

- a. DM Telecom - Telecommunications & Special Telecommunications Systems Design Manual, 2016.

1.5 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.6 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

- A. Provide each product type by a single manufacturer.

2.2 GROUNDING AND BONDING CONDUCTORS

- A. Equipment Grounding Conductors: UL 83 insulated stranded copper, except solid copper for sizes 10 AWG and smaller. Continuous green insulation color for equipment grounding conductors, except wire sizes 4 AWG and larger may be identified according to NFPA 70.
- B. Bonding Conductors: ASTM B8 bare stranded copper, except ASTM B1 solid bare copper at sizes 10 AWG and smaller.
- C. Isolated Power System: Type XHHW-2 insulation with 3.5 or less dielectric constant.
- D. Telecom System Grounding Riser Conductor: TIA 607, minimum 1/0 AWG insulated stranded copper grounding conductor, unless otherwise indicated.

2.3 GROUND RODS

- A. Copper Clad Steel: UL 467, 3/4-inch diameter by 10 feet long.
- B. Provide quantity required to obtain specified ground resistance.

2.4 SPLICES AND TERMINATION COMPONENTS

- A. Splices and Termination Components: Meet or exceed UL 467, clearly marked with manufacturer, catalog number, and permitted conductor sizes.

2.5 TELECOMMUNICATION SYSTEM GROUND BUSBARS

- A. Busbar: Solid copper, pre-drilled from two-hole lug connections, minimum 1/4-inch thick for wall and backboard mounting using standard insulators sized as follows:
 - 1. Room Signal Grounding: 12 inches by 4 inches.
 - 2. Master Signal Ground: 24 inches by 4 inches.

2.6 GROUND CONNECTIONS

- A. Below Grade: Exothermic-welded type connectors.
- B. Above Grade:
 - 1. Bonding Jumpers: Compression type connectors, using zinc-plated fasteners and external tooth lockwashers.
 - 2. Ground Busbars: Two-hole compression type lugs using tin-plated copper or copper alloy bolts and nuts.

3. Rack and Cabinet Ground Bars: One-hole compression-type lugs using zinc-plated or copper alloy fasteners.
- C. Cable Shields: Make ground connections to multipair communications cables with metallic shields using shield bonding connectors with screw stud connection.

2.7 GROUND TERMINAL BLOCKS

- A. Terminal Blocks: Provide screw lug-type at equipment mounting locations, such as backboards and hinged cover enclosures, where rack-type ground bars cannot be mounted.

2.8 SPLICE CASE GROUND ACCESSORIES

- A. Splice Case Grounding and Bonding Accessories: Supplied by splice case manufacturer or 6 AWG insulated ground wire with shield bonding connectors.

2.9 COMPUTER ROOM AND ENTRANCE ROOM GROUND

- A. Computer Room and Entrance Room Ground: 1/0 AWG bare copper grounding conductors bolted at mesh intersections to form equipotential grounding grid in 24-inch mesh pattern. Bond grid to each access floor pedestal.

PART 3 - EXECUTION

3.1 GROUNDING - GENERAL

- A. Ground according to NFPA 70, TDM Chapter 4, as shown on drawings, and as specified.
- B. Grounding:
 1. Ground equipment to eliminate shock hazard and minimize, to maximum extent possible, ground loops, common mode returns, noise pickup, and cross-talk.
 2. System:
 - a. Ground CFE and identified GFE to earth ground, via approved electrical ground with wires run inside building, to eliminate shock hazards. Provide minimum number of ground connections. Ground resistance to be 0.1 ohm or less.
 - b. Use of AC neutral for system control, subcarrier or audio reference ground, either in power panel or receptacle outlet, is not acceptable.
 - c. Conduit, signal duct, or cable trays may not be used as system or electrical ground. These items are acceptable only for dissipation of internally generated system static charges, not to be confused with externally generated lightning, that may be applied or generated outside mechanical and physical confines of system to earth ground. Discovery of improper system grounding is ground to declare system unacceptable and termination of system acceptance testing.
 3. Cabinet Bus: Extend minimum 10 AWG solid copper wire common ground bus throughout each equipment cabinet. Home-run common ground bus from each equipment cabinet to system ground.

4. Equipment: Bond equipment to cabinet ground bus with copper braid equivalent to minimum 14 AWG.
 - a. Acceptable Alternatives: Self-grounding equipment enclosures, racks or cabinets, providing OEM certified functional ground connections through physical contact with installed equipment.
 5. Cable Shields: Bond cable shields to cabinet ground buss with minimum 14 AWG stranded copper wire at one end of cable run. Insulate cable shields from each other, face-plates, equipment racks, consoles, enclosures or cabinets, except at system common ground point. Provide one ground connection at source for coaxial and audio cables, if possible, with minimum number of cable shield ground connections.
- C. System Grounding:
1. Secondary Service Neutrals: Ground at supply side of secondary disconnecting means and at related transformers.
 2. Separately Derived Systems (Transformers Downstream from Service Entrance): Ground secondary neutral.
 3. Do not system ground isolation transformers and isolated power systems.
- D. Equipment Grounding: Bond and ground metallic structures, including ductwork and building steel, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, and other conductive items in close proximity to electrical circuits.

3.2 INACCESSIBLE GROUNDING CONNECTIONS

- A. Inaccessible Grounding Connections: Exothermically weld buried or otherwise normally inaccessible grounding connections, except connections for which periodic testing access is required.

3.3 SECONDARY EQUIPMENT AND CIRCUITS

- A. Main Bonding Jumper: Bond secondary service neutral to ground bus in service equipment.
- B. Metallic Piping, Building Steel, and Supplemental Electrodes:
1. Provide grounding electrode conductor sized according to NFPA 70 between service equipment ground bus and metallic water and gas pipe systems, building steel, and supplemental or made electrodes. Jumper insulating joints in metallic piping. Make connections to electrodes with fittings according to UL 467.
 2. Provide supplemental ground electrode and bond to grounding electrode system.
- C. Conduit Systems:
1. Ground metallic conduit systems. Provide metallic conduit systems with equipment grounding conductor.
 2. Provide equipment grounding conductor for non-metallic conduit systems, except for non-metallic feeder conduits carrying grounded conductor from exterior transformers to interior or building-mounted service entrance equipment.

3. Bond conduit containing only grounding conductor, provided for mechanical protection of conductor at entrance and exit from conduit.
- D. Feeders and Branch Circuits: Install equipment grounding conductors with feeders and power and lighting branch circuits.
- E. Boxes, Cabinets, Enclosures, and Panelboards:
 1. Bond equipment grounding conductor to each pullbox, junction box, outlet box, device box, cabinets, and other enclosures through which conductor passes.
 2. Provide lugs in each box and enclosure for equipment grounding conductor termination.
 3. Provide ground bars in panelboards, bolted to housing, with sufficient lugs to terminate equipment grounding conductors.
- F. Do not ground receptacles through their mounting screws, ground with jumper from receptacle green ground terminal to device box ground screw and branch circuit equipment grounding conductor.

3.4 CORROSION INHIBITORS

- A. When making ground and ground bonding connections, apply corrosion inhibitor to contact surfaces. Use corrosion inhibitor appropriate for protecting connection between metals used.

3.5 CONDUCTIVE PIPING

- A. Bond conductive piping systems, interior and exterior, to building to grounding electrode system. Make bonding connections as close as practical to equipment ground bus.

3.6 TELECOMMUNICATIONS SYSTEM

- A. Bond telecommunications system grounding equipment to facility main electrical grounding electrode system at source point.
- B. Provide wire and hardware required to properly ground, bond and connect communications raceway, cable tray, metallic cable shields, and equipment to ground source.
- C. Provide continuous ground bonding jumpers without splices. Use shortest possible bonding jumper length.
- D. Provide permanent and continuous ground paths with maximum 1-ohm resistance from raceway, cable tray, and equipment connections to building grounding electrode. Resistance across individual bonding connections to be maximum 10 milliohms.
- E. Below-Grade Grounding Connections: When making exothermic welds, wire brush or file point of contact to bare metal surface. Use exothermic welding cartridges and molds according to manufacturer's instructions. After welds have been made and cooled, brush slag from weld area and thoroughly clean joint area. Notify Resident Engineer/Contracting Officer's Representative (RE/COR) before backfilling any ground connections.
- F. Above-Grade Grounding Connections: When making bolted or screwed connections to attach bonding jumpers, remove paint to expose entire contact surface by grinding where necessary,

thoroughly clean connector, plate and other contact surfaces, and apply appropriate corrosion inhibitor to surfaces before joining.

G. Bonding Jumpers:

1. Provide insulated ground wire of size and type shown on Drawings or use minimum 6 AWG insulated copper wire.
2. Assemble bonding jumpers using insulated ground wire terminated with compression connectors.
3. Provide compression connectors of proper size for conductors specified. Use connector manufacturer's compression tool.

H. Bonding Jumper Fasteners:

1. Conduit: Fasten bonding jumpers with screw lugs on grounding bushings or conduit strut clamps, or clamp pads on push-type conduit fasteners. When screw lug connection to conduit strut clamp is not possible, fasten plain end of bonding jumper wire by slipping plain end under conduit strut clamp pad and firmly tighten clamp screw. Where appropriate, use zinc-plated external tooth lockwashers.
2. Wireway and Cable Tray: Fasten bonding jumpers using zinc-plated bolts, external tooth lockwashers, and nuts. Install protective cover, for example, zinc-plated acorn nuts on any bolts extending into wireway or cable tray to prevent cable damage.
3. Ground Plates and Busbars: Fasten bonding jumpers using two-hole compression lugs. Provide tin-plated copper or copper alloy bolts, external tooth lockwashers, and nuts.
4. Raised Floor Stringers: Fasten bonding jumpers using zinc-plated, self-drill screws and external tooth lockwashers. Contact AHJ 07A2 for specific instructions.

3.7 COMMUNICATION ROOM GROUNDING

A. Telecommunications Ground Busbars:

1. Provide communications room telecommunications ground busbar hardware, minimum size as described in TDM Chapter 4 at locations indicated on Drawings.
2. Connect telecommunications room ground busbars to other room grounding busbars as indicated on drawings.

B. Telephone-Type Cable Rack Systems: An aluminum pan installed on telephone-type cable rack serves as primary ground conductor within communications room. Make ground connections by installing the following bonding jumpers:

1. 6 AWG bonding between telecommunications ground busbar and nearest access to aluminum pan installed on cable rack.
2. Provide 6 AWG bonding jumpers across aluminum pan junctions.

C. Self-Supporting and Cabinet-Mounted Equipment Rack Ground Bars:

1. When ground bars are provided at rear of lineup of bolted together equipment racks, bond copper ground bars together using solid copper splice plates furnished by ground bar manufacturer.
 2. Bond together nonadjacent ground bars on equipment racks and cabinets with 6 AWG insulated copper wire bonding jumpers attached at each end with compression-type connectors and mounting bolts.
 3. Provide 6 AWG bonding jumper between rack or cabinet ground busbar and overhead cable tray aluminum pan or raised floor stringer as required.
- D. Backboards: Provide screw lug-type terminal block or drilled and tapped copper strip near top of backboards used for communications cross-connect systems. Connect backboard ground terminals to telephone-type cable tray aluminum pan using insulated 16 AWG bonding jumper.
- E. Other Communication Room Ground Systems: Ground metallic conduit, wireways, and other metallic equipment located away from equipment racks or cabinets to cable tray pan or telecommunications ground busbar, whichever is closer, using insulated 6 AWG ground wire bonding jumpers.

3.8 COMPUTER ROOM GROUNDING

- A. Conduit: Ground and bond metallic conduit systems as follows:
1. Ground metallic service conduit and any pipes entering or being routed within computer room at each end using 6 AWG bonding jumpers.
 2. Bond at intermediate metallic enclosures and across joints using 6 AWG bonding jumpers.

3.9 COMMUNICATIONS CABLE GROUNDING

- A. Bond metallic cable sheaths in multipair communications cables together at each splicing or terminating location to provide 100 percent metallic sheath continuity throughout communications distribution system.
1. At terminal points, install cable shield bonding connector to provide screw stud connection for ground wire. Use bonding jumper to connect cable shield connector to appropriate ground source, such as rack or cabinet ground bar.
 2. Bond metallic cable shields together within splice closures using cable shield bonding connectors or splice case grounding and bonding accessories furnished by splice case manufacturer. When an external ground connection is provided as part of splice closure, connect to approved ground source and other metallic components and equipment at that location.

3.10 COMMUNICATIONS CABLE TRAY SYSTEMS

- A. Bond metallic structures of one cable tray in each tray run following same path to provide 100 percent electrical continuity throughout cable tray systems as follows:

1. Splice plates furnished by cable tray manufacturer is acceptable for ground bonding connection between cable tray sections when resistance across bolted connection is maximum 10 milliohms. Verify loss by testing across one splice plate connection.
2. Install 6 AWG bonding jumper across each cable tray splice or junction where splice plates cannot be used.
3. At cable tray terminations to cable rack, install 6 AWG bonding jumper between cable tray and cable rack pan.

3.11 COMMUNICATIONS RACEWAY GROUNDING

- A. Conduit: Provide insulated 6 AWG bonding jumpers to ground metallic conduit at each end and to bond at intermediate metallic enclosures.
- B. Wireway: Provide insulated 6 AWG bonding jumpers to ground or bond metallic wireway at each end at intermediate metallic enclosures and across section junctions.
- C. Cable Tray Systems: Provide insulated 6 AWG bonding jumpers to ground cable tray to column-mounted building ground plates (pads) at each end and approximately every 50 ft.

3.12 GROUND RESISTANCE

- A. Grounding System Resistance: Maximum 5.0 ohms to ground. Make necessary modifications or additions to grounding electrode system for compliance at no additional cost to Government. Perform tests to ensure requirement is met.
- B. Measure grounding electrode system resistance using four-terminal fall-of-potential method according to IEEE 81. Make ground resistance measurements before electrical distribution system is energized in normally dry conditions minimum 48 hours after last rainfall. Make resistance measurements of separate grounding electrode systems before systems are bonded together below grade. Combined resistance of separate systems is acceptable to meet required resistance, but specified number of electrodes must still be provided.
- C. Comply with utility company ground resistance requirements for services at utility company interface points.
- D. RE/COR will inspect below-grade connections before backfilling. Notify RE/COR and AHJ SMCS 07A2 24 hours before connections are ready for inspection.
- E. Provide Communications Circulating Ground System certification certificate, accomplished by an approved commercial certified grounding professional, which is additionally signed and stamped by the Project's BICSI RCDD Certified design professional, to the RE/COR for inclusion in the project official documents after approved by AHJ SMCS 07A2.

3.13 GROUND ROD INSTALLATION

- A. Drive each rod vertically into earth, minimum 10 feet deep.
- B. Where permanently concealed ground connections are required, make connections by exothermic process to form solid metal joints. Make accessible ground connections with mechanical pressure type ground connectors.

- C. Where rock prevents driving vertical ground rods, install angled ground rods or grounding electrodes in horizontal trenches to achieve specified resistance.

3.14 GROUNDING FOR RF/EMI CONTROL

- A. See DM Telecom, Paragraph 9.1. (d) for minimum requirements.
- B. Install bonding jumpers to bond conduit, cable trays, sleeves and equipment for low voltage signaling and data communications circuits. Bonding jumpers consist of 4 inches wide copper strip or two 10 AWG copper conductors spaced minimum 4 inches apart. Provide 6 AWG copper where exposed and subject to damage.
- C. Comply with the following when shielded cable is used for data circuits:
 - 1. Shields to be continuous throughout each circuit.
 - 2. Connect shield drain wires together at each circuit connection point and insulate from ground. Do not ground the shield.
 - 3. Do not connect shields from different circuits together.
 - 4. Connect shield only at one end. Connect shield to signal reference at circuit origin. Consult equipment manufacturer to determine signal reference.

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SECTION 27 05 33
CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. New state-of-the-art fully functional conduits, fittings, and boxes to form complete, coordinated raceway system for FMS and OI&T communications cabling installed in VA's Great Lakes National Cemetery to regulate communication pathways to accommodate the facility's entire TIP to buildings and building areas unless otherwise officially specified and shown of the drawings.
- B. See Section 27 05 00, COMMON WORK RESULTS FOR COMMUNICATIONS for requirements governing work of this section.

1.2 RELATED REQUIREMENTS

- A. Mounting Board for Communication Closets: Section 06 10 00, ROUGH CARPENTRY.
- B. Sealing around penetrations to maintain integrity of fire rated construction: Section 07 84 00, FIRESTOPPING.
- C. Fabrications for deflection of water away from building envelope at penetrations: Section 07 60 00, FLASHING AND SHEET METAL.
- D. Sealing around conduit penetrations through building envelope to prevent moisture migration into building: Section 07 92 00, JOINT SEALANTS.
- E. Identification and painting of conduit and other devices: Section 09 91 00, PAINTING.
- F. General electrical requirements and items common to more than one Division 27 section: Section 27 05 00, COMMON WORK RESULTS FOR COMMUNICATIONS.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. National Electrical Manufacturers Association (NEMA):
 - 1. TC-3-15 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
 - 2. FB-1-14 - Fittings, Cast Metal Boxes and Conduit Bodies for Conduit, Electrical Metallic Tubing (EMT) and Cable.
- C. National Fire Protection Association (NFPA):
 - 1. 70-17 - National Electrical Code (NEC).
- D. UL LLC (UL):
 - 1. 1-05 - Flexible Metal Conduit.
 - 2. 5-16 - Surface Metal Raceway and Fittings.
 - 3. 6-07 - Electrical Rigid Metal Conduit-Steel.
 - 4. 50-15 - Electrical Equipment, Non-Environmental Considerations.
 - 5. 360-13 - Liquid-Tight Flexible Steel Conduit.

6. 467-13 - Grounding and Bonding Equipment.
 7. 514A-13 - Metallic Outlet Boxes.
 8. 514B-12 - Conduit, Tubing, and Cable Fittings.
 9. 514C-14 - Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
 10. 651-11 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
 11. 651A-11 - Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
 12. 797-07 - Electrical Metallic Tubing-Steel.
 13. 1242-06 - Electrical Intermediate Metal Conduit-Steel.
- E. United States Department of Veterans Affairs (VA):
1. VA Construction and Facilities Management (CFM):
 - a. DG OIT - Office of Information & Technology, 2011.
 - b. DM Electrical - Electrical Design Manual, 2015.
 - c. DM Telecom - Telecommunications & Special Telecommunications Systems Design Manual, 2016.
 - d. PRSDM - Physical Resilience Security Design Manual for VA Life-Safety Protected Facilities, 2016.

1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.5 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

- A. Conduit Size: NFPA 70, but minimum 1/2 inch, unless otherwise shown on drawings. Where permitted by NFPA 70, 1-inch flexible conduit is acceptable for tap connections to recessed lighting fixtures.
- B. Conduit:
1. Rigid galvanized steel: UL 6, ANSI C80.1.
 2. Rigid aluminum: UL 6A, ANSI C80.5.
 3. Rigid intermediate steel conduit (IMC): UL 1242, ANSI C80.6.
 4. Electrical metallic tubing (EMT): UL 797, ANSI C80.3. Maximum 4 inch and only with cable rated maximum 600 Volts.
 5. Flexible galvanized steel conduit: UL 1.
 6. Liquid-tight flexible metal conduit: UL 360.
 7. Direct burial plastic conduit: UL 651 and UL 651A, heavy wall PVC or high-density polyethylene (PE).
 8. Surface metal raceway: UL 5.

C. Conduit Fittings:

1. Rigid Steel and IMC Conduit Fittings: UL 514B and NEMA FB 1.
 - a. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Steel or malleable iron materials. Integral retractable type IMC couplings are also acceptable.
 - b. Locknuts: Bonding type with sharp edges for digging into metal wall of an enclosure.
 - c. Bushings: Metallic insulating type, with insulating insert molded or locked into fitting metallic body. Metal or nonmetallic bushing materials are not acceptable.
 - d. Erickson (Union-Type) and Set Screw Type Couplings: Approved for use in concrete to complete conduit run. Provide case-hardened steel set screws with hex head and cup point to firmly seat in conduit wall for positive ground. Do not tighten set screws with pliers.
 - e. Sealing Fittings: Threaded cast iron type. Provide continuous drain type sealing fittings to prevent passage of water vapor. In concealed work, install fittings in flush steel boxes with blank cover plates in finish to match other electrical plates in same room.
2. Rigid Aluminum Conduit Fittings:
 - a. Standard Threaded Couplings, Locknuts, Bushings, and Elbows: Malleable iron, steel or aluminum alloy materials, zinc or cadmium plate iron or steel fittings. Maximum 0.4 percent copper permitted in aluminum fittings.
 - b. Locknuts and Bushings: As specified for rigid steel and IMC conduit.
 - c. Set Screw Fittings: Not acceptable for use with aluminum conduit.
3. Electrical Metallic Tubing Fittings: UL 514B and NEMA FB-1, steel or malleable iron materials.
 - a. Couplings and Connectors: Concrete tight and rain tight, with insulated throats connectors.
 - 1) Provide gland and ring compression type couplings and connectors for conduit sizes 2 inches and smaller.
 - 2) Provide set screw type couplings with four set screws each for conduit sizes over 2 inches.
 - 3) Provide case-hardened steel set screws with hex head and cup point to firmly seat in wall of conduit for positive grounding.
 - b. Do not use indent type connectors or couplings.
 - c. Do not use die-cast or pressure-cast zinc-alloy fittings or "pot metal" fittings.
4. Flexible Steel Conduit Fittings:
 - a. Comply with UL 514B, steel or malleable iron materials.
 - b. Clamp type, with insulated throat.
5. Liquid-tight flexible metal conduit fittings: UL 514B and NEMA FB-1, steel or malleable iron materials.

- a. Provide fittings with threaded grounding cone, steel or plastic compression ring, and gland for tightening. Connectors to have insulated throats.
- 6. Direct Burial Plastic Conduit Fittings:
 - a. Fittings: UL 514C and NEMA TC-3.
 - b. As recommended by conduit manufacturer.
- 7. Surface Metal Raceway Fittings: As recommended by raceway manufacturer.
- 8. Expansion and Deflection Couplings:
 - a. Comply with UL 467 and UL 514B.
 - b. Allowable Deflection, Expansion, or Contraction in Any Direction: 0.75 inch.
 - c. Allowable Angular Deflection: 30 degrees.
 - d. Include internal flexible metal braid sized to guarantee conduit ground continuity and fault currents according to UL 467 and NFPA 70 tables for ground conductors.
 - e. Jacket: Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber material with stainless steel jacket clamps.
- D. Conduit Supports:
 - 1. Parts and Hardware: Zinc-coat or equivalent corrosion protection.
 - 2. Individual Conduit Hangers: To suit application, with pre-assembled closure bolt and nut and provisions for receiving hanger rod.
 - 3. Multiple Conduit (Trapeze) Hangers: Minimum 1-1/2 by 1-1/2 inch, 0.11-inch thick steel, cold formed, lipped channels; with minimum 3/8-inch diameter steel hanger rods.
 - 4. Solid Masonry and Concrete Anchors: Self-drilling expansion shields, or machine bolt expansion.
- E. Outlet, Junction, and Pull Boxes: UL 50 and UL 514A.
 - 1. Cast metal where required by NFPA 70 or shown on drawings, and equipped with rustproof boxes.
 - 2. Sheet Metal Boxes: Galvanized steel, except as otherwise shown on drawings.
 - 3. Install flush mounted wall or ceiling boxes with raised covers so that front face of raised cover is flush with adjacent finish surface. Install surface mounted wall or ceiling boxes with surface style flat or raised covers.
- F. Wireways: Equip with hinged covers, except where removable covers are shown on drawings.
- G. Warning Tape: Standard, 4 mil thick, polyethylene 3 inch wide non-detectable type tape, red with black letters, and imprinted "CAUTION BURIED COMMUNICATIONS CABLE BELOW".

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install conduit as follows:
 - 1. In complete runs before pulling in cables or wires.

2. Flattened, dented, or deformed conduit is not acceptable. Remove and replace damaged conduits with new undamaged material.
 3. Ensure conduit installation does not encroach into ceiling height head room, walkways, or doorways.
 4. Cut square with hacksaw, ream, remove burrs, and draw up tight.
 5. Mechanically continuous.
 6. Independently support conduit at 8 feet on center. Supports such as suspended ceilings, suspended ceiling supporting members, lighting fixtures, conduits, mechanical piping, or mechanical ducts are not acceptable.
 7. Support within 1 foot of changes of direction, and within 1 foot of each enclosure to which connected.
 8. Close ends of empty conduit with plugs or caps at rough-in stage to prevent entry of debris, until wires are pulled in.
 9. Secure conduits to cabinets, junction boxes, pull boxes and outlet boxes with bonding type locknuts. For rigid and IMC conduit installations, provide locknut inside enclosure, made up wrench tight. Do not make conduit connections to junction box covers.
 10. Flashing of roofing membrane penetrations is specified in Section 07 60 00, FLASHING AND SHEET METAL.
 11. Aluminum conduits in wet locations are not acceptable.
 12. Unless otherwise indicated on drawings or specified, install conduits concealed within finished walls, floors and ceilings.
- B. Conduit Bends:
1. Make bends with standard conduit bending machines.
 2. Conduit hickey is acceptable for slight offsets, and for straightening stubbed out conduits.
 3. Bending of conduits with pipe tee or vise is not acceptable.
- C. Layout and Homeruns:
1. Install conduit with wiring, including homeruns, as shown on drawings.
 2. Deviations: Make only where necessary to avoid interferences and only after drawings showing proposed deviations have been submitted to and approved by Resident Engineer/Contracting Officer's Representative (RE/COR).
- D. Fire Alarm:
1. Paint fire alarm conduit red (red "top-coated" conduit from conduit manufacturer is acceptable in lieu of painted conduit) as specified in Section 28 31 00, FIRE DETECTION AND ALARM.

3.2 CONCEALED WORK INSTALLATION

- A. In Concrete:

1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs in contact with soil, gravel or vapor barriers.
 2. Align and run conduit in direct lines.
 3. Install conduit through concrete beams only when the following occurs:
 - a. Where shown on structural drawings.
 - b. Approved by RE/COR before construction and after submission of drawing showing location, size, and position of each penetration.
 4. Do not install conduit in concrete less than 3 inches thick.
 - a. Conduit outside diameter larger than 1/3 of slab thickness is prohibited.
 - b. Space between Conduits in Slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
 - c. Install conduits approximately in center of slab so there will be minimum 3/4 inch of concrete around conduits.
 5. Install couplings and connections watertight. Provide UL approved conductive type thread compounds to ensure low resistance ground continuity through conduits. Do not tighten set screws with pliers.
- B. In Furred or Suspended Ceilings and Walls:
1. Conduit for conductors above 600 Volts:
 - a. Rigid steel or rigid aluminum.
 - b. Aluminum conduit mixed indiscriminately with other types in same system is not acceptable.
 2. Conduit for conductors 600 Volts and below:
 - a. Rigid steel, IMC, rigid aluminum, or EMT. Different type conduits mixed indiscriminately in same system is not acceptable.
 3. Align and run conduit parallel or perpendicular to building lines.
 4. Connect recessed lighting fixtures to conduit runs with maximum 6 feet of flexible metal conduit extending from junction box to fixture.
 5. Do not tighten set screws with pliers.

3.3 EXPOSED WORK INSTALLATION

- A. Unless otherwise indicated on drawings, exposed conduit is only permitted in mechanical and electrical rooms.
- B. Conduit for Conductors above 600 Volts:
1. Rigid steel or rigid aluminum.
 2. Aluminum conduit mixed indiscriminately with other types in same system is not acceptable.
- C. Conduit for Conductors 600 Volts and below:
1. Rigid steel, IMC, rigid aluminum, or EMT. Different type of conduits mixed indiscriminately in system is not acceptable.

- D. Align and run conduit parallel or perpendicular to building lines.
- E. Install horizontal runs close to ceiling or beams and secure with conduit straps.
- F. Support horizontal or vertical runs at maximum 8-foot intervals.
- G. Surface metal raceways: Provide only where shown on drawings.
- H. Painting:
 - 1. Paint exposed conduit as specified in Section 09 91 00, PAINTING.
 - 2. Paint conduits containing cables rated over 600 Volts safety orange. Refer to Section 09 91 00, PAINTING for preparation, paint type, and exact color. Paint legends with 2-inch high black numerals and letters, showing cable Voltage rating. Provide legends where conduits pass through walls and floors and at maximum 20-foot intervals in between.

3.4 EXPANSION JOINTS

- A. Provide expansion and deflection couplings for conduits 3 inches and larger, secured to building structure on opposite sides of building expansion joint. Install couplings according to manufacturer's instructions.
- B. Provide conduits smaller than 3 inches with junction boxes on both sides of expansion joint. Connect conduits to junction boxes with sufficient flexible conduit slack to produce 5-inch vertical drop midway between ends. Install copper green ground bonding jumper at flexible conduit. Expansion and deflection couplings as specified above for 15 inches and larger conduits are also acceptable.
- C. Install expansion and deflection couplings where shown on Drawings.

3.5 CONDUIT SUPPORT INSTALLATION

- A. Safe Working Load: Maximum 1/4 of fastening devices proof test load.
- B. Provide pipe straps or individual conduit hangers to support individual conduits with 8 foot on center maximum distance between supports.
- C. Support multiple conduit runs with trapeze hangers. Provide trapeze hangers designed to support load equal to or greater than sum of conduit weights, wires, hanger itself, and 200 lbs. Attach each conduit with U-bolts or other approved fasteners.
- D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.
- E. Fasteners and Supports in Solid Masonry and Concrete:
 - 1. New Construction: Steel or malleable iron concrete inserts set in place before concrete placement.
 - 2. Existing Construction:
 - a. Steel expansion anchors minimum 1/4-inch bolt size and minimum 1-1/8-inch embedment.
 - b. Power set fasteners minimum 1/4-inch diameter with depth of penetration minimum 3 inches.

- c. Provide vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.
- F. Hollow Masonry: Toggle bolts are permitted.
- G. Bolts supported only by plaster or gypsum wallboard are not acceptable.
- H. Metal Structures: Provide machine screw fasteners or other devices, designed and approved for application.
- I. Attachment by wood plugs, rawl plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is not acceptable.
- J. Chain, wire, or perforated strap to support or fasten conduit is not acceptable.
- K. Spring steel type supports or fasteners are not acceptable except as horizontal and vertical supports/fasteners within walls.
- L. Vertical Supports: Provide riser clamps and supports at vertical conduit runs according to NFPA 70 and as shown on drawings. Provide cable and wire supports with fittings that include internal wedges and retaining collars.

3.6 BOX INSTALLATION

- A. Boxes for Concealed Conduits:
 - 1. Flush mounted.
 - 2. Provide raised covers for boxes to suit wall or ceiling, construction and finish.
- B. In addition to boxes shown on drawings, install additional boxes where required to prevent damage to cables and wires during pulling in operations.
- C. Remove knockouts only as required and plug unused openings. Provide threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.
- D. Back-to-back outlet boxes in same wall are not acceptable. Maintain minimum 24 inches, center-to-center lateral spacing between boxes.
- E. Minimum outlet box for ground fault interrupter (GFI) receptacles: 4 inches square by 2-1/8 inches deep, with device covers coordinated with wall material and thickness.
- F. Stencil or install phenolic nameplates on box covers identified on riser diagrams; for example, "SIG-FA JB No. 1".
- G. Identify circuits on branch circuit junction box covers with black marker.

3.7 COMMUNICATION AND ELECTRONIC SAFETY AND SECURITY SYSTEM CONDUIT

- A. Install communication raceway system as shown on drawings.
- B. Minimum Conduit Size: 3/4 inch, but minimum size shown on drawings.
- C. Equip conduit ends with insulated bushings.
- D. Provide pull boxes after every two 90-degree bends at 4-inch conduits within buildings. Size boxes according to NFPA 70.
- E. Terminate vertical conduits/sleeves through closet floors minimum 3 inches below floor and minimum 3 inches below ceiling of floor below.

- F. Terminate conduit runs to and from closet backboard or interstitial space at top or bottom of backboard. Conduits to enter communication closets next to wall and be flush with backboard.
- G. Where drilling is required for vertical conduits, locate holes where approved in structural sections, such as ribs or beams.
- H. Seal empty conduits located in communication closets or on backboards with standard non-hardening duct seal compound to prevent moisture and gas entry and to meet fire resistance requirements.
- I. Maximum four quarter turns (90-degree bends) are permitted in conduit runs between pull boxes/backboards. Minimum communication conduit bend radius as follows (special long radius):

Sizes of Conduit Trade Size	Radius of Conduit Bends, Inches
3/4	6
1	9
1-1/4	14
1-1/2	17
2	21
2-1/2	25
3	31
3-1/2	36
4	45

- J. Provide 3/4-inch thick fire retardant treated plywood specified in Section 06 10 00, ROUGH CARPENTRY on communication closet walls where shown on drawings. Install plywood with bottom edge 1 foot above finished floor.
- K. Provide and pull wire in empty conduits, except through floor sleeves.

3.8 FIRESTOPPING

- A. Firestopping: Where conduits, wireways, and other communications and electronic safety and security raceways pass through fire partitions, fire walls, smoke partitions, or floors, install fire stop that provides an effective barrier against spread of fire, smoke and gases as specified in Section 07 84 00, FIRESTOPPING, with only rock wool fiber or silicone foam sealant. Completely fill and seal clearances between raceways and openings with fire stop material.

3.9 WATERPROOFING

- A. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around conduit and make watertight as specified in Section 07 92 00, JOINT SEALANTS.

3.10 CLEANING

- A. Remove and legally dispose of debris and excess material from project site.

--- E N D ---

SECTION 28 08 00
COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this section apply to all sections of Division 28.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by NCA will manage the commissioning process.

1.2 RELATED WORK

- A. Section 01 00 01 GENERAL REQUIREMENTS.
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.3 SUMMARY

- A. This section includes requirements for commissioning the Facility electronic safety and security systems, related subsystems and related equipment. This section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 28 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's operation and maintenance personnel in accordance with the requirements of Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and of Division 28, is required in cooperation with the VA and the Commissioning Agent.
- B. The Facility Electronic Safety and Security systems commissioning will include the systems listed in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.6 SUBMITTALS

- A. The commissioning process requires review of selected submittals that pertain to the systems to be commissioned. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, and SAMPLES for further details.

- B. The commissioning process requires submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION INSPECTIONS

- A. Commissioning of Electronic Safety and Security systems will require inspection of individual elements of the electronic safety and security systems throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and the commissioning plan to schedule electronic safety and security systems inspections as required to support the commissioning process.

3.2 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 28 shall be scheduled and documented in accordance with Section 01 00 01 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 7 calendar-days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady-state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer/Contracting Officer's Representative (RE/COR). The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for additional details.

3.5 TRAINING OF VA PERSONNEL

- A. Training of the VA operation and maintenance personnel is required in cooperation with the RE/COR and Commissioning Agent. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The instruction shall be scheduled in coordination with the RE/COR after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 28 Sections for additional Contractor training requirements.

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**SECTION 28 10 00
ACCESS CONTROL**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. New state-of-the-art fully functioning physical access and control system (PACS) installed in VA's National Cemetery (NCA) Great Lakes to regulate access to restricted buildings.
 - 2. Door position sensors reporting to intrusion detection system, only when PACS is not managed by host facility.

1.2 RELATED REQUIREMENTS

- A. Firestopping: Section 07 84 00, FIRESTOPPING.
- B. Penetration Sealants: Section 07 92 00, JOINT SEALANTS.
- C. Door Position Sensor Preparation: Section 08 11 13, HOLLOW METAL DOORS AND FRAMES and Section 08 14 00, INTERIOR WOOD DOORS.
- D. Electric Locks and Strikes: Section 08 71 00, DOOR HARDWARE.
- E. Electrical Power Wiring: Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- F. Electrical Power System Grounding: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.
- G. Electrical Power System: Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS and Section 26 27 26, WIRING DEVICES.
- H. Perimeter Lighting: Section 26 56 00, EXTERIOR LIGHTING.
- I. Communications General Requirements: Section 27 05 00, COMMON WORK RESULTS FOR COMMUNICATIONS.
- J. Communications System: Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS, Section 27 05 33, CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS
- K. Weapons Storage Surveillance: Section 28 20 00, VIDEO SURVEILLANCE.
- L. Alarm Systems: Section 28 31 00, INTRUSION DETECTION.
- O. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- P. Section 28 08 00 COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American National Standards Institute/Security Industry Association (ANSI/SIA):
 - 1. AC-01-1996.10 - Access Control Standard Protocol for the 26-bit Wiegand TM Reader Interface.

