2 - PRODUCTS

Ensure that products listed under the PART 2 – Products paragraphs have corresponding installation instructions in PART 3 – Execution, or in another specification section if furnished but not installed under this section.

WSUP has standardized on certain manufacturers and certain products for all new Structured Cabling Systems in WSUP facilities. Products shall be specified accordingly. The Designer shall ensure that the latest part numbers are used for specified products. Any substitutions require WSUP pre-approval before specification.

If the Designer wishes to use products that deviate from WSUP standards, a Standards Variance Request shall be made, as described in the Technology Infrastructure Design Guide (TIDG). If the alternative product is approved, the Designer shall adapt this to reflect the approved changes.

The products listed throughout Part 2 - Products below are not all-inclusive for any given project. The Designer shall ensure that all required products are specified. The Designer shall also verify that the most current part number of each specified product is listed in this section.

2.1 GENERAL

- A. Materials shall consist of fill, topsoil, concrete formwork, concrete, raceway, maintenance holes, handholes and other incidentals and accessories as required.

2.2 BASE, BEDDING AND BACKFILL

- A. Use of on-site soils for base, bedding, and backfill is not acceptable.
- B. Base: Readily compactable and meeting the following gradation requirements.
 - 1. Maintenance Holes and Handholes (provide gravel):

Sieve Size	Percent Passing
1 inch Square	100
¼ inch Square	25 - 80
U.S. No. 200	15 max
Sand Equivalent	30 min

- 2. Trenches (provide sand):

Sieve Size	Percent Passing
U.S. No. 10	35 - 100
U.S. No. 20	20 - 80
U.S. No. 40	10 - 55

U.S. No. 100	0 - 10
U.S. No. 200	0 - 3

C. Bedding: Same as Base for Trenches, above.

D. Backfill:

1. Maintenance Holes and Handholes - Same as Base for Maintenance Holes and Handholes, above.
2. Trenches

Sieve Size	Percent Passing
½ inch Square	100
¼ inch Square	65 - 100
U.S. No. 10	40 - 100
U.S. No. 50	3 - 50
U.S. No. 100	0 - 4
U.S. No. 200	0 - 3

2.3 CAST-IN-PLACE CONCRETE

A. Formwork:

1. Forms: Metal or plywood in good condition
 - a. Form Release Agent: Burke Form Coating (or equal)
2. Gypsum board

B. Reinforcement:

1. Reinforcing Steel: ASTM A615, Grade 40. Uncoated, free from rust, dirt, and loose scale.
2. Tie Wire: 18 gauge 40 or heavier black annealed wire.
3. Embedded Anchor Bolts: Mild galvanized steel, cold bent.

C. Concrete:

1. Cement: Different types of cement, including the same type of cement provided by more than one manufacturer, are not acceptable: Cement shall conform to:
 - a. ASTM C150-7, type 1.
 - b. 2500 psi. minimum compressive at 28 days per ASTM C39.
 - c. 4 inches maximum slump per ASTM C-143.
2. Aggregate:
 - a. Course: ASTM C33-71 with a maximum size of 1-¼ inch.
 - b. Fine: ASTM C33-71.
3. Water: Fresh, clean, potable and not detrimental to concrete.
4. Admixtures:
 - a. Air Entrainment: Conform to ASTM C260 and ASTM C173 or C231 with 5% to 7% air entrainment.
 - b. Other: Not allowed without prior approval from the Designer.
5. Curing Compound: Conform to ASTM C309. Free from petroleum resins or waxes. Formulated for sealing, surface hardening, and curing concrete.

2.4 CONDUIT AND DUCTBANKS

A. Conduit

1. Rigid Non-Metallic Conduit (RNC):
 - a. UL listed, NEMA TC2 Schedule 40 or 80 rigid polyvinyl chloride (PVC) approved for direct burial without concrete encasement
 - b. Fittings: NEMA TC3, matched to conduit and material.
2. Rigid Galvanized Steel Conduit (RGC):
 - a. Rigid steel conduit hot-dipped galvanized inside and out with threaded ends meeting ANSI C80.1.
 - b. Couplings: Unsplit, NPT threaded with galvanizing equal to (and compatible with) conduit. Running thread or set screw threaded fittings (except for three piece and watertight split couplings) are not acceptable.
 - c. Nipples: Same as conduit, factory-made up to 8 inches in diameter, no running threads.
3. PVC Coated Rigid Steel Conduit (PSC):
 - a. NEMA RN 1 rigid steel conduit coated with rigid polyvinyl chloride (PVC).
 - b. Fittings: NEMA RN 1.
4. Fittings:
 - a. Sweeps: Factory manufactured with a single arc of not less than a 15 foot radius. Sweeps shall be either PVC Coated Rigid Steel or fiberglass.
 - b. End Caps (Plugs): Pre-manufactured and water-tight. Tape is not an acceptable end cap or cover.
5. Pull Ropes: ¼ inch polypropylene with a minimum tensile strength of 200 pounds.
6. Muletape Pull cord with footage marks: WPxxxP