2. AC-03-2000.06 - Access Control Guideline Dye Sublimation Printing Practices for PVC Access Control Cards.
- C. Federal Information Processing Standards (FIPS):
 1. FIPS 201-2 - Personal Identity Verification (PIV) of Federal Employees and Contractors.
- D. Government Accountability Office (GAO):
 1. 03-8-02 - Security Responsibilities for Federally Owned and Leased Facilities.
- E. Government Services Administration (GSA):
 1. APL - PACS Approved Products List.
- F. International Organization for Standardization/Independent Electrical Contractors (ISO/IEC):
 1. 7810-03 - Identification Cards - Physical Characteristics.
 2. 7811 - Identification cards - Integrated circuit cards - Part 3: Cards with contacts - Electrical interface and transmission protocols.
 3. 7816 - Identification cards - Integrated circuit cards, most current date for each part.
 4. 14443 - RFID cards; Contactless Proximity Cards Operating at 13.56 MHz in up to 5 Inches Distance, most current date for each part.
 5. 15693 - RFID cards; Contactless Vicinity Cards Operating at 13.56 MHz in up to 50 Inches Distance, most current date for each part.
- G. National Electrical Manufacturers Association (NEMA):
 1. 250-14 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- H. National Fire Protection Association (NFPA):
 1. 70-14 - National Electrical Code.
- I. National Institute of Standards and Technology (NIST):
 1. IR 6887 V2.1 - Government Smart Card Interoperability Specification.
 2. Special Pub 800-96 - PIV Card Reader Interoperability Guidelines.
- J. Master Painters Institute (MPI):
 1. No. 18 - Primer, Zinc Rich, Organic.
- K. Telecommunications Industry Association(TIA):
 1. 232-F - Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
 2. 485-A - Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems.
- L. UL LLC (UL):
 1. Listed - Online Certifications Directory.
 2. 294-13 - Access Control System Units.
 3. 827-14 - Central Station Alarm Services.
 4. 1076-95 - Proprietary Burglar Alarm Units and Systems.
 5. 1981-14 - Central Station Automation System.

- M. United States Access Board (USAB):
 - 1. ABA - Architectural Barriers Act Accessibility Standards.
- N. United States Department of Homeland Security (HLS):
 - 1. HSPD 12-04 - Policy for a Common Identification Standard for Federal Employees and Contractors.
- O. United States Department of Veterans Affairs (VA):
 - 1. VA Construction and Facilities Management (CFM):
 - a. DG OIT - Office of Information & Technology, 2011.
 - b. DM Electrical - Electrical Design Manual, 2015.
 - c. DM Telecom - Telecommunications & Special Telecommunications Systems Design Manual, 2016.
 - d. PSDM - Physical Security Design Manual for VA Life-Safety Protected Facilities.
 - 2. VA Office of Security and Law Enforcement (SLA):
 - a. Directive 0730-12 - Security and Law Enforcement.
 - b. VA Office of Information and Technology (OI&T):
 - 1) Handbook 6100-10 - Telecommunications: Cyber and Information Security Office of Cyber and Information Security.
 - 2) Handbook 6330-93 - Directives Management Procedures.
 - 3) Handbook 6500-15 - Risk Management Framework for VA Information Systems - Tier 3: VA Information Security Program.

1.4 PREINSTALLATION MEETINGS

- A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.
 - 1. Required Participants:
 - a. Resident Engineer/Contracting Officer's Representative (RE/COR).
 - b. VA AHJ SMCS 07A2, for special communications systems.
 - c. Inspection and Testing Agency.
 - d. Contractor.
 - e. Installer.
 - f. Field representative.
 - g. Other installers responsible for adjacent and intersecting work, including electrical installer.
 - 2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
 - a. Installation schedule.
 - b. Installation sequence.
 - c. Preparatory work.
 - d. Protection before, during, and after installation.

- e. Installation.
 - f. Terminations.
 - g. Transitions and connections to other work.
 - h. Inspecting and testing.
 - i. Other items affecting successful completion.
3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- 1. Submittal Drawings and as-built Drawings: Four sets paper format Architectural F size. Two sets electronic format.
- B. Submittal Drawings:
- 1. Show size, configuration, and fabrication and installation details.
 - 2. Cover Sheet:
 - a. Identify each drawing included in submittal.
 - b. Show facility name, building name, floor, and sheet number.
 - c. Include security abbreviations and symbols lists.
 - d. Reference general notes included in submittal.
 - e. Specification and scope of work pages for individual security systems.
 - f. Include detailed device identification table.
 - 3. Floor Plans and Site Plans:
 - a. Show drawing scale in metric and English units.
 - b. Show each device identification and location.
 - c. Show control and power wiring.
 - d. Show pull box and conduit locations, sizes, and fill capacities.
 - e. Include general and drawing specific notes.
 - 4. Riser Diagram:
 - a. Include sequence of operation.
 - b. Show relationship of integrated components on one diagram.
 - c. Show number, size, identification, and maximum lengths of interconnecting wires.
 - d. Include wiring schedule showing conductor type, wiring drawing symbol, manufacturer's name, and part number.
 - 5. System Drawing for Each Security System:
 - a. Show equipment, including panels and devices, and system layout.
 - b. Show point-to-point wiring.
 - c. Identify wire types.
 - d. Show device locations on floor plans.

- e. Include general and drawing specific notes.
- 6. System Equipment Schedule: Show the following:
 - a. Device ID.
 - b. Device Location.
 - c. Mounting type.
 - d. Power supply or circuit breaker and power panel number.
 - e. Door number, door type, locking mechanism and control device.
- 7. Detail and Elevation Drawings: Show installation details.
- C. System Operational Description: Submit detailed description of system operation, performance, and interface with other entities, equipment, and systems.
- D. Manufacturer's Literature and Data:
 - 1. Description of each product.
 - 2. Installation instructions.
- E. Equipment Lists: As bill of materials.
 - 1. Show quantities for each specified product.
 - 2. Identify products included on GSA Approved Products List and approval status.
- F. Submit manufacture's certification of UL LLC (UL) listing as specified.
- G. Qualifications: Substantiate qualifications comply with specifications.
 - 1. PACS integrator with project experience list.
 - 2. Responsible design professional approved by AHJ SMCS 07A2.
 - 3. Installer with project experience list.
 - 4. Factory authorized representative.
 - 5. Field representative with project experience list.
- H. Delegated Design Drawings and Calculations: Each signed, dated, and sealed by BICSI RCDD certified responsible design professional.
 - 1. Identify deviations from details shown on drawings.
- I. Field conditions report indicating differing conditions.
- J. Field survey report identifying equipment by manufacturer and model number wherever possible indicating:
 - 1. Non-functioning equipment, proposed replacement equipment, and replacement cost.
 - 2. Existing equipment reuse, removal, and replacement schedule.
 - 3. Existing equipment connection and disconnecting schedule, including times for system interruption.
- K. Acceptance Test Plan: Submit minimum 30 days before testing.
 - 1. Include individual component and subsystem acceptance testing procedures.
 - 2. Include integrated system test ensuring proper operation.
- L. Field Representative:

1. Observation reports and supplemental instructions issued.
2. Installation certification.
- M. Field Quality Control Reports: Four copies. Submit minimum 15 working days before scheduled acceptance test.
 1. System pretest recorded measurements.
 2. Certifications system is acceptance test ready.
- N. Operation and Maintenance Data: Four sets. Submit minimum 15 working days before scheduled performance tests.
 1. Start-up, maintenance, troubleshooting, emergency, and shut-down instructions for each operational product.
 2. Demonstration and training video recordings.
- O. As-Built Drawings: Submit minimum 15 working days before scheduled performance tests.
 1. Wiring diagrams showing labels, inputs, outputs, and room locations.
 2. Electronic Format: Match NCA specified AutoCAD version.

1.6 QUALITY ASSURANCE

- A. PACS Integrator: System designer and installer.
 1. Regularly integrates PACS and specified products.
 2. Employs licensed design professional with current BICSI RCDD certification responsible for PACS design.
 3. Integrated PACS and specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
- B. Installer Qualifications: BICSI RCDD certified and licensed security Contractor. Manufacturer authorized representative.
 1. Regularly installs specified products.
 2. Installed specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
- C. Factory Authorized Representative: As directed by RE/COR.
- D. Field Representative: BICSI certified Registered Communications Distribution Designer (RCDD) experienced with specified components and system.
 1. Project Experience List: Provide contact names and addresses for completed projects.
- E. Installer Qualifications: Product manufacturer. Manufacturer authorized representative.
 1. Regularly installs specified products.
 2. Installed specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.

1.7 FIELD CONDITIONS

- A. Existing Conditions: Review drawings and specifications with existing site conditions.
 - 1. Report discrepancies affecting system design and installation and propose solution.
 - 2. Request RE/COR approval for proposed solution.

1.8 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. PACS Integration:
 - 1. Designed by approved BICSI RCDD.
 - 2. Installed and tested by Contractor with manufacturer guidance.
 - 3. Acceptance tested and commissioned by AHJ SMCS 07A2.
- B. PACS: Standalone, local access controls connected to remote VA Medical Center central station providing system software and access privileges database management, intrusion detection and video surveillance functions.
 - 1. Protocol: Internet, addressable, and programmable.
 - 2. Interface: Computer, via VA FTS and Telco Tie Lines or current federal communications media.
- C. System Components Including but not limited to:
 - 1. Interface cabinet for hard wired existing system extension.
 - 2. Head end cabinet for standalone system.
 - 3. Control and communications panels.
 - 4. Electronic security management system fully compatible with existing Host VAMC Security Management System.
 - 5. Card readers at restricted access entry points.
 - 6. Credential cards.
 - 7. Door position indicators.
 - 8. Portal control devices.
 - 9. Entry Control Device.
 - 10. Electronic door hardware.
 - 11. Power supplies.
 - 12. Power and control wiring, raceways, and grounding.
- D. Access Control Locations:
 - 1. Administration Building:
 - a. Employee entrances.
 - b. Secure records storage.

- c. Telephone, MCR, and telecom rooms.
 - d. Electrical rooms.
 - 2. Maintenance Building:
 - a. Main building entry.
 - 3. Honor Guard Building:
 - a. Building entry.
 - b. Weapons storage room.
- E. Integrate intrusion detection and video surveillance into PACS. See Section 28 31 00, INTRUSION DETECTION and Section 28 20 00, VIDEO SURVEILLANCE.
 - 1. Camera Security Monitoring System:
 - a. Provide 24-hour perimeter and building entry points and emergency exits using fixed color cameras.
 - b. Provide 24-hour camera monitoring, controlling, and recording capability.
 - c. Automatically display camera viewing access point in alarm state.
 - d. Additional System Requirements: See Section 28 20 00, VIDEO SURVEILLANCE.
 - 2. Intrusion Detection System (IDS):
 - a. Monitor door position sensors.
 - b. Provide 24-hour IDS monitoring and controlling capability.
 - c. Activate audible alarm when IDS device signals alarm.
 - d. Additional System Requirements: See Section 28 31 00, INTRUSION DETECTION.
 - 3. Integrate security subsystems via computer programming or direct hardwiring.
 - 4. Comply with manufacturer requirements for correct system operations. Ensure system integration computers meet or exceed system software minimum system requirements.
- F. Locate PACS components according to accessibility standards.
 - 1. Ease of Use: Design, install and program PACS for ease of operation, programming, servicing, maintaining, testing, and upgrading.

2.2 SYSTEM PERFORMANCE

- A. Delegated Design: Prepare submittal documents including design calculations and drawings signed and sealed by registered design professional, licensed in state where work is located.
- B. Design PACS and system components complying with specified performance:
 - 1. Standard Compliance: UL 294.
 - 2. Personal Identity Verification: FIPS 201, HLS HSPD 12, NIST IR 6887, and NIST Special Pub 800 compliant.
 - 3. Duty Rating: Continuous service.
 - 4. Totally functional, without degradation, to host or secondary control/management systems.
 - 5. Environment Rating: NFPA 70.
 - a. Exterior Locations: Wet.

- b. Maintenance Building Interior Locations: Damp.
- c. Other Interior Locations: Dry.
- 6. Electrical Power: 120 Volts AC, 60 Hz.
- 7. Control Power: 12 Volts AC and 12 Volts DC.
- 8. Backup Power: 96-hour duration, on primary power loss.

2.3 PRODUCTS - GENERAL

- A. Products: GSA APL approved.
- B. Provide identical control and communications panels from same manufacturer ensuring compatibility.

2.4 INTERFACE, HEAD END, CONTROL, AND COMMUNICATIONS PANELS

- A. Panels: Expandable, network capable, expandable, providing entire facility access control through primary interface head end panel.
 - 1. Indoor Locations: NEMA 250; Type 1.
 - 2. Outdoor Locations: NEMA 250; Type 4X.
 - 3. Mounting: Wall.
 - 4. Access Doors: Locking, front only; operable without disturbing and damaging internal wiring.
 - 5. Ventilation: Electric fan, non-disposable air filter and enclosure openings required to dissipate heat from panel modules.
 - 6. Signal Wiring Strips:
 - a. Input Strip: Top row, receiving output signal from connected devices.
 - b. Output Strip: Bottom row transmitting input signal to connected devices.
 - 7. Power outlet strip.
 - 8. Bulkhead connector panel.
 - 9. Computer Access: Password protected.
 - 10. Database: Single, integrated, relational type.
 - 11. Operating System:
 - a. Microsoft Windows 10.
 - b. Linux embedded OS, browser based thin-client.
 - 12. Programming Source Code: Single, unified 32-bit program interfacing with panel modules.
 - 13. Panel Modules: Programmable; general control, access control, alarm monitoring, credential management, digital video, and intrusion detection.
- B. Client Applications: Web enabled using panel database.
 - 1. Operating System Support:
 - a. Microsoft: Windows 10.
 - b. Macintosh.
 - c. UNIX.
 - d. Linux.

- e. Solaris.

2.5 PANEL MODULES

A. General Control Module:

1. Process access control and alarm monitoring operations.
 - a. Access Request Response Time: Maximum 0.5 seconds when connected to 64 card readers.
2. Store access levels, hardware configuration, and alarm outputs. Transmit alarm condition to remote client workstation designated by RE/COR.
3. Functional and Operational Requirements:
 - a. Communications: Electronically supervised, minimum 115,200 bps. Support direct-connect and remote dial-up.
 - 1) Downstream Multi-Drop: TIA 485; card readers and control panel.
 - 2) Downstream Serial: TIA 232.
 - 3) Upstream: TIA 485; full duplex, system head-end UL 1076 Grade AA communication channel.
 - 4) Electronically Supervised Communications with system software.
 - b. Memory: Minimum eight MB.
 - 1) Cardholders: Store minimum 5,000.
 - 2) Events: Store minimum 10,000.
 - c. Local Area Network (LAN): RJ45 (10/100baseT) Ethernet Interface Token Ring, four MB connectivity.
 - d. Support multiple PIV card technologies.
 - 1) Support minimum eight card formats and facility codes.
 - 2) Integrate with card readers.
 - e. Issue Code Support for both Magnetic and Wiegand Card Formats.
 - f. Individual Shunt Times.
 - g. PIN Codes: Maximum nine-digit.
 - h. LED Status Indicators: Show component and communication status.

B. Access Control Module:

1. Control Capacity: Minimum 16 openings.
2. Input and Output: Programmable relays.
3. Input Relays: UL 294 and UL 1076; analog, monitoring and reporting alarm conditions, power faults, and tampers.
 - a. Normal Operation: Monitor control relays for alarm condition.
 - b. Alarm Operation: Activate programmed alarm outputs.
 - c. Functional and Operational Requirements:
 - 1) Scan zone alarm contact status minimum 120 times per second.

- 2) Processor: Low power complementary-symmetry/metal-oxide semiconductor (CMOS) type.
 - 3) Filtered data for noise rejection to prevent false alarms.
 - 4) Alarm Inputs: Unsupervised.
 - 5) Supervised Inputs: Minimum 16.
 - 6) Tamper and Power Status: Two dedicated inputs.
4. Output Relays: Control output device in response to:
- a. Input alarms.
 - b. Commands from system operator.
 - c. Time zone control automatic operation.
 - d. Functional and Operational Requirements:
 - 1) Individual Relay Pulsing: Programmable, predetermined duration.
 - 2) System Operator Command Responses: Pulse, on, off, and normal state reset.
 - 3) Output Rating: 5 Amps, 30 Volts DC.

2.6 ELECTRONIC SECURITY MANAGEMENT SYSTEM (SMS)

- A. System Configuration Functions: Any combination of the following:
1. Personnel enrollment and badging.
 2. Alarm monitoring.
 3. Administrative.
 4. Asset management.
 5. Digital video management.
 6. Intrusion detection.
 7. Remote access level management.
 8. Integrated client workstations.
- B. Expandability: Support unlimited number of individual module or integrated client workstations.
- C. Network Connectivity: Connect access control devices and Intelligent System Controllers (ISC) to each networked Windows 2003/2000/2007/XP based access control system workstation.
- D. Reporting Capability: Compose, file, maintain, update, and print reports.
1. Individual Reports: Report employee's name, office location, phone number or direct extension, and normal hours of operation, and detail listing of employee's daily access controlled events.
 2. System Reports: Report information on daily, weekly, and monthly basis including events, alarms, and other activity associated with system users.
 3. Report Format: Tabular, chronologic by date and time.
- E. Network Protocol and Topology Capability:
1. Transmission Control Protocol (TCP)/IP.
 2. Novell Netware (IPX/SPX).

3. Banyan VINES.
 4. IBM LAN Server (NetBEUI).
 5. Microsoft LAN Manager (NetBEUI).
 6. Network File System (NFS) Networks.
 7. Remote Access Service (RAS) via ISDN, x.25, and standard phone lines.
- F. Subsystem Control: Provide full interface and control of following subsystems:
1. Public key infrastructure.
 2. Card management.
 3. Identity and access management.
 4. Personal identity verification.
- G. System Features and Compatibilities:
1. Local and remote operation via LAN, WAN, internet, or intranet only at MCR.
 2. Event and alarm monitoring.
 3. Database partitioning.
 4. Ability to fully integrate with security subsystems.
 5. Enhanced monitoring station with split screen views.
 6. Alternate and extended shunt by door.
 7. Escort management.
 8. Enhanced IT-based password protection.
 9. N-man rule and occupancy restrictions.
 10. Open journal data format for enhanced reporting.
 11. Automated personnel import.
 12. ODBC support.
 13. Windows 2000 Professional, Windows Server 2003, Windows XP Professionals for Servers.
 14. Field-level audit trail.
 15. Cardholder access events.
- H. Provide network server and client workstations as approved by OI&T during project design.

NETWORK SERVER	
Processor	1.8 gHz, Intel Pentium/Dual Processor
Free HD space	300 gB
Memory	4.0 gB
Network card	10/100 base-T
CD-ROM drive	20X
Monitor/video adaptor	27" SVGA/HDTV (1024 X 768)
Operating system	Windows 2000/2003/2007 Professional, Windows Server 2003/Windows XP Professional as approved by host VAMC OI&T

NETWORK SERVER	
Ports	2 Serial; 1 Parallel, 4 USB
Back-up	Tape/CD-RW
Modem	56.7 kbps (must be specifically approved by Host VAMC's OI&T)
CLIENT WORKSTATION	
Processor	1.5 GHz Intel Pentium/dual core
Free HD Space	200 GB
Memory	2.0 GB
CD-ROM Drive	20X
Network/Video adapter	22" HDTV/SVGA (1024 X 768)
Operating System	Windows 2000/3000/7000 Professional/XP Professional (host VAMC OI&T)

I. Un-Interruptible Power Supplies (UPS):

1. COTS full electrical/electronic supervision notification network capable; rack mounting.
2. Capacity: Minimum 1 hour for routine outages and 2 hours for emergency systems under full load.
3. UPS KVA capacity to meet the power requirements of existing and the new equipment and system devices.

2.7 PIV CARDS

- A. PIV Cards: Provided by host station Security Service Contractor as a part of contract, with instructions from host station Security Service.

2.8 CARD READERS - GENERAL

- A. Card Readers: FIPS 201 and ISO/IEC 14443, A or B compliant; programmable, addressable, and wired.
1. Control locking door hardware. See Section 08 71 00, DOOR HARDWARE.
 2. Report to control panel for recording door access:
 - a. Time and date.
 - b. Individual identification.
 - c. Door location.
 3. Connected by home run to main panel.
 4. Card Reader Type: Card only.
 5. Output: Wiegand, RS-232, TIA 485 or TCP/IP.
- B. Housing: Aluminum bezel with wide card entry lead-in.
- C. Electronics: Read head and sender encoding control signals.
- D. Status Lights: LED indicating card reader status and access status.

- E. Off-Line Operation: Programmable; locked, unlocked, or facility code operation when main control panel communication is lost.
- F. Access Status Audible Indicator:
 - 1. Access Granted: Two tones or beeps.
 - 2. Access Denied: Three tones or beeps.
- G. Inputs: Minimum two, programmable.
- H. Outputs: Minimum two, programmable.
- I. Keypads: Integral with card reader alphanumeric arranged in ASCII code ordinal sequence with tactile and audible feedback when buttons are pressed.
 - 1. Display: LED; access status and user prompts.
 - a. Status Indication:
 - 1) Power on and off.
 - 2) Access granted.
 - 3) Access denied.
 - b. Limit keypad display viewing angles, measured normal to keypad surface centerlines.
 - 1) Horizontal Limit: Maximum 5 degrees.
 - 2) Vertical Limit: Maximum 15 degrees.
 - 2. Output: Signal control panel.
 - a. Response Time: Maximum 800 milliseconds after last keypad entry.
 - 3. Power Consumption: Maximum 150 Watts.
 - 4. Wall Mounting: Surface, semi-recessed, and recessed.
 - a. Exterior Locations: Weatherproof.
 - 5. Duress Signal: Report emergency when special code is entered.

2.9 SMART CARD READERS

- A. Smart Card Readers: FIPS 201, contactless type, reading ISO/IEC 7816, ISO/IEC 14443, and ISO/IEC 15693 compliant cards.
 - 1. Card Proximity Range: Minimum 1 to 2 inches.
 - 2. Card Types: DESfire and iCLASS.
- B. Functional and Operational Requirements:
 - 1. "Flash" download capability to accommodate card format changes.
 - 2. Read and transmit card data to control panel.
 - 3. Data Output Formats: Field configurable with command card.
 - a. FIPS 201 Low: Outputs FASC-N in assorted Wiegand formats from 40 to 200 bits.
 - b. FIPS 201 Medium: Outputs combination FASC-N and HMAC in assorted Wiegand formats from 32 to 232 bits.

2.10 PROXIMITY (PROX) CARD READER

- A. Proximity Card Reader: Active/passive proximity detection, contactless type.

1. Active Detection: Receive and decode unique identification transmitted from credential card.
 2. Passive Detection: Read card resonant frequencies for unique identification.
- B. Card Reading Range:
1. Parking Lots and Parking Garages: 2 to 16 inches.
 2. Other Locations: 2 to 6 inches.

2.11 PORTAL CONTROL DEVICES

- A. Assist System by:
1. Monitoring door status.
 2. Allowing exit via push button, request to exit, or panic/crash bar.
 3. Providing system override via keypad or key bypass.
 4. Assisting door operations using automatic openers and closures.
 5. Providing secondary means of access to space via keypad.
 6. Monitoring via main control panel.
 7. Providing secondary means of access control within secure area.
- B. Push-Button Switches: Momentary contact; back lighted push buttons, and stainless-steel switch enclosures.
1. Contacts: Double-break silver contacts making 720 VA at 60 Amperes and breaking 720 VA at 10 Amperes.
 2. Guard Control: Provide interface board including buttons to remotely release access controlled doors. Label buttons identifying controlled doors.
- C. Key Bypass: Provide cylinders for locks and exit devices. See Section 08 71 00, DOOR HARDWARE.

2.12 DOOR STATUS INDICATORS

- A. Door Position Sensors: Surface or flush mounted, wide-gap type. Monitor and report OPEN and CLOSED door status.
1. Access Control Switches: Double pole, double throw switches; reporting independently to access control system and intrusion detection system.
 2. Gap Operating Range: 0 to 2 inches.
- B. Request-to-Exit Devices (RX):
1. RX Device: Infrared sensor and push button to de-energize each electromagnetically locked door allowing free exit.
 2. Infrared Sensors:
 3. Alarm output: 2ea. - form "C" Relay contacts.
 4. Indicators: 1ea. - Activation LED.
 5. Power Requirements: 12 or 24 Volt AC, 12 or 24 Volt DC; 26 mA at 12 Volt DC.

2.13 ENTRY CONTROL DEVICES

- A. Electric Strikes: See Section 08 71 00, DOOR HARDWARE.

2.14 POWER SUPPLIES

- A. UL Listed; capable of powering two entry control devices, continuously, without failure.
 - 1. Input Power: 110 Volt AC, 60 Hz, 2.0 Amperes.
 - 2. Output Power: 12 Volt DC nominal (13.8 Volt DC) and 24 Volt DC nominal (27.6 Volt DC); filtered and regulated.
 - 3. Battery: Minimum 14 Ampere-hour at full load, rechargeable.
 - 4. Output Current: Maximum 10.0 Amperes at 13.8 Volt DC and 5.0 Amperes at 27.6 Volt DC.
 - 5. Primary Fuse: 6.3 Ampere, non-removable.
 - 6. Battery Fuse: 12 Ampere, 3ASG.
 - 7. Battery Charging Circuit: Manufacturer's standard.

2.15 LABELS

- A. Labeling Abbreviations: Use accepted industry standards consistent with submittal drawings and recorded in as-built drawings.
- B. Wire Labels: Permanent, with contrasting identification alpha or numeric, identifying each cable according to system submittal drawings.
- C. Equipment and AC Power Labels: Permanent with contrasting plastic laminate or Bakelite material.

2.16 WIRING

- A. Grounding and Bonding Materials: See Section 27 05 26, GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS.
- B. Raceways: See Section 27 05 33, CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS.

2.17 INSTALLATION KIT

- A. Include, at minimum, connectors and terminals, labeling systems, audio spade lugs, barrier strips, punch blocks, wire wrap terminals, heat shrink tubing, cable ties, solder, hangers, clamps, bolts, conduit, cable duct, cable tray, and other items required for neat and secure installation.
 - 1. Terminate wires in spade lug and barrier strip, wire wrap terminal or punch block.
 - 2. Unfinished and unlabeled wire connections are not allowed.
 - 3. Deliver unused and partially opened installation kit boxes, coaxial, fiber-optic, and twisted pair cable reels, conduit, cable tray, cable duct bundles, wire rolls, and physical installation hardware to RE/COR.
- B. System Grounding Kit: Include cable and installation hardware required to connect head end equipment, power supplies, and following components to earth ground via internal building wiring, according to NFPA 70.
 - 1. Coaxial cable shields.
 - 2. Control cable shields.
 - 3. Data cable shields.

4. Equipment racks.
5. Equipment cabinets.
6. Conduits.
7. Cable duct blocks.
8. Cable trays.
9. Power panels.
10. Connector panels.
- C. Coaxial Cable Kit: Include coaxial connectors, cable tying straps, heat shrink tabbing, hangers, clamps, and other items required for neat and secure installation.
- D. Wire and Cable Kit: Include connectors and terminals, audio spade lugs, barrier straps, punch blocks, wire wrap strips, heat shrink tubing, tie wraps, solder, hangers, clamps, labels and other items required for neat and secure installation.
- E. Conduit, Cable Duct, and Cable Tray Kit: Include conduit, duct, trays, junction boxes, backboxes, cover plates, feed through nipples, hangers, clamps, and other hardware required for neat and secure conduit, cable duct, and cable tray installation according to NFPA 70.
- F. Equipment Interface Kit: Include equipment, cable, mounting hardware, and materials to interface systems with subsystems according to manufacturer's instructions.
- G. Labeling Kit: Include labels, tools, stencils, and materials to label each subsystem according to manufacturer's instructions and as-built drawings.
- H. Documentation Kit: Include items, computer discs, as-built drawings, equipment, operation and maintenance manuals, and manufacturer's publications to fully document installed system.

2.18 ACCESSORIES

- A. Sealant: See Section 07 92 00, JOINT SEALANTS.
- B. Provide connectors, terminators, and other accessories required for operable system.
- C. Galvanizing Repair Paint: MPI No. 18.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Field survey, test and inspect existing door equipment and signal lines intended to be incorporated into the SYSTEM.
 1. Door equipment and wiring usable without modification may be reused with RE/COR approval.
- B. Obtain RE/COR approval minimum 3 days before interrupting existing system service.
- C. Protect existing construction and completed work from damage.
 1. Repair damage caused by construction operations.
- D. Remove existing door equipment and wiring to permit new installation.
 1. Retain existing serviceable door equipment indicated for reuse.

2. Dispose of other removed materials.

3.2 INSTALLATION - GENERAL

- A. Install products according to UL 294, manufacturer's instructions and approved submittal drawings.
 1. When manufacturer's instructions deviate from specifications, submit proposed resolution for RE/COR consideration.

3.3 INSTALLATION - EQUIPMENT

- A. Configure components with service points to pinpoint system trouble in less than 15 minutes.
- B. Ensure components are fully compatible as a system and can be integrated with associated and remote security subsystems, whether system is stand-alone, hardwired, or networked to meet requirements of AHJ SMCS 07A2.
- C. Install system components including Government furnished equipment, and appurtenances according to manufacturer's instructions. Provide necessary connectors, terminators, interconnections, services, and adjustments required for operable system.
- D. Connect existing door equipment, wiring, and devices shown on drawings.
- E. Raceway Penetrations:
 1. Enter control panels through panel bottom.
 2. Seal penetrations located outdoors. Seal penetrations through building exterior enclosure.
 3. Firestop penetrations through fire rated assemblies. See Section 07 84 00, FIRESTOPPING.
 4. Terminate conduit riser in hot-dip galvanized metal cable terminator. Fill terminator with sealant recommended by cable manufacturer.
- F. Control Panels:
 1. Install control panels plumb and level, securely attached to wall.
 - a. Mount panels allowing servicing and testing access.
 2. Connect wiring to control modules.
 3. Program control modules to provide specified functions.
- G. SMS:
 1. Coordinate with VA agency's IT personnel to place computer on local area network or intranet with security system protection levels ensuring only authorized VA personnel have access to system.
 2. Program and set-up SMS ensuring full operation.
- H. Card Readers:
 1. Install card readers. Connect wiring.
 2. Program card reader.
- I. Door Status Indicators:
 1. Install door position switches. Connect wiring.

- 2. Install RX devices. Locate RX switches away from glazed openings; maximum 6 feet from door.
- J. Install entry control devices. See Section 08 71 00, DOOR HARDWARE. Connect wiring.
- K. Video Surveillance System Integration: Program SMS to automatically display designated video surveillance camera when an access control system device signals alarm state.
- L. Touch up damaged factory finishes.
 - 1. Repair galvanized surfaces with galvanized repair paint.

3.4 LABELING

- A. Cable and Wires: Install labels on cables at each termination, pull box, and break in conductor run.
 - 1. Labels: Permanent, with contrasting identification alpha or numeric, identifying each cable according to system submittal drawings.
- B. Equipment: Label equipment, and equipment inputs and outputs.
 - 1. Permanently affix labels to equipment face with metal screws, permanent mounting devices, or cement.
 - 2. Label equipment corresponding to control source. Label remote control equipment corresponding to controlled equipment.
- C. AC Power: Label power panel circuit breaker identifying connected access control panel.
 - 1. Permanently affix labels to equipment face with metal screws, permanent mounting devices or cement.
- D. Conduit: Label access control system conduit with permanent marking devices or spray painted stenciling, maximum 10 feet spacing.

3.5 SYSTEM START-UP

- A. Before powering system, verify installation is complete, including:
 - 1. Equipment is set up according to Manufacturer's instructions.
 - 2. Visual inspection ensuring installed equipment is not defective and wiring connections are tight.
 - 3. System wiring continuity and resistance.
 - 4. Grounding and transient protection systems are installed and connected.
 - 5. Power supplies are correct voltage and frequency.
- B. Completing system startup does not relieve Contractor of responsibility for incorrect installation, defective equipment items, and Contractor caused resulting collateral damage.

3.6 FIELD QUALITY CONTROL

- A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.
- B. Field Representative Services:
 - 1. Observe preparation and initial construction.

2. Provide technical assistance and recommendations.
 3. The Contractor shall also be available on an as needed basis to provide assistance with follow-up phases of quality control.
 4. Observe system start-up, testing, and certification.
 5. Certify system is fully operational according to contract requirements.
- C. Upon 30 - 50 Percent System Completion:
1. Certify completed work before continuing installation.
 2. Verify components are UL Listed and labeled, and installation is NFPA 70 and NFPA 101 compliant.
 3. Mechanical Inspection: Performed by factory authorized representative verifying proper installation; witnessed and recorded by RE/COR.
 4. Perform full acceptance test.
- D. Upon 65 - 80 Percent System Completion: Repeat inspections and tests as required by RE/COR.
- E. System Protection during Testing: See Section 27 05 00, COMMON WORK RESULTS FOR COMMUNICATIONS.
- F. Acceptance Testing:
1. Verify system components are authorizing proper credentials at access controlled doors and system alarms are functioning.
 - a. Perform visual check and record presence of required access controlled opening components and devices.
 - b. Test each opening while in locked status by physically pushing and pulling on door, in and out, and up and down.
 - c. Validate door remains in locked position with no visible gaps forming between door and frame at any point along the opening edges.
 - d. Door position sensor shall not alarm.
 2. Test each opening and system response for following conditions:
 - a. Authorized credential presented.
 - b. Unauthorized credential presented.
 - c. Wrong pin entered.
 - d. Door held open.
 - e. Door forced.
 3. Validate tamper switch operation for following devices:
 - a. Door position switch. Signal alarm when door strike edge moves maximum 1 inch from closed and latched position.
 - b. Control panels.
 - c. Card readers.
 4. Observe and verify SMS system operation including:

- a. System transaction records.
 - b. System alarm and tamper reports.
 - c. Graphical map accuracy.
 - d. Alarm generation to alarm reporting latency period.
 - e. Alarm text indication accuracy.
- G. Test Conclusion: See FAR clause 52.246 21, "Warranty of Construction."
- H. Post System Testing - Cleaning: See Section 27 05 00, COMMON WORK RESULTS FOR COMMUNICATIONS.

3.7 TRAINING

- A. The Contractor will provide training. The training method shall agree with the precepts of an accepted training methodology such as the Systems Approach to Training that is used by the DoD. No Ad Hoc training will be considered acceptable. Student(s) will be provided printed training materials as well as a CD/DVD copy of the classes. The training must provide the student(s) the ability to: set up the system, maintain the system, trouble shoot problems, recognize system/component failures as well as any nuanced customization of the system for the specific location.
- B. Training on each installed system [IE components] will minimally include:
- 1. Physical Access Control (PACS)
 - a. Management of Access Levels
 - b. Management of Card Holder Records
 - c. Management of Time zone/Reader Modes
 - d. Rebooting the system(s)
 - e. Basic understanding of software "patch" changes that may impact VA specific Information Technology protocols. (Example would be patching that may clash with Windows environs or virus protection software)
 - 2. Visitor Management
 - a. Management of Visitor Management tools
 - 3. Overall system(s) maintenance.
 - a. Those steps necessary for the basic understanding of: lifecycle maintenance of system to include factors such as: yearly support agreements, impact of power surges/loss as well as those endemic pieces of knowledge that include preventive maintenance considerations and or tasks.
- C. The Contractor will provide instruction giving the students sufficient training to be able to effectively operate the system and recognize problems as they arise. All training must include guided practical application exercises to ensure student(s) understanding. Certification of the training/curriculum/rosters will be provided to the RE/COR upon training task completion.

GREAT LAKES NATIONAL CEMETERY
PHASE 2 DEVELOPMENT

PROJECT NO. 935-004
MAY 10, 2019

--- E N D ---

**SECTION 28 20 00
VIDEO SURVEILLANCE**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Closed circuit television system.
- B. See Section 27 05 00, COMMON WORK RESULTS FOR COMMUNICATIONS for requirements governing work of this section.

1.2 RELATED REQUIREMENTS

- A. For firestopping application and use, Section 07 84 00, FIRESTOPPING.
- B. For labeling and signs, Section 10 14 00, INTERIOR SIGNAGE.
- C. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS
- D. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES.
- E. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS
- F. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS
- G. For General Requirements, Section 01 00 01, GENERAL REQUIREMENTS.
- H. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- I. Section 28 08 00 COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American National Standards Institute (ANSI)/Electronic Industries Alliance (EIA):
 - 1. 330-09 - Electrical Performance Standards for CCTV Cameras.
- C. Institute of Electrical and Electronics Engineers (IEEE):
 - 1. C62.41-02 - IEEE Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
 - 2. 802.3af-08 - Power over Ethernet Standard.
- D. National Electrical Contractors Association (NECA):
 - 1. 303-2005 - Installing Closed Circuit Television (CCTV) Systems.
- E. National Electrical Manufacturers Association (NEMA):
 - 1. 250-14 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. National Fire Protection Association (NFPA):
 - 1. 70-17 - National Electrical Code (NEC).
- G. Federal Information Processing Standard (FIPS):
 - 1. 140-2-02 - Security Requirements for Cryptographic Modules.
- H. UL LLC (UL):
 - 1. 983-06 - Standard for Surveillance Camera Units.
 - 2. 2044-08 - Standard for Surveillance Closed Circuit Television Equipment.

- I. United States Department of Veterans Affairs (VA):
 - 1. VA Construction and Facilities Management (CFM):
 - a. DM Electrical - Electrical Design Manual, 2015.

1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.5 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. CCTV system to comply with UL 2044 and operate on 120 Volt AC; 60 Hz power system, with backup power system that will provide minimum 96 hours run time in the event of power failure.
- B. Design, engineer, install, and test CCTV System to ensure components are fully compatible as a system and can be integrated with associated security subsystems, whether system is stand-alone or complete network.
- C. Integrate CCTV System where appropriate with security subsystems:
 - 1. PACS:
 - a. Provide 24-hour coverage of all entry points to perimeter and agency buildings and all emergency exits utilizing fixed color camera.
 - b. Record cameras on 24-hour basis.
 - c. Programmed go into alarm state when an emergency exit is opened and notify Access Control System and Database Management of an alarm event.
 - 2. IDS:
 - a. Provide recorded alarm event via color camera connected to IDS system by direct hardwire or security system computer network.
 - b. Record cameras on 24 hours basis.
 - c. Be programmed to go into alarm state when an IDS device is put into an alarm state and notify Police and Engineering.
 - d. For additional CCTV System requirements as they relate to the IDS, refer to Section 28 31 00, INTRUSION DETECTION.
 - 3. Security Access Detection:
 - a. Provide full coverage of vehicle and lobby entrance screening areas utilizing fixed color camera.
 - b. Record cameras on 24 hours basis.
 - c. Provide CCTV System with facial recognition software to assist in identifying individuals for current and future purposes.
 - 4. EPPS:

- a. Provide recorded alarm event via color camera connected to EPPS system by direct hardwire or security system computer network.
 - b. Record cameras on 24 hours basis.
 - c. Be programmed to go into alarm state when emergency call box or duress alarm/panic device is activated and notify Access Control System and Database Management of an alarm event.
- D. Integration with these security subsystems to be achieved by computer programming or direct hardwiring of systems.
- E. For programming purposes refer to manufacturer's instructions for correct system operations. Ensure computers being utilized for system integration meet or exceed minimum system requirements outlined on system's software packages.
- F. Complete CCTV System to be comprised of, but not limited to, the following components:
 1. Cameras.
 2. Lenses.
 3. Video Display Equipment.
 4. Camera Housings and Mounts.
 5. Controlling Equipment.
 6. Recording Devices.
 7. Wiring and Cables.
- G. Visit site and verify that site conditions are in agreement and compliance with design package. Submit report of all changes to site or conditions that will affect system performance to Resident Engineer/Contracting Officer's Representative (RE/COR). Do not take any corrective action without written permission received from RE/COR.
- H. Existing Equipment:
 1. Connect to and utilize existing video equipment, video and control signal transmission lines, and devices as outlined in design package. Video equipment and signal lines that are usable in their original configuration without modification may be reused with RE/COR approval.
 2. Perform field survey, including testing and inspection of all existing video equipment and signal lines intended to be incorporated into CCTV System, and provide report to RE/COR as part of site survey report. For those items considered nonfunctioning, provide (with report) specification sheets, or written functional requirements to support findings and estimated cost to correct deficiency. As part of report, include schedule for connection to all existing equipment.
 3. Make written requests and obtain approval before disconnecting any signal lines and equipment and creating equipment downtime. Proceed with such work only after receiving RE/COR approval of requests. If any device fails after work has commenced on that device, signal or control line, diagnose failure and perform necessary equipment corrections.

4. Contractor will be held responsible for repair costs due to Contractor negligence, abuse, or incorrect installation of equipment.
5. Provide RE/COR with full list of all equipment to be removed or replaced, including description and serial/manufacture numbers, where possible. Dispose of all equipment that has been removed or replaced based upon RE/COR approval after reviewing equipment removal list. In all areas where equipment is removed or replaced, repair those areas to match current existing conditions.
- I. Enclosure Penetrations: All enclosure penetrations will be from bottom of enclosure unless system design requires penetrations from other directions. For penetrations of interior enclosures involving transitions of conduit from interior to exterior, seal penetrations on exterior enclosures with rubber silicone sealant to preclude water infiltration. and comply with Section 07 84 00, FIRESTOPPING. Terminate conduit riser in hot-dipped galvanized metal cable terminator. Fill terminator with approved sealant as recommended by cable manufacturer without damaging cable.
- J. Cold Galvanizing: Coat field welds and brazing on factory galvanized boxes, enclosures, and conduits with cold galvanized paint containing at least 95 percent zinc by weight.
- K. Interconnection of Console Video Equipment: Connect signal paths between video equipment as specified by OEM.
- L. Provide cables of sufficient lengths for rack mounted equipment on slide mounts to allow full extension of slide rails from rack.

2.2 EQUIPMENT

- A. See Section 27 05 00 COMMON WORK RESULTS FOR COMMUNICATIONS.
- B. Custom Control Console (CCC) and cabinets:
 1. Meets system's specific requirements in PCR, ECR, and EMCR.
- C. Provide CCTV system meeting following requirements:
 1. Cameras: UL 983 compliant.
 2. Charge coupled device (CCD) cameras conforming to National Television System Committee (NTSC) formatting.
 3. Fixed color cameras and primary choice for monitoring following activities described below. Pan/Tilt/Zoom (P/T/Z) cameras to be color and utilized to compliment fixed cameras.
 4. System powered by 12 Volts direct current (VDC) or 24 VAC. Power supplies, to be Class 2 and UL compliant and have back-up power source to ensure cameras are still operational in event of loss of primary power to CCTV System.
 5. Rated for continuous operation under the following environmental conditions:
 - a. Ambient temperatures of minus 14 degrees F to 131 degrees F utilizing equipment that will provide automatic heating and cooling.

- b. Humidity, wind gusts, ice loading, and seismic conditions specified or encountered for locations where CCTV cameras will be utilized.
6. Home run to monitoring and recording device via controlling device such as matrix switcher or network server and monitored on 24-hour basis at designated Access Control System and Database Management location.
7. Each function and activity to be addressed within system by unique twenty character user defined name. Use of codes or mnemonics identifying CCTV action is not acceptable.
8. Furnished with built-in video motion detection that automatically monitors and processes information from each camera. Camera motion detection will detect motion within camera's field of view and provide automatic visual, remote alarms, and motion-artifacts as result of detected motion as follows:
 - a. Motion-detection settings to include adjustable object size and velocity, as well as selectable detection area of 132 zones in twelve by eleven grid.
 - b. Sensors to accept video signals from CCTV cameras and, when synchronizing is required, be in composite synchronization.
 - c. Sensor processors that detect motion by digitizing multiple pixels within each video scene and by comparing pixel gray scale to previously stored reference. Number of pixels digitized depends on application. System designer should consider cost effectiveness since digitizing large number of pixels could increase cost dramatically with little additional actual detection capability for specific application.
 - d. Alarm will be initiated when comparison varies by six percent or more.
9. Design, provide, and post appropriate signage to notify people that an area is under camera surveillance.
10. Dummy or fake cameras will not be utilized.
11. Programmed to digitally flip from color to black and white at dusk and vise-versa at dawn.
12. Fitted with auto-iris lenses to ensure image is maintained in low light.
13. Lightning protection to be IEEE C62.41 compliant and provided for all cameras. Surge protectors or lightning grid may be utilized. Ensure lightning protection equipment is compliant with NFPA 70 (Article 780). Use of fuses and circuit breakers as lightning protection is not acceptable.
14. For camera as part of CCTV network, provide video encoder to convert National Television Systems Committee (NTSC) signal to Moving Picture Experts Group (MPEG) format.
15. Utilize P/T/Z cameras to complement fixed cameras, not as primary means of monitoring activity.
16. Fixed Color Cameras Technical Characteristics:

Imaging Device	1/3 inch interline transfer CCD
Picture Elements	NTSC 510 (H) x 492 (V)

Imaging Device	1/3 inch interline transfer CCD
Scanning System	NTSC 525 lines, 21 interlace
Synchronization System	AC line lock/internal
Horizontal Resolution	330 TV lines
Iris Control	Selectable on/off
Electronic Shutter Range	NTSC 1/60-1/100,000 second
Auto Iris Lens Type	DC/video drive (auto sensing)
Minimum Illumination	0.6 lux
Signal to Noise Ratio	Greater than 50 dB
Automatic Gain Control	On/off switchable
Backlight Compensation	On/off switchable
Auto White Balance	On/off switchable
Video Output	1 Vp-p, 75 ohms
Power Consumption	Less than 5 watts
Video Connector	BNC
Lens Mount	C/CS mount (adjustable)

17. P/T/Z Cameras Technical Characteristics:

Effective Pixels	768 (H) x 494 (V)
Scanning Area	1/4-type CCD
Synchronization	Internal/Line-lock/Multiplexed Vertical Drive (VD2)
Video Output	1.0 v[p-p] NTSC composite/75 ohm
H. Resolution	570-line at B/W, or 480-line at color imaging
Signal-to-noise Ratio	50dB (AGC off, weight on)
Super Dynamic II	64 times (36dB) (selectable on/off)
Minimum Illumination	0.006 fc at B/W, 0.1 fc
Zoom Speed	Approx. 2.1s (TELE/WIDE) in sequence mode
Focus Speed	Approx. 2s (FAR/NEAR) in sequence mode
Iris	Automatic (Open/Close is possible)/manual
Maximum Aperture Ratio	1: 1.6 (Wide) ~ 3.0 (Tele)
Focal Length	0.15 ~ 3.3 inch
Angular Field of View	H 2.6° ~ 51.7° V 2.0° ~ 39.9°
Electronic Shutter	1/60 (off), 1/100, 1/250, 1/500, 1/1,000, 1/2,000, 1/4,000, 1/10,000 s
Zoom Ratio	Optical 22x w/10x electronic zoom

Effective Pixels	768 (H) x 494 (V)
Iris Range	F1.6 ~ 64, Close
Panning Range	360° endless
Panning Speed	Manual: Approx. 0.1°/s ~ 120°/s 16 steps
Tilting Range	0 ~ 90° (Digital Flip off), 0 ~180° (Digital Flip on)
Tilting Speed	Manual: Approx. 0.1°/s ~ 120°/s. 16 steps
Pan/Tilt	Manual/Sequential position/Auto Pan
Controls	Pan/Tilt, Lens, 64 Preset Positions, Home Position
Video Connector	BNC
Controller I/F	Multiplex-coaxial

2.3 CAMERAS

A. General Requirements:

1. UL 983 compliant.
2. Conform to National Television System Committee (NTSC) format.

B. Fixed Cameras:

1. Pan/Tilt/Zoom capability.
2. Powered by 24 Volt AC, with Class 2, UL compliant power supply.
3. Rated for continuous operation under the following environmental conditions:
 - a. Ambient temperatures of minus 14 degrees F to 131 degrees F. Provide automatic heating and cooling.
 - b. Humidity, wind gusts, ice loading, and seismic conditions specified or encountered for locations where CCTV cameras will be utilized.

C. Power over Ethernet (PoE) Cameras:

1. General Requirements:
 - a. IEEE 802.3af compliant.
 - b. Utilized only as part of CCTV Network and not integrated with standard analog or digital CCTV System equipment.
 - c. Utilized for interior and exterior purposes.
 - d. Routed to controlling device via network switcher or direct connection to network server.
 - e. Hybrid design with both Internet Protocol (IP) output and monitor video output which produces picture equivalent to analog camera and allows simultaneous output of both.
 - f. Provide minimum 200,000 effective pixels with built-in complementary color filter for accurate color with no image lag or distortion.
 - g. Programmable IP address that allows installation of multiple units in same Local Area Network (LAN) environment.

- h. Incorporate minimum of Transmission Control Protocol (TCP)/IP, User Datagram Protocol (UDP), Hypertext Transfer Protocol (HTTP), File Transfer Protocol (FTP), Internet Control Message Protocol (ICMP), Address Resolution Protocol (ARP), Real-Time Transport Protocol (RTP), Dynamic Host Configuration Protocol (DHCP), Network Time Protocol (NTP), Simple Mail Transfer Protocol (SMTP), Internet Group Management Protocol (IGMP), and Differentiated Service Code Point (DSCP) protocols for various network applications.
2. Provide Category (CAT)-V cable as primary source for carrying signals maximum 300 ft. from switch hub or network server. If any camera is installed over 300 ft. from controlling device, then the following will be required:
 - a. Local or remote 12 Volt DC or 24 Volt AC power source from Class 2, UL compliant power supply.
 - b. Signal converter to convert from CAT-V cable over to fiber optic or standard signal cable. Signal will be required to convert back to CAT-V cable at controlling device using signal converter card.
3. Technical Characteristics:

Video Standards	MPEG-4; M-JPEG
Video Data Rate	9.6 Kbps - 6 Mbps Constant & variable
Image Resolution	768x494 (NTSC)
Video Resolution	704 x 576/480 (4CIF: 25/30 IPS) 704 x 288/240 (2CIF: 25/30 IPS) 352 x 288/240 (CIF: 25/30 IPS) 176 x 144/120 (QCIF: 25/30 IPS)
Select Frame Rate	1-25/30 IPS (PAL/NTSC); Field/frame-based coding
Network Protocols	RTP, Telnet, UDP, TCP, IP, HTTP, IGMP, ICMP
Software Update	Flash ROM, remote programmable
Configuration	Via web browser, built-in web server interfaces
Video Out	1x Analog composite: NTSC or PAL; BNC connector 75 Ohm
Sensitivity	1 0.65 lux (color) 0.26 lux (NightSense)
Minimum Illumination	0.30 lux (color) 0.12 lux (NightSense)
Video Signal-to-Noise Ratio	50 dB
Video Signal Gain	21 dB, (max) Electronic Shutter Automatic, up to 1/150000 sec. (NTSC)

Video Standards	MPEG-4; M-JPEG
Alarm In	Automatic sensing (2500 - 9000 K)
Input Voltage	+5 V nominal, +40 Volt DC max VDC: 11-36 V (700 mA) VAC: 12-28 V (700 mA) PoE: IEEE 802.3af compliant

D. Wireless Cameras:

1. General Requirements:
 - a. Ensure operating frequency is given full approval by VA controlling authority before installation of any wireless camera.
 - b. Utilize wireless cameras as part of CCTV network or standard analog system.
 - c. Meets Federal Communication Commission (FCC) approval and compliancy.
2. Power: 110 Volt AC tied into dedicated circuit breaker on dedicated power panel to security system and fed from power source with back-up in the event primary power to CCTV System is lost.
 - a. Run power to camera and connect at both ends according to Division 26 Sections and DM Electrical.
3. Locate wireless cameras within minimum one quarter mile of receiving unit. Provide repeaters as required to ensure strongest possible signal between transmitters and receivers.
 - a. Utilize the following equipment to ensure system operation:
 - 1) Receiver.
 - 2) Receiver antenna, as required.
 - 3) Repeater, as required.
 - 4) Mounting hardware.
4. Receivers: Provide maximum four cameras per unit.
5. Technical Characteristics:
 - a. Wireless Cameras:

Imaging Device	1/3 inch interline transfer CCD
Picture Elements	NTSC 510 (H) x 492 (V)
Sensing Area	6 mm diagonal
Scanning System	NTSC 525 lines, 21 interlace
Synchronization System	AC line lock/internal
Horizontal Resolution	330 TV lines
Iris Control	Selectable on/off
Electronic Shutter Range NTSC	1/60-1/100,000 second
Frequency range	2.41-2.47GHz

Imaging Device	1/3 inch interline transfer CCD
Modulation	FM
Video signal/noise ratio	48dB
Audio signal/noise ratio	45db
Minimum Illumination	0.6 lux
Signal to Noise Ratio	Greater than 50 dB
Automatic Gain Control	On/off switchable
Backlight Compensation	On/off switchable
Auto White Balance	On/off switchable
Video Output	1 Vp-p, 75 ohms
Lens Mount	C/CS mount (adjustable)

1) Receivers:

Frequency range	2.4-2.49GHz
Video output	1V P/P
Signal/noise ratio	38dB

2.4 LENSES

A. General Requirements:

1. Provides maximum coverage of area being monitored by camera.
2. Provide lenses 0.33 inches to fit CCD fixed camera.
3. Glass with coated optics.
4. Mounts compatible with camera selected.
5. Packaged and furnished with camera.
6. Maximum f-stop of f/1.3 for fixed lenses, and maximum f-stop of f/1.6 for variable focus lenses.
7. Equipped with auto-iris mechanism.
8. Sufficient circle of illumination to cover image sensor evenly.
9. Not to be used on camera with image format larger than lens is designed to cover.
10. Pre-set capability.

B. Manual Variable Focus:

1. Provide manual variable focus lenses in large areas being monitored such as perimeter fence lines, vehicle entry points, parking areas, and areas indicated on Drawings.
2. Manual variable focus lenses to allow for setting virtually any angle of field, which maximizes surveillance effects.
3. Technical Characteristics:

Image format	1/3 inch
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Image format	1/3 inch
Focal length	5-50mm
Iris range	F1.4 to close
Focus range	3.3 ft.
Back focus distance	0.4 inches
Angle view Wide (1/3 inches)	53.4 x 40.1
Angle view Tele (1/3 inches)	5.3 x 4.1
Iris control	manual
Focus ctrl	manual
Zoom ctrl	manual

C. Auto Iris Fixed:

1. Provide auto iris fixed lenses in areas where small specific point of reference is monitored such as doorways, elevators, and locations indicated on Drawings.
2. Provide focal length calculation using focal length calculator or focal length chart provided by lens manufacturer.
3. Technical Characteristics:

Image format	1/3 inch	1/3 inch	1/3 inch
Focal length	2.8 mm	4 mm	8 mm
Iris range	F1.2 - 200	F1.2 - 200	F1.2 - 200
Min. Object	1 ft	1 ft	1 ft
Lens mount	CS-mount	CS-mount	CS-mount
Angle of view	94 X 72	64 X 49	33 x 25
Focus control	Manual	Manual	manual

2.5 VIDEO DISPLAY EQUIPMENT

1. Video display equipment to consist of color monitors and be able to display analog, digital, and other images in NTSC or MPEG format associated with operation of Security Management System (SMS). Other requirements include the following:
 - a. Front panel controls for power on/off, horizontal and vertical hold, brightness, and contrast.
 - b. Accept multiple inputs, directly or indirectly.
 - c. Capable of observing and programming CCTV System.
 - d. Installation cannot be witnessed by general public.
2. Color Video Monitors Technical Characteristics:

Sync Format	PAL/NTSC
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Sync Format	PAL/NTSC
Display Tube	90-degree deflection angle
Horizontal Resolution	250 TVL minimum, 300 TVL typical
Video Input	1.0 Vp-p, 75 Ohm
Front Panel Controls	Volume, Contrast, Brightness, Color
Connectors	BNC

3. Liquid Crystal Display (LCD) Flat Panel Display Monitor:

a. Technical Characteristics:

Sync Format	PAL/NTSC
LCD Panel	TFT LCD
Resolution	1280 x 1024 pixels; 500 TV
Contrast Ratio (CR)	500: 1
Viewing Angle	140 degrees horizontal, 130 degree vertical
Video Input	(CVBS) 1.0 Vp-p (0.5-1.5 Vp-p), 75 Ohm Y/C (S-video) 0.7 Vp-p, 0.3 Vp-p, 75 Ohm
Video 1	Composite video two (2) BNC (1 in, 1 out)
Video 2	Composite video two (2) BNC (1 in, 1 out)
Y/C (S-video)	two mini-dins, 4-pin (1 in, 1 out)

2.6 CAMERA HOUSINGS AND MOUNTS

A. Environmentally Sealed:

1. General Requirements:

- Provides condensation free environment for correct camera operation.
- Operate in 100 percent condensing humidity atmosphere.
- Equipped with fill valve for introduction of nitrogen into housing to eliminate existing atmospheric air and pressurize housing to create moisture free conditions.
- Equipped with overpressure valve to prevent damage to housing by over pressurization.
- Equipped with humidity indicator, visible at all times, to ensure correct atmospheric conditions.
- Maximum housing leak rate of 2 lbs./sq.in. at sea level in 90-day period.
- Camera mounts or supports as required for correct positioning of camera and lens.
- White housing and sunshield.

2. Provide all electrical and signal cables required for correct operations in hardened carrier system from controller to camera.

3. Provide adjustable mounting brackets for housing weight of camera and housing unit.

4. Camera and mount accessibility required for maintenance and service purposes.
- B. Indoor Mounts:
1. Ceiling Mounts:
 - a. Fasten enclosure and mount to finished or suspended ceiling.
 - b. Do not support enclosure mount from ceiling metal suspension system. Provide support according to mount manufacturer's instructions.
 - c. Suspended ceiling mounts to be low profile and suitable for replacement of 2 foot by 2-foot ceiling panels.
 2. Wall Mounts:
 - a. Enclosure installation to match existing décor, placed at unobtrusive height, unable to cause personal harm, and prevent tampering and vandalism.
 - b. Provide mounts with manual pan/tilt head for 360 degree horizontal and vertical positioning from horizontal position and locking bar or screw to maintain its fixed position once adjusted.
- C. Domes:
1. Domes to be pendant mount, pole mount, ceiling mount, surface mount, or corner mounted equipment.
 - a. Interior Dome Construction:
 - 1) Lower portion that provides camera viewing to be black opaque acrylic and have light attenuation factor of maximum 1 f-stop.
 - 2) Housing to be equipped with integral pan/tilt capabilities complete with wiring, wiring harness, connectors, receiver/driver, pan/tilt control system, pre-position cards, or other hardware and equipment as required for fully functional pan/tilt dome.
 - b. Exterior Domes Construction:
 - 1) Lower portion that provides camera viewing to be black opaque acrylic and have light attenuation factor of maximum 1 f-stop.
 - 2) Housing to be dust and water tight, and fully operational in 100 percent condensing humidity.
 2. Pan/Tilt Mechanism:
 - a. Constructed of heavy duty bearings and hardened steel gears.
 - b. Permanently lubricated to ensure smooth and consistent movement of all parts for life of product.
 - c. Equipped with motors thermally or impedance protected against overload damage.
 - d. Pan Movements: 360 degrees and tilt movement minimum +/- 90 degrees.
 - e. Pan Speed: Minimum 10 degrees per second.
- D. Exterior Wall Mounts:

1. Provide mounts with adjustable head for camera mounting.
 - a. Head adjustable for minimum plus and minus 90 degrees of pan, and minimum plus and minus 45 degrees of tilt.
 2. Constructed of aluminum, stainless steel, or steel with corrosion-resistant finish.
 - a. Install mounts at height that allows for maximum coverage of area being monitored.
- E. Explosion Proof Housing:
1. Housing to meet or exceed all requirements of NEMA 250 for Type 4 enclosures for hazardous locations.
 2. Provide mounting brackets as specified for camera and lens.

2.7 CONTROLLING EQUIPMENT

- A. Controlling equipment to be utilized to call up, operate, and program cameras associated CCTV System components:
1. Operates cameras locally and remotely. Utilize matrix switcher or network server as CCTV System controller.
 2. Fit controller into standard 19-inch equipment rack.
 3. Provide control and programming keyboards with its own type of switcher. Keyboards to meet the following:
 - a. Located at each monitoring station.
 - b. Addressable for programming purposes.
 - c. Provide interface between operator and CCTV System.
 - d. Provide full control and programming of switcher.
 - e. Minimum controls:
 - 1) Programming.
 - 2) Switching.
 - 3) Lens function.
 - 4) Pan/Tilt/Zoom.
 - 5) Environmental housing.
 - 6) Annotation.
 4. Matrix Switcher: Meet the following minimum requirements:
 - a. Take multiple camera inputs and route them to multiple monitoring stations.
 - b. Allow for centralized user management controlling configurations.
 - c. Provide live viewing of cameras.
 - d. Provide P/T/Z, focus, and iris control of unitized cameras.
 - e. Be expandable to allow for addition of multiple cameras and monitoring stations over life of system visual identification system by utilizing input and output video and controller cards.
 - f. Input cards to allow for addition of minimum four camera inputs per card.

- g. Output cards to allow for addition of minimum eight outputs per card.
- h. Have ability to be programmed locally or remotely.
- i. Remotely operate multiple cameras from multiple stations.
- j. Fully interface with digital video recorder (DVR) for recording of all events.
- k. Utilize RS-232 or fiber optic connections for integration with SMS computer station via remote port on network hub.
- l. Alarm interface compatible with all associated security subsystems. Alarm inputs to be via relay or EIA ANSI/EIA/TIA-232-F interface. Interface allowing for minimum 24 alarm inputs and 12 alarm outputs.
- m. Switcher response time to alarm input to be minimum 200 milliseconds from time an alarm is sensed until picture is displayed on monitor.
- n. Switcher with built in buffer to allow back-log of alarms. Viewable alarms by operator.
- o. Addressable if multiple matrix switchers are connected to SMS.
- p. Configured, i.e. camera names, monitor names, sequences, alarms and alarm actions, etc. utilizing configuration program and tools provided by matrix manufacturer.
- q. Matrix switcher meeting the following minimum input/output requirements:

Camera inputs	16
Video outputs	4
Keyboard/Controller Outputs	4
Alarm inputs	323

5. Matrix switcher having the following components and technical characteristics:

a. Main Unit:

Functions	Monitor control Camera selection, tour sequence, group sequence, group preset, OSD display, Camera/Receiver control via coaxial or RS-485 cable communication, Recorder control
Alarm control	Alarm event, Alarm Acknowledge, Alarm reset, Alarm suspension, Alarm History Display, Timer event, and Camera event
RS-485 (Camera)Port	6-conductor modular jack x 12 (2- wire or 4-wire communication, With termination switches (MODE 1 to 4))
Extension Port	6-conductor modular jack x 2(With a (EXTENSION 1 IN, OUT) termination switch (TERM: ON, OFF))
Extension Port	37-pin D-sub connector x 2(EXTENSION IN 2 or 3)
Extension Port	37-pin D-sub connector x 2(EXTENSION OUT 2 or 3)

b. Input Board:

Camera Input	1 V [P-P]/75 Ohm (BNC), composite video signal 0.5 V [P- P]/75 Ohm data signal and 2.5 V [P-P]/75 Ohm (25 pin D sub connector x 4)
Alarm Input	N.O. (Normally Open contact) or N.C. (Normally Close contact) selectable x 32 (37 pin D sub connector)

c. Output Board:

Monitor Output	1 V [P-P]/75 Ohm (BNC)
Alarm Output	Open collector output x 32, Max. 24 VDC, 100 mA
Extension Port	6-conductor modular jack x 2
Serial Port	9-pin D-sub connector x 2

6. Network Server:

- a. Allow for transmission of live video, data, and audio over existing Ethernet network or dedicated security system network, requiring IP address or Internet Explorer 5.5 or higher, or work as analog-to-Ethernet "bridge" controlling matrices, multiplexers, and pan/tilt/zoom cameras. Network to operate in box-to-box configuration allowing for encoded video to be decoded and displayed on analog monitor.
- b. If CCTV System network will be utilized as primary means of monitoring, operating, and recording cameras then the following equipment will be required:
 - 1) System Server.
 - 2) Computer Workstation.
 - 3) Recording Device.
 - 4) Encoder/Decoder.
 - 5) Monitor.
 - 6) Hub/Switch.
 - 7) Router.
 - 8) Encryptor.
- c. Servers to provide overall control, programming, monitoring, and recording of cameras and associated devices within CCTV System.
- d. Equipment on network to be IP addressable.
- e. CCTV System network is required to meet or exceed the following design and performance specifications:
 - 1) Two MPEG-4 video streams for total of 40 images per second.
 - 2) PC Software that manages installation and maintenance of hardware transmitters and receivers on network.

- 3) Video Source that supports NTSC video source to computer network will be addressed.
- 4) Receivers used to display video on standard analog NTSC or PAL monitor will be addressed.
- f. System supporting the following network protocols:
 - 1) Internet connections: RTP, Real Time Control Protocol (RTCP), UDP, IP, TCP, ICMP, HTTP, Simple Network Management Protocol (SNMP), IGMP, DHCP, and ARP.
 - 2) Video Display: MPEG-4, M-JPEG in server push mode only.
 - 3) Have ability to adjust bandwidth, image quality and image rate.
 - 4) Support image sizes of 704 by 576 pixels or 352 by 288 pixels.
 - 5) Have audio coding format of G.711 or G.728.
 - 6) Provide video frame rate of minimum 30 images per second.
 - 7) Support LAN Interface Ethernet 10/100BaseT and be auto sensing.
 - 8) Have LAN Data Rate of 9.6 Kbps to 5.0 Mbps.
 - 9) Utilize data interface RS-232/RS-422/RS-485.
- g. All connections within system to be via CAT-V cable and RJ-45 jacks. If analog equipment is used as part of system, then encoder or decoder will be utilized to convert analog signal to digital one.
- h. CCTV network system to conform to all VA agency wide security standards for administrator and operator use.
- i. Server Technical Characteristics:

Hardware	Personal Computer
CPU	Pentium IV, 3.0 GHz or better
Hard Disk Interface	IDE or better
RAM	256 MB
OS	Windows XP Home/XP Professional
Graphic Card	NVIDIA GeForce 6600 NVIDIA Quadro FX 1400 ATI RADEON X600/X800 or better
Ethernet Card	100 Mb
Software	DirectX 9.0c
Free Memory	120 MB

- j. Network Switch Technical Characteristics:

Protocol and standard	IEEE802.3 IEEE802.3u IEEE802.3ab
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Protocol and standard	IEEE802.3 IEEE802.3u IEEE802.3ab
Ports	24 10/100/1000M auto-negotiation RJ-45 ports with auto MDI/MDI-X
Network media	Cat 5 UTP for 1,000Mbps Cat 3 UTP for 10Mbps
Transmission method	store-and-forward
LED	indicator power, act/link, speed

k. Router Technical Characteristics:

Network Standards	IEEE 802.3, 802.3u 10Base-T Ethernet (WAN) 100Base-T Ethernet (LAN) IEEE 802.3x Flow Control IEEE802.1p Priority Queue ANS/IEEE 802.3 NWay auto-negotiation
Protocol	CSMA/CD, TCP, IP, UDP, PPPoE, AND DHCP (client and server)
VPN Supported	PPTP, IPSec pass-through
Management	Browser
Ports	4 x 10/100Base-T Auto sensing RJ45 ports, and an auto uplink RJ45ports 1 x 10Base-T RJ45 port, WAN
LEDs	Power, WAN Activity, LAN Link (10/100), LAN Activity

l. Encryptor Technical Characteristics:

Cryptography	Standard - Triple DES 168-bit (ANSI 9.52) Rijndael - AES (128, 192, 256)
Performance	Throughput (end-to-end) @ 100 Mbps line speed: greater than 188 Mbps full duplex (large frames) greater than 200 kfps full duplex (small frames) Latency (end-to-end) @ 100 Mbps
Key Management	Automatic KEK/DEK Exchange Using Signed Diffie-Hellman Unit Authentication Using X.509 Certificates
Physical Interfaces	10BaseT or 10/100BaseT Ethernet (Host and Network Ports) 10BaseT Ethernet Management Port Back and Front-Panel Serial Control Port

Cryptography	Standard - Triple DES 168-bit (ANSI 9.52) Rijndael - AES (128, 192, 256)
Device Management	THALES Element Manager, Front Panel Viewer, and Certificate Manager 10Base T (RJ-45) or 9-pin Serial Control Port SNMP Network Monitoring
Security Features	Tamper Proof Cryptographic Envelope Tamper Evident Chassis Hardware Random Number Generator
Management	Channel Encrypted Using Same Algorithm as Data Traffic
Security Certifications	FIPS 140-2 Level 3 CAPS Baseline and Enhanced Grades Common Criteria EAL4 and EAL5 (under evaluation)
Regulatory	EN60950, FCC, UL, CE, EN 50082-1, and EN 55022

2.8 RECORDING DEVICES

- A. Cameras on CCTV System to be recorded in real time using Digital Video Recorder (DVR), Network Video Recorder (NVR), or Time Lapse Video Recorder (VCR). Type of recording device utilized to be determined by size and type of CCTV System designed and installed, and to what extent system is to be utilized.
- B. Provide rack-mounted recording devices.
 - 1. Size: 19 inch.
- C. DVR's and NVR's viewable over Intranet or Internet will be routed through encryptor meeting the following requirements:
 - 1. Comply with FIPS PUB 140-2.
 - 2. Support TCP/IP.
 - 3. Directly interfaces to low-cost commercial routers.
 - 4. Provide packet-based crypto synchronization.
 - 5. Encrypt source and destination IP addresses.
 - 6. Support web browser-based management requiring no additional software.
 - 7. Have high data sustained throughput - 1.544 Mbps (T1) full duplex data rate.
 - 8. Provide for both bridging and routing network architecture support.
 - 9. Support Electronic Key Management System (EKMS) compatible.
 - 10. Have remote management ability.
 - 11. Automatically reconfigure when secure network or wide area network changes.

D. Digital Video Recorder (DVR):

1. Ability to record video to hard drive-based digital storage medium in NTSC or MPEG format and meet the following minimum requirements:
 - a. Record at minimum 30 images per second (IPS).
 - b. Have minimum 8 to 16 looping inputs.
 - c. Have minimum 8 to 16 alarm inputs and 2 relay outputs.
 - d. Provide instantaneous playback of recorded images.
 - e. IP addressable, if part of CCTV network.
 - f. Built-in digital motion detection with masking and sensitivity adjustments.
 - g. Provide easy playback and forward/reverse search capabilities.
 - h. Complete audit trail database, with minimum six-month history that tracks all events related to alarm; specifically, who, what, where and when.
 - i. DVR management capability providing automatic video routing to back-up spare recorder in case of failure.
 - j. Accessible locally and remotely via Internet, Intranet, or personal digital assistant (PDA).
 - k. Records all alarm events in real time, ensuring 60 seconds before and after event are included in recording.
 - l. Utilize RS-232 or fiber optic connections for integration with SMS computer station via remote port on network hub.
 - m. Allow for independently adjustable frame rate settings.
 - n. Compatible with matrix switcher utilized to operate cameras. DVR could be utilized as matrix switcher only if it meets all requirements listed in matrix switcher section.
 - o. Technical Characteristics:

Processor	Intel Pentium III 750 MHz
Memory	256 MB RAM
Operating System	Windows 98, NT, ME, 2000, and XP
Video Card	4 MB of RAM capable of 24-bit true color display
Free Hard Disk Space	160 MB for software installation
Network Card	10Base-T network for LAN operation
Archiving	80 GB, 160 GB, 320 GB and 640 GB Hard Drive; CD-RW
Video Input	1.0 Vpp (signal 714mV, sync 286mV) 75 ohms (BNC unbalanced)
Video Output Level	1.0 Vpp +/-10%,75 ohms (BNC unbalanced)
Impedance	75 ohms/Hi- impedance x 16 switchable
Network Interface	Ethernet (RJ-45, 10/100M)

Processor	Intel Pentium III 750 MHz
Network Protocol	TCP/IP, DHCP, HTTP, UDP
Network Capabilities	Live/Playback/P/T/Z control
Recording Rate	30 ips for 720 x 240 (NTSC)
Password Protection	Menu Setup, Remote Access
Recording Capacity	160 (1 or 2 fixed HDD) 1 CD-RW
Power Interrupt	Auto recovered to recording mode

2. Network Video Recorder (NVR):

a. Ability to record video to hard drive-based digital storage medium in MPEG format and meet the following minimum requirements:

- 1) Record at minimum 30 IPS.
- 2) Have minimum 8 to 16 looping inputs.
- 3) Have minimum 8 to 16 alarm inputs and 2 relay outputs.
- 4) Provide instantaneous playback of all recorded images.
- 5) IP addressable, if part of CCTV network.
- 6) Built-in digital motion detection with masking and sensitivity adjustments.
- 7) Easy playback and forward/reverse search capabilities.
- 8) Complete audit trail database, with minimum six-month history tracking all events related to alarm; specifically, who, what, where and when.
- 9) NVR management capability providing automatic video routing to back-up spare recorder in case of failure.
- 10) Accessible locally and remotely via Internet, Intranet, or personal digital assistant (PDA).
- 11) Records all alarm events in real time, ensuring 60 seconds before and after event are included in recording.
- 12) Utilize RS-232 or fiber optic connections for integration with SMS computer station via remote port on network hub.
- 13) Allow for independently adjustable frame rate settings.
- 14) Be compatible with matrix switcher utilized to operate cameras.

b. Technical Characteristics:

Hardware/CPU	Pentium III Xeon or IV, 1.8 GHz
HDD Interface	IDE or better; optional: SCSI II, SCSI Ultra, or Fiber Channel
RAM	1024 MB
Operating System	Windows 2000/XP Professional/Server 2003 Standard
Graphic	Card VGA
Ethernet Card	100/1000 MB

Hardware/CPU	Pentium III Xeon or IV, 1.8 GHz
Memory	20 MB
Software Setup	Centralized setup from each authorized PC; access via VIDEOS or integrated web server
Storage Media	All storage media possible (e.g., HD, RAID), depending on operating system
Storage Mode	Linear mode, ring mode (capacity-based)
Recording Configuration	Camera name assignment, bandwidth limit, frame rate, video quality
Recording Content	Video and/or audio data
Search Parameters	Time, date, event
Playback	Playback via VIDEOS over any IP network (LAN/WAN) simultaneous recording, playback, and backup
Network Interface	Ethernet (RJ-45, 10/100M)
Network Protocol	TCP/IP, DHCP, HTTP, UDP
Network Capabilities	Live/Playback/P/T/Z control
Recording Rate	30 ips for 720 x 240 (NTSC)
Password Protection	Menu Setup, Remote Access
Recording Capacity	160 (1 or 2 fixed HDD) 1 CD-RW
Power Interrupt	Auto recovered to recording mode

3. Time Lapse Video Recorder (VCR):

- a. Ability to be specifically designed as time lapse recorder within CCTV System meeting the following minimum requirements:
 - 1) Allow for repeat recording.
 - 2) Allow for series recording with multiple recorders.
 - 3) Able to record Daily/Weekly/Holiday schedules.
 - 4) Jog/Shuttle for easy forward or reverse field playback.
 - 5) Search using alarm index, time and date, skip, counter memory stop.
 - 6) Built in time and date generator that can be turned on and off and impose time and date on video during recording.
 - 7) Built in alarm that annunciates end of tape, excessive condensation, transport malfunction, or tape jam.
 - 8) On-screen programming.
 - 9) Interface with matrix switcher.
 - 10) Automatic head cleaning.
 - 11) Battery backup for internal settings.