B. Ductbanks:

1. Conduit Spacers/Supports: High-density plastic interlocking spacers/supports. Spacers shall be:
 - a. Underground Devices Inc.: WUNPEECE
2. Warning Tape: 6 inch wide metallic warning tape, orange in color.
3. Grounding/Bonding: #2 AWG bare copper ground

2.5 LANDSCAPING:

- A. Topsoil: Imported from off construction site.

2.6 LABELING AND ADMINISTRATION

A. Labels

1. As recommended in ANSI/TIA/EIA 606. Permanent (i.e. not subject to fading or erasure), permanently affixed, waterproof and legible. Paint and other marking substances are acceptable.

PART 3 - EXECUTION

Ensure that products incorporated into the project under PART 3 paragraphs have corresponding Product information in PART 2 – Products, or in another specification Section if installed but not supplied under this Section.

The following paragraphs include installation requirements written specifically for the Products listed in Part 2 above. If other products are approved, the Designer shall ensure that appropriate Part 3 installation requirements are added/removed or modified as applicable and described in equal or greater detail to the following paragraphs.

All installation requirements shall be consistent with the manufacturer's requirements.

3.1 EXCAVATING, TRENCHING AND FILL

Review and edit the following installation requirements based on the products specified in PART 2 – Products above or on the products specified in another section if installed but not supplied under this section, and as applicable to this project.

A. Excavation:

1. Do not excavate when the outside temperature is less than 35° F or when there is standing water or snow on the subgrade.
2. Where crossing of concrete or asphalt is required, saw cut and remove surface material prior to excavating. Remove concrete in complete sections from control joint to control joint regardless of the width of the excavation. Restore concrete and asphalt surfaces following excavation to match existing depth, strength, color, and type of material.
3. If an adjacent structure may be compromised or damaged by excavation work, underpin the structure as required. If the structural integrity is in question, obtain an evaluation and recommendation from a registered structural Designer employed by the Contractor prior to proceeding with the work.
4. Maintain adequate separation between the excavation and adjacent underground utilities. Locate excavations such that ductbanks, maintenance holes, and handholes have a minimum separation of 12 inches between the ductbank and/or MH/HH and the nearest underground utility after installation. For gas lines, a minimum separation of 18 inches is required. For water lines, a minimum separation of 36 inches is required. Contact the Designer prior to proceeding if minimum separation distances cannot be achieved.
5. Protect excavations at the end of the work shift. Cover with steel sheets and barricade prior to leaving the job site, in accordance with all applicable rules, regulations, building codes, and ordinances.
6. Install, operate and maintain pump or dewatering equipment as necessary to prevent water from accumulating in the excavation.
7. Excavation Depth/Width
 - a. MH/HH: Excavate to a sufficient depth to cover the overall assembled height of the vault plus the added height of risers, covers and bedding material consisting of a minimum 6 to 12 inches of base. Excavate to a sufficient width to provide a minimum of 6 inches clearance around each side of the MH/HH.
 - b. Trenches: Excavate to a sufficient depth to provide a minimum of 24 inches cover over the conduit or ductbank formation and to allow for the proper alignment of conduits into the MH/HH. Excavate to a sufficient width to provide a minimum of 6 inches to each side of the ductbank formation.
8. Over-excavate, fill, and compact any soft spots in the subgrade.
9. Run trench excavation true and as straight as possible. Clear trenches of stones and soft spots.
10. Slope trench grade to fall 3 inches per 100 feet in general and ¼ inch per foot where possible.
 - a. Slope trench toward lower MH/HH or from high points toward MH/HH at both ends.
 - b. Slope trench away from building entrances.