- 12) Tape use counter.
- 13) Daylight saving time setting.
- b. Video tape used in recorder to meet the following requirements:
 - 1) Contained in cassette mechanism.
 - 2) Self-loading and not require operator to thread tape.
 - 3) Load through front of recorder.
 - 4) Labeled with date and times of coverage.
 - 5) Stored for minimum period specified in VA CCTV standards.
- c. Locally installed at monitoring station.
- d. Technical Characteristics:

Tape Format	Standard 1/2 inch VHS
Video Recording Standard	6/8 Hour in NTSC
Time Lapse Recording	18/30/54/78/102/126/174 or 24/40/72/104/136/160/232 hour
Video Recording System	Rotary 2-head azimuth
Video Head Configuration	4-head double azimuth Tape Transport
Rewind/FF Speed	Within 120 seconds (with T-120 VHS tape)
Head Cleaning	Automatic
Record/Playback	Time Mode (EP) 6H, L18H, L30H, 48H, 72H, 96H, 0H
Horizontal Resolution	(SR Mode) 400 lines (VHS Mode) 240 lines
Video Input/Output	(BNC) 1.0 Vp-p, 75 Ohm
Audio System Record/Playback	6H, L18H, L30H
Timer Recording	8 event programmability
Display	Month/Day/Year and Time

2.9 WIRES AND CABLES

A. General Requirements:

1. Wires and cables to meet or exceed manufacturer's recommendation for power and signal.
2. Carried in enclosed conduit system, utilizing electromagnetic tubing (EMT) to include equivalent in flexible metal, rigid galvanized steel (RGS) to include equivalent of liquid tight, polyvinylchloride (PVC) Schedule 40 or 80.
3. Conduits to be sized and installed according to NFPA 70. Security system signal and power cables that traverse or originate in high security office space to be contained in EMT or RGS conduit.

4. Conduit, pull boxes, and junction boxes to be marked with colored permanent tape or paint that allow it to be distinguished from other conduit and infrastructure.
 5. Conduit fills not to exceed 50 percent, unless otherwise documented.
 6. Pull string to be pulled along and provided with signal and power cables to assist in future installations.
 7. Apply firestopping materials at locations where there is wall penetration or core drilling is conducted for conduit installation.
 8. Do not place high voltage and signal cables same conduit and keep separate up to connection point. High voltage for security system is defined as any cable or sets of cables carrying 30 VDC/VAC or higher.
 9. For equipment carrying digital data between Access Control System and Database Management or at remote monitoring station, provide minimum 20 AWG and stranded copper wire for each conductor. Cable or each individual conductor within cable to have shield that provides 100 percent coverage. Cables with single overall shield to have tinned copper shield drain wire.
 10. Cables and conductors, except fiber optic cables, that act as control, communication, or signal lines to include surge protection. Provide surge protection at equipment end and additional triple electrode gas surge protectors rated for application on each wire line circuit to be installed within 3 ft. of building cable entrance. Test inputs and outputs in both normal and common mode using the following wave forms:
 - a. 10 microsecond rise time by 1000 microsecond pulse width waveform with peak Voltage of 1500 watts and peak current of 60 Amperes.
 - b. 8 microsecond rise time by 20 microsecond pulse width wave form with peak Voltage of 1000 Volts and peak current of 500 Amperes.
 - c. Prevent surge suppression device from attenuating or reducing video or sync signal under normal conditions. Do not use fuses and relays for surge protection.
- B. Coaxial Cables:
1. Provide coaxial cables for video signal cables for CCTV System, except to PoE cameras that have characteristic impedance of 75 ohms plus or minus 3 ohms.
 2. For runs up to 750 feet, use of RG-59/U is required. RG-59/U to be shielded which provides minimum 95 percent coverage, with stranded copper center conductor of minimum 23 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
 3. For runs between 750 feet and 1250 feet, RG-6/U is required. RG-6/U to be shielded which provides minimum 95 percent coverage, with stranded copper center conductor of minimum 18 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.

4. For runs of 1250 to 2750 feet, RG-11/U is required. RG-11/U to be shielded which provides minimum 95 percent coverage, with stranded copper center conductor of minimum 14 AWG, polyethylene insulation, and black non-conductive polyvinylchloride (PVC) jacket.
5. All runs greater than 2750 feet will be with fiber optic cable. Utilize the following equipment if using fiber optics as signal carrier:
 - a. Multimode fiber optic cable minimum 62 microns.
 - b. Video transmitter, installed at camera that utilizes 12 Volt DC or 24 Volt AC for power.
 - c. Video receiver, installed at switcher.
6. RG-59/U Technical Characteristics:

AWG	22
Stranding	7x29
Conductor Diameter	.031 in.
Conductor Material	BCC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	0.145 inches
Outer Shield Type	Braid/Braid
Outer Jacket Material	PVC
Overall Nominal Diameter	0.242 inches
UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.094 μ H/ft
Nom. Capacitance	Conductor to Shield 17.0 pF/ft
Nom. Velocity of Propagation	80 %
Nom. Delay	1.3 ns/ft
Nom. Conductor DC Resistance @ 20°C	12.2 Ohms/1000 ft
Nom. Outer Shield DC Resistance @ 20°C	2.4 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

7. RG-6/U Technical Characteristics:

AWG	18
Stranding	7x27
Conductor Diameter	.040 in.
Conductor Material	BC
Insulation Material	Gas-injected FHDPE

AWG	18
Insulation Diameter	0.180 inches
Outer Shield Material	Trade Name Duofoil
Outer Shield Type	Tape/Braid
Outer Shield %Coverage	100 percent
Outer Jacket Material	PVC
Overall Nominal Diameter	0.274 inches
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.106 μ H/ft
Nom. Capacitance	Conductor to Shield 16.2 pF/ft
Nom. Velocity of Propagation	82 percent
Nom. Delay	1.24 ns/ft
Nom. Conductor DC Resistance	6.4 Ohms/1000 ft
Nominal Outer Shield DC Resistance @ 20°C	2.8 Ohms/1000 ft
Max. Operating Voltage	UL 300 V RMS

8. RG-11/U Technical Characteristics:

AWG	15
Stranding	19x27
Conductor Diameter	0.064 inches
Conductor Material	BC
Insulation Material	Gas-injected FHDPE
Insulation Diameter	0.312 inches
Inner Shield Type	Braid
Inner Shield Material	BC - Bare Copper
Inner Shield %Coverage	95 percent
Inner Jacket Material	PE - Polyethylene
Inner Jacket Diameter	0.391 inches
Outer Shield Type	Braid
Outer Shield Material	BC - Bare Copper
Outer Shield %Coverage	95 percent
Outer Jacket Material	Trade Name Belflex
Outer Jacket Material	PVC Blend
Overall Nominal Diameter	0.520 inches
Operating Temperature Range	-35°C To +75°C

AWG	15
Non-UL Temperature Rating	75°C
Nom. Characteristic Impedance	75 Ohms
Nom. Inductance	0.097 μ H/ft
Nom. Capacitance	Conductor to Shield 17.3 pF/ft
Nom. Velocity of Propagation	78 percent
Nom. Delay	1.30 ns/ft
Nom. Conductor DC Resistance	3.1 Ohms/1000 ft
Nom. Inner Shield DC Resistance	1.8 Ohms/1000 ft
Nom. Outer Shield DC Resistance	1.4 Ohms/1000 ft
Max. Operating Voltage Non-UL	300 V RMS

C. Signal Cables:

1. Signal wiring for PoE cameras depends on distance camera is being installed from hub or server.
2. If camera is up to 300 ft. from hub or server, provide shielded UTP category 5 (CAT-V) cable with standard RJ-45 connector at each end. Cable to comply with Power over Ethernet, IEEE802.3af, Standard.
3. If camera is over 300 ft. from hub or server, provide multimode fiber optic cable, minimum 62 microns.
4. Provide separate cable for power.
5. CAT-5 Technical Characteristics:

Number of Pairs	4
Total Number of Conductors	8
AWG	24
Stranding	Solid
Conductor Material	BC - Bare Copper
Insulation Material	PO - Polyolefin
Overall Nominal Diameter	0.230 inches
IEC Specification	11801 Category 5
TIA/EIA Specification	568-B.2 Category 5e
Max. Capacitance Unbalance	(pF/100 m) 150 pF/100 m
Nom. Velocity of Propagation	70 percent
Max. Delay	(ns/100 m) 538 @ 100MHz
Max. Delay Skew	(ns/100m) 45 ns/100 m

Number of Pairs	4
Max. Conductor DC Resistance	9.38 Ohms/100
Max. DCR Unbalance@ 20°C	3 percent
Max. Operating Voltage	UL 300 V RMS

6. Fiber Optic Cables Technical Characteristics:

Fiber Type	62.5 Micron
Number of Fibers	4
Core Diameter 6	2.5 +/- 2.5 microns
Core Non-Circularity	5 percent Maximum
Clad Diameter	125 +/- 2 microns
Clad Non-Circularity	1 percent Maximum
Core-clad Offset	1.5 Microns Maximum
Primary Coating Material	Acrylate
Primary Coating Diameter	245 +/- 10 microns
Secondary Coating Material	Engineering Thermoplastic
Secondary Coating Diameter	900 +/- 50 microns
Strength Member Material	Aramid Yarn
Outer Jacket Material	PVC
Outer Jacket Color	Orange
Overall Diameter	0.200 inches
Numerical Aperture	.275
Maximum Gigabit Ethernet	985 feet
Maximum Gigabit Ethernet	1804 feet

D. Power Cables:

1. Sized accordingly and complying with NFPA 70. High Voltage power cables to be minimum three conductors, 14 AWG, stranded, and coated with non-conductive polyvinylchloride (PVC) jacket. Low Voltage cables to be minimum 18 AWG, stranded and non-conductive polyvinylchloride (PVC) jacket.
2. Power cables to be provided for all CCTV System components that require 110 Volt AC 60 Hz or 220 Volt AC 50 Hz input. Connect each feed to dedicated circuit breaker at security system power panel.
3. Protect equipment connected to AC power from surges. Equipment protection to withstand surge test waveforms described in IEEE C62.41. Fuses are not acceptable for surge protection.
4. Low Voltage Power Cables:

- a. Minimum 18 AWG, stranded with polyvinylchloride outer jacket.
- b. Determine cable size by basic voltage over distance calculation and comply with NFPA 70 requirements for low Voltage cables.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL.

- A. Install products according to manufacturer's instructions and approved submittal drawings.
 1. When manufacturer's instructions deviate from specifications, submit proposed resolution for RE/COR consideration.
- B. Install systems according to NECA 303, manufacturer and related documents and references, for each type of security subsystem designed, engineered and installed.

3.2 INSTALLATION - EQUIPMENT

- A. Configure components with appropriate service points to pinpoint system trouble in less than 30 minutes.
- B. Install system components, including Government furnished equipment, and appurtenances according to manufacturer's instructions, and provide necessary connectors, terminators, interconnections, services, and adjustments required for complete and operable system.
- C. Cameras:
 1. Install cameras with focal length lens as indicated for each zone.
 2. Connect power and signal lines to cameras.
 3. Set cameras with fixed iris lenses to f-stop to give full video level.
 4. Aim camera to give field of view as required to cover alarm zone.
 5. Aim fixed mounted cameras installed outdoors facing rising or setting sun sufficiently below horizon to preclude camera looking directly at the sun.
 6. Focus lens to give sharp picture (to include checking for day and night focus and image quality) over entire field of view; and synchronize all cameras so picture does not roll on monitor when cameras are selected. Dome cameras to have all preset positions defined and installed.
- D. Monitors:
 1. Install monitors as shown and specified in construction documents.
 2. Connect signal inputs and outputs as shown on drawings and specified.
 3. Terminate video input signals as required.
 4. Connect monitor to AC power.
- E. Switcher:
 1. Install switcher as shown in construction documents and according to OEM.
 2. Connect subassemblies as specified by manufacturer and as shown on drawings.

3. Connect video signal inputs and outputs as shown on drawings and specified; terminate video inputs as required.
 4. Connect alarm signal inputs and outputs as shown on drawings and specified; connect control signal inputs and outputs for ancillary equipment or secondary control/monitoring sites as specified by manufacturer and as shown on drawings.
 5. Connect switcher CPU and switcher subassemblies to AC power.
 6. Load all software as specified and required for operational CCTV System configured for site and building requirements, including data bases, operational parameters, and system, command, and application programs.
 7. Provide original and two copies of accepted software on successful completion of endurance test.
 8. Program video annotation for each camera.
- F. Video Recording Equipment:
1. Install video recording equipment as shown in construction documents, and as specified by OEM.
 2. Connect video signal inputs and outputs as shown on drawings and specified.
 3. Connect alarm signal inputs and outputs as shown on drawings and specified.
 4. Connect video recording equipment to AC power.
- G. Video Signal Equipment:
1. Install video signal equipment as shown in construction documents, and as specified by OEM.
 2. Connect video or signal inputs and outputs as shown on drawings and specified.
 3. Terminate video inputs as required.
 4. Connect alarm signal inputs and outputs as required.
 5. Connect control signal inputs and outputs as required.
 6. Connect electrically powered equipment to AC power.
- H. Camera Housings, Mounts, and Poles:
1. Install camera housings and mounts as specified by manufacturer and as shown on drawings. Provide mounting hardware sized appropriately to secure each camera, housing and mount for maximum wind and ice loading encountered at site.
 2. Provide foundation for each camera pole as specified and shown on drawings.
 3. Provide ground rod for each camera pole and connect camera pole to ground rod as specified in Division 26 Sections and VA Electrical Manual 730.
 4. Provide electrical and signal transmission cabling to mount location via hardened carrier system from Access Control System and Database Management to device.
 5. Connect signal lines and AC power to housing interfaces.
 6. Connect pole wiring harness to camera.

3.3 TRAINING

- A. The Contractor will provide training. The training method shall agree with the precepts of an accepted training methodology such as the Systems Approach to Training that is used by the DoD. No Ad Hoc training will be considered acceptable. Student(s) will be provided printed training materials as well as a CD/DVD copy of the classes. The training must provide the student(s) the ability to: set up the system, maintain the system, trouble shoot problems, recognize system/component failures as well as any nuanced customization of the system for the specific location.
- B. Training on each installed system [IE components] will minimally include:
 - 1. CCTV
 - a. Management of Recording Devices
 - b. Trouble shooting cameras (Basic understanding)
 - c. Search/Obtain Video Recordings
 - 1) How to isolate and capture videography for exportation to both a portable device/disk/server file
 - d. Video Analytics
 - 2. Visitor Management
 - a. Management of Visitor Management tools
 - 3. Overall system(s) maintenance.
 - a. Those steps necessary for the basic understanding of: lifecycle maintenance of system to include factors such as: yearly support agreements, impact of power surges/loss as well as those endemic pieces of knowledge that include preventive maintenance considerations and or tasks.
- C. The Contractor will provide instruction giving the students sufficient training to be able to effectively operate the system and recognize problems as they arise. All training must include guided practical application exercises to ensure student(s) understanding. Certification of the training/curriculum/rosters will be provided to the RE/COR upon training task completion.

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**SECTION 28 31 00
INTRUSION DETECTION**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. New state-of-the-art fully functioning Intrusion Detection System (IDS) installed in VA's National Cemetery (NCA) Great Lakes to protect buildings and building areas.
 - 2. IDS sensors report to host facility intrusion detection system.
- B. See Section 27 05 00, COMMON WORK RESULTS FOR COMMUNICATIONS for requirements governing work of this section.

1.2 RELATED REQUIREMENTS

- A. General electrical requirements: Section 27 05 00, COMMON WORK RESULTS FOR COMMUNICATIONS.
- B. Access Control Integration: Section 28 10 00, ACCESS CONTROL.
- C. Security Cameras: Section 28 20 00, VIDEO SURVEILLANCE.
- D. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- E. Section 28 08 00 COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEM.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American National Standards Institute/Security Industry Association (ANSI/SIA):
 - 1. PIR-01-00 - Passive Infrared Motion Detector Standard - Features for Enhancing False Alarm Immunity.
 - 2. CP-01-14 - Control Panel Standard - Features for False Alarm Reduction.
- C. National Electrical Manufacturers Association (NEMA):
 - 1. 250-14 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. UL LLC (UL):
 - 1. Listed - Online Certifications Directory.
 - 2. 464-16 - Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories.
 - 3. 639-07 - Intrusion-Detection Units.

1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

1.5 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Intrusion detection system and system components complying with specified performance:
 - 1. Systems Success Probability: Minimum 95 percent.
 - a. False Alarm: Maximum one false alarm per 30 days, per sensor zone, averaged by total number of zones.
 - b. Nuisance Alarm:
 - 1) Initial Installation: Maximum one alarm per seven days, per zone during first 60 days after installation and acceptance.
 - 2) Adjusted Installation: Maximum one alarm per 30 days after sensor adjustment.
 - 2. Detect line fault and power loss for supervised cabling.
 - a. Line Fault Detection: Communication links active mode line fault detection. Provide graphic resolutions for systems level Fault isolation as for intrusion detection.
 - 1) Alarm: Distinguishable from other alarms.
 - b. Power Loss Detection: Detect temporary and permanent power loss and annunciate affected components.
 - 3. Sensor Standard Compliance: UL 639.
 - 4. Audible Annunciation: UL 464.
 - 5. Duty Rating: Continuous service.

2.2 CONTROL PANELS

- A. Control Panel: ANSI CP-01; providing programming, monitoring, accessing, securing, and troubleshooting capabilities.
 - 1. Report alarms to Section 28 10 00, ACCESS CONTROL PACS via computer interface or direct connection to alarm control panel.
 - 2. Provide multifunctional keypad and input and output modules for alarm zone expansion, interfacing with additional security subsystems, programming, monitoring, and controlling IDS.
 - 3. Programming Outputs:
 - a. 2 Ampere alarm power at 12 Volts DC.
 - b. 1.4 Ampere auxiliary power at 12 Volts DC.
 - c. Four alarm output patterns.
 - d. Programmable bell test.
 - e. Programmable bell shut-off timer.
 - 4. System Response:
 - a. Selectable point response time.
 - b. Cross point capability.
 - c. Alarm verification.

- d. Watch mode.
 - e. Scheduled events arm, disarm, bypass and un-bypass points, control relays, and control authority levels.
5. User Interface:
- a. Supervises up to eight command points (e.g. Up to 16 unsupervised keypads can be used).
 - b. Provides custom keypad text.
 - c. Addresses full function command menu including custom functions.
 - d. Allows user authority by defined area and 16-character name.
 - e. Provides 14 custom authority control levels allowing user's authority to change, add, delete pass codes, disarm, bypass points, and start system tests.

B. Control Panel Technical Characteristics:

Input Voltage via 110 Volts AC or 220 Volts AC Step-down Transformer	16 or 18 Volts AC
Operating Voltage	12 Volts DC
Output Voltage	12 Volts DC 2 Ampere maximum
Direct Hardwire Zones	7
Partitions	8
Multifunctional Keypads	16 (2 per partition)
Communications Port	RJ-11

- C. Keypad: Multifunctional user interface for arming, disarming, monitoring, troubleshooting, and programming alarm control panel.
- 1. Multiple function keypads suitable for remote mounting, maximum 4000 ft., distant from control panel.
 - 2. Indicators: Light emitting diodes (LED) for individually distinguishable intrusion alarm and system trouble conditions by zone.
 - 3. Display: Alphanumeric English language display, with keypad programmability, and EE-PROM memory.
 - 4. Entry and Exit Zones: Minimum four; selectable with programmable time delay.
 - 5. Keypad activated complete system test.
 - 6. Capability for opening and closing reports to remote monitoring location.
 - 7. Adjustable entry and exit delay times.
 - 8. Capability for minimum two multiple function keypads.

9. Capability to shunt or bypass selected interior zones while arming perimeter protection and remaining interior zones.
10. Capability for minimum seven assignable pass-codes keypad programmable from suppressed master code.
11. Keypad Technical Characteristics:

Connections	4-wire flying lead for data and power
Operating Temperature	32 to 122 degrees F
Display Window	8-point LED
Indicators: Illuminated keys	Armed Status-LED
	Point Status-LED
	Command Mode-LED
	Power-LED
Voltage	Nominal 12 Volts DC

- D. Input Module: Connect detection devices to control panel. Minimum technical characteristics:

Operating Voltage	8.5 to 14.5 Volts DC Nominal
Zone Inputs	Style A (Class B) Supervised
Operating Temperature	32 to 140 degrees F

- E. Output Module: Interface control panel with other security subsystems. Minimum technical characteristics:

Operating Voltage	8.5 to 14.5 Volts DC Nominal
Output Relays	"Form C" Dry Relay Contracts
Relay Contact Rating	4A @ 24 Volts DC
	4A @ 24 Volts AC
	1A @ 70 Volts AC
Operating Temperature	32 to 140 degrees

- F. Communications Port: Minimum RJ-11 for connection to remote computer for programming, monitoring, and troubleshooting. RJ-45 is acceptable option for IDS control panels.

2.3 INTERIOR DETECTION DEVICES (SENSORS)

- A. Interior Sensors Environmental Range: Remain operational throughout specified ranges.

Temperatures - Conditioned Spaces	32 to 120 degrees F
Temperatures - Unconditioned Spaces	0 to 120 degrees F

Temperatures - Conditioned Spaces	32 to 120 degrees F
Pressure	Sea Level to 15,000 feet above sea level
Relative Humidity	5 to 95 percent
Fungus	Components of non-fungus nutrient materials
Acoustical Noise Suitability	Minimum 100 decibels

B. Balanced Magnetic Switches (BMS): Contain minimum 2 encapsulated reed switches.

1. Mounting:
 - a. Recessed wherever possible.
 - b. Surface mounted only where recessed is not possible.
2. Alarms:
 - a. Signal alarm when magnet and switch are separated maximum 1 inch.
 - b. Signal tamper alarm when field between magnet and switch is disturbed without magnet and switch separation.
3. Provide current protective device, rated to limit current to 80 percent of switch capacity.
4. Surface Mounted Exterior BMS Enclosure: Weatherproof.
5. BMS Field Adjustments: None for fixed space between magnet and switch housing.
6. BMS Technical Characteristics:

Maximum current	0.25 Amperes
Maximum Voltage	30 Volts DC
Maximum power	3.0 W (without internal terminating resistors). 1.0 W (with internal terminating resistors).
Components	Two pre-adjusted reed switches or Three triple biased high security balance magnet switches
Output contacts	Transfer type SPDT
Contact rating	0.5 Amperes, 28 Volts DC
Switch mechanism	Internally adjustable 1/4 to 1/2 inch
Wiring	Two wires #22 American Wire Gauge (AWG), 900 or 11 feet attached cable
Activation lifetime	1,000,000 activations
Enclosure	Nonferrous materials
Tamper alarm activation	Cover opened 1/8 inch and inaccessible until actuated

- C. Passive Infrared Motion Sensors (PIR): ANSI PIR-01; Detect intruder by monitoring infrared energy within protected zone. Signal alarm when motion and temperature changes are detected.
1. Provide multiple detection zones distributed at various angles and distances.
 2. Provide passive sensors; requiring no transmitted energy for detection.
 3. Detect infrared energy emitted at wavelengths corresponding to human body and other objects at ambient temperatures.
 4. Do not signal alarm in response to general area thermal variations and radio frequency interference.
 5. Do not signal alarm for temperature changes due to HVAC systems cycling on or off.
 6. House sensors in tamper-alarmed enclosure.
 7. Provide motion analyzer processing, adjustable lens, and walk test LEDs visible from any angle.
 8. Provide means of signaling alarm condition during installation and calibration. Provide means of disabling indication within sensor enclosure.
 9. Provide motion monitoring verification circuit to signal trouble or alarm when motion is not detected for extended period.
 10. PIR Technical Characteristics:

Power	6 to 12 Volt DC 25 mA continuous current draw 38 mA peaks
Alarm Velocity	5 feet at a velocity of 0.1 ft./s, and one step per second, assuming 6 inches per step. Also, faster than 0.1 feet/s, up to 10 feet/s
Maximum detection range	Minimum 35 feet
Frequency range- non-activation or setup use	26 to 950 MHz using 50-Watt transmitter located 1 foot from unit or attached wiring
Infrared detection	3 degrees F different from background temperature
Detection Pattern	180 degrees for volumetric units, non PIR 360
PIR 360°Detection Pattern	Programmable 60 detection zones including one directly below
Mounting	Ceiling and walls
Ceiling heights	8 to 18 feet
Sensitivity adjustments	Three levels

- D. Microwave-Passive Infrared Detector: Detect human body motion within protected area by combination of microwave sensing technology and passive infrared (MPIR) sensing technology.

1. Require both technologies to sense intrusion before signaling alarm.
2. Mounting: Wall type with high-security gimbaled bracket.
3. Focus PIR fields of view on pyroelectric element by internal multi-faceted mirror.
4. Incorporate look-down lens system to detect intruder directly beneath sensor.
5. Incorporate a microwave supervision system to signal trouble when device technology fails.
6. Incorporate self-diagnostics to monitor sensor systems and report trouble when system device fails.
7. Compensate against loss of sensitivity as ambient temperature nears human body temperature.
8. MPIR Technical Characteristics:

Technology	Microwave and Passive Infrared
Power	9 to 15 Volt DC maximum current consumption 22 mA at 12 Volt DC
Operating Temperature	32 to 120 degrees F
Detection Area	98 feet long by 9.8 feet wide or 69 feet long by 69 feet wide
Electronics	Microcontroller based
Alarm Contact	Form-C rated 125 mA, 28 Volt DC
Tamper Contact	125 mA, 28 Volt DC
Trouble Contact	Form-B rated 25 mA, 30 Volt DC
Microwave Operating Frequency	10.525 GHz
Microwave Sensitivity	Adjustable on circuit board
Detection pattern adjustment	Changing of internal lens
Sensing element	Pyro-electric
LED Indicators	PIR, microwave, alarm
Bug and Dust protection	zero-clearance, gasket bug guard
Lens	Interchangeable: standard 60 by 80 feet, corner mounting, ultra-wide, pet alley, long range, room and corridor combo, room and ceiling combo, creep zone

- E. Ultrasonic Sensors: Detect intruder by transmitting ultrasonic energy into protected zone, receiving direct and reflected energy, and monitoring frequency shift between transmitted and received signals.
1. Provide sensors consisting of control unit and one or more transceivers required for zone detection within control unit limitations.

2. Automatically adapt to changing air turbulence.
3. Ultrasonic system sensors to provide means of signaling alarm condition during installation and calibration. Provide means of disabling indication within sensor enclosure.
4. Provide transceivers consisting of adjustable-gain preamplifier, ultrasonic-to-electrical transducer, and electrical-to-ultrasonic transducer in single enclosure.
 - a. Transducers: Adjustable in position to allow adequate adjustment and directivity.
5. Provide sensitivity adjustments inaccessible to operating personnel, factory set to approximately midrange.
6. House sensor elements in tamper-alarmed enclosure.
7. Ultrasonic Sensor Technical Characteristics:

Power output	Peak not to exceed 105 dB at 3 feet
Transceiver protection zone	20 by 30 feet in zone with 8 to 12 feet ceiling
Nuisance alarm reduction	Selective filtering
Detection frequency range	Above 24 kHz and below 30 kHz (nominally 26 kHz)
Detection velocity	5 feet at a velocity of 0.1 feet/s and one step per second, assuming 6 inches per step. Also, faster than 0.1 feet/s, up to 10 feet/s

- F. Photoelectric Sensors: Detect intruder by disruption of emitted series of infrared or ultraviolet beams.
1. Provide sensors consisting of modulating transmitter, focusing lenses, mirrors, demodulating receiver, power supply, and interconnecting lines.
 2. Design beam transmitters to emit light beams, reflected by one or more mirrors before being received and amplified.
 3. Signal alarm when light beam is interrupted with monitoring controls set at midrange.
 4. Uniquely modulate light beams to prohibit defeat by shining another light source into receiver.
 5. Provide local alarm indication on detector for use at protected zone during installation and calibration.
 - a. Provide indicator-disabling device within sensor enclosure.
 6. Use automatic gain control or provide sensitivity adjustments to allow for various light beam lengths.
 7. Make sensor controls inaccessible to operating personnel.
 8. Test sensors using multiple light beams by attempting to crawl under and jump through and over light beams. Provide cutoffs of minimum 90 percent to handle high percentage of light cutoffs before signaling alarm.

9. House sensor components tamper-alarmed enclosure.

10. Photoelectric Sensor Technical Characteristics:

Power requirements	9 to 16 Volt DC, protected against reverse polarity
Relay output	Normally closed. 18-ohm resistor in series with contacts. 0.5 Amperes resistance/24 Volt DC
Current	Transmitter 15 mA, Receiver 15 mA
LED	Alignment, walk-test alarm, off
Range	Indoor: 130 feet Outdoor: 65 feet
Alarm relay contacts	2 Amperes at 120 Volt AC minimum
Enclosure	High impact acrylic
Type	Dual beam
Mounting	Wall, corner, flush
Beam width	5 to 8 degrees
Receiver field of view	5 to 8 degrees horizontal and vertical
Adjustments	Vertical +10 - 20 degrees Horizontal 30 degrees
Alarm period	2 to 3 seconds
Infrared source	Long-life Gallium Arsenide LED
Infrared sensor	PIN photodiode
Transmitter Frequency	1 kHz 10 microsecond pulse width
IR Wavelength	950 nm

G. CCTV Video Motion Detection Sensors: See Section 28 20 00, VIDEO SURVEILLANCE.

H. Tamper Alarm Switches: Corrosion-resistant switches to monitor and detect potential sensor, control panel, and enclosure tampering.

1. Provide at enclosures including cabinets, housings, boxes, raceways, and fittings with hinged doors or removable covers containing circuits and power supplies.
2. Annunciate tamper alarms clearly distinguishable from IDS alarms.
3. Mount tamper switches out of direct line of sight.
 - a. Alarm Signal Time: Minimum 1 second after enclosure is opened or panel removal is attempted.
4. Signal alarm when enclosure doors and covers are removed maximum 1/4 inch from closed position unless otherwise indicated.
5. Tamper Switches:
 - a. Push/pull automatic reset type.
 - b. Inaccessible until switch is activated.

- c. Spring-loaded and held in closed position by door or cover.
 - d. Wired to break circuit when door or cover is removed with each sensor annunciated individually at central reporting processor.
- 6. Fail-Safe Mode: Provide capability to detect and annunciate diminished functional capabilities and perform self-tests. Annunciate fail-safe alarms clearly distinguishable from other alarms.

2.4 ENCLOSURES

- A. Mount control panels, input and output modules, and power supplies within metal enclosures.
- B. Enclosures: NEMA 250; UL Listed, lockable with tamper alarm switch monitored by control panel.
 - 1. Indoor Locations: Type 1.
 - 2. Outdoor Locations: Type 4X.

2.5 ACCESSORIES

- A. Adhesives: Low pollutant-emitting, water based type recommended by adhered product manufacturer for each application.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine and verify substrate suitability for product installation.
- B. Protect existing construction and completed work from damage.
- C. Clean substrates. Remove contaminants capable of affecting subsequently installed product's performance.

3.2 INSTALLATION - GENERAL

- A. Provide necessary connectors, terminators, interconnections, services, and adjustments required for complete and operable system.
- B. Protect underground and overhead wiring circuits at both ends against lightening and power surges to central alarm reporting and display unit.
 - 1. Provide primary detection devices, such as three electrode gas-type surge arresters, and secondary protectors to reduce dangerous voltages to cause no damage. Fuses are not acceptable as protection devices.
 - 2. Provide fail-safe gas tube type surge arresters on exposed IDS data circuits.
 - 3. Protect against transient spikes up to 1000 Volts peak voltage with one-microsecond rise time and 100-microsecond decay time, without causing false alarms with automatic and self-restoring device.
 - 4. Provide circuits designed and installed for maximum 25 Ohms resistance to ground.
- C. Cleaning and Adjustments:
 - 1. After installation, clean each system component of dust, dirt, grease, or oil incurred during installation in accordance to manufacturer's instructions.

2. Prepare for system activation according to manufacturer's instructions for adjustment, alignment, or synchronization. Prepare each component according to component's installation, operations, and maintenance instructions.

3.3 BMS SURFACE MOUNTED

- A. Provide surface mounted BMS housing with capability to receive threaded conduit.
- B. Secure housing covers to be not easily removed.
 1. Secure cast aluminum housing covers with stainless steel screws.
 2. Protect BMS housings from unauthorized access by cover operated, corrosion-resistant tamper device.
- C. Install conductors from BMS to alarm circuits in flexible armored cord constructed from corrosion-resistant metal.
 1. Terminate both ends of armored cord in junction box or other enclosure.
 2. Mechanically secure armored cord ends to junction boxes by clamps or bushings.
 3. Provide lug terminals for conductors at both ends of armored cord.
 4. Install conductors and armored cord without inducing mechanical strain as door is moved from fully open to closed position.
 5. Signal alarm when short circuit is applied to armored cord.
- D. For exterior application on double gates, mount both BMS elements on gate. Provide electrical connection with flexible armored cord constructed from corrosion-resistant metal.

3.4 BMS RECESSED MOUNTED

- A. Mount ball bearing door trips within vault door headers so when locking mechanism is secured, door bolt engages actuator, mechanically closing switch.
- B. Ensure door bolt locking mechanisms are fully engaged before ball bearing door trip is activated.
- C. Provide circuit jumpers from door.

3.5 VIBRATION SENSORS

- A. Mount vibration sensors directly contacting monitored surface.
- B. Provide minimum one sensor on each contiguous slab and wall section, even though spacing closer than required for midrange sensitivity may result.
- C. House sensors in protective mountings and fasten to surface with concealed mounting screws or adhesive.
- D. Adjust discriminator to suit application. Connect sensors to electronic control unit with wiring or fiber optics cable installed in rigid steel conduit or electrical metallic tubing (EMT).

3.6 ULTRASONIC SENSORS

- A. Install transceivers with zones slightly overlapping.
- B. Ensure adequate sensitivity in areas abundant in sound-absorbing materials such as carpets and drapes.

- C. When protected zone is broken up by furniture or large objects, arrange sensors so it is not possible to traverse zone undetected.

3.7 PASSIVE INFRARED DETECTORS (PIR)

- A. Focus protective beam in a straight line.
- B. Install transmitters and receivers so light beam distance is maximum 80 percent of manufacturer's maximum recommended rating.
- C. Use mirrors to extend light beam or to establish light beam network, provided mirrors do not reduce rated maximum system range by more than 50 percent.
- D. Outdoor Mirrors and Photoelectric Sources: Self-heated to eliminate condensation and housed in weatherproof enclosures.

3.8 TAUT-WIRE

- A. Cover housing for switch assembly with neoprene cap to retain center bolt (lever arm), functions as a lever to translate movement of attached horizontal wire into contact closure. When neoprene cap is firmly seated on cup-shaped polycarbonate housing, cap functions as fulcrum for lever (bolt).
- B. Thread upper exposed end of lever to accommodate clamping to horizontal wire. Fashion lower end of lever to serve as movable electrical contact, held suspended in small cup-shaped contact floating in plastic putty material.
- C. Plastic putty must retain elasticity under varying temperature conditions and provide sensor switch with self-adjusting property to ignore small, very slow changes in lever alignment and to react to fast changes only, as caused by manual deflection or cutting of wires.
- D. Provide metal slider strips having slots through which barbed wires pass. Install rivet to prevent wires from leaving slots. Use slider strip to translate normal forces to barbed wire and to sensor horizontal displacement.
- E. Install one slider strip pair, upper and lower, on every fence post except where sensor posts or anchor strips are installed.
- F. Separation between slider elements along fence to be 10 feet.
- G. Attach sensor wires to existing, specially installed fence posts, called anchor posts, located equidistant on both sides of sensor posts and at ends of sensor zone run.
- H. Provide steel plate anchor strip on which fastening plates are installed. Weld or mechanically attach anchor strip to anchor post and ends of tensed barbed wires wrapped around fastening plates.
 - 1. Install plates to break off upon attempts to climb on fastening plates and on attached barbed wires; creating alarm and making it impossible to defeat system by climbing at anchor post.

3.9 STRAIN SENSITIVE CABLE SENSORS

- A. Divide fence length into 300 ft. zones.

- B. Install sensors every 10 ft. on fence fabric or posts. Wire in series to sensor zone control unit and associated power supply.

3.10 BURIED ELECTROMAGNETIC CABLE SENSORS

- A. Install sensors capable of following irregular contours and barrier bends without degrading sensitivity below specified detection level.
- B. Sensor Distance: Maximum 300 ft. and without significantly degrade sensitivity.
- C. Provide continuous coverage across adjacent zones without crosstalk interference.
- D. House exterior components in rugged corrosion-resistant enclosures, protected from environmental degradation. Include tamper switches.
- E. Connect exterior units with underground cables.
- F. Exterior Support Hardware: Stainless steel or galvanized steel to avoid tension degradation.
- G. Sensor and Field Wires: Stainless steel. Maintain constant wire spacing for various configurations constant throughout each zone and uniformity with respect to ground.
- H. Mount signal processing equipment separately so no desensitized zones are created within detection zone.

3.11 ACOUSTIC SENSORS

- A. Install acoustic sensors on wall or ceiling within manufacturer's required distance.

3.12 MICROWAVE SENSORS

- A. Do not install microwave sensors where radiated ionization from fluorescent lights may interfere with detection.

3.13 TAMPER SWITCHES

- A. Install tamper switches to initiate alarm signal when panel, box, or component housing door or cover is moved or opened.
- B. Locate tamper switches within enclosures, cabinets, housings, boxes, raceways, and fittings to prevent direct line of sight to internal components and to prevent tampering with switch or circuitry.
- C. Conceal tamper switch mounting hardware so switch location within enclosure cannot be determined from exterior.

3.14 TRAINING

- A. The Contractor will provide training. The training method shall agree with the precepts of an accepted training methodology such as the Systems Approach to Training that is used by the DoD. No Ad Hoc training will be considered acceptable. Student(s) will be provided printed training materials as well as a CD/DVD copy of the classes. The training must provide the student(s) the ability to: set up the system, maintain the system, trouble shoot problems, recognize system/component failures as well as any nuanced customization of the system for the specific location.
- B. Training on each installed system [IE components] will minimally include:

1. Duress Systems
 - a. Schema of Duress Location
 - b. Management of Alarms
 - 1) Basic trouble shooting and re-set of software or associated components.
 2. Visitor Management
 - a. Management of Visitor Management tools
 3. Overall system(s) maintenance.
 - a. Those steps necessary for the basic understanding of: lifecycle maintenance of system to include factors such as: yearly support agreements, impact of power surges/loss as well as those endemic pieces of knowledge that include preventive maintenance considerations and or tasks.
- C. The Contractor will provide instruction giving the students sufficient training to be able to effectively operate the system and recognize problems as they arise. All training must include guided practical application exercises to ensure student(s) understanding. Certification of the training/curriculum/rosters will be provided to the Resident Engineer/Contract Officer's Representative upon training task completion.

--- E N D ---

**SECTION 28 46 00
FIRE DETECTION AND ALARM**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section of the specifications includes the furnishing, installation, and connection of the fire alarm equipment to form a complete coordinated system ready for operation. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control units, fire safety control devices, annunciators, power supplies, and wiring as shown on the drawings and specified.
- B. Fire alarm systems shall comply with requirements of NFPA 72 unless variations to NFPA 72 are specifically identified within these contract documents by the following notation: "variation". The design, system layout, document submittal preparation, and supervision of installation and testing shall be provided by a technician that is certified NICET level III or a registered fire protection engineer. The NICET certified technician shall be on site for the supervision and testing of the system. Factory engineers from the equipment manufacturer, thoroughly familiar and knowledgeable with all equipment utilized, shall provide additional technical support at the site as required by the Resident Engineer/Contracting Officer's Representative (RE/COR) or his authorized representative. Installers shall have a minimum of two years' experience installing fire alarm systems.
- C. Fire alarm signals:
 - 1. The existing PIC Admin general evacuation fire alarm signal in accordance with ASA S3.41 to notify all occupants in the respective building to evacuate shall be tested when restroom renovation is completed.
- D. Alarm signals (by device), supervisory signals (by device) and system trouble signals (by device not reporting) shall be distinctly transmitted to the main fire alarm system control unit.
- E. The main fire alarm control unit shall automatically transmit alarm signals to a listed central station using a digital alarm communicator transmitter in accordance with NFPA 72.

1.2 SCOPE

- A. All existing fire alarm equipment, wiring, devices and sub-systems for the PIC Administration building restrooms that are not shown to be reused shall be removed. All existing fire alarm conduit not reused shall be removed. Smoke detectors and wiring shall be installed in the renovated restrooms and connected to the existing FACP and area NAC circuit.
- B. Existing fire alarm bells, chimes, door holders, 120VAC duct smoke detectors, may be reused only as specifically indicated on the drawings and provided the equipment:
 - 1. Meets this specification section
 - 2. Is UL listed or FM approved
 - 3. Is compatible with new equipment being installed

4. Is verified as operable through Contractor testing and inspection
5. Is warranted as new by the Contractor.
- C. Existing reused equipment shall be covered as new equipment under the Warranty specified herein.
- D. Basic Performance:
 1. Signaling line circuits (SLC) within buildings shall be wired Style 4 in accordance with NFPA 72. Individual signaling line circuits shall be limited to covering 22,500 square feet of floor space or 3 floors whichever is less.
 2. Notification appliance circuits (NAC) shall be wired Style Y in accordance with NFPA 72.

1.3 RELATED WORK

- A. Section 01 00 01, GENERAL REQUIREMENTS: Restoration of existing surfaces.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Procedures for submittals.
- C. Section 07 84 00, FIRESTOPPING: Fire proofing wall penetrations.
- D. Section 08 71 00, DOOR HARDWARE: Combination Closer-Holders.
- E. Section 09 91 00, PAINTING: Painting for equipment and existing surfaces.
- F. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical requirements for items which are common to other Division 26 sections.
- G. Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS: Conduits and boxes for cables/wiring.
- G. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- H. Section 28 08 00 COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEM.

1.4 SUBMITTALS

- A. General: Submit 4 copies and 1 reproducible in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.
- B. Update of Existing Drawings:
 1. Prepare drawings using AutoCAD software and include all Contractor's information. Layering shall be by VA criteria as provided by the RE/COR. Bid drawing files on AutoCAD will be provided to the Contractor at the pre-construction meeting. The Contractor shall be responsible for verifying all critical dimensions shown on the drawings provided by VA.
 2. Floor plans: Provide locations of all devices (with device number at each addressable device corresponding to control unit programming), appliances, panels, equipment, junction/terminal cabinets/boxes, risers, electrical power connections, individual circuits and raceway routing, system zoning; number, size, and type of raceways and conductors in each raceway; conduit fill calculations with cross section area percent fill for each type and size of conductor and raceway. Only those devices connected and incorporated into the final system shall be on

- these floor plans. Do not show any removed devices on the floor plans. Show all interfaces for all fire safety functions.
3. Riser diagrams: Provide, for the entire system, the number, size and type of riser raceways and conductors in each riser raceway and number of each type device per floor and zone. Show door holder interface, HVAC shutdown interface, and all other fire safety interfaces. Show wiring Schedules on the riser diagram for all circuits. Provide diagrams both on a per building and campus wide basis.
 4. Detailed wiring diagrams: Provide for control panels, modules, power supplies, electrical power connections, auxiliary relays and annunciators showing termination identifications, size and type conductors, circuit boards, LED lamps, indicators, adjustable controls, switches, ribbon connectors, wiring harnesses, terminal strips and connectors, spare zones/circuits. Diagrams shall be drawn to a scale sufficient to show spatial relationships between components, enclosures and equipment configuration.
 5. Two weeks prior to final inspection, the Contractor shall deliver to the RE/COR one set of reproducible, as-built drawings, two blue-line copies and one set of the as-built drawing computer files using AutoCAD Release 14 or later. As-built drawings (floor plans) shall show all new and existing conduit used for the fire alarm system.
- C. Manuals:
1. Submit simultaneously with the shop drawings, companion copies of complete maintenance and operating manuals including technical data sheets for all items used in the system, power requirements, device wiring diagrams, dimensions, and information for ordering replacement parts.
 - a. Wiring diagrams shall have their terminals identified to facilitate installation, operation, expansion and maintenance.
 - b. Wiring diagrams shall indicate internal wiring for each item of equipment and the interconnections between the items of equipment.
 - c. Include complete listing of all software used and installation and operation instructions including the input/output matrix chart.
 - d. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate, inspect, test and maintain the equipment and system. Provide all manufacturers' installation limitations including but not limited to circuit length limitations.
 - e. Complete listing of all digitized voice messages.
 - f. Provide standby battery calculations under normal operating and alarm modes. Battery calculations shall include the magnets for holding the doors open for one minute.
 - g. Include information indicating who will provide emergency service and perform post contract maintenance.

- h. Provide a replacement parts list with current prices. Include a list of recommended spare parts, tools, and instruments for testing and maintenance purposes.
 - i. A computerized preventive maintenance schedule for all equipment. The schedule shall be provided on disk in a computer format acceptable to the VA facility and shall describe the protocol for preventive maintenance of all equipment. The schedule shall include the required times for systematic examination, adjustment and cleaning of all equipment. A print out of the schedule shall also be provided in the manual. Provide the disk in a pocket within the manual.
 - j. Furnish manuals in 3 ring loose-leaf binder or manufacturer's standard binder.
 - k. A print out for all devices proposed on each signaling line circuit with spare capacity indicated.
- 2. Two weeks prior to final inspection, deliver four copies of the final updated maintenance and operating manual to the RE/COR.
 - a. The manual shall be updated to include any information necessitated by the maintenance and operating manual approval.
 - b. Complete "As installed" wiring and schematic diagrams shall be included that shows all items of equipment and their interconnecting wiring. Show all final terminal identifications.
 - c. Complete listing of all programming information, including all control events per device including an updated input/output matrix.
 - d. Certificate of Installation as required by NFPA 72 for each building. The certificate shall identify any variations from the National Fire Alarm Code.
 - e. Certificate from equipment manufacturer assuring compliance with all manufacturers installation requirements and satisfactory system operation.
- D. Certifications:
 - 1. Together with the shop drawing submittal, submit the technician's NICET level III fire alarm certification as well as certification from the control unit manufacturer that the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include in the certification the names and addresses of the proposed supervisor of installation and the proposed performer of contract maintenance. Also include the name and title of the manufacturer's representative who makes the certification.
 - 2. Together with the shop drawing submittal, submit a certification from either the control unit manufacturer or the manufacturer of each component (e.g., smoke detector) that the components being furnished are compatible with the control unit.
 - 3. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer that the wiring and connection diagrams meet this specification, UL and NFPA 72 requirements.

1.5 WARRANTY

- A. Warrant all work performed and all material and equipment furnished under this contract subject to the terms of "Warranty of Construction", FAR clause 52.246-21 except that warranty period is five years

1.6 APPLICABLE PUBLICATIONS

- A. The publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. The publications are referenced in text by the basic designation only.
- B. National Fire Protection Association (NFPA):
 - 70-2011 National Electrical Code (NEC).
 - 72-2010 National Fire Alarm and Signaling Code.
 - 90A-2009 Installation of Air Conditioning and Ventilating Systems.
 - 101-2012 Life Safety Code
- C. Underwriters Laboratories, Inc. (UL):
 - 2000-2011 Fire Protection Equipment Directory
- D. Factory Mutual Research Corp (FM): Approval Guide, 2009 Edition
- E. American National Standards Institute (ANSI):
 - S3.41-2008 Audible Emergency Evacuation Signal
- F. International Code Council, International Building Code (IBC) 2012 Edition

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS, GENERAL

- A. All equipment and components shall be new and the manufacturer's current model. All equipment shall be tested and listed by Underwriters Laboratories, Inc. or Factory Mutual Research Corporation for use as part of a fire alarm system. The authorized representative of the manufacturer of the major equipment shall certify that the installation complies with all manufacturers' requirements and that satisfactory total system operation has been achieved.

2.2 CONDUIT, BOXES, AND WIRE

- A. Conduit shall be in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS and as follows:
 - 1. All new and reused conduit shall be installed in accordance with NFPA 70.
 - 2. Conduit fill shall not exceed 40 percent of interior cross-sectional area.
 - 3. All new conduit shall be 3/4 inch minimum.
- B. Wire:
 - 1. All existing wiring shall be removed, and new wiring installed in a conduit or raceway.
 - 2. Wiring shall be as recommended by the manufacturer of the fire alarm system. All wires shall be color coded. Number and size of conductors shall be as recommended by the fire alarm

- system manufacturer, but not less than 18 AWG for initiating device circuits and 14 AWG for notification device circuits.
3. Addressable circuits and wiring used for the multiplex communication loop shall be twisted and shielded unless specifically excepted by the fire alarm equipment manufacturer in writing.
- C. Terminal Boxes, Junction Boxes, and Cabinets:
1. Shall be galvanized steel in accordance with UL requirements.
 2. All new and reused boxes shall be sized and installed in accordance with NFPA 70.
 3. New and existing covers shall be repainted red in accordance with Section 09 91 00, PAINTING and shall be identified with white markings as "FA" for junction boxes and as "FIRE ALARM SYSTEM" for cabinets and terminal boxes. Lettering shall be a minimum of 3/4 inch high.
 4. Terminal boxes and cabinets shall have a volume 50 percent greater than required by the NFPA 70. Minimum sized wire shall be considered as 14 AWG for calculation purposes.
 5. Terminal boxes and cabinets shall have identified pressure type terminal strips and shall be located at the base of each riser. Terminal strips shall be labeled as specified or as approved by the RE/COR.

2.3 ALARM NOTIFICATION APPLIANCES

- A. Strobes:
1. Xenon flash tube type minimum 15 candela in toilet rooms and 75 candela in all other areas with a flash rate of 1 HZ. Strobes shall be synchronized where required by the National Fire Alarm Code (NFPA 72).
 2. Backplate shall be red with 1/2-inch permanent red letters. Lettering to read "Fire", be oriented on the wall or ceiling properly, and be visible from all viewing directions.
 3. Each strobe circuit shall have a minimum of twenty percent spare capacity.
 4. Strobes may be combined with the audible notification appliances specified herein.
- B. Fire Alarm Horns:
1. Shall be electric, utilizing solid state electronic technology operating on a nominal 24 VDC.
 2. Shall be a minimum nominal rating of 80 dBA at ten feet.
 3. Mount on removable adapter plates on conduit boxes.
 4. Horns located outdoors shall be of weatherproof type with metal housing and protective grille.
 5. Each horn circuit shall have a minimum of twenty percent spare capacity.

2.4 ALARM INITIATING DEVICES

- A. Smoke Detectors:
1. Smoke detectors shall be UL listed for use with the fire alarm control unit being furnished.
 2. Smoke detectors shall be addressable type complying with applicable UL Standards for system type detectors. Smoke detectors shall be installed in accordance with the manufacturer's recommendations and NFPA 72.

3. Detectors shall have an indication lamp to denote an alarm condition. Provide remote indicator lamps and identification plates where detectors are concealed from view. Locate the remote indicator lamps and identification plates flush mounted on walls so they can be observed from a normal standing position.
4. All spot type and duct type detectors installed shall be of the photoelectric type.
5. Photoelectric detectors shall be factory calibrated and readily field adjustable. The sensitivity of any photoelectric detector shall be factory set at 3.0 plus or minus 0.25 percent obscuration per foot.
6. Detectors shall provide a visual trouble indication if they drift out of sensitivity range or fail internal diagnostics. Detectors shall also provide visual indication of sensitivity level upon testing. Detectors, along with the fire alarm control units shall be UL listed for testing the sensitivity of the detectors.

B. Heat Detectors:

1. Heat detectors shall be of the addressable restorable rate compensated fixed-temperature spot type.
2. Detectors shall have a minimum smooth ceiling rating of 2500 square feet.
3. Provide a remote indicator lamp, key test station and identification nameplate (e.g. "Heat Detector - Elevator P- ") for each elevator group. Locate key test station in plain view on elevator machine room wall.

2.5 ADDRESS REPORTING INTERFACE DEVICE

- A. Shall have unique addresses that reports directly to the building fire alarm panel.
- B. Shall be configurable to monitor normally open or normally closed devices for both alarm and trouble conditions.
- C. Shall have terminal designations clearly differentiating between the circuit to which they are reporting from and the device that they are monitoring.
- D. Shall be UL listed for fire alarm use and compatibility with the panel to which they are connected.
- E. Shall be mounted in weatherproof housings if mounted exterior to a building.

2.6 SPARE AND REPLACEMENT PARTS

- A. Provide spare and replacement parts as follows:
 1. Manual pull stations - 0
 3. Heat detectors - 0 of each type
 4. Fire alarm strobes - 1
 5. Fire alarm bells - 0
 6. Fire alarm speakers - 0
 7. Smoke detectors - 1
 8. Duct smoke detectors with all appurtenances - 0
 9. Control equipment utility locksets - 0

10. Control equipment keys - 0
 11. 2.5 oz containers aerosol smoke - 0
 12. Printer paper - 0 boxes
 13. Printer replacement ribbons - 0
 14. Monitor modules - 0
 15. Control modules - 0
 16. Fire alarm SLC cable (same as installed) – 0 feet
- C. Spare and replacement parts shall be in original packaging and submitted to the RE/COR.
- D. Furnish and install a storage cabinet of sufficient size and suitable for storing spare equipment. Doors shall include a pad locking device. Padlock to be provided by the VA. Location of cabinet to be determined by the RE/COR.
- E. Provide to the VA, all hardware, software, programming tools, license and documentation necessary to permanently modify the fire alarm system on site. The minimum level of modification includes addition and deletion of devices, circuits, zones and changes to system description, system operation, and digitized evacuation and instructional messages.

2.7 INSTRUCTION CHART

Provide a typeset printed or typewritten instruction card mounted behind a Lexan plastic or glass cover in a stainless steel or aluminum frame with a backplate. Install the frame in a conspicuous location observable from each control unit where operations are performed. The card shall show those steps to be taken by an operator when a signal is received under all conditions, normal, alarm, supervisory, and trouble. Provide an additional copy with the binder for the input output matrix for the sequence of operation. The instructions shall be approved by the RE/COR before being posted.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation shall be in accordance with NFPA 70, 72, 90A, and 101 as shown on the drawings, and as recommended by the major equipment manufacturer. Fire alarm wiring shall be installed in conduit. All conduit and wire shall be installed in accordance with Section 26 05 33, RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS and all penetrations of smoke and fire barriers shall be protected. as required by Section 07 84 00, FIRESTOPPING.
- B. All new conduits, junction boxes, conduit supports, and hangers shall be concealed in finished areas and may be exposed in unfinished areas. All existing accessible fire alarm conduit not reused shall be removed.
- C. All new or reused exposed conduit shall be painted in accordance with Section 09 91 00, PAINTING to match surrounding finished areas and red in unfinished areas.

- D. Existing devices that are reused shall be properly mounted and installed. Where devices are installed on existing shallow backboxes, extension rings of the same material, color and texture of the new fire alarm devices shall be used. Mounting surfaces shall be cut and patched in accordance with Section 01 00 01, GENERAL REQUIREMENTS, Restoration, and be re-painted in accordance with Section 09 91 00, PAINTING as necessary to match existing.
- E. All fire detection and alarm system devices, control units and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas. Exact locations to be approved by the RE/COR.
- F. Strobes shall be flush wall mounted 80 inches above the floor or 6 inches below ceiling, whichever is lower. Locate and mount to maintain a minimum 36 inches clearance from side obstructions.

3.2 TYPICAL OPERATION

- A. Activation of any manual pull station, heat detector, or smoke detector shall cause the following operations to occur:
 - 1. Operate the emergency voice communication system in Buildings. For buildings without sprinkler protection throughout, flash strobes continuously only on the floor of alarm.
 - 2. Continuously sound a temporal pattern general alarm and flash all strobes in the building in alarm until reset at the local fire alarm control unit in Buildings.
 - 3. Release only the magnetic door holders after the alert signal.
 - 4. Transmit a separate alarm signal, via the main fire alarm control unit to the fire department.
 - 5. Unlock the electrically locked exit doors within the zone of alarm.

3.3 TESTS

- A. Provide the service of a NICET level III, competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. Make all adjustments and tests in the presence of the RE/COR.
- B. When the systems have been completed and prior to the scheduling of the final inspection, furnish testing equipment and perform the following tests in the presence of the RE/COR. When any defects are detected, make repairs or install replacement components, and repeat the tests until such time that the complete fire alarm systems meet all contract requirements. After the system has passed the initial test and been approved by the RE/COR, the Contractor may request a final inspection.
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Test the insulation on all installed cable and wiring by standard methods as recommended by the equipment manufacturer.
 - 3. Open each alarm initiating and notification circuit to see if trouble signal actuates.

4. Ground each alarm initiation and notification circuit and verify response of trouble signals.

3.4 FINAL INSPECTION AND ACCEPTANCE

- A. Prior to final acceptance a minimum 30 day "burn-in" period shall be provided. The purpose shall be to allow equipment to stabilize and potential installation and software problems and equipment malfunctions to be identified and corrected. During this diagnostic period, all system operations and malfunctions shall be recorded. Final acceptance will be made upon successful completion of the "burn-in" period and where the last 14 days is without a system or equipment malfunction.
- B. At the final inspection a factory trained representative of the manufacturer of the major equipment shall repeat the tests in Article 3.3 TESTS and those required by NFPA 72. In addition, the representative shall demonstrate that the systems function properly in every respect. The demonstration shall be made in the presence of a NCA representative.

3.5 INSTRUCTION

- A. The manufacturer's authorized representative shall provide instruction and training to the NCA as follows:
 1. Two one-hour sessions to cemetery staff and security personnel for simple operation of the system. One session at the completion of installation and one session 3 months after the completion of installation.
- B. The Contractor and/or the Systems Manufacturer's representative shall provide a typewritten "Sequence of Operation" including a trouble shooting guide of the entire system for submittal to the VA. The sequence of operation will be shown for each input in the system in a matrix format and provided in a loose-leaf binder. When reading the sequence of operation, the reader will be able to quickly and easily determine what output will occur upon activation of any input in the system. The INPUT/OUTPUT matrix format shall be as shown in Appendix A to NFPA 72.
- C. Furnish the services of a competent instructor for instructing personnel in the programming requirements necessary for system expansion. Such programming shall include addition or deletion of devices, zones, indicating circuits and printer/display text.

- - - END - - -

**SECTION 31 20 00
EARTH MOVING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Site Preparation.
 - 2. Excavation.
 - 3. Filling and Backfilling.
 - 4. Grading.
 - 5. Soil Disposal.
 - 6. Clean Up.

1.2 RELATED REQUIREMENTS

- A. Section 01 00 01, GENERAL REQUIREMENTS; Protection of existing utilities, fire protection services, existing equipment, roads, and pavements, differing site conditions, changes and changes-supplement, subsurface investigation.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Submittal requirements.
- C. Section 01 45 29, TESTING LABORATORY SERVICES; Materials testing and inspection during construction
- D. Section 02 41 00, DEMOLITION AND SITE CLEARING; Site preparation.
- E. Section 31 23 19, DEWATERING: Site preparation.
- F. Section 32 12 16; ASPHALT PAVING; Paving sub-grade.
- G. Section 32 90 00, PLANTING: Finish Grading.

1.3 ROCK EXCAVATION MEASUREMENT AND PAYMENT

- A. Measurement: Cross section and measure uncovered and separated materials, and compute quantities by Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 01, GENERAL REQUIREMENTS. Do not measure quantities beyond following limits:
 - 1. 24 inches from outside face concrete work when forms are required, except footings.
 - 2. 12 inches from outside perimeter formed footings.
 - 3. 6 inches below bottom pipe and maximum pipe diameter plus 24 inches in width trenches width.
 - 4. Outside concrete work dimension when no forms are required (trenches, conduits, and similar items not requiring forms).

1.4 DEFINITIONS

- A. Unsuitable Materials:

1. Fills: Topsoil; frozen materials; construction materials and materials subject to decomposition; clods of clay and stones larger than 3 inches; organic unstable material, including silts and clays; and inorganic materials, including silts and clays that are too wet to be stable and any material with liquid limit and plasticity index exceeding 40 and 15 respectively. Unsatisfactory soils also include satisfactory soils not maintained within 3 percent optimum moisture content without going over at time of compaction, as defined by ASTM D 1557.
2. Existing Subgrade (Except Footing Subgrade): Same materials as 1.4.A.1, not capable of direct support of slabs, pavement, and similar items with possible exception of improvement by compaction, proof-rolling, or similar methods.
3. Existing Subgrade (Footings Only): Same as paragraph 1. When materials differ from reference borings and design requirements, excavate to acceptable bearing strata subject to Resident Engineer/Contracting Officer's Representative's (RE/COR) approval.
- B. Building Earthwork: Earthwork operations required in area enclosed by line located 10 feet outside of principal building perimeter. Also includes earthwork required for auxiliary structures and buildings.
- C. Trench Earthwork: Trenchwork required for underground utility lines.
- D. Site Earthwork: Earthwork operations required in area outside of line located 5 feet of principal building perimeter and within new construction area with exceptions noted above.
- E. Degree of Compaction: Degree of compaction is expressed as a percentage of maximum density obtained by laboratory test procedure. Percentage of maximum density is obtained through use of data provided from results of field test procedures presented in ASTM D1557.
- F. Fill: Satisfactory soil materials used to raise existing grades. In the Construction Documents, the term "fill" means fill or backfill.
- G. Backfill: Soil materials or controlled low strength material used to fill an excavation.
- H. Unauthorized Excavation: Removal of materials beyond indicated sub-grade elevations or indicated lines and dimensions without written authorization by the RE/COR. No payment will be made for unauthorized excavation or remedial work required to correct unauthorized excavation.
- I. Authorized Additional Excavation: Removal of additional material authorized by the RE/COR based on the determination by the Government's soils testing agency that unsuitable bearing materials are encountered at required sub-grade elevations. Removal of unsuitable material and its replacement will be paid on basis of conditions of contract relative to changes in work.
- J. Subgrade: The undisturbed earth or the compacted soil layer immediately below granular sub-base, drainage fill, or topsoil materials.
- K. Structure: Buildings, foundations, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below ground surface.
- L. Borrow: Satisfactory soil imported from off-site for use as fill or backfill.

- M. Drainage course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- N. Bedding course: Layer placed over excavated sub-grade in trench before laying pipe. Bedding course shall extend up to the spring line of the pipe.
- O. Sub-base Course: Layer placed between the sub-grade and base course for asphalt paving or layer placed between the sub-grade and a concrete pavement or walk.
- P. Utilities include on-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.
- Q. Debris: Debris includes all materials located within the designated work area not covered in the other definitions and shall include but not be limited to items like vehicles, equipment, appliances, building materials or remains thereof, tires, any solid or liquid chemicals, or products stored or found in containers or spilled on the ground.
- R. Contaminated soils: Soil that contains contaminants as defined and determined by the RE/COR or the Government's testing agency.
- S. Topsoil: Fertile, friable, natural topsoil of loamy character and characteristic of locality, capable of growing healthy horticultural crops of grasses.

1.5 CLASSIFICATION OF EXCAVATION

- A. Unclassified Excavation: Removal and disposal of pavements and other man-made obstructions visible on surface; utilities, and other items including underground structures indicated to be demolished and removed; together with any type of materials regardless of character of material and obstructions encountered.
- B. Rock Excavation:
 - 1. Trenches and Pits: Removal and disposal of solid, homogenous, interlocking crystalline material, firmly cemented, laminated, or foliated masses or conglomerate deposits, cannot be excavated with late-model, track-mounted hydraulic excavator; equipped with 42-inch wide, short-tip-radius rock bucket; rated at minimum 138 hp. flywheel power with bucket-curling force of minimum 28,090 lbf. and stick-crowd force of minimum 19,000 lbf.; measured according to SAE J-1179. Trenches in excess of 10 feet wide and pits in excess of 30 feet in either length or width are classified as open excavation.
 - 2. Open Excavation: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be dislodged and excavated with a late-model, track-mounted loader; rated at minimum 210 hp. flywheel power and developing a minimum of 48,510 lbf. breakout force; measured according to SAE J-732.
 - 3. Other types of materials classified as rock are unstratified masses, conglomerated deposits and boulders of rock material exceeding 1 cubic yard for open excavation, or 3/4 cubic yard for footing and trench excavation that cannot be removed by rock excavating equipment

equivalent to the above in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted.

4. Blasting: Removal and disposal of solid, homogenous, interlocking crystalline material firmly cemented, laminated, or foliated masses or conglomerate deposits that cannot be removed with conventional methods may not be performed by blasting.
5. Definitions of rock and guidelines for equipment are presented for general information purposes only.

1.6 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American Nursery and Landscape Association (ANLA):
 1. 2004 - American Standard for Nursery Stock.
- C. American Association of State Highway and Transportation Officials (AASHTO):
 1. T99-15 - Moisture-Density Relations of Soils Using a 5.5 lb Rammer and a 12-inch Drop.
 2. T180-15 - Moisture-Density Relations of Soils using a 10 lb Rammer and an 18-inch Drop.
- D. ASTM International (ASTM):
 1. D448-12 - Sizes of Aggregate for Road and Bridge Construction.
 2. D698-12 - Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/cu. ft. (600 kN m/cu. m.)).
 3. D1556-07 - Density and Unit Weight of Soil in Place by the Sand-Cone Method.
 4. D1557-12 - Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/cu. ft. (2700 kN m/cu. m.)).
 5. D2167-15 - Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
 6. D2487-12 – Classification of Soils for Engineering Purposes (Unified Soil Classification System).
 7. D422 – 63 (07) Standard Test Method for Particle Size Analysis of Soils.
 8. D2488–17e1 Standard Practice for Description and Identification of Soils (Visual-Manual Procedures)
 9. D4318–17e1 –Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
 10. D6938-17a – Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
 11. D2940-15 - Graded Aggregate Material for Bases or Subbases for Highways or Airports.
- E. Society of Automotive Engineers (SAE):
 1. J732-12 - Specification Definitions - Loaders.
 2. J1179-08 - Hydraulic Excavator and Backhoe Digging Forces.

1.7 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Test Reports: Certify products comply with specifications.
 - 1. Rock Excavation Report:
 - a. Certification of rock quantities excavated.
 - b. Excavation method.
 - c. Labor.
 - d. Equipment.
 - e. Land Surveyor's or Architect/Engineer's name and official registration stamp.
 - f. Plot plan showing elevation
- C. Furnish to RE/COR:
 - 1. Qualifications: Substantiate qualifications comply with specifications.
 - a. Manufacturer with project experience list.
 - b. Fabricator with project experience list.
 - c. Installer with project experience list.
 - 2. Delegated Design Drawings and Calculations: Signed and sealed by responsible design professional.
 - a. Show location and magnitude of loads applied to building structural frame.
 - b. Identify deviations from details shown on drawings.

1.8 QUALITY ASSURANCE

- A. Manufacturer, Fabricator, Installer Qualifications:
 - 1. Regularly manufactures specified products.
 - 2. Manufactured specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
- B. Installer Qualifications:
 - 1. Regularly installs specified products.
 - 2. Installed specified products with satisfactory service on five similar installations for minimum five years.
- C. Welders and Welding Procedures Qualifications: AWS D1.1.
- D. Preconstruction Testing:
 - 1. Engage independent testing laboratory to perform tests and submit reports.
 - a. Deliver samples to laboratory in number and quantity required for testing.

1.9 FIELD CONDITIONS

- A. Existing Conditions: Document site features in the vicinity of structures with pre-excavation photographs and videotape, including surface finishes, cracks, or other structural blemishes that might misconstrued as damage caused by earthwork operations.

1.10 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide borrow soil material when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Fills: ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, low plasticity CL and ML, or any combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
 - 1. Dry Density: 110 pcf minimum.
 - 2. Plasticity Index: 15 maximum.
 - 3. Liquid Limit: 40 maximum.
- C. Unsatisfactory Fills: Materials which do not comply with the requirements for satisfactory materials are unsatisfactory.
- D. Engineered Fill: Naturally or artificially graded mixture; ASTM D2487 Soil Classification Groups GW, GP, GM, SW, SP, SM, SC, low plasticity CL and ML, or any combination of these groups, or approved by the Architect/Engineer, or material with at least 90 percent passing a 1 1/2-inch sieve and maximum 12 percent passing a No. 200 sieve, per ASTM D2940.
- E. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with 100 percent passing a 1-inch sieve and maximum 8 percent passing a No. 200 sieve.
- F. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1 1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
- G. Granular Fill:
 - 1. Under Concrete Slab: Crushed stone or gravel graded from 1 inch to No. 4, ASTM D2940.
 - 2. Bedding for Sanitary and Storm Sewer Pipe: Crushed stone or gravel graded from 1/2 inch to No 4, ASTM D2940.
- H. Decorative Stone:
 - 1. Three-eighths inch washed, rounded pea gravel, generally matching the color of stone within the existing decorative stone strips at the base of the columbarium walls within Columbarium A. Stone shall be free from organic materials, surface coatings or other deleterious materials. Final color selection shall be determined during the submittal process. For comparison, Contractor shall provide a representative sample of the existing pea gravel along with the proposed product.

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. Clearing:

1. Clear within limits of earthwork operations as indicated on Drawings.
2. Remove trees, shrubs, fences, foundations, incidental structures, paving, debris, trash, and other obstructions.
3. Remove materials from Cemetery Property.

B. Grubbing:

1. Remove stumps and roots 1 inch and larger diameter.
2. Leave undisturbed sound stumps, roots up to 1-inch diameter, and nonperishable solid objects minimum 3 feet below subgrade or finished embankment.
3. Do not leave material within burial profile up to 8 feet below finished grade.

C. Trees and Shrubs:

1. Remove trees and shrubs, not shown for removal, within 15 feet of new construction and 7.5 feet of utility lines, when approved in advance by RE/COR.
2. Remove materials from Cemetery Property.
3. Dig trees and shrubs with a ball of earth and burlap indicated to be relocated, according to "American Standard for Nursery Stock" of the American Association of Nurserymen, Inc.
4. Transplant trees and shrubs to a permanent or temporary position within two hours after digging.
5. Maintain trees and shrubs held in temporary locations by watering as necessary and feeding liquid fertilizer semiannually with a minimum analysis of 5 percent nitrogen, 10 percent phosphorus, and 5 percent potash.
6. Maintain plants moved to permanent positions as specified for plants in temporary locations until substantial completion.
7. Protect existing trees and shrubs. Trim, clean, and paint damage existing trees and shrubs including roots, according to standard industry horticultural practice for the geographic area and plant species.
8. Do not store building materials closer to trees and shrubs to remain than farthest extension of their limbs.

D. Stripping Topsoil:

1. Strip topsoil within limits of earthwork operations.
2. Stockpile and protect topsoil as directed by RE/COR.
3. Eliminate foreign materials larger than 1/2 cubic foot in volume, from soil when stockpiled. Retain topsoil on station.
4. Remove foreign materials larger than 2 inches in any dimension from topsoil used in final grading.

5. Do not do topsoil work on wet soil.
 6. Test soil for chemicals, pesticides and fertilizers when topsoil is removed from formerly utilized farmland, to verify suitability for use in new lawn areas.
- E. Concrete Slabs and Paving:
1. Score deeply or saw cut existing concrete slabs and paving to be removed in a neat, straight cut, sections where excavation or trenching occurs.
 2. Extend pavement section, minimum 12 inches both sides of widest part of trench excavation. Provide parallel final score lines, unless otherwise indicated on Drawings.
 3. Remove material from Cemetery Property.
- F. Lines and Grades: Establish by Registered Professional Land Surveyor or Registered Civil Engineer, specified in Section 01 00 01, GENERAL REQUIREMENTS.
1. Grades: Conform to elevations indicated on Drawings, within the tolerances herein specified.
 - a. Establish grades free from irregular surface changes.
 - b. Comply with compaction requirements and grade cross sections, lines, and elevations indicated on Drawings. Establish grade based on interpolation of elevations between spot grades when indicated on Drawings, while maintaining appropriate transition at structures and paving and uninterrupted drainage flow into inlets.
 2. Locations of existing and proposed elevations indicated on Drawings, except spot elevations, are approximate from site survey that measured spot elevations and subsequently generated existing contours and spot elevations. Proposed spot elevations and contour lines have been developed utilizing the existing conditions survey and developed contour lines and may be approximate. Notify RE/COR of any differences between existing elevations indicated on Drawings and those encountered on site by Architect/Engineer. Notify RE/COR of any differences between existing or constructed grades, as compared to those indicated on the Drawings.
 3. Subsequent to establishment of lines and grades, provide additional cut and fill required for site grading to conform to elevations indicated on Drawings.
 4. Finish grading specified in Section 32 90 00, PLANTING.
- G. Disposal:
1. Removed materials from site and disposed of at legally approved site.
 2. Comply with applicable Federal, State and local regulations.
 3. Do not burn materials on site.