B. Fill:

1. Drain and/or pump groundwater and surface water from the recipient area prior to the placement of fill.
2. Do not place frozen fill.
3. Base:
 - a. Scarify and moisture-condition the subgrade bed to receive fill prior to placing materials.
 - b. Moisture-condition base material to within 3 percent of optimum moisture content and place in loose, horizontal layers.
 - c. Level the subgrade bed using sand for trenches and gravel for MH/HH as necessary to form an even base.
4. Bedding: Do not exceed 4 inch depth of bedding lifts/layers before compacting
5. Backfill: Do not exceed 6 inches depth of backfill lifts/layers before compacting.

6. Compaction: Compact using a vibratory plate or roller or other mechanical device. Compaction through jetting and/or pounding is not acceptable. Compact per APWA Standard Specification Paragraph 7-10.3 (11).
 - a. Bedding: Compact material to a dense state equaling at least 95% of the maximum dry density per ASTM D1557.
 - b. Backfill: Compact material up to 2 feet below the finished grade with a minimum relative compaction of 90% of the maximum dry density per ASTM D1557. Compact material from 2 feet below the finished grade up to the finished grade with a minimum relative compaction of 95% of the maximum dry density per ASTM D1557.

The Designer shall coordinate with local WSUP authorities to determine whether WSUP wishes to have the fill material from the trenching deposited elsewhere on the site or hauled away. Review and edit the following waste disposal requirements to accommodate WSUP's fill material removal wishes as applicable to this project.

- C. Waste Disposal: Remove excavation materials and other construction debris from the site in a timely manner and dispose of legally.

3.2 CAST-IN-PLACE CONCRETE

- A. Construct concrete in accordance with the applicable portions of the specifications, standards, codes and regulations (latest editions and/or amendments) listed in Section 1, STANDARDS AND CODES.

- B. Formwork:

1. Construction:
 - a. Forms: Use the most advantageous panel sizes and panel joint locations. Neat patches and minor surface imperfections are permitted. Form surfaces in true planes within ¼ inch in 10 feet. Clean forms and remove debris prior to pouring concrete. Make braces unyielding and tight to prevent leakage. Maintain formwork construction tolerances complying with ACI 347. Formwork shall be readily removable without impact, shock, or damage to concrete surfaces and adjacent materials. Use chamfer strips fabricated to produce uniform smooth lines and tight edge joints for exposed corners and edges. Note: chamfer strips are not required for concrete encased ductbank corners and edges.
 - 1) Gypsum board shall not be used for forms except to form concrete encased ductbank.
 - b. Reinforcement: Construct reinforcement in accordance with ACI SP-6. Weld reinforcement in accordance with ANSI/AWS D1.4 or ANSI/AWS D12.1. Accurately position, support, and secure reinforcement against displacement. Support reinforcement by metal/plastic chairs, runners, bolsters, spacers, hangers, or other incidental materials as required.
 - c. Where metal or plywood forms are used, coat the forms with a form release agent prior to placement of concrete. Coat faces and edges of forms applied at a rate of 500 to 550 square feet per unit.
 - d. Curved Surfaces: Use only curved forms for constructing curved structures and surfaces.
2. Slope: For flatwork, construct forms with 1% side slope to both south and east sides.
3. Joints:
 - a. Control: Build into form.
 - b. Expansion: Build expansion joints into form, premolded ½ inch thick, and conforming to ASTM D1751. Seal the top ½ inch of expansion joints with an approved joint sealer.
4. Removal: Remove forms after concrete has cured (see Curing below) for 7 days or after concrete has attained a compressive strength of 2000 psi.
 - a. Where gypsum board forms are used to form concrete encased ductbank they can be left in place and backfilled after the specified curing period.

- C. Concrete:

1. Transport: Comply with ACI 304. Transport concrete from the mixer to the construction location via methods preventing separation of materials.
2. Application:
 - a. Prior to placement, inspect and complete formwork construction, reinforcement, and items to be embedded or cast-in.
 - 1) Provide rebar between ductbanks and pre-cast vaults and also at cold-joints in ductbanks to prevent differential settling forces from damaging conduits or cabling.
 - b. Deposit concrete in forms in layers not deeper than 24 inches and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer on the preceding layer while the preceding layer is still plastic. Cold joints are not acceptable.
 - c. Deposit concrete in a plastic condition and uniformly work around reinforcements.
 - d. Consolidate concrete using internal machine vibration (stinger) during pouring.
 - e. Once concrete work has commenced, work continuously until the work segment and/or section has been completed.
 - f. Cold Weather: Protect concrete from damage caused by frost, freezing, or low temperatures in compliance with ACI 306R. When temperature is below 40° F, heat water and aggregates before mixing to obtain a concrete mixture of not less than 50° F and not more than 80° F.
 - g. Hot Weather: Protect concrete from damage caused by hot weather in compliance with ACI 305R. When temperature is above 90° F chill water before mixing to obtain a concrete mixture of not more than 90° F. Cover reinforcing steel with water-soaked burlap if it becomes too hot immediately before placement of concrete. Temperature of steel shall not exceed the ambient air temperature.
3. Curing:
 - a. Curing method and rate of application shall be according to manufacturer's recommendations.
 - b. Protect concrete from premature drying, rain, excessive temperatures, and mechanical injury during the curing period.
 - c. Cure concrete for 7 days in accordance with ACI 301 and keep continuously moist during this time. Maintain concrete temperature between 50° and 90° F during the curing period.
 - d. Provide curing and sealing compound to exposed slabs, sidewalks, curbs, etc. as soon as final finishing operations are complete (within 2 hours). Re-coat areas subjected to heavy rainfall within 3 hours of the initial application.
4. Finish:
 - a. Consolidate, level and screen surfaces for evenness and uniformity. Remove excess concrete. Fill low spots. Float the surface after water sheen has disappeared from surface.
 - b. Finish flatwork with a special tool to match patterned finish of adjacent existing concrete.
 - c. Tool edges, control, and expansion joints to make finish work straight and even.
5. Ductbanks:
 - a. Reinforce ductbanks along full length with formed sides. Install reinforcement at each corner of the conduit spacers/supports.
 - b. Do not pour concrete against trench walls. Consolidate concrete during placement using an internal concrete vibrator.
 - c. Provide each MH/HH penetration with reinforcing bars tied to MH/HH reinforcement. Dowel reinforcement in foundation wall of building penetrations.
 - d. Secure conduit spacers/supports and reinforcing to prevent movement during concrete placement. Use stakes and/or tie wire to minimize floating and spreading.
6. Protection for exposed concrete: Cover exposed concrete (i.e. sidewalk, driveway, etc.) with plywood, weighted with concrete blocks or similar heavy object in order to prevent surface damage.
7. Bond and ground reinforcement bars to the nearest approved ground.

3.3 CONDUITS AND DUCTBANKS

A. Conduits:

1. Outdoor underground: Provide either
 - a. RNC Schedule 40 (Type 1).
 - b. RGC with half lapped wrap of Scotchrap No. 51 plastic tape or a coat of Kopper's Bitumastic No. 505 (minimum 20 mil thickness).
2. Outdoor exposed: Provide RGC.
3. Transitions: Transition to PSC at stub up locations. Transition to PSC for building entrances a minimum of 10 feet before reaching building foundation. Transitioning back to RNC after passing 5 feet inside the building foundation is acceptable.
4. Sweeps:
 - a. Shallow curves comprised of continuous lengths of individual straight RNC conduit are permissible with a minimum sweep radius of 40 feet.
 - b. Where the conduit sweep radius is less than 40 feet, sweeps shall be factory-manufactured bends with a minimum of 48 inch radius. Bending conduit in the field using manual or mechanical methods is not acceptable.
 - c. Do not exceed 90 degrees for an individual sweep.
 - d. Where unique construction requirements for bend radius or arc length do not permit the use of factory-manufactured sweeps, sweeps shall be field-manufactured using factory-recommended equipment. The internal diameter of the sweep shall not be changed during the sweep field-manufacturing process.
 - e. A conduit section shall have not more than the equivalent of two 90-degree sweeps (a total of 180 degrees) between pull points. The 180-degree maximum shall include kicks and offsets. Where it is not possible to construct a section of conduit within the 180-degree sweep maximum, an intermediate MH/HH shall be installed.
 - f. Two 90-degree sweeps separated by less than 10 feet is not permissible.
 - g. Construct sweeps for conduits within a common ductbank parallel, measured from the same center-point.
 - h. Do not install LB's, condulets, or 90 degree electrical elbows.
5. Fittings:
 - a. Cut conduit ends square and ream to remove burrs and sharp ends. Extend conduits the maximum distance into fittings, couplings, and/or connectors. Tighten fittings securely and seal watertight (see Sealing, below).
 - b. End Caps (Plugs): Provide end caps on conduit ends throughout construction to prevent the intrusion of water or debris. Install end caps on conduit that is not directly being worked on during the work day and on conduits at night. Leave end caps in place upon final completion of the work.
 - c. End Bells: Provide end bells for terminating conduit in maintenance holes and handholes. Install protective end bells on conduits flush with MH/HH walls. Do not use TERM-A-DUCT.
6. Sealing: Apply a watertight, conductive thread compound (for PSC) or solvent-type cement (for RNC) to make conduit connections waterproof and rustproof. Seal and grout conduit terminations in maintenance holes and handholes to ensure that voids in the joints are filled. Seal conduit terminations in buildings until used for cable.
7. Cleaning: After installation, and within five days prior to releasing conduit for cabling installation, clean each conduit with a wire brush and swab. Clean each conduit a minimum of two times in the same direction and swab with clean rags until the rag comes out of the conduit clean and dry. Swab away from buildings for conduit sections connected to buildings.
8. Test Mandrels: Prove out each conduit with a minimum 16 inch long test mandrel that is ¼ inch smaller than the inside diameter of the conduit. Pull the test mandrel after backfilling but prior to the replacement of landscaping. Repair or replace any conduit that does not prove out at no cost to the Owner.
9. Conduit Entrances:

- a. MH/HH: Conduit entrances at opposite ends of a maintenance hole or handhole shall be at the same level and in the same position with respect to the side walls. Ensure that each conduit leaving a MH/HH in any position enters the next MH/HH in the same relative position.
 - b. Buildings: Terminate conduits 4 inches above the finished floor.
 10. Length: Unless otherwise shown on the Contract Documents, do not exceed 600 feet of ductbank between pulling points. Contact the Designer prior to proceeding if a ductbank section will exceed 600 feet.
 - a. Record the length of each conduit on the As-Built drawings.
 11. Pull Ropes & Muletape Pull Cord: Install in each conduit longer than 10 feet immediately after the conduit has been cleaned and mandreled. Leave a minimum of 10 feet looped, tied-off, and labeled at each end of the conduit.
 12. Protection: Insure that after installation the conduit coatings and finishes are without damage. Repair as follows:
 - a. PVC Coated Rigid Steel Conduit: Patch nicks and scrapes in PVC coating after installing conduits.
 - b. Rigid Non-metallic Conduit: Repair damage with matching touchup coating recommended by the manufacturer.
- B. Ductbanks:
1. Unless otherwise noted on the Contract Documents or required for sweep radius, construct ductbanks without concrete encasement. Where shown as concrete encased, use concrete encased RNC (see CAST-IN-PLACE CONCRETE, above).
 2. Encased in Concrete:
 - a. See CAST-IN-PLACE CONCRETE, above.
 3. Conduit Spacers/Supports: Place supports on 8 foot centers if encased in concrete and 5 foot centers otherwise. Interlock spacers horizontally only. Stagger spacers encased in concrete at least 6 inches vertically.
 4. Warning Tape: Install metallic warning tape half the distance between the top of the ductbank and finished grade.
 5. Grounding/Bonding: Install ground wire along length of ductbank. Bond to grounding electrodes of MH/HH and to building service grounds.
 6. Slope ductbank grade to fall 3 inches per 100 feet in general and ¼ inch per foot where possible.
 - a. Slope ductbank toward lower MH/HH or from high points toward MH/HH at both ends.
 - b. Slope ductbank away from building entrances.

3.4 LABELING AND ADMINISTRATION

- A. Outside Plant Conduits:
1. Conduits shall be labeled by permanently marking the maintenance hole wall adjacent to each conduit. The markings shall indicate the maintenance hole name/number or building name where the opposite end of the conduit terminates.
- B. Outside Plant Maintenance Holes:
1. Maintenance holes shall be labeled by permanently marking the wall of the maintenance hole in a location that is as high as possible while remaining visible and readable from above ground. Preferably, the location should be higher than the groundwater level in the maintenance hole. The markings shall indicate the maintenance hole name/number.

3.5 LANDSCAPING

- A. Topsoil: Provide imported topsoil for excavations in grass and/or landscaped areas. Provide loosely compacted topsoil to a depth of 4 inches or depth of excavation for excavations less than 12 inches. Restore existing grades where disturbed. Rake and smooth topsoil following proper placement.

Installation shall be approved by the Owner prior to placing sod. Place topsoil per APWA Paragraph 8-01.3(2).

- B. Provide sod for grass areas disturbed by construction activity and replace shrubbery and trees damaged, removed or disturbed by construction activity. The use of seed/hydroseed is only acceptable when approved in advance by the Owner and the Designer prior to installation.

END OF SECTION