3.2 EXCAVATION

- A. All excavations and slopes should be made and maintained in accordance with OSHA excavation safety standards.

- B. Shoring, Sheet piling and Bracing: Shore, brace, or slope, its angle of repose banks of excavations or to an angle acceptable by the RE/COR, to protect workmen, banks, adjacent paving, structures, and utilities.
 - 1. Begin construction of excavation system support after review by RE/COR.
 - 2. Extend shoring and bracing minimum 5 feet below bottom of excavation. Shore excavations carried below elevations of adjacent existing foundations.
- C. Excavation Drainage:
 - 1. Operate pumping equipment, and provide other materials, means and equipment to keep excavation free from water and subgrade dry, firm, and undisturbed until permanent work is approved by RE/COR.
 - 2. Obtain approval from RE/COR before placement of permanent work on subgrades.
- D. Subgrade Protection:
 - 1. Protect subgrades from softening, undermining, washout, or damage by rain or water accumulation.
 - 2. Reroute surface water runoff from excavated areas a. Do not use excavated trenches as temporary drainage ditches.
 - 3. Remove disturbed material to firm undisturbed material after water is brought under control, when subgrade for foundations is disturbed by water.
 - 4. Replace disturbed subgrade in trenches with concrete or material approved by RE/COR.
- E. Blasting: Blasting of materials classified as rock is permitted only when authorized by RE/COR. Comply with all federal, state, and local requirements.
- F. Perform blasting with explosives of quantity and power, fired in sequence and locations not to injure personnel, damage or crack adjacent structure, property, or existing work or other portions of new work. Blasting is not acceptable.
- G. Subgrade Preparation: Subgrade beneath structural areas (buildings, slabs and pavement areas) should be prepared in accordance with the recommendations presented in the Subsurface Exploration and Geotechnical Engineering report.
- H. Proofrolling:
 - 1. Proofroll exposed subgrade with fully loaded dump truck or construction equipment having a minimum axle loads of 10 tons and approved by RE/COR or Owner's soil testing agency to check for pockets of soft material. Proofroll should not be performed on frozen subgrade.
 - 2. Proofroll subgrade at least two complete passes, one pass in a direction perpendicular to first one. Remove areas that deflect, rut, or pump excessively during proof rolling, or fail to consolidate after successive passes to suitable soils. Replace with compacted engineered fill. Maintain subgrade until succeeding operation has been accomplished.
- I. Building Earthwork:
 - 1. Excavate foundation excavations to solid undisturbed subgrade.

2. Remove loose or soft materials to a solid bottom.
 3. Fill excess cut under footings or foundations with 3000 psi concrete poured separately from the footings.
 4. Do not tamp earth for backfilling in footing bottoms.
 5. Slope grades to direct water away from excavations and to prevent ponding.
- J. Trench Earthwork:
1. Utility Trenches (Except Sanitary and Storm Sewer):
 - a. Excavate to width required for sheeting and bracing and proper performance of Work.
 - b. Grade bottom of trenches with bell holes scooped out to provide uniform bearing.
 - c. Support piping on undisturbed earth unless mechanical support is indicated on Drawings.
 - d. Length of open trench in advance of piping laying not be greater than authorized by RE/COR.
 2. Sanitary and Storm Sewer Trenches:
 - a. Trench Width:
 - 1) Below Point 6 inches Above Top of Pipe:
 - a) Pipe up to 12 inches: 24 inches maximum diameter.
 - b) Pipe Larger than 12 inches: Four-thirds pipe diameter plus 8 inches.
 - 2) Trench Width Above 6 inches: Pipe size as required for sheeting and bracing and proper performance of the Work.
 - b. Bed Bottom Quadrant of Pipe:
 - 1) Undisturbed Soil: Bell holes no larger than required for jointing. Backfill with clean earth, placed and tamped by hand, maximum 12 inches above top of pipe.
 - 2) Granular Fill: Depth of fill minimum 3 inches plus one sixth of pipe diameter below pipe to 12 inches above top of pipe. Place and tamp fill material by hand.
 - c. Place and compact excess backfill using acceptable excavated materials. Do not use unsuitable materials.
 - d. Use granular fill for bed where rock or rocky materials are excavated.
- K. Site Earthwork:
1. General: Earth excavation includes pavement excavation and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; including soil, boulders, and other materials not classified as rock or unauthorized excavation. Perform excavation as indicated on Drawings and as follows:
 - a. Excavate to elevations and dimensions indicated on Drawings within a tolerance of plus or minus 1 inch.

- b. Extend excavations of sufficient distance from structures for placing and removing concrete formwork, installing services and other construction, and inspections. Comply with OSHA requirements.
 - c. Remove and replace unsuitable subgrade materials as determined by RE/COR.
 - d. Obtain material samples for soil classification, under the direction of the RE/COR, for testing by an independent testing laboratory to determine suitability.
 - e. When unsuitable material is encountered and removed, contract price and time will be adjusted according to Articles, DIFFERING SITE CONDITIONS, CHANGES and CHANGES-SUPPLEMENT of the GENERAL REQUIREMENTS as applicable.
Adjustments will be based on volume in cut section only.
2. Site Grading:
- a. Provide a smooth transition between adjacent existing grades and new grades.
 - b. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
 - c. Slope grades to direct water away from buildings and to prevent ponds from forming, where not designed. Finish subgrades to required elevations within the following tolerances:
 - 1) Lawn or Unpaved Areas: Plus or minus 1 inch.
 - 2) Walks: Plus or minus 1 inch.
 - 3) Pavements: Plus or minus 1 inch.
 - d. Grading Inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with 10-foot straightedge.

3.3 FILLING AND BACKFILLING

- A. General: Fill or backfill when all debris, water, unsatisfactory soil materials, obstructions, frozen soils and deleterious materials have been removed from excavation. Use excavated and borrow for fill and backfill, as applicable. Supply borrow materials. Do not use unsuitable excavated materials. Do not backfill until foundation walls have been completed above grade and adequately braced, waterproofing or dampproofing applied, foundation drainage, and pipes in contact with backfill have been installed, and work inspected and approved by RE/COR.
 - 1. The Contractor has the option to use suitable borrow material generated by the concurrent design/build project onsite. Coordinate with the design/build Contractor.
- B. Placing: Place materials in horizontal layers maximum 8 inches in loose depth for material compacted by heavy compaction equipment, and maximum 4 inches in loose depth for material compacted by hand-operated tampers and then compacted. Place backfill and fill materials evenly on all sides of structures to required elevations, and uniformly along full length each structure. Do not place material on muddy, frozen, or with frost surfaces.

C. Compaction: Compact with approved tamping rollers, sheepsfoot rollers, pneumatic tired rollers, steel wheeled rollers, vibrator compactors, or other equipment (hand or mechanized) well to suit soil compacted. Do not operate mechanized vibratory compaction equipment within 10 feet of new or existing building walls without prior approval of RE/COR. Moisten or aerate material as necessary to provide moisture content that will readily facilitate obtaining specified compaction with equipment used. Compact soil to minimum the following percentages of maximum dry density, according to ASTM D698 or ASTM D1557 as specified below:

1. Fills, Embankments, and Backfill.
 - a. Under Proposed Structures, Building Slabs, Steps, and Paved Areas: Scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill material according to ASTM D1557 95 percent.
 - b. Curbs, Curbs and Gutters: ASTM D698 95 percent.
 - c. Under Sidewalks: Scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill material according to ASTM D698 95 percent.
 - d. Landscaped Areas Top 16 inches: ASTM D698 85 percent.
 - e. Landscaped Areas Below 16 inches of Finished Grade: ASTM D698 90 percent.
2. Natural Ground (Cut or Existing):
 - a. Under Building Slabs, Steps and Paved Areas, Top 6 inches: ASTM D1557 95 percent.
 - b. Curbs, Curbs and Gutters, Top 6 inches: ASTM D698 95 percent.
 - c. Under Sidewalks, Top 6 inches: ASTM D698 95 percent.

3.4 GRADING

- A. General: Uniformly grade areas within limits specified below, including adjacent transition areas. Smooth the finished surface within specified tolerance. Provide uniform levels or slopes between points where elevations are indicated, or between points and existing finished grades. Provide smooth transition between abrupt changes in slope.
- B. Cut rough or sloping rock to level beds for foundations. In pipe spaces or other unfinished areas, fill low spots and level off with coarse sand or fine gravel.
- C. Slope backfill outside building away from building walls with minimum distance of 6 feet.
- D. Finish grade earth floors in pipe basements as indicated on Drawings, to level, uniform slope and leave clean.
- E. Finished grade minimum 6 inches below bottom line of window or other building wall openings unless greater depth is indicated on Drawings.
- F. Place crushed stone or gravel fill under concrete slabs on grade, tamped and leveled, 6 inches thick, unless otherwise indicated on Drawings.
- G. Finish subgrade in condition acceptable to RE/COR at least one day in advance of paving operations. Maintain finished subgrade in smooth and compacted condition until succeeding operation has been accomplished. Scarify, compact, and grade subgrade before further

construction when approved compacted subgrade is disturbed by subsequent operations or adverse weather.

H. Tolerances:

1. Subgrade and Base Course Final Grade for Paved Areas: Plus or minus 0.25 inches of indicated grades.

3.5 QUALITY CONTROL AND QUALITY ASSURANCE TESTING AND INSPECTIONS

- A. The contractor shall carry out their own quality control procedures during construction of the project which are considered in addition to the Owner's Independent Testing Laboratory (ITL). Any testing/inspections performed by the ITL is not meant to alleviate the contractor from performing their own quality control program and/or alleviate the contractor from performing the work in accordance with the project drawings and specifications.
- B. Responsibilities: Unless otherwise specified, the quality assurance testing and inspection specified below will be conducted by the Owner's ITL at no cost to the Contractor. The Contractor shall perform additional quality control testing and inspections as considered necessary.
- C. Field testing, frequency, and methods may vary as determined by and between the Owner and the ITL.
- D. Report of testing and inspection results shall be made upon the completion of testing.
- E. Classification of Materials: Perform test for classification of materials used and encountered during construction in accordance with ASTM D2488 and ASTM D2487.
- F. Laboratory Testing of Materials: Perform laboratory testing of materials (Proctor, Sieve Analysis, Atterberg Limits, etc.) as specified.
- G. Proofrolling: Document and explain proofrolling inspection procedures and results in the inspection report.
- H. Field Density Tests.
 - a. Building Subgrade Areas, including 5 feet Outside of Exterior Building Lines: A minimum of 1 compaction test per 2,500 square foot area shall be tested for each 8-inch loose measure lift placed; but not less than 3 tests per lift.
 - b. Paving Areas and other Areas of Construction Exclusive of Building Subgrade: A minimum 1 compaction test for every 5,000 square feet for each 8-inch lift, measured loose; but not less than 3 tests per lift.
 - c. The elevation and location of the tests should be clearly identified at the time of fill placement.
 - d. Utility Trench Backfill: Intervals not exceeding 50-feet of trench for first and every other 8-inch lift of compacted trench backfill.
 - e. Test Method: In-place nuclear density, ASTM D1557.
 - f. If inclement weather occurs after testing, retest prior to placement of overlying materials.
- I. Observation and Inspection:

- a. Observe all subgrades/excavation bases below footings and slabs and verify design bearing capacity is achieved as required.
- b. Observe and document presence of groundwater within excavations.

3.6 DISPOSAL OF UNSUITABLE AND EXCESS EXCAVATED MATERIAL

- A. Disposal: Transport surplus satisfactory soil to designated storage areas on Cemetery property. Stockpile or spread soil as directed by RE/COR.
 - 1. Remove waste material, including unsatisfactory soil, trash, and debris, and legally dispose of Cemetery property.

3.7 CLEANING

- A. Upon completion of earthwork operations, clean areas within contract limits, remove tools, and equipment. Clean site, free of debris, and suitable for subsequent construction operations. Remove all debris, rubbish, and excess material from Cemetery Property.

--- E N D ---

**SECTION 31 23 19
DEWATERING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Implementation of Erosion and Sedimentation Control Plan.
 - 2. Dewater excavations, including seepage and precipitation.
- B. Provide all labor, materials, tools, equipment, power, and services necessary for care of water and erosion control. Begin excavation work before the approved Erosion and Sedimentation Control Plan is in place.

1.2 RELATED REQUIREMENTS

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Submittal requirements.
- B. Section 01 00 01, GENERAL REQUIREMENTS: Protection of existing utilities, fire protection services, existing equipment, roads, and pavements:
- C. Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS: Erosion Control.

1.3 SUBMITTALS

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Submittal Procedures:
- B. Submittal Drawings:
 - 1. Show drawings and data with method employed in dewatering excavated areas, 30 days before commencement of excavation.
 - 2. Show location, depth and size of wellpoints, headers, sumps, ditches, size and location of discharge lines, capacities of pumps and standby units, and detailed description of dewatering methods to be employed to convey water from site to adequate disposal. Show details of the dewatering facilities, including equipment and erosion protection. Include facilities and procedures for insuring discharge water quality according to the applicable provisions of Erosion Control Plan or SWPPP or NPDES requirements, Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
 - 3. Include written report outlining control procedures to be adopted when a dewatering problem arises.
 - 4. Submit materials in format acceptable to all regulatory agencies.
- C. Inspection Reports.
- D. All required permits.

1.4 QUALITY ASSURANCE

- A. Permitting Requirements: Comply and obtain required Federal, State, and County permits where Work is performed.

- B. Comply and provide information to Resident Engineer/Contracting Officer's Representative (RE/COR), all conditions of regulating permits. Obtain written approval from RE/COR before discontinuing operation of dewatering system.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install dewatering system to lower and control ground surface water to permit excavation, construction of structure, and placement of backfill materials in dry conditions. Make dewatering system adequate to pre-drain the water-bearing strata above and below bottom of structure foundations, utilities and other excavations.
- B. Reduce hydrostatic pressure head in water-bearing strata below structure foundations, utility lines, and other excavations, minimum 1 foot) below prevailing excavation surface.
- C. Operation:
 - 1. Place dewatering system in operation before excavation below ground water table. Operate system continuously 24 hours a day, 7 days a week until construction work below existing ground water level is complete.
 - 2. Place adequate weight of backfill material to prevent buoyancy before discontinuing operation of the system.
- D. Water Disposal:
- E. Dispose water removed from excavations in such a manner as:
 - a. Avoid endanger portions of work under construction or completed.
 - b. Avoid inconvenience to Government or to others working near site.
 - c. Comply with permit regulations for disposal of water.
 - d. Control Runoff: Control runoff in work areas including but not limited to excavations, access roads, parking areas, laydown, and staging areas. Provide, operate, and maintain all ditches, basins, sumps, culverts, site grading, and pumping facilities to divert, collect, and remove all water from the work areas. Remove water from work areas and dispose according to applicable permits.
- 2. Excavation Dewatering:
 - a. Divert, collect, control, and remove water from construction work areas and excavations.
 - b. Arrange drainage features and alter as required to avoid degradation of the final excavated surfaces.
 - c. Utilize all necessary erosion and sediment control measures to avoid construction related degradation of natural water quality.

3. Remove and dispose surface and ground water entering excavations, trenches, and work areas during construction. Keep excavation dry during subgrade preparation and until construction is complete and pipe is installed to avoid damage from hydrostatic pressure, flotation, or other cause will result.
- F. Standby Equipment:
1. Install complete standby equipment for immediate operation, as required to maintain de-watering on a continuous basis and in the event that all or any part of the system become inadequate or fail.
- G. Corrective Action:
1. Perform work necessary to restore foundation soil and damaged structure resulting from failure of dewatering system.
- H. Damages:
1. Immediately repair damages to adjacent facilities caused by dewatering operations.

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SECTION 32 05 23
CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Site work concrete.
 - 2. Combination curb and gutter.
 - 3. Pedestrian Pavement: Walks, flower/water stations, mow strips, and wheelchair curb ramps.
 - 4. Vehicular Pavement: Maintenance yards.
 - 5. Equipment Pads: Transformers.

1.2 RELATED REQUIREMENTS

- A. Section 01 45 29, TESTING LABORATORY SERVICES, Laboratory and Field Testing Requirements.
- B. Section 03 30 53, CAST-IN-PLACE CONCRETE: Concrete Materials, Quality, Mixing, Design and Other Requirements.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. M31M/M31-15 - Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 - 2. M55M/M55-09 - Steel Welded Wire Reinforcement, Plain, for Concrete, Single User.
 - 3. M147-65 (2004) - Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
 - 4. M148-05 - Liquid Membrane-Forming Compounds for Curing Concrete.
 - 5. M171-05 - Sheet Materials for Curing Concrete.
 - 6. M182-05(2012) - Burlap Cloth Made from Jute or Kenaf and Cotton Mats.
 - 7. M213-01(2010) - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
 - 8. M233-86 - Boiled Linseed Oil Mixture for Treatment of Portland Cement Concrete.
 - 9. T99-15 - Moisture-Density Relations of Soils Using a 5.5-lb Rammer and a 12-in. Drop.
 - 10. T180-15 - Moisture-Density Relations of Soils Using a 10-lb Rammer and a 18-in. Drop.
- C. American National Standards Institute (ANSI):
 - 1. B101.3 - Wet DOCF of Common Hard Surface Floor Materials (Including Action and Limit Thresholds for the Suitable Assessment of the Measured Values).
- D. ASTM International (ASTM):
 - 1. A775/A775M-16 - Epoxy-Coated Steel Reinforcing Bars.
 - 2. C94/C94M-16 - Ready-Mixed Concrete.
 - 3. C143/C143M-15a - Slump of Hydraulic Cement Concrete.

4. C1116/C1116M-10a(2015) - Fiber-Reinforced Concrete.
5. D5893/D5893M-10 - Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
6. D6690-15 - Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.

1.4 PREINSTALLATION MEETINGS

- A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.
 1. Required Participants:
 - a. Resident Engineer/Contracting Officer's Representative (RE/COR).
 - b. Architect/Engineer.
 - c. Inspection and Testing Agency.
 - d. Contractor.
 - e. Installer.
 2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
 - a. Installation schedule.
 - b. Installation sequence.
 - c. Preparatory work.
 - d. Protection before, during, and after installation.
 - e. Installation.
 - f. Terminations.
 - g. Transitions and connections to other work.
 - h. Inspecting and testing.
 - i. Other items affecting successful completion.
 3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Submittal Procedures.
- B. Submittal Drawings:
 1. Show size, configuration, and fabrication and installation details.
 2. Show reinforcing.
 3. Include jointing plan for concrete pavements, curbs and gutters.
- C. Manufacturer's Literature and Data:
 1. Description of each product.
 - a. Expansion joint filler.
 - b. Hot poured sealing compound.
 - c. Reinforcement.
 - d. Curing materials.

- 2. Installation instructions.
- D. Test Reports: Certify products comply with specifications.
 - 1. Job-mix formula.
 - 2. Select subbase materials.
- E. Qualifications: Substantiate qualifications comply with specifications.
 - 1. Installer with project experience list.
 - 2. Land surveyor.
- F. Select subbase job-mix design: Report the following:
 - 1. Material sources.
 - 2. Gradation.
 - 3. Plasticity index.
 - 4. Liquid limit.
 - 5. Laboratory compaction curves indicating maximum density at optimum moisture content.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Regularly installs specified products.
 - 2. Installed specified products with satisfactory service on five similar installations.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
- B. Land Surveyor: Professional land surveyor or engineer registered to provide land surveys in jurisdiction where project is located.
- C. Preconstruction Testing:
 - 1. Engage independent testing laboratory to perform tests and submit reports.
 - a. Deliver samples to laboratory in number and quantity required for testing.
 - 2. Concrete mix design.

1.7 DELIVERY

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, and manufacture date.
- C. Deliver steel reinforcement to prevent damage.
- D. Before installation, return or dispose of products with damaged or opened packaging and distorted or damaged steel reinforcement.
- E. Bulk Products: Deliver bulk products away from buildings, utilities, pavement, and existing turf and planted areas. Maintain dry bulk product storage away from contaminants.

1.8 STORAGE AND HANDLING

- A. Store products indoors in dry, weathertight facility.
- B. Protect products from damage during handling and construction operations.

1.9 FIELD CONDITIONS

- A. Place concrete as specified under Article 3.4 E., for Cold Weather Placement and Article 3.4 D., for Hot Weather Placement of Section 03 30 53, CAST-IN-PLACE CONCRETE.

1.10 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 CONCRETE

- A. Concrete: Type C, air-entrained as specified in Section 03 30 53, CAST-IN-PLACE CONCRETE, except as follows:

TYPE	MAXIMUM SLUMP*
Curb & Gutter	3 inches
Pedestrian Pavement	3 inches
Vehicular Pavement	2 inches (Machine Finished) 4 inches (Hand Finished)
Equipment Pad	3 to 4 inches
* For concrete to be vibrated: Slump as determined by ASTM C143. Tolerances as established by ASTM C94.	

2.2 REINFORCEMENT

- A. Steel Reinforcement: Type, amount, and locations as shown on drawings and as specified.
- B. Epoxy-Coated Steel Reinforcement: ASTM A775
- C. Welded Wire-Fabric: AASHTO M55.
- D. Dowels: Plain steel bars complying with AASHTO M31.
- E. Tie Bars: Deformed steel bars complying with AASHTO M31.

2.3 FORMS

- A. Forms: Metal or wood, straight and suitable in cross-section, depth, and strength to resist springing during depositing and consolidating of concrete.
- B. Tolerance: 1/8-inch maximum variation from straight line in any 10-foot long section, in either a horizontal or vertical direction.
- C. Wood Forms: Minimum 2 inches thick (nominal), free from warp, twist, loose knots, splits, or other defects. Provide approved flexible or curved forms for forming radii.

2.4 CONCRETE CURING MATERIALS

- A. Concrete Curing Materials: Comply with one of the following:
1. Burlap: AASHTO M182, weighing 7 oz./sq. yd. dry.
 2. Impervious Sheeting: AASHTO M171.
 - a. Polyethylene: Minimum 4 mils thick.
 3. Liquid Membrane Curing Compound: AASHTO M148 Type 2, without paraffin or petroleum.

2.5 EXPANSION JOINT FILLERS

- A. Expansion Joint Filler: AASHTO M213.

2.6 ACCESSORIES

- A. Equipment and Tools: Obtain RE/COR approval of equipment and tools for handling materials and performing work before work begins. Maintain equipment and tools in satisfactory working condition at all times.
- B. Sealants:
 - 1. Concrete Paving Expansion Joints: ASTM D5893, Type SL, single component, self-leveling, silicone joint sealant.
 - 2. Concrete Paving Joints: ASTM D6690, Type IV, hot-applied, single component joint sealant.
- C. Concrete Protective Coating: AASHTO M233 linseed oil mixture.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine and verify substrate suitability for product installation.
- B. Protect existing construction and completed work from damage.
- C. Prepare, construct, and finish subgrade as specified in Section 31 20 00, EARTH MOVING.
- D. Maintain subgrade in smooth, compacted condition, complying with required section and established grade until succeeding operation has been accomplished.

3.2 SETTING FORMS

- A. Form Substrate:
 - 1. Compact form substrate to uniformly support forms along entire length at grade as shown on drawings.
 - 2. Correct substrate imperfections or variations by cutting or filling and compacting.
- B. Form Setting:
 - 1. Set forms sufficiently in advance of concrete placement to permit performance and approval of operations required with and adjacent to form lines.
 - 2. Set forms to indicated line and grade and use stakes, clamps, spreaders, and braces to prevent movement in any direction.
 - 3. Tolerances: Conform to line and grade with 1/8-inch tolerance when checked with straightedge, with maximum 1/4-inch deviation from true line at any point.
 - 4. Remove forms when removal will not damage concrete and when required for finishing.
 - 5. Clean and oil forms before each use.
- C. Land Surveyor: Establish and control alignment and form grade elevations or concrete slipforming machine operations.
 - 1. Make necessary corrections to forms immediately before placing concrete.

2. When any form has been disturbed or any subgrade or subbase has become unstable, reset and recheck form before placing concrete.

3.3 PLACING REINFORCEMENT

- A. Keep reinforcement free of dirt, oil, rust, scale or other substances preventing concrete bond.
- B. Install reinforcement as shown on drawings.
- C. Support and securely tie reinforcing steel to prevent displacement during concrete placement.
- D. Obtain RE/COR approval of reinforcement placement before placing concrete.

3.4 PLACING CONCRETE - GENERAL

- A. Preparation:
 1. Obtain RE/COR approval.
 2. Remove debris and other foreign material from between forms.
 3. Uniformly moisten subgrade, base, or subbase without standing water.
- B. Convey concrete from mixer to final location without segregation or loss of ingredients. Deposit concrete to minimize handling.
- C. During placement, consolidate concrete by spading or vibrating to minimize voids, honeycomb, and rock pockets.
 1. Vibrate concrete against forms and along joints.
 2. Avoid excess vibration and handling causing segregation.
- D. Place concrete continuously between joints without bulkheads.
- E. Install construction joint whenever concrete placement is suspended for more than 30 minutes and at end of each day's work.
- F. Workmen or construction equipment coated with foreign material will not be permitted to walk or operate in concrete during placement and finishing operations.

3.5 PLACING CONCRETE FOR CURB AND GUTTER, PEDESTRIAN PAVEMENTS, AND EQUIPMENT PADS

- A. Place concrete in one layer conforming to cross section shown on drawings after consolidating and finishing.
- B. Deposit concrete near joints without disturbing joints. Do not place concrete directly onto joint assemblies.
- C. After concrete has been placed in forms, use a strike-off guided by side forms to bring surface to proper section to be compacted.
- D. Consolidate concrete thoroughly by tamping and spading, or with approved mechanical finishing equipment.
- E. Finish concrete surface to grade with wood or metal float.
- F. Construct concrete pads and pavements with sufficient slope to drain, preventing standing water.

3.6 CONCRETE FINISHING - GENERAL

- A. Follow operation sequence below, unless otherwise indicated on drawings:

1. Consolidating, floating, straight-edging, troweling, texturing, and joint edging.
2. Maintain finishing equipment and tools in clean and approved condition.

3.7 CONCRETE FINISHING - CURB AND GUTTER

- A. Gutter and Curb Top:
 1. Round edges of gutter and curb top with edging tool to 1/4-inch radius or as otherwise shown on drawings.
 2. Float surfaces and finish with smooth wood or metal float until true to grade and section and uniform texture.
 3. Finish surfaces longitudinally, while still wet, with bristle type brush.
- B. Curb Face:
 1. Remove curb form and immediately rub curb face with wood or concrete rubbing block and water until blemishes, form marks, and tool marks have been removed.
 2. Brush curb face, while still wet, to match gutter and curb top.
- C. Tolerances: Except at grade changes or curves, when tested with 10-foot straightedge.
 1. Variation from Indicated Plane and Grade:
 - a. Gutter: Maximum 1/8 inch.
 - b. Curb Top and Face: Maximum 1/4 inch.
- D. Replace curbs and gutters within joint boundary when curbs and gutters exceed specified tolerances.
- E. Correct depressions causing standing water.
- F. Visible surfaces and edges of finished curb, gutter, and combination curb and gutter to be free of blemishes, form marks, and tool marks, and uniform in color, shape, and appearance.

3.8 CONCRETE FINISHING PEDESTRIAN PAVEMENT

- A. Walks, Flower Water Stations, Mow Strips, and Wheelchair Curb Ramps,
 1. Finish concrete surfaces to grade and cross section with metal float, troweled smooth and finished with a broom moistened with clear water.
 2. Broom surfaces transverse to traffic direction.
 3. Carefully finish slab edges, including at formed joints, with edger with radius as shown on drawings.
 4. Unless otherwise indicated, edge transverse joints before brooming. Use brooming to eliminate flat surface produced by edger. Produce uniform corrugations, maximum 1/16 inch deep.
 5. Provide surface uniform in color and free of surface blemishes, form marks, and tool marks.
 6. Paving Tolerances:
 - a. Variation from Indicated Plane: Maximum 3/16 inch in 10 feet.
 - b. Variation from Indicated Thickness: Maximum 1/4 inch.
 7. Replace paving within joint boundary when paving exceeds specified tolerances.

3.9 CONCRETE FINISHING - EQUIPMENT PADS

- A. Strike pad surface to elevation shown on drawings.
- B. Provide smooth, dense float finish, free from depressions or irregularities.
- C. Carefully finish pad edges with edger having radius as shown on drawings.
- D. After removing forms, rub pad edge faces with wood or concrete rubbing block, removing blemishes, form marks, and tool marks and providing uniform color.
- E. Pad Tolerances:
 - 1. Variation from Indicated Plane: Maximum 1/8 inch in 10 feet.
- F. Correct irregularities when pads exceed specified tolerances.

3.10 JOINTS - GENERAL

- A. Place joints, where shown on drawings.
 - 1. Conform to details shown.
 - 2. Install joints perpendicular to finished concrete surface.
- B. Make joints straight and continuous from edge to edge of pavement.

3.11 CONTRACTION JOINTS

- A. Cut joints to depth as shown with grooving tool or jointer of radius as shown on drawings or by sawing with blade to produce required width and depth.
- B. Construct joints in curbs and gutters by inserting 1/8-inch steel plates conforming to curb and gutter cross sections.
 - 1. Keep plates in place until concrete can hold its shape.
- C. Finish joint edges with edging tool having radius as shown on drawings.
- D. Score pedestrian pavement with standard grooving tool or jointer.

3.12 EXPANSION JOINTS

- A. Form expansion joints with preformed expansion joint filler material of thickness shown on drawings.
 - 1. Without dowels, locate joints around perimeter of structures and features abutting site work concrete.
 - 2. Create complete, uniform separation between structure and site work concrete.
- B. Extend expansion joint material full depth of concrete with top edge of joint filler below finished concrete surface where sealant is indicated on drawings.
- C. Cut and shape material matching cross section.
- D. Anchor with approved devices to prevent displacing during placing and finishing operations.
- E. Round the edges of joints with an edging tool.

3.13 CONSTRUCTION JOINTS

- A. Place transverse construction joints of type shown, where indicated, and whenever concrete placement is suspended for more than 30 minutes.
- B. Provide butt-type joint with dowels in curb and gutter if joint occurs at planned joint location.

- C. Provide keyed joints with tiebars if joint occurs in middle third of typical curb and gutter joint interval.

3.14 FORM REMOVAL

- A. Keep forms in place minimum 12 hours after concrete placement. Remove forms without damaging concrete.
- B. Do not use bars or heavy tools against concrete to remove forms. Promptly repair damaged concrete found after form removal.

3.15 CONCRETE

- A. Concrete Protection:
 - 1. Protect unhardened concrete from rain and flowing water.
 - 2. Ensure sufficient curing and protection materials are available and ready for use before concrete placement begins.
 - 3. Protect concrete to prevent pavement cracking from ambient temperature changes during curing period.
 - a. Replace pavement damaged by curing method allowing concrete cracking.
 - b. Employ another curing method as directed by RE/COR.
- B. Cure concrete for minimum 7 days by one of the following methods appropriate to weather conditions preventing moisture loss and rapid temperature change:
 - 1. Burlap Mat: Provide minimum two layers kept saturated with water during curing period. Overlap mats minimum 6 inches.
 - 2. Impervious Sheeting: Provide waterproof paper, polyethylene-coated burlap, or polyethylene sheeting.
 - a. Wet exposed concrete surface with fine water spray and cover with sheet materials.
 - b. Overlap sheets minimum 12 inches.
 - c. Securely anchor sheet materials preventing displacement.
- C. Liquid Membrane Curing Compound:
 - 1. Protect joints indicated to receive sealants preventing contamination from curing compound.
 - 2. Insert moistened paper or fiber rope into joint or cover joint with waterproof paper.
 - 3. Apply curing compound before concrete dries.
 - 4. Apply curing compound in two coats at right angles to each other.
 - 5. Application Rate: Maximum 200 sq. ft./gal., both coats.
 - 6. Immediately reapply curing compound to surfaces damaged during curing period.

3.16 FIELD QUALITY CONTROL

- A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.
 - 1. Section 03 30 53 CAST-IN-PLACE CONCRETE: Concrete testing.
 - a. Delivery samples.

- b. Field samples.
- 2. Slip Resistance: Steps and pedestrian paving.

3.17 CLEANING

- A. After completing curing:
 - 1. Remove curing material, except liquid membrane.
 - 2. Sweep the concrete clean.
 - 3. Seal all joints after removing foreign matter from joint.
 - 4. Clean concrete of debris and construction equipment as soon as curing and joint sealing have been completed.
- B. Remove and legally dispose of debris, rubbish, and excess material from project site.

3.18 PROTECTION

- A. Protect exterior improvements from traffic and construction operations.
 - 1. Prohibit traffic on paving for minimum seven days after placement, or longer as directed by RE/COR.
- B. Remove protective materials immediately before acceptance.
- C. Repair damage.
 - 1. When directed by RE/COR, replace concrete containing cracking, fractures, spalling, and other defects within joint boundary, at no additional cost to Government.

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SECTION 32 08 00
COMMISSIONING OF IRRIGATION SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this section apply to all sections of Division 32.
- B. This project will have selected building systems commissioned. The complete list of equipment and systems to be commissioned is specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The commissioning process, which the Contractor is responsible to execute, is defined in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

1.2 RELATED WORK

- A. Section 01 00 01 GENERAL REQUIREMENTS
- B. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS
- C. Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- D. Section 23 05 93 TESTING, ADJUSTING AND BALANCING FOR HVAC

1.3 SUMMARY

- A. This section includes requirements for commissioning the Facility site utilities systems, related subsystems and related equipment. This section supplements the general requirements specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.
- B. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members.

1.4 DEFINITIONS

- A. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for definitions.

1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 32 is part of the construction process. Documentation and testing of these systems, as well as training of the VA's operation and maintenance personnel in accordance with the requirements of Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and of Division 32, is required in cooperation with the VA and the Commissioning Agent.
- B. The Plant Irrigation systems commissioning will include the systems listed in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

1.6 SUBMITTALS

- A. The commissioning process requires review of selected submittals that pertain to the systems to be commissioned. The Contractor shall develop a complete list of submittals for the project (submittal register), and provide to the Commissioning Agent to review. The Commissioning Agent will provide a list of submittals that will be reviewed by the Commissioning Agent. This list

will be reviewed and approved by the VA prior to forwarding to the Contractor. Refer to Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES for further details.

- B. The commissioning process requires submittal review simultaneously with engineering review. Specific submittal requirements related to the commissioning process are specified in Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 CONSTRUCTION INSPECTIONS

- A. Commissioning of Site Utility systems will require inspection of individual elements of the site utility systems construction throughout the construction period. The Contractor shall coordinate with the Commissioning Agent in accordance with Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and the commissioning plan to schedule site utility systems inspections as required to support the commissioning process.

3.2 PRE-FUNCTIONAL CHECKLISTS

- A. The Contractor shall complete Pre-Functional Checklists to verify systems, subsystems, and equipment installation is complete and systems are ready for Systems Functional Performance Testing. The Commissioning Agent will prepare Pre-Functional Checklists to be used to document equipment installation. The Contractor shall complete the checklists. Completed checklists shall be submitted to the VA and to the Commissioning Agent for review. The Commissioning Agent may spot check a sample of completed checklists. If the Commissioning Agent determines that the information provided on the checklist is not accurate, the Commissioning Agent will return the marked-up checklist to the Contractor for correction and resubmission. If the Commissioning Agent determines that a significant number of completed checklists for similar equipment are not accurate, the Commissioning Agent will select a broader sample of checklists for review. If the Commissioning Agent determines that a significant number of the broader sample of checklists is also inaccurate, all the checklists for the type of equipment will be returned to the Contractor for correction and resubmission. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for submittal requirements for Pre-Functional Checklists, Equipment Startup Reports, and other commissioning documents.

3.3 CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 32 shall be scheduled and documented in accordance with Section 01 00 01 GENERAL REQUIREMENTS. All testing shall be incorporated into the project schedule. Contractor shall provide no less than 15 calendar-days' notice of testing. The Commissioning Agent will witness selected Contractor tests at the sole

discretion of the Commissioning Agent. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.4 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance under steady-state conditions, to test system reaction to changes in operating conditions, and system performance under emergency conditions. The Commissioning Agent will prepare detailed Systems Functional Performance Test procedures for review and approval by the Resident Engineer/Contracting Officer's Representative (RE/COR). The Contractor shall review and comment on the tests prior to approval. The Contractor shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The Commissioning Agent will witness and document the testing. The Contractor shall sign the test reports to verify tests were performed. See Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS for additional details.

3.5 TRAINING OF VA PERSONNEL

- A. Training of the VA operation and maintenance personnel is required in cooperation with the RE/COR and Commissioning Agent. Provide competent, factory-authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. Contractor shall submit training agendas and trainer resumes in accordance with the requirements of Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS. The instruction shall be scheduled in coordination with the RE/COR after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 32 Sections for additional Contractor training requirements.

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**SECTION 32 12 16
ASPHALT PAVING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Composition, mixing, and construction on prepared subgrade and protection of hot asphalt concrete pavement.
 - 2. Cold milling.
 - 3. Patching.

1.2 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. 2016 - Standard Specifications for Transportation Materials and Methods of Sampling and Testing, and AASHTO Provisional Standards.
 - 2. M320-10 - Performance-Graded Asphalt Binder.
 - 3. T283-14 - Resistance of Compacted Asphalt Mixtures to Moisture-Induced Damage.
- C. Asphalt Institute:
 - 1. Specification SS2.
- D. ASTM International (ASTM):
 - 1. C29/C29M-16 - Bulk Density ("Unit Weight") and Voids in Aggregate.
 - 2. C977-10 - Quicklime and Hydrated Lime for Soil Stabilization.
 - 3. D3786/D3786M-13 - Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method.
 - 4. D4355/D4355M-14 - Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
 - 5. D4632/D4632M-15a - Grab Breaking Load and Elongation of Geotextiles.
 - 6. D6390-11 - Draindown Characteristics in Uncompacted Asphalt Mixtures.
- E. National Asphalt Paving Association (NAPA):
 - 1. PS-33 (2009) - Porous Asphalt Pavements.
- F. Michigan Department of Transportation (MDOT) Standard Specifications for Construction (2012)

1.3 PREINSTALLATION MEETINGS

- A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.
 - 1. Required Participants:
 - a. Resident Engineer/ Contracting Officer's Representative (RE/COR).
 - b. Architect/Engineer.
 - c. Inspection and Testing Agency.

- d. Contractor.
- e. Installer.
- 2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
 - a. Installation schedule.
 - b. Installation sequence.
 - c. Preparatory work.
 - d. Protection before, during, and after installation.
 - e. Installation.
 - f. Terminations.
 - g. Transitions and connections to other work.
 - h. Inspecting and testing.
 - i. Other items affecting successful completion.
- 3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Concrete wheel stops.
- C. Test Reports: Certify products comply with specifications.
 - 1. Aggregate Base Course.
 - 2. Porous Asphalt and Asphalt Base/Surface Course.
 - 3. Job-mix formula.
- D. Certificates: Certify products comply with specifications.
 - 1. Asphalt prime and tack coat material complying with MDOT requirements.
 - 2. Asphalt cement complying with MDOT requirements.
 - 3. Job-mix certification that mix equals or exceeds MDOT requirements.
- E. Qualifications: Substantiate qualifications comply with specifications.
 - 1. Manufacturer
 - 2. Land Surveyor.
- F. One copy of MDOT Standard Specifications for Construction (Latest Edition).
- G. Sequencing plans for mill and overlay operations.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Regularly manufactures specified products.
 - 2. Manufactured specified products with satisfactory service on five similar installations for minimum five years.

- B. RE/COR to have access to all parts of material producing plants to check mixing operations and materials and adequacy of equipment.
- C. Land Surveyor: Professional land surveyor or engineer registered to provide land surveys in jurisdiction where project is located.
- D. Preconstruction Testing:
 - 1. Engage independent testing laboratory to perform tests and submit reports.
 - 2. Asphalt Base Course:
 - a. Test sources, gradation, liquid limit, plasticity index, percentage of wear, and other properties required by MDOT.
 - 3. Porous Asphalt and Asphalt Base/Surface Course:
 - a. Test aggregate source, gradation, soundness loss, percentage of wear, and other properties required by MDOT.
 - 4. Job Mix Formula:
 - a. Test required by MDOT.

1.6 FIELD CONDITIONS

- A. Environment:
 - 1. Do not begin asphaltic concrete material placement when atmospheric temperature is below 50 degrees F, nor during fog, rain, or other unsuitable conditions.

1.7 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 ASPHALT PAVING AGGREGATES

- A. Aggregates: Crushed stone, gravel, sand, or other sound, durable mineral materials processed and blended, and naturally combined.
- B. Aggregate Subbase: Class II in accordance with Section 902.07 of the MDOT Standard Specifications for Construction.
- C. Crushed Aggregate Base Course Class II in accordance with Section 302 of the Michigan DOT Standard Specifications. If crushed gravel or some other material is used in lieu of crushed stone, the material may have a lower structural coefficient and a thicker base may be required.
- D. Asphaltic Binder Course: in accordance with Michigan DOT Standard Specifications, Section 601
- E. Asphaltic Surface Course: in accordance with Michigan DOT Standard Specifications, Section 501.

2.2 NON-WOVEN GEOTEXTILE FABRIC

- A. Fabric: Needled nonwoven polypropylene fibers with the following properties:
 - 1. Grab Tensile Strength (ASTM D4632) \geq 120 lbs.
 - 2. Mullen Burst Strength (ASTM D3786) \geq 225 psi.

3. Flow Rate (ASTM D4491) \geq 95 gal/min/sq. ft.
4. UV Resistance after 500 hours (ASTM D4355) \geq 70 percent.
5. Heat-set or heat-calendared fabrics are not acceptable.

2.3 ASPHALTS

- A. Comply with Asphalt Institute Specification SS2:
 1. Asphalt cement: Mix Type E3 in accordance with Table 902.06 of the MDOT Standard Specifications for Construction.
 2. Prime coat: Cut-back type, grade MC-250.
 3. Tack coat: Uniformly emulsified, grade SS-1H.

2.4 SEALER

- A. Sealer: Suitable fibrated chemical type asphalt base binders and fillers with container consistency suitable for troweling after thorough stirring and containing no clay or other deleterious substance.
- B. In conflicts between this specification and requirements in latest version of MDOT Specifications, MDOT Specifications take precedence.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Land Surveyor to establish and control pavement (aggregate or asphalt base course and asphalt surface course) alignments, grades, elevations, and cross sections as shown on Drawings.

3.2 MIXING ASPHALTIC CONCRETE MATERIALS

- A. Provide hot plant-mixed asphaltic concrete paving materials.
 1. Temperature leaving plant: 290 degrees F minimum, 320 degrees F maximum.
 2. Temperature at time of placing: 280 degrees F minimum.

3.3 SUBGRADE

- A. Subgrade Preparation: Section 31 20 00 EARTHWORK.
- B. Shape to line and grade and compact with self-propelled rollers.
- C. Fill depressions developed under rolling with acceptable material and re-roll area.
- D. Remove soft areas, fill with acceptable materials and re-roll area.
- E. If subgrade becomes rutted or displaced before the placing of subbase, rework subgrade to bring to line and grade.
- F. Proof-roll subgrade with maximum 50-ton gross weight dump truck as directed by RE/COR. If pumping, pushing, or other movement is observed, rework area to provide stable and compacted subgrade.
- G. Final subgrades shall be compacted to a minimum of 90% of the Modified Proctor for fine-grained soils and 95% for granular soils.

3.4 BASE COURSES

- A. Subbase:

1. Spread and compact to thickness shown on drawings.
 2. Begin rolling at sides, continue toward center, and continue until there is no movement ahead of roller.
 3. After completion of subbase rolling, no hauling is permitted over subbase, except top course material delivery.
- B. Base:
1. Spread and compact to thickness shown on Drawings.
 2. Begin rolling sides, continue toward center, and continue until there is no movement ahead of roller.
 3. After completion of base rolling, no hauling is permitted over base except top course material delivery.
- C. Thickness Tolerance: Compacted thicknesses shown on Drawings within minus 0.0 inches to plus 0.5 inch.
- D. Smoothness Tolerance: Lines and grades shown on Drawings within 3/16 inch in 10 feet.
- E. Moisture Content: Only amount required to achieve specified compaction.

3.5 ASPHALTIC CONCRETE PAVING PLACEMENT

- A. Remove all loose materials from compacted base.
- B. Apply prime coat, and tack coat where required, and allow to dry according to manufacturer's instructions as approved by RE/COR.
- C. Receipt of Asphaltic Concrete Materials:
1. Do not accept material unless covered with tarpaulin until unloaded, and unless material is minimum 280 degrees F.
 2. Do not begin asphaltic concrete material placement when atmospheric temperature is below 50 degrees F, nor during fog, rain, or other unsuitable conditions.
- D. Spreading:
1. Spread material with minimal handling.
 2. For finished paving 3 inches or less, spread in one layer.
- E. Rolling:
1. After material has been spread to proper depth, roll until surface is hard, smooth, unyielding, and true to thickness and elevations shown on drawings.
 2. Roll in minimum two directions until no roller marks are visible.
 3. Finished paving smoothness tolerance:
 - a. No depressions which will retain standing water.
 - b. Maximum deviation: 1/8 inch in 6 feet.

3.6 SEAL COAT APPLICATION

- A. Prepare surfaces, mix seal coat material, and apply according to manufacturer's instructions as approved by RE/COR.

- B. Apply one coat of sealer.
- C. Finished surface seal, when dry and thoroughly set, to be smooth, tough, resilient, of uniform black color, and free from coarse textured areas, lap marks, ridges, and other surface irregularities.

3.7 COLD MILLING

- A. Clean existing pavement surface of loose or deleterious material immediately before cold milling. Remove existing asphalt pavement to grades and cross sections indicated on Drawings.
 - 1. Cold milling operations shall be performed at night. All roadways shall be stabilized and open to the public by 7 a.m. each day.

3.8 PATCHING

- A. Hot Mix Asphalt Pavement: Sawcut patch perimeter and excavate existing pavement to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated on drawings. Cut excavation faces vertically. Remove excavated material. Recompact existing aggregate base course to provide new subgrade.
- B. Tack Coat: Apply uniformly to vertical and horizontal surfaces abutting area to receive new hot mix asphalt paving at rate of 0.05 to 0.15 gal./sq.yd.
 - 1. Allow tack coat to cure before applying hot mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, remove spillage and clean affected surfaces.
- C. Patching: Fill excavated pavement with hot mix asphalt base mix for full thickness of patch; while still hot, compact flush with adjacent pavement surface.

3.9 CLEANING

- A. Remove debris, rubbish, and excess material from project site.

3.10 PROTECTION

- A. Protect asphaltic concrete paved areas from traffic until sealer is set and cured and does not pick up under foot or wheeled traffic.
- B. Repair damage.

--- E N D ---

**SECTION 32 17 23
PAVEMENT MARKINGS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes paint and reflective glass beads on pavement surfaces, in form of traffic lanes, parking bays, areas restricted to handicapped persons, crosswalks, and other detail pavement markings.

1.2 RELATED REQUIREMENTS

- A. Paint VOC Limits: Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. Federal Specifications (Fed. Spec.):
 - 1. TT-B-1325D - Beads (Glass Spheres) Retro-Reflective.
 - 2. TT-P-1952F - Paint, Traffic and Airfield Marking, Waterborne.
- C. Master Painters Institute (MPI):
 - 1. No. 97 - Traffic Marking Paint, Latex.

1.4 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Submittal Drawings:
 - 1. Show pavement marking configuration and dimensions.
 - 2. Show international symbol of accessibility at designated parking spaces.
- C. Manufacturer's Literature and Data:
 - 1. Description of each product.
 - 2. Application instructions.
- D. Samples:
 - 1. Paint: 8 inches square, each type and color.
- E. Certificates: Certify products comply with specifications.
- F. Qualifications: Substantiate qualifications comply with specifications.
 - 1. Installer with project experience list.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Regularly installs specified products.
 - 2. Installed specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.

1.6 DELIVERY

- A. Deliver products in manufacturer's original sealed packaging.

- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.
- C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

- A. Store products indoors in dry, weathertight conditioned facility.
- B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

- A. Environment:
 - 1. Product Temperature: Minimum 55 degrees F for minimum 48 hours before installation.
 - a. Surface to be painted and ambient temperature: Minimum 50 degrees F and maximum 95 degrees F.
- B. Field Measurements: Verify field conditions affecting traffic marking installation. Show field measurements on Submittal Drawings.

1.9 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

- A. Design paint complying with specified performance:
 - 1. Application: Fed. Spec. TT-P-1952F.

2.2 PRODUCTS - GENERAL

- A. Provide each product from one manufacturer and from one production run.
 - 1. Low Pollutant-Emitting Materials: Comply with VOC limits specified in Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for the following products:
 - a. Paints and coatings.

2.3 SANDBLASTING EQUIPMENT

- A. Air compressor, hoses, and nozzles of proper size and capacity as required for cleaning surfaces to be painted. Compressor to provide minimum 150 cfm of air at pressure of minimum 90 psi at each nozzle used.

2.4 PAINT APPLICATOR

- A. Apply marking paint with approved mechanical equipment. Provide equipment constant agitation of paint and travel at controlled speeds. Synchronize one or more paint "guns" to automatically begin and cut off paint flow in case of skip lines. Provide pneumatic spray guns for hand application of paint in areas where mobile paint applicator cannot be used.

2.5 PAINT

- A. Paint: MPI No. 97. For obliterating existing markings comply with Fed. Spec. TT-P-1952F. Provide minimum 5 gal. containers.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

- A. Examine and verify substrate suitability for product installation.
 - 1. Allow new pavement surfaces to cure for minimum 14 days before application of marking materials.
- B. Protect existing construction and completed work from damage.
- C. Clean substrates. Remove contaminants capable of affecting subsequently installed product's performance.
 - 1. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or combination of these methods.
 - 2. Completely remove rubber deposits, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushings, sandblasting, mechanical abrasion, or approved chemicals as directed by Resident Engineer/Contracting Officer's Representative (RE/COR).
 - 3. Application of paint conforming to Fed. Spec. TT-P-1952F is an option to removal of existing paint markings on asphalt pavement. Apply black paint in as many coats as necessary to completely obliterate existing markings.
 - 4. Where oil or grease are present on old pavements to be marked, scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application.
 - a. After cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through new paint.
 - 5. Pavement marking to follow as closely as practicable after surface has been cleaned and dried, but do not begin any marking until RE/COR has inspected surface and gives permission to proceed.

3.2 TEMPORARY PAVEMENT MARKING

- A. Apply Temporary Pavement Markings of colors, widths and lengths shown on drawings or directed by RE/COR. Upon RE/COR direction, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method to avoid damage. As an option, provide approved preformed pressure sensitive, adhesive tape type of temporary pavement marking of required colors, widths and lengths in lieu of temporary painted marking. Remove any unsatisfactory tape type marking and replace with painted and reflective markings at no additional cost to Government.

3.3 INSTALLATION - GENERAL

- A. Install products according to manufacturer's instructions and approved submittal drawings.
 - 1. When manufacturer's instructions deviate from specifications, submit proposed resolution for RE/COR consideration.

3.4 PAINT APPLICATION

- A. Apply uniformly painted pavement marking of required colors, length, and width with true, sharp edges and ends on properly cured, prepared, and dried surfaces in conformance with details shown on drawings and established control points.
 - 1. Skip Markings Line Tolerances:
 - a. Length: Plus or minus 3 inches.
 - b. Width: Plus or minus 1/8 inch.
 - c. Length of intervals exceeding line length tolerance are not acceptable.
 - 2. Apply paint at wet film thickness of 0.015 inch. Apply paint in one coat.
 - 3. At the direction of RE/COR, apply additional coats at markings showing light spots.
 - 4. Comply with paint manufacturer's maximum drying time requirements to prevent undue softening of asphalt, and pick-up, displacement, or discoloration by tires of traffic.
 - 5. If any deficiency in marking drying occurs, discontinue paint operations until cause of slow drying is determined and corrected.
 - 6. Remove and replace marking applied at less than minimum material rates, deviates from true alignment, exceeds stipulated length and width tolerances, or shows light spots, smears, or other deficiencies or irregularities. Remove marking so that surface to which marking was applied will not be damaged by carefully controlled sand blasting, approved grinding equipment, or other approved method.

3.5 DETAIL PAVEMENT MARKING

- A. Apply Detail Pavement Markings in locations indicated on drawings. Apply International Handicapped Symbol where indicated in parking spaces. Color as shown on drawings. Apply paint for symbol using suitable template that will provide pavement marking with true, sharp edges and ends. Place detail pavement markings of colors, widths and lengths, and design pattern at locations shown on drawings.

3.6 CLEANING

- A. Remove excess paint before paint sets.
- B. Remove all debris, rubbish and excess material from project site.

3.7 PROTECTION

- A. Protect pavement markings from traffic and construction operations.
 - 1. Protect newly painted markings track free.
 - 2. Place warning signs to alert traffic from both directions.
 - 3. Place small flags or other similarly small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.
- B. Repair damage.

--- E N D ---

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Zinc-coated chain link fence, gates and accessories.
2. This work consists of all labor, materials, and equipment necessary for furnishing and installing chain link fence in the maintenance yard, where it is removed by the Contractor as part of the work in the vicinity of where the new outdoor storage covering is to be constructed. The Contractor may reuse existing fencing element fencing elements where they can be salvaged without causing damage to the elements during the removal process. Fence fabric, horizontal top and middle rails, tension wire, stretcher bars, rail connection end pieces may be reused at the Contractor's discretion, if the elements are carefully removed, stored so they don't get damaged and are inspected and approved as acceptable by the Resident Engineer/ Contracting Officer's Representative (RE/COR) before they are installed. If any existing chain link fence elements are not acceptable to the RE/COR, they shall be provided as new and shall match the existing.

1.2 RELATED REQUIREMENTS

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES: Submittal Requirements.
- B. Section 03 30 53, CAST-IN-PLACE CONCRETE: Concrete Footings.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. ASTM International (ASTM):
 1. A121-13 - Metallic Coated Carbon Steel Barbed Wire.
 2. A392-11a - Zinc-Coated Steel Chain-Link Fence Fabric.
 3. A817-12 - Metal-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire.
 4. F567-14a - Installation of Chain-Link Fence.
 5. F626-14 - Fence Fittings.
 6. F668-11 - Polyvinyl Chloride (PVC) and other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
 7. F900-11 - Industrial and Commercial Swing Gates.
 8. F934-96 (R2013) - Standard Colors for Polymer-Coated Chain Link Fence Materials.
 9. F1083-16 - Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
 10. F1184-16 - Industrial and Commercial Horizontal Slide Gates. Federal Specifications (Fed. Spec.):

- C. American Welding Society (AWS):
 - 1. D1.2-14 - Structural Welding Code - Aluminum.
- D. Federal Specifications (Fed. Spec.).

1.4 SUBMITTALS

- A. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES: Submittal Procedures.
- B. Submittal Drawings:
 - 1. Show size, configuration, and fabrication and installation details.
- C. Manufacturer's Literature and Data:
 - 1. Description of each product.
 - 2. Installation instructions.
 - 3. Warranty.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Regularly manufactures specified products.
 - 2. Manufactured specified products with satisfactory service on five similar installations for minimum five years.

1.6 DELIVERY

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.
- C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

- A. Protect products from damage during handling and construction operations.

1.8 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."
- B. Manufacturer's Warranty: Warrant against material and manufacturing defects.
 - 1. Warranty Period: Five years.

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

- A. Provide fences and gates from one manufacturer.

2.2 CHAIN-LINK FENCE

- A. Materials: ASTM F1083 and ASTM A392 ferrous metals, zinc-coated.
 - 1. ASTM A934 PVC coating system, black.
- B. Chain-Link Fabric: ASTM A392 9 gage wire woven in 2-inch mesh. Knuckle top and bottom selvage. Zinc-coating weight 2.0 ounces per square foot.

- C. Post: ASTM F1083, Grade SK-40A, round, zinc-coated steel. Size and type as indicated on Drawings. Provide post braces and truss rods for each gate, corner, pull or end post. Provide truss rods with turnbuckles or other equivalent provisions for adjustment.
- D. Top Rail and Bottom Rail: ASTM F1083, Grade SK-40A, round, zinc-coated steel.
- E. Top and Bottom Tension Wires: ASTM A817 and ASTM F626, zinc-coated, with minimum coating same as fence fabric.

2.3 CONCRETE

- A. Concrete: As specified in Section 03 30 53, CAST-IN-PLACE CONCRETE.

2.4 ACCESSORIES

- A. General: ASTM F626, caps, rail and brace ends, wire ties or clips, braces and tension bands, tension bars, truss rods, and miscellaneous accessories.
- B. Barrier Coating: ASTM D1187/D1187M.
- C. Welding Materials: AWS D1.2/D1.2M, type to suit application.
- D. Galvanizing Repair Paint: MPI No. 18.
- E. Touch-Up Paint: Match shop finish.
- F. Fencing Slats: Fence screen 2000 series or approved equal. Color black.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine and verify substrate suitability for product installation.
- B. Protect existing construction and completed work from damage.
- C. Remove existing fence and gate to permit new installation.
 - 1. Retain existing fence and gate for reuse.
 - 2. Dispose of other removed materials.
- D. Correct substrate deficiencies.
 - 1. Fill.
 - 2. Grind.
 - 3. Level.
- E. Apply barrier coating to aluminum surfaces in contact with dissimilar metals and cementitious materials to minimum 30 mils dry film thickness.

3.2 INSTALLATION - GENERAL

- A. General: Comply with ASTM F567. Install products according to manufacturer's instructions.
 - 1. When manufacturer's instructions deviate from specifications, submit proposed resolution for RE/COR consideration.
- B. Excavation: Excavate concrete-embedded items of dimensions indicated on Drawings, except in bedrock. When bedrock is encountered before reaching required depth, continue excavation to depth indicated or 18 inches into bedrock, whichever is less, and provide minimum 2 inches

larger diameter than outside diameter of post. Clear loose material from post holes. Grade area around finished concrete footings as shown and dispose of excess earth as directed by the RE/COR.

- C. Post Setting: Install posts plumb and in alignment. Set post in concrete footings of dimensions indicated on Drawings, except in bedrock. Compact concrete free of voids and finish in slope or dome. Install posts in bedrock with non-shrink grout minimum one inch around each post, free of voids and finish in slope or dome. Cure concrete and grout minimum 72 hours.
- D. Post Caps: Snugly fit exposed ends of post with caps. Install caps to accommodate top rail. Install post caps according to manufacturer's instructions and as indicated on Drawings.
- E. Supporting Arms: Install supporting arms according to manufacturer's instructions and as indicated on Drawings.
- F. Top Rails and Bottom Rails: Install rails before installing chain link fabric. Install expansion couplings (rail sleeves) spaced according to manufacturer's instructions. Install expansion couplings over expansion joints in wall when fence is on top of wall.
- G. Top and Bottom Tension Wire: Install and pull taut tension wire before installing chain-link fabric.
- H. Accessories: Install accessories (posts braces, tension bands, tension bars, truss rods, and miscellaneous accessories), as required and recommended by the manufacturer, for complete fence installation, with fabric taut and attached to posts, rails, and tension wire.
- I. Touch up damaged factory finishes.
 - 1. Repair galvanized surfaces with galvanized repair paint.

3.3 FABRIC

- A. Pull fabric taut and secure with wire ties or clips to top rail bottom rail and tension wire close to both sides of each post and at intervals maximum 24 inches on centers. Secure fabric to posts using stretcher bars and ties or clips.

3.4 REPAIR OF GALVANIZED SURFACES

- A. Use galvanized repair compound, stick form, or other method, where galvanized surfaces need field or shop repair. Repair surfaces according to manufacturer's directions.

3.5 CLEANING

- A. Remove debris, rubbish and excess material from site.

--- E N D ---

**SECTION 32 33 00
SITE FURNISHINGS**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Gravesite Layout Markers at specified locations.
 - 2. Flower-watering stations, including trash receptacles, water spigot, and flower vase container.
 - 3. Benches.
 - 4. Flag Sleeves.

1.2 RELATED REQUIREMENTS

- A. Materials product data and samples: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Product and Finish Color: Specified below or as shown in drawings to match existing.
- C. Concrete footings: Section 03 30 53, CAST-IN-PLACE-CONCRETE.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. ASTM International (ASTM):
 - 1. ASTM A53/A53M-12 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - 2. B221-14 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
 - 3. B61-15 - Steam or Valve Bronze Castings.
 - 4. B62-15 - Composition Bronze or Ounce Metal Castings.
- C. American Welding Society (AWS):
 - 1. D1.1-2006 - Structural Welding Code - Steel.
 - 2. D1.2-2014 - Structural Welding Code - Aluminum.
- D. National Association of Architectural Metal Manufacturers (NAAMM):
 - 1. AMP 500-06 Metal Finishes Manual.

1.4 SUBMITTALS

- A. Submittals Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES:
- B. Submittal Drawings:
 - 1. Show size, configuration, and fabrication and installation details.
 - 2. Show floral regulations decal content, lettering color and background color.
- C. Manufacturer's Literature and Data:
 - 1. Description of each product.
 - 2. Installation instructions.

- 3. Warranty.
- D. Samples:
 - 1. Each Product: each type and color.
 - a. Submit quantity required to show full color, texture, and range.
 - 2. Trash Receptacle, Markers, Benches, Ash Receptacle, and Flower Vase Receptacle: Full sized, complete assembly.
 - 3. Approved samples may be incorporated into work.
- E. Qualifications: Substantiate qualifications comply with specifications.
 - 1. Manufacturer.
 - 2. Fabricator with project experience list.
 - 3. Installer with project experience list.
- F. Record Documentation:
 - 1. Flag Sleeve: Annotated Record Drawings using swing tie measurements from prominent features, at approximate 90- degree angles.

1.5 QUALITY ASSURANCE

- A. Manufacturer, Fabricator, Installer Qualifications:
 - 1. Regularly manufactures, fabricates, and installs specified products.
 - 2. Manufactured, Fabricated, Installed, specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
 - 1) Photographs, drawings and other documents showing character and quality of final installation.
- B. Installer Qualifications: Product manufacturer..
 - 1. Regularly installs specified products.
 - 2. Installed specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
 - 1) Photographs, drawings and other documents showing character and quality of final installation.

1.6 DELIVERY

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, color, production run number, and manufacture date.
- C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.7 STORAGE AND HANDLING

- A. Store products indoors in dry, weathertight conditioned facility.
- B. Protect products from damage during handling and construction operations.

1.8 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."
- B. Manufacturer's Warranty: Warrant benches, bollards, trash receptacles, flower vase receptacles, flag sleeves and water spigots against material and manufacturing defects.
 - 1. Warranty Period: Three years.

PART 2 - PRODUCTS - GENERAL

2.1 PRODUCTS - GENERAL

- A. Basis of Design: Match color of existing products on site.
- B. Provide each product from one manufacturer.

2.2 FLOWER WATERING STATIONS

- A. General: Materials, finishes and colors match existing.

2.3 GRAVESITE LAYOUT MARKERS

- A. General: Provide both Gravesite Grid Monuments and Gravesite Grid Markers.
 - 1. Gravesite Grid Monuments: Bronze survey marker (monument marker) set into cast-in-place concrete base.
 - a. Materials:
 - 1) Monument Base: Cast-in-place concrete monument base, minimum of 3,500 psi @ 28 days, reinforcement and dimensions as indicated on Drawings.
 - 2) Monument Marker: Domed-top, 3 1/2" diameter, bronze concrete survey marker with integral locator magnet, and flared anchor post for concrete installation.
 - 2. Gravesite Grid Markers: Bronze survey marker (Grid Marker) with insulator set on No. 6 rebar.
 - a. Materials:
 - 1) Grid Marker: Domed-top, 3 1/4 inches diameter, bronze concrete marker.
 - 2) Rebar: Manufacturer's standard rebar, No. 6; dimension as indicated on Drawings.
 - 3) Insulator: Manufacturer's standard plastic insulator.
- B. Text and Cross-hairs: Top text as indicated on Drawings.
 - 1. Text: All caps, 3/16 inches high.
 - 2. Cross hairs: Field engrave as indicated on Drawings. Align gravesite grid and engrave based on surveyed location data.

2.4 TRASH RECEPTACLE

- A. Trash Receptacles: Match existing.
 - 1. Steel Body Construction:
 - a. Vertical Bar: Solid steel, 3/8 x 1 inch.
 - b. Horizontal Bands: Solid steel, 1/4 x 2-1/2 inches.
 - c. Support Bars: Steel, 3/8 x 3 inches.

- d. Top Ring: Solid steel, 5/8 inch.
- e. Leveling Feet: 3/8-inch diameter threaded steel shaft.
- f. Joints: Fully welded, grind smooth.
- 2. Capacity: 36-gallon.
- 3. Inner Liner: High-density plastic inner liner, 6 lbs. maximum weight.
- 4. Lids: Manufacturer's standard tapered formed lid and dome, secured with stainless steel aircraft cable and attachments, with self-closing door.
- 5. Mounting Plate: Standard (1) anchor bolt hole.
- 6. Identification: Identify trash receptacle with the word "TRASH," as indicated in Drawings, material, finish, color, letter style and size to match existing..
- 7. Steel Powder Coat Finish: Manufacturer's standard shot blasted, etched, phosphatized, preheated, and electrostatically polyester, powder coatings, 200-250 microns dry film thickness.
 - a. Color: To match existing.

2.5 FLOWER VASE RECEPTACLE

- A. Materials: To match existing, with special lightweight hinged lid.
 - 1. Size: As indicated on Drawings.
 - 2. Finish and Color: Same as trash receptacle, except as follows:
 - a. Identification: Identify flower vase receptacles with the word "FLOWER VASES" as indicated on Drawings.
 - b. Decal: "Floral Regulations" decal, factory applied pressure sensitive vinyl on top of receptacle lid as indicated on Drawings. Contents and color approved by Resident Engineer/Contracting Officer's Representative (RE/COR).

2.6 WATER SPIGOT ASSEMBLIES

- A. Water spigots, to match existing, Victor Stanley color coating approved by RE/COR, or approved equal, freeze resistant, with integral shut-off valve.
 - 1. Housing: Cast aluminum, paint finish, color to match Victor Stanley paint system.
 - 2. Inner Supply: Solid-brass castings, ASTM B61 and B62.
 - 3. Lever Handle: Aluminum-bronze casting, self-closing, operates with maximum 5 lbs. force at maximum 40 psi inlet water pressure.
 - 4. Outer casings and inner supply line: Manufacturer's standard galvanized steel pipe.
 - 5. Nozzle: Solid brass casting.
 - 6. Outlet: Plain ends.

2.7 BENCHES

- A. Description: Front welds ground and polished to form continuous surface from top tubular section to each vertical steel slat. Steel seat members reverse contoured; solid steel bar end sections,

welded and ground; end arm rests standard integral welded configuration, with no center armrests.

1. Bench 1 – Arcata Backless Bench w/polysite slats by Landscape Forms or approved equal.
 2. Bench 2 – Arcata Backed Bench w/polysite slats by Landscape Forms or approved equal.
- B. Material: Steel and recycled materials.
- C. Locations, sizes and quantities as indicated Drawings.
- D. Finish: Manufacturer's standard shotblasted, etched, phosphatized, preheated, and electrostatically polyester, powder coatings.
1. Color: Steel, to match existing – Landscape Forms “Graphite” or approved equal.
 - a. Color: Polysite slats, to match existing – Landscape Forms “Driftwood” or approved equal.
- E. Mounting Hardware: Tamper resistance stainless steel. Exposed bolt ends or flat bolt heads are not acceptable.

2.8 FLAG SLEEVES

- A. Provide flag sleeves at locations and details on Drawings to match existing flag sleeves.

2.9 FINISHES

- A. Steel Finish:
1. Powder-Coat Finish: Manufacturer's standard two-coat finish system consisting of the following:
 - a. One coat primer.
 - b. One coat thermosetting topcoat.
 - c. Dry-film Thickness: 2 mils minimum.
 - d. Color: Match existing on site.
- B. Aluminum Anodized Finish: NAAMM AMP 500.
1. Clear Anodized Finish: AA-C22A41; Class I Architectural, 0.7 mil thick.
 2. Color Anodized Finish: AA-C22A42 or AA-C22A44; Class I Architectural, 0.7 mil thick.
 3. Clear Anodized Finish: AA-C22A31; Class II Architectural, 0.4 mil thick.
 4. Color Anodized Finish: AA-C22A32 or AA-C22A34; Class II Architectural, 0.4 mil thick.
- C. Aluminum Paint finish:
1. Baked-Enamel or Powder-Coat Finish: Polyester powder coating. Comply with manufacturer's coating process.
 2. Fluorocarbon Finish: AAMA 2605; 70 percent fluoropolymer resin, 2-coat system.

2.10 ACCESSORIES

- A. Primers: General metal – fast drying alkyd.
- B. Welding Materials: AWS D1.1/D1.1M, type to suit application.
- C. Fasteners: Tamper resistant Stainless steel, acorn nut.
- D. Anchors: Per manufacturer's recommendation for application.

- E. Galvanizing Repair Paint: MPI No. 18.
- F. Touch-Up Paint: Match shop finish.
- G. Concrete Footing: Comply with Section 03 30 53, CAST-IN-PLACE CONCRETE.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Inspect planned installation materials and locations. Notify RE/COR of any discrepancies in conditions.
 - 1. Verify materials are damage free and compliant with Drawings. Report non-compliance to RE/COR.

3.2 PREPARATION

- A. Examine and verify substrate suitability for product installation.
- B. Protect existing construction and completed work from damage.
- C. Correct substrate deficiencies.
 - 1. Fill.
 - 2. Grind.
 - 3. Level.
- D. Stake alignment and locations for approval by RE/COR. Verify elements "fit" within location provided.

3.3 INSTALLATION - GENERAL

- A. Install products according to manufacturer's instructions and approved submittal drawings.
 - 1. When manufacturer's instructions deviate from specifications, submit proposed resolution for RE/COR consideration.
 - 2. Install items rigid and plumb as indicated on Drawings.
- B. Gravesite Grid Monuments and Markers:
 - 1. Install at locations indicated on Drawings.
- C. Flower Watering Stations:
 - 1. Stake flower watering station location. Obtain RE/COR approval before forming concrete pad. Install concrete pad according to Section 03 30 53, CAST-IN-PLACE CONCRETE.
 - 2. Anchor flower vase container as indicated on Drawings and manufacturer's instructions.
- D. Trash and Recycle Receptacle:
 - 1. Anchor receptacle as indicated on Drawings and manufacturer's instructions.
- E. Water Spigot:
 - 1. Install water spigot assemblies according to manufacturer's instructions, including pipe, isolation valve, fittings, pressure reducing valve, and valve boxes. Install washed stone for splash area.
- F. Benches:

1. Install benches as recommended by manufacturer.

G. Flag Sleeves:

1. Install flag sleeves with flag poles set plumb and top sleeves set at correct elevation, on finish grade, so as not to interfere with mowing operations.
2. Mark Flag sleeve locations along adjoining roadway, chiseled mark in curb perpendicular to road centerline.

3.4 CLEANING

- A. Clean exposed surfaces. Remove contaminants and stains.
- B. Polish exposed surfaces.
- C. Remove excess material and debris. Clean above ground portions of receptacles and other site improvements.

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**SECTION 32 84 00
PLANTING IRRIGATION**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Contractor is responsible for providing a system with full and complete coverage. Furnish all labor, materials, supplies, equipment, tools, and transportation, and perform all operations in connection with and reasonably incidental to the complete installation of the irrigation system, and guarantee/warranty as shown on the drawings, the installation details, and as specified herein.

Items of work specifically included are:

1. Procurement of all applicable licenses, permits, and payment of required fees.
2. Coordination of Utility Locates ("Call Before You Dig").
3. Maintenance period.
4. Sleeving for irrigation pipe and wire.

1.2 RELATED WORK

- A. Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS
- B. Division 26 ELECTRICAL
- C. Section 32 08 00 COMMISSIONING OF PLANTING IRRIGATION SYSTEMS
- D. Section 32 33 00 SITE FURNISHINGS
- E. Section 32 90 00 PLANTING

1.3 QUALITY ASSURANCE

- A. Contractor:
1. Irrigation Contractor must have demonstrated, using persons directly employed by the Contractor, experience with the installation of at least five (5) irrigation systems having large diameter gasketed pipe (8-inch and larger), centralized control systems with RF communication, 24 VAC electrically operated remote-control valves and large radius rotary sprinklers (minimum 1-inch inlet with pre-fabricated swing joint assembly).
 2. Irrigation Contractor and project superintendent must be certified by control system manufacturer as a certified Contractor and provide RF survey for installation of control system RF antennas, wiring and grounding systems. Provide documentation from control system manufacturer regarding certification.
 3. Irrigation Contractor and Project superintendent must be currently an Irrigation Association Certified Irrigation Contractor (CIC) and in good standing.
 4. Irrigation Contractor must be licensed in the Michigan.
 5. Provide documentation of Contractor qualifications with equipment submittals.
- B. Equipment Manufacturer:
1. Manufacturer regularly and presently manufactures the item as one of their principal products.

C. System Requirements:

1. Full and complete coverage is required. Contractor shall, at no additional cost to the Government, make necessary adjustments to layout required to achieve full coverage of irrigated areas.
2. Layout work as closely as possible to drawings. Drawings are diagrammatic to the extent that swing joints, offsets and all fittings are not shown.

1.4 SUBMITTALS

- A. Make submittal and provide number of copies per Section 01 33 23 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES. If not specified, provide digital copies of irrigation information in PDF format with table of contents and index sheet. Provide sections that are indexed and labeled for Contractor qualifications, valves, sprinklers, pipe and fittings, wire and wire connectors, ID tags, shop drawings sign and all other irrigation equipment shown or described on the drawings and within these specifications. Highlight items being supplied on the catalog cut sheets. Submittal package must be complete prior to being reviewed by the Resident Engineer/Contracting Officer Representative (RE/COR). Incomplete submittals will be returned without review.
1. Materials List: Include all materials and products that are part of the irrigation system including, but not limited to: pipe, fittings, valves, mainline components, water emission components, and control system components. Quantities of materials need not be included.
 2. Manufacturers' Data: Submit manufacturers' catalog cuts, specifications, and operating instructions for equipment shown on the materials list. For rotary sprinklers include Center for Irrigation Technology SpacePro Single Leg Profile showing the Distribution Uniformity and Scheduling Coefficient for the nozzles being used at the specified offset spacing.
 3. Equipment submitted must conform to the Buy American Act. Provide manufacturing location of items submitted.
 4. Shop Drawings: Submit shop drawings called for in the installation details. Show products required for proper installation, their relative locations, and critical dimensions. Note modifications to the installation detail.
 5. Testing:
 - a. Document the occurrence of all tests on the Daily Report. Indicate which test was conducted and whether it was successful.
 - b. Submit a proof of testing report following completion of each test listed in Part 1 of these specifications. Unless otherwise noted, include name of test, date of test, name of the individual completing the test, name of the company completing the test and a summary of the test results. If system fails test, document all retests until system passes test.

6. Maintenance and Operation Instructions: Submit information listed in Part 3 of these specifications.
7. Colored Irrigation Controller Charts: Submit information listed in Part 3 of these specifications.
8. Record Drawings: Submit information listed in Part 3 of these specifications.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Federal Specifications (Fed. Spec.): RR-F-621E Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
- C. American National Standard Institute (ANSI):
B40.1 Gauges-Pressure Indicating Dial Type Elastic Element
- D. American Society of Agricultural Engineers (ASAE):
S398 Sprinkler Testing and Performance Reporting.
- E. American Society of Civil Engineers (ASCE):
Manual and Reports on Engineering Practice No. 108, "Pipe Design for Installation by Horizontal Directional Drilling" (2005)
- F. American Society for Testing and Materials (ASTM):
B61-15 Steam or Valve Bronze Castings
B62-17 Composition Bronze or Ounce Metal Castings
D1785-15 Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedule 40, 80, and 120
D2241-15 Poly(Vinyl Chloride) (PVC) Pressure Rated Pipe (SDR Series)
D2287-12 Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds
D2464-15 Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
D2466-17 Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
D2564-12 (2018) Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Pipe And Fittings
D2855-15 Making Solvent Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings
D3350-14 Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
F477-14 Elastomeric Seals (Gaskets) for Joining Plastic Pipe
F714-13 Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

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|----------|--|
| F656-15 | Primers for Use In Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings |
| F1962-11 | Use of Maxi-Horizontal Directional Drilling for Placement of Polyethylene Pipe or Conduit Under Obstacles, Including River Crossings |
| F2164-18 | Field Leak Testing for Polyethylene Pressure Piping Systems |
| F2768-09 | Modified Stub ACME Thread Joint with Elastomeric Seal in Plastic Piping Components |
| B209-14 | Aluminum and Aluminum-Alloy Sheet and Plate |
- G. American Water Works Association (AWWA):
- | | |
|---------|--|
| C110-12 | Ductile-Iron and Gray-Iron Fittings, 3-Inch Through 48-Inch for Water and Other Liquids |
| C111-17 | Rubber Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe Fittings. |
| C115-11 | Flanged and Ductile Iron and Gray Iron Pipe with Threaded Flanges |
| C151-17 | Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand Lined Molds, for Water or Other Liquids |
| C153-11 | Ductile-Iron Compact Fittings, 3 Inch Through 12-Inch for Water and Other Liquids. |
| C500-09 | Gate Valves for Water and Sewerage Systems |
| C504-15 | Rubber Sealed Butterfly Valves |
| C600-17 | Installation for Ductile-Iron Water Mains and Their Appurtenances |
| C900-16 | Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. |
| C901-17 | Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service |
- H. Irrigation Association (IA):
- Technical Resources, Irrigation Best Practices & Standards
- I. Manufacturers Standardization Society (MSS):
- | | |
|---------------|--|
| SP70-90, 2011 | Cast Iron Gate Valves, Flanged and Thread Ends |
|---------------|--|
- J. National Electrical Manufacturers Association (NEMA):
- | | |
|--------------|---|
| 250-85, 2014 | Enclosures for Electrical Equipment (1000 Volts Maximum);
Revision 1, May 1986 |
|--------------|---|
- K. National Electric Code: (latest edition 2017)
- L. North American Society for Trenchless Technology (NASTT):

1. Mini-Horizontal Directional Drilling
 2. Horizontal Directional Drilling Good Practices
- M. Plastics Pipe Institute Chapter 12 Horizontal Directional Drilling
- N. Uniform Plumbing Code: (2018)

1.6 RULES AND REGULATIONS

- A. Work and materials will be in accordance with the latest edition of the National Electric Code, the Uniform Plumbing Code, and applicable laws and regulations of the governing authorities.
- B. When the contract documents call for materials or construction of a better quality or larger size than required by the above-mentioned rules and regulations, provide the quality and size required by the contract documents.
- C. If quantities are provided either in these specifications or on the drawings, these quantities are provided for information only. It is the Contractor's responsibility to determine the actual quantities of all material, equipment, and supplies required by the project and to complete an independent estimate of quantities and wastage.

1.7 AVAILABILITY AND USE OF UTILITY SERVICES

- A. The government shall make NO utilities available to the Contractor from existing outlets and supplies except as follows. Upon completion of the irrigation system or completion of portions thereof, the contractor through the temporary connection of the new irrigation system to the potable water system, shall be provided water for flushing and testing of the new irrigation system. Once the system is deemed operable and approved, and prior to the final inspection, the contractor may use water at no cost through the irrigation system for establishing turf and maintaining plant material. No other expressed or implied uses of government furnished water exist.
- B. The Contractor, at Contractor's expense and in a workmanlike manner satisfactory to the RE/COR, shall install and maintain all necessary temporary connections and distribution lines, and meters required by the public utilities. Before final acceptance of the work by the Government, the Contractor shall remove all the temporary connections, distribution lines, meters, and associated appurtenances.

1.8 TESTING

- A. Notify the RE/COR five working days in advance of testing.
- B. Subject pipelines jointed with rubber gaskets or threaded connections to a pressure test after partial completion of backfill. Pipelines jointed with solvent-welded PVC joints will be allowed to cure at least 24 hours before testing.
- C. Subsections of mainline pipe may be tested independently, subject to the review of the RE/COR.
- D. Furnish clean, clear water, pumps, labor, fittings, and equipment necessary to conduct tests or retests.
- E. Volumetric Leakage Test – Gasketed Mainline Pipe:

1. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
 2. Purge all air from the pipeline before test.
 3. Subject mainline pipe to the anticipated operating pressure of 100 PSI for two hours. Maintain constant pressure. The amount of additional water pumped in during the test will not exceed:
 - a. 0.82 gallons per 100 joints of 3-inch diameter pipe
 - b. 1.08 gallons per 100 joints of 4-inch diameter pipe
 - c. 1.62 gallons per 100 joints for 6-inch diameter pipe
 - d. 2.16 gallons per 100 joints for 8-inch diameter pipe.
 4. Allowable leakage to be calculated using $L = (ND\sqrt{P})/7400$ where
 - L = Allowable Leakage
 - N = Number of Joints
 - D = Nominal Diameter of Pipe (inches)
 - P = Average Test Pressure (PSI)
 5. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.
 6. Cement or caulking to seal leaks is prohibited.
- F. Hydrostatic Pressure Test – Solvent Weld Lateral Pipe:
1. Subject lateral pipe to a hydrostatic pressure equal to the anticipated operating pressure of 80 PSI for 30 minutes.
 2. Cap all sprinkler risers.
 3. Backfill to prevent pipe from moving under pressure. Expose couplings and fittings.
 4. Leakage will be detected by visual inspection. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat the test until the pipe passes test.
 5. As an alternative to the visual inspection described in Item 4. above, the RE/COR may request that a pressure drop test be performed:
 - a. Purge air from pipe before test. Attach pressure gauge to a riser in the middle of the lateral. Cap all sprinkler risers.
 - b. Pressurize the lateral via the remote-control valve then turn down flow control handle on remote control valve to seal off lateral.
 - c. Observe pressure loss on pressure gauge. If pressure loss is greater than 5 PSI, identify reason for pressure loss. Replace defective pipe, fitting, joint, valve, or appurtenance. Repeat test until pressure loss is equal to or less than 5 PSI.
 6. Cement or caulking to seal leaks is prohibited.
 7. After lateral passes test and prior to operational test, install sprinklers and backfill and compact all pipe, fittings, joints, or appurtenance.
- G. Operational Test – Remote Control Valves, Lateral Piping and Sprinklers:

1. Activate each remote-control valve in sequence from each controller. Manual operation of the valves from the bleed valve on the remote-control valve is not an acceptable method of activation. The RE/COR will visually observe operation, water application patterns, and leakage.
2. Replace defective remote-control valve, solenoid, wiring, or appurtenance to correct operational deficiencies.
3. Replace, adjust, add, or move water emission devices to correct operational or coverage deficiencies.
4. Replace defective pipe, fitting, joint, valve, sprinkler, or appurtenance to correct leakage problems. Cement or caulking to seal leaks is prohibited.
5. Repeat test(s) until each lateral pass all tests. Repeat tests, replace components, and correct deficiencies at no additional cost to the Owner.

H. Distribution Uniformity (DU):

1. Irrigation Audits
 - a. Performed by an Irrigation Association Certified Landscape Irrigation Auditor.
 - b. Complete an irrigation audit to include five (5) representative irrigation zones/test areas, one per burial section.
 - c. Identify the five (5) areas to be tested based on cemetery site conditions in consultation with the irrigation auditor, Design Team Irrigation Specialist and RE/COR. Submit a map indicating the locations of the zones to be tested.
 - d. Two irrigation zones will be operated for each test area.
2. Sprinkler Characteristics
 - a. Minimum one audit for each combination of sprinkler model, nozzle type, spacing, and pressure commonly used for a burial section.
3. Final determination of the areas to be tested will be based on the recommendation of the Contractor and their understanding of the purpose and goals of performing these irrigation audits with final approval by the Design Team Irrigation Specialist. Submit a map indicating the locations of the zones to be tested.
4. Follow the methodology found in the current edition of the Irrigation Association Landscape Irrigation Auditor Manual and Irrigation Audit Guidelines for performing irrigation audits.
 - a. During each audit, a wind anemometer shall be used, and wind speed information recorded every 5 minutes, and a graph of this information shall be provided with the summary report and audit information.
 - 1) If at any time during the audit the wind exceeds 5 mph, it shall be noted in the summary report.

- 2) If at any time the wind exceeds 10 mph, the audit shall be stopped and restarted (cans emptied and started anew) when the wind drops below 5 mph for an extended period of time, at the discretion of the auditor.
 - 3) If a site is being audited that consistently has winds above 10 mph, then the Contractor and National Irrigation Specialist will determine the best course of action to proceed as to the effect of the wind on the audits.
5. Provide all data called for in the irrigation audit worksheets used in the current edition of the Irrigation Association Landscape Irrigation Auditor Manual.
 - a. Supply all data in a digital (MS Excel format) as well as paper report format to NCA via RE/COR.
 - b. Create similar templates/data sheets as those forms represented in MS Excel if none are readily available to the general public from the Irrigation Association.
 - c. Provide copies of all field notes, drawings, and data collection forms used in the field, to be submitted along with the paper report and digital media versions of the audit information.
6. Do not complete the Pre-Audit Inspection Corrective Actions included in the Irrigation Association Guidelines, as the irrigation system is to be audited in its current condition. However, pressure is to be checked at the pressure regulating device on each valve tested by using a Schrader valve compatible connection and liquid filled pressure gauge. If there is no pressure regulating valve, the closest sprinkler to the RCV will be checked using a pitot tube and liquid filled pressure gauge.
7. Based on the area being audited, the Contractor shall use several catch cans that is divisible by 4, with a minimum of 28 catch cans being used for each audit.
8. Catch cans shall be laid out in a grid format per the current edition of Irrigation Association Landscape Irrigation Audit Manual, based on:
 - a. Number of catch cans used
 - b. Size of the area tested
 - c. Number of sprinklers tested
 - d. Site conditions
 - e. Spacing shall be consistent and in a square pattern throughout each testing area.
9. Catch cans shall be as level as possible prior to beginning the audit. Cal Poly ITRC Catch Cans shall be used or approved equal.
10. If water gets into the catch cans prior to the audit beginning, then all catch cans shall be emptied out and the sprinklers test shall start over.
11. Depending on the type of sprinklers being audited, the following general rules shall be followed for determining sprinkler run times: Rotor type sprinklers – a minimum of 10-minute run time and a maximum of a 30-minute run time;

12. Catch can data collection shall be performed by the same person for all irrigation audits for consistency of data purposes.
 13. All worksheets shall be filled out to the fullest extent possible. As much data as can be reasonably determined on each site for each test shall be provided in the worksheets.
 - a. Any missing worksheet data shall be accounted for with a written explanation as to why the data is not present in the worksheets. An example of this would be:
 - 1) Reason – no flow meter present on site
 - b. No flow meter information provided
 - c. Worksheets shall include all collected catch can data and determination of Low Quarter Distribution Uniformity (DULQ) and Precipitation Rate (PR) along with all the other pertinent data in the worksheets.
 14. On a copy of the irrigation plan accurately (within 1-foot) show the following:
 - a. All sprinklers and associated valves for each test area;
 - b. Any surrounding hardscape, plants, or physical site surroundings (roads, walkways, headstones, benches, water spigots, trees, shrubs, etc.)
 - c. All catch cans (numbered per the worksheets) and associated data collected.
 15. A summary report (maximum of one page per audit) shall be provided along with a map and audit data for each location audited along with associated worksheets filled out as specified above.
 16. If any conclusions can be drawn based on the area tested, distribution uniformity or precipitation rate, they should be explained in the summary page, along with any recommendations for improvements of irrigation uniformity for the audit condition.
 17. Submit Entire audit report to RE/COR within 10 working days of the completed field work.
- I. Control System Grounding:
1. Test for proper grounding of control system per manufacturer's recommendations. Test results must meet or exceed manufacturer's guidelines for acceptance.
 2. Replace defective wire, grounding rod or appurtenances. Repeat the test until the manufacturer's guidelines are met.
 3. If the test is acceptable, the individual completing the test must document the results of the grounding test on the inside of each controller pedestal door and via a written report. Documentation should include satellite name or number, date of test, and the ohms resistance to ground. The test results should be marked on the inside of each controller pedestal door using a permanent marker.
 4. A written report of the test data listing controller name or number, date of test, name of the individual completing the test, name of the company completing the test and the ohms resistance to ground for each controller must be submitted to the RE/COR.

J. Acceptance Test Prior to Final Inspection:

1. Upon completion of construction and prior to Final Inspection, an Acceptance Test must be passed.
2. Coordinate start of Acceptance Test with RE/COR.
3. During the Acceptance Test, the irrigation system must be fully operational via the central control system. The irrigation system must operate with no faults for 14 consecutive days. If at any time during the 14-day test period, a system fault occurs, the source of the fault must be determined and corrected, and the 14-day evaluation period will start again. If a system fault occurs, make repairs within 72 hours of notification from RE/COR. Document any faults in the proof of test report listing date of fault, fault, cause of the fault and the corrective action taken.
4. When the system has operated for 14 days without fault, contact the RE/COR to schedule Final Inspection.

1.9 CONSTRUCTION REVIEWS

- A. The purpose of on-site reviews by the RE/COR is to periodically observe the work in progress, the Contractor's interpretation of the construction documents, and to address questions regarding the installation.
1. Schedule reviews for irrigation system layout or testing with the RE/COR as required by these specifications.
 2. Impromptu reviews may occur at any time during the project.
 3. A Final Inspection will occur at the completion of the irrigation Acceptance Test. The intent of the Final Inspection is to verify that all installation; testing; maintenance and operation submittals; and project record drawing submittals are completed prior to the start of the Maintenance and Guarantee/Warranty periods.
 4. All costs, including travel expenses and site visits by the Department of Veterans Affairs (DVA) or DVA representative for additional Inspections that may be required after the Final Inspection due to non-compliance with the Construction Documents are the sole responsibility of the Contractor.

1.10 GUARANTEE/WARRANTY AND REPLACEMENT

- A. The purpose of this guarantee/warranty is to ensure that the Government receives irrigation materials of prime quality, installed and maintained in a thorough and careful manner.
- B. Guarantee/warranty irrigation materials, equipment, and workmanship against defects for a period of one year from Final Inspection by RE/COR. Fill and repair depressions. Restore landscape, utilities, structures or site features damaged by the settlement of irrigation trenches or excavations. Repair damage to the premises caused by construction or a defective item. Make repairs within 72 hours of notification from RE/COR.

- C. Replace damaged items with identical materials and methods per contract documents or applicable codes. Make replacements at no additional cost to the contract price.
- D. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

1.11 GENERAL CONSTRUCTION REQUIREMENTS

- A. Coordinate construction of irrigation system with RE/COR and Cemetery Staff. See irrigation plans and installation details for required coordination efforts related to the installation of specific irrigation components.
- B. Control of Excavations: See Section 3.3 for safety and access directions.
- C. Install mainline and wiring sleeving under new roads prior to installation of road base.
- D. Install irrigation components in landscaped areas only.
- E. Construction cannot proceed unless staking of irrigation mainline, remote control valve locations, and sprinkler locations are reviewed and accepted by the RE/COR.

PART 2 - PRODUCTS

2.1 QUALITY

- A. Use new materials without flaws or defects.

2.2 SUBSTITUTIONS

- A. Unless noted otherwise, use specified equipment. RE/COR must approve equipment prior to construction. The Contractor through written request prior to purchase or installation may request substitutions to the approved equals listed herein. Changes and associated design costs to accommodate alternative equipment are Contractor's.
- B. Pipe sizes referenced in the construction documents are minimum sizes and may be increased at Contractor's option.

2.3 SLEEVING

- A. Provide sleeve beneath hardscape for irrigation pipe and wiring. Provide separate sleeve beneath hardscape for wiring.
- B. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with an integral belled end.
- C. Use Class 200, SDR-21, rated at 200 PSI, conforming to dimensions and tolerances established by ASTM Standard D2241 for mainline pipe, lateral pipe and wiring sleeves.
- D. Size sleeves are as shown on the drawings. Wiring bundle contained in the sleeve should not exceed 40% of the available area within the sleeve per NEC recommendations.

2.4 PIPE AND FITTINGS

- A. Mainline Pipe and Fittings:

1. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with an integral belled end.
 2. Use Class 200, SDR-21, rated at 200 PSI, conforming to dimensions and tolerances established by ASTM Standard D2241.
 3. Use rubber-gasketed pipe equipped with factory installed reinforced gaskets for mainline pipe. Gasketed pipe joints must conform to the "Laboratory Qualifying Tests" section of ASTM D3139. Gasket material must conform to ASTM F477. Use push-on rubber-gasketed ductile iron fittings conforming to ASTM A536 and ASTM F477. Use lubricant approved by the pipe manufacturer. Acceptable manufacturer for ductile iron fittings is Harco or approved equal.
 4. Provide joint restraint harness at valves, changes of direction and as recommended by the manufacturer. For joint restraints on PVC pipe applications, use restraint components constructed of 60-42-10 ductile iron conforming to ASTM A536 and ASTM F1674.
 5. Mainline pipe within sleeves: Use solvent weld pipe for mainline pipe within sleeves.
- B. Lateral Pipe and Fittings:
1. Use rigid, unplasticized polyvinyl chloride (PVC) 1120, 1220 National Sanitation Foundation (NSF) approved pipe, extruded from material meeting the requirements of Cell Classification 12454-A or 12454-B, ASTM Standard D1784, with an integral belled end suitable for solvent welding.
 2. Use Class 200, SDR-21, rated at 200 PSI, conforming to dimensions and tolerances established by ASTM Standard D2241. Use PVC pipe rated at higher pressures than Class 200 in the case of small nominal diameters not manufactured in Class 200.
 3. Use solvent weld pipe for lateral pipe. Use Schedule 40, Type 1, PVC solvent weld fittings conforming to ASTM Standards D2466 and D1784 for PVC pipe. Use primer approved by pipe manufacturer. Solvent cement to conform to ASTM Standard D2564, of type approved by pipe manufacturer.
- C. Specialized Pipe and Fittings:
1. Use mechanical joints conforming to ANSI A 21.10 (AWWA C110) and ANSI A21.11 (AWWA C111) or flanged fittings conforming to ANSI/AWWA C110 and ANSI B16.1 (125#).
 2. Joint sealant: Use only teflon-type tape or teflon based paste pipe joint sealant on plastic threads. Use nonhardening, nontoxic pipe joint sealant formulated for use on water-carrying pipes on metal threaded connections.
- D. Joint Restraint Harness:
1. Provide joint restraint harness on gasketed pipe at valves and changes of pipe direction. Restrain length of pipe as presented in the installation details and as recommended by the joint restraint manufacturer.

2. Use restraint harness consisting of grip rings, restraint rods, bolts and nuts. Use ductile iron grip rings conforming to ASTM A536 and F1674 and meeting the requirements of UNI-B-13-94. Grip ring serrations to be machined. Cast serrations are not permitted. Restraint rods, bolts, and nuts to be low alloy steel meeting AWWA/ANSI C111/A21.11. Acceptable manufacturer and model are HARCO 820000 Series, Ford Meter Box Uni-Flange Series or approved equal.

E. Detectable Warning Tape:

1. Provide detectable warning tape over all mainline pipe.
2. Use 2-inch wide detectable marking tape with a minimum 5.0 mill thickness. Tape to have a minimum 0.35 mill solid aluminum foil core. Tape to be color coded to meet APWA standard for identification of buried utilities and be labeled "CAUTION BURIED WATER LINE BELOW".

2.5 MAINLINE COMPONENTS

A. Isolation Gate Valve Assembly:

1. As presented in the installation details.
2. Iron body, bronze mounted, double disc with parallel or inclined seats, non-rising stem turning clockwise to close, 200 PSI minimum working pressure. AWWA C509. Acceptable manufacturers are Clow, Kennedy, Mueller, Waterous or approved equal.
3. Valve Box: Use plastic (ABS) 10-inch round valve box with black lid. Acceptable manufacturer is Carson, Pentek, or approved equal.
4. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.

B. Air-Vacuum Relief Valve Assembly:

1. As presented in the installation details.
2. Cast Iron body with epoxy coating, polypropylene float, glass fiber reinforced nylon kinetic float, Buna-N seals and O-rings, stainless steel nuts and bolts, pressure range 2 PSI to 230 PSI. Use a continuous acting combination air and vacuum and air release valve. Acceptable manufacturer is Bermad, Crispin, Fresno, Val-Matic or approved equal.
3. Steel Ball Valve: Use a true union ball rated to 235 PSI. Acceptable manufacturer is Nibco or approved equal.
4. Valve Box: Use plastic (ABS) jumbo rectangular valve box with black lid. Acceptable manufacturer is Carson, Pentek, or approved equal.
5. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.

C. Quick Coupling Valve Assembly:

1. As presented in the installation details.
2. Brass construction, 1-inch nominal size, operating pressure 5-125 PSI with locking rubber or vinyl cover. Acceptable manufacturer and model is Toro 100-SLSC Series to match existing equipment or approved equal.

3. Swing Joint: Use pre-manufactured triple swing joint. Acceptable manufacturer is Spears, Lasco or approved equal.
 4. Quick Coupler Anchor: Use pre-manufactured bolt on anchor. Acceptable manufacturer is Harco or approved equal.
 5. Valve Box: Use plastic (ABS) 10-inch round valve box with black lid. Acceptable manufacturer is Carson, Pentek, or approved equal.
 6. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.
- D. Flower Water Station Hydrant Connection Assembly:
1. As presented in the installation details.
 2. Curb Stop Valve: Brass body, 300 PSI minimum working pressure. ASTM B-62, female threaded connections, with stop and waste feature. Acceptable manufacturers are Ford, Mueller, A.Y. McDonald or approved equal.
 3. Pressure regulator: Use an adjustable, bronze body pressure regulator with integral stainless-steel strainer. Spring range 25-75 PSI, 1-inch inlet and outlet. Acceptable manufacturers and models are Apollo Series 36, Watts Model 223, Wilkins Model 600 or approved equal.
 4. Valve Box: Use plastic 10-inch round valve box with black lid. Acceptable manufacturer is Carson, Maclean Highline (Pentek) or approved equal.
 5. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.

2.6 SPRINKLER IRRIGATION COMPONENTS

- A. Remote Control Valve Assembly:
1. As presented in the installation details.
 2. Remote Control Valve: Use a normally closed 24 VAC 50/60 cycle solenoid actuated globe pattern design. The valve pressure rating will not be less than 200 PSI. The valve body and bonnet will be constructed of heavy-duty glass-filled UV resistant nylon and have stainless steel studs and flange nuts; diaphragm will be of nylon reinforced nitrile rubber. The valve will have both internal and external manual open/close control (internal and external bleed) to manually open and close the valve without electrically energizing the solenoid. The valve's internal bleed will prevent flooding of the valve box. The valve will house a fully encapsulated, one-piece solenoid. The solenoid will have a captured plunger with a removable retainer for easy servicing and a leverage handle for easy turning. This 24 VAC 50/60 Hz solenoid will open with 19.6 volt minimum at 200 PSI. At 24 VAC, average inrush current will not exceed 0.41 amps. Average holding current will not exceed 0.23 amps. The valve will have a brass flow control stem for accurate manual regulation and/or shutoff of outlet flow. The valve must open or close in less than 1 minute at 200 PSI and less than 30 seconds at 20 PSI. The valve will have a self-cleaning stainless-steel screen designed for use in dirty water applications. Provide for all internal parts to be removable from the top of the valve without disturbing the valve installation. The valve will have a pressure regulation module to regulate outlet

- pressure as specified. Acceptable manufacture and model is Toro P220S to match and be compatible with existing.
3. Shut-off Valve: Use an angle valve, AWWA C135 rated, ductile iron epoxy coated with stainless steel valve mechanism and restraint system. Acceptable manufacture and model is Leemco LV212/218.
 4. Valve Box: Use plastic (ABS) standard valve box with black lid or combination of standard and round valve boxes with black lid. Acceptable manufacturer is Carson, Pentek, or approved equal.
 5. Filter Fabric: Use a spunbond polyester 3.5 oz. per square yard landscape fabric.
 6. Install assembly over gravel sump as presented in the installation details.
 7. Wire connectors: Use 3M DBR/Y-6.
 8. Use standard Christy I.D. tags with hot-stamped black letters on a yellow background.
- B. Pop-Up Gear-Driven Rotary Sprinkler Assembly:
1. As presented in the installation details.
 2. Rotary Sprinkler: Use a gear drive sprinkler capable of covering the radius with the discharge rate at the pressure as presented on the drawings. Furnish part circle sprinklers with an adjustable arc of 20- to 340-degrees, and full circle sprinklers with a nonadjustable arc. Furnish sprinkler with stainless steel pop-down spring. Nozzle must be tested per ASAE S398.1 and be verified to deliver Distribution Uniformity of 80% or more and a Scheduling Coefficient of 1.2 or less at the specified offset spacing. Furnish sprinkler with stainless steel risers, integral check valve in base of the case capable of holding back 10 feet of elevation. Minimum pop-up height is 3 ½-inches. Acceptable manufacturer and model is Toro TS90 to match and be compatible with existing.
 3. Swing Joint: Use pre-manufactured triple swing joint. Acceptable manufacturer is Spears, Lasco or approved equal.
- C. Pop-Up Sprinkler Assembly:
1. As presented in the installation details.
 2. Sprinkler body: Use a spray sprinkler capable of covering the radius with the discharge rate at the pressure as presented on the drawings. Furnish sprinkler with pressure reducing module in the riser stem and integral check valve in base of the case capable of holding back a minimum of 8 feet of elevation. Minimum pop-up height is 4-inches. Acceptable manufacturer and model is Toro 570ZPR COM to match and be compatible with existing.

2.7 CONTROL SYSTEM COMPONENTS

- A. Control Unit:
1. Description: Existing controller system is Toro Sentinel Central Control with Sentinel satellite controllers mounted in a plastic pedestal. New controller and pedestal to be Toro Sentinel to

match and be compatible with existing. Communication between Central and Satellite controls is via radio.

2. Electrical conduit: Use PVC Schedule 40 conforming to the dimensions and tolerances established by ASTM Standard D-1785. Fittings for PVC conduit will be Schedule 40, Type 1, PVC solvent weld fittings, ASTM Standards D2466 and D1784.
3. Wire markers: Prenumbered or labeled with indelible nonfading ink, made of permanent, nonfading material.
4. Lightning protection: Provide one 12"x36"x0.0625" ground plate, one 5/8"x10 foot copper clad UL listed grounding rod, approximately 30 feet of #6 AWG bare copper grounding wire, two 6-inch plastic round valve boxes, and one CADWELD connector at each existing and new satellite or satellite controller group.

B. Power Wire:

1. Electric wire from the power source to satellite control unit shall be solid or stranded copper, Type TC Round Jacketed multi conductor cable with ground, direct burial, UL listed, rated at 600 volts. Power wires shall be black, white, and green in color. Size as presented in the drawings. If the control system changes, the Contractor is responsible for verifying that the power wire sizes are compatible and adequate for the control system being used.
2. Splices: Use 3M #82-A2 Series with Split Bolts or Butt Connectors for inline splices and 82-B1 or 90-B1 Series for wye splices rated for direct burial applications.
3. Electrical conduit: Use PVC Schedule 40 conduit conforming to dimensions and tolerances established by ASTM Standard D-1785. Use Schedule 40, Type 1, PVC solvent weld sweep fittings for PVC conduit conforming to ASTM Standards D2466 and D1784 for buried installations. Use rigid metallic conduit with sweep elbows for above grade installations.
4. Warning tape to be installed above all power wire. Use non-detectable marking tape 4.0 mil thickness, linear low-density polyethylene, specifically formulated for extended use underground. The legend shall continually repeat a minimum of every three feet. The tape tensile strength shall be in accordance with ASTM D882 and not be less than 4100 MD and 3650 TD. Elongation properties shall be in accordance with ASTM D882 and be greater than 550% at break point. Tape flexibility shall be in accordance with ASTM D671 and shall remain pliable. Tape composition shall be of virgin LLDPE/LDPE. The tape color shall be red. The legend shall read "Caution Electric Line Buried Below". The tape width shall be 3-inch. Manufacturer T. Christy Enterprises, or approved equal.

C. Controller Wire:

1. Control Wire: Use American Wire Gauge (AWG) #14 solid copper, Type UF or PE cable, UL listed for direct underground burial from satellite controller units to each remote-control valve assembly.

2. Common wire: Use American Wire Gauge (AWG) #12 solid copper, Type UF, PE cable, UL listed for direct underground burial from the satellite controller units to each remote-control valve assembly.
3. Construction of UF Wire:
 - a. Conductor: Solid-annealed, uncoated copper conforming to UL Standard 719, Parts 18-22.
 - b. Insulation: Polyvinyl chloride, 60°C rated conforming to UL Standard 719, Parts 23-25.
 - c. Construction Data: UL heavy duty PVC, colored, conforming to UL Standard 44.
 - d. Manufacturer's Identification: Surface embossed with manufacturer's name, voltage rating, size and type designation.
 - e. Underwriters Laboratories Approval: All cables will be tested physically and electrically in accordance with UL Standard 719 and will bear UL labels.
4. Construction of PE Wire:
 - a. Conductor: Soft drawn bare copper meeting the requirements of ASTM Specification B-3 or B-8.
 - b. Temperature Rating: -55°C to + 60°C.
 - c. Insulation Thickness: .045"
 - d. Shielding: 0.005" x .5" type 304 stainless steel tape helically wrapped with a minimum of 33% overlap.
 - e. Manufacturer's Identification: Surface marked with voltage rating, size and type, and UL file number.
 - f. Underwriters Laboratories Approval: All cables will be tested physically and electrically in accordance with UL Standard 493 and 83 (paragraphs 28.1, 29.1, and 29.2). All reels and cartons bear UL labels.
 - g. Tests: Material must be able to pass the following tests without showing signs of degradation.
 - 1) Cold bend: The insulation will not show any cracks when sample is bent around a mandrel of 3 x wire diameter after being subjected to -55°C +/- 1°C for one hour.
 - 2) Electrical: AC test voltage, 5 minutes at 3,000 volts.
 - 3) Environmental Aging: Immersed for 14 days in concentrated solutions of fertilizers, herbicides and insecticides.
5. Color: Use white for common ground wire. Use easily distinguished colors for other control wires. Spare control wires will be of a color different from that of the active control wire. A different colored control wire and spare wire will be used for adjacent controllers. Wire color must be continuous over its entire length.
6. Splices: Use 3M DBR/Y-6 splice kits.

7. Valve Box: Use plastic standard rectangular valve with green lid for valves installed in landscaped areas.
8. Warning tape to be installed above control wire when not installed with mainline pipe. Use non-detectable marking tape 4.0 mil thickness, linear low-density polyethylene, specifically formulated for extended use underground. The legend shall continually repeat a minimum of every three feet. The tape tensile strength shall be in accordance with ASTM D882 and not be less than 4100 MD and 3650 TD. Elongation properties shall be in accordance with ASTM D882 and be greater than 550% at break point. Tape flexibility shall be in accordance with ASTM D671 and shall remain pliable. Tape composition shall be of virgin LLDPE/LDPE. The tape color shall be red. The legend shall read "Caution Electric Line Buried Below". The tape width shall be 3-inch. Manufacturer T. Christy Enterprises, or approved equal.

2.8 OTHER COMPONENTS

- A. Tools and Spare Parts: Provide operating keys, servicing tools, spare parts and other items indicated in the General Notes of the drawings.
- B. Other Materials: Provide other materials or equipment shown on the drawings or installation details that are part of the irrigation system, even though such items may not have been referenced in these specifications.

PART 3 - EXECUTION

3.1 INSPECTIONS AND REVIEWS

- A. Site Inspections:
 1. Verify construction site conditions and note irregularities affecting work of this section. Report irregularities to the RE/COR prior to beginning work.
 2. Beginning work of this section implies acceptance of existing conditions.
- B. Utility Locates ("Call Before You Dig"):
 1. Arrange for and coordinate with local authorities the location of all underground utilities, and with cemetery maintenance personnel.
 2. Repair any underground utilities damaged during construction. Make repairs at no additional cost to the contract price.
- C. Irrigation System Layout Review: Irrigation system layout review will occur after the staking has been completed. Notify the RE/COR one week in advance of review. The RE/COR will identify modifications during this review.

3.2 LAYOUT OF WORK

- A. Stake locations of sprinklers using a licensed surveyor.
- B. Stake out the irrigation system. Items staked include: irrigation mainline pipe, thrust blocks, isolation gate valve assemblies, air/vacuum relief valve assemblies, quick coupling valves, remote control valves, lateral piping, and sprinklers.

- C. If staked irrigation components conflict with utilities or other components or site features, coordinate rerouting of components with RE/COR.

3.3 EXCAVATION, TRENCHING, AND BACKFILLING

- A. Excavate to permit the pipes to be laid at the intended elevations and to permit workspace for installing connections and fittings.
- B. Survey Markers:
 - 1. Protect markers during construction.
 - 2. If a survey marker is disturbed during construction, the Contractor is responsible for replacing the marker. The Contractor must hire a licensed surveyor to resurvey the location of the marker and replace it.
- C. Minimum cover:
 - 1. 36-inches over irrigation mainline pipe. (distance from top of pipe to finish grade)
 - 2. 32- to 34-inches over irrigation lateral pipe to sprinklers in pre-placed crypt field. Lateral pipe must be installed 12-inches below top of crypt lid. (distance from top of pipe to finish grade)
 - 3. 24-inches over irrigation lateral pipe to sprinklers in landscape. (distance from top of pipe to finish grade)
 - 4. 18-inches vertical separation between lateral and mainline pipe installed in a common trench.
 - 5. 2-inches minimum horizontal separation between pipes and wiring in a common trench.
 - 6. Install sleeves at depth to maintain specified depth of pipe or wire routed through sleeve.
- D. Install and maintain safety fencing around all unattended excavation. Place safety signs adjacent to construction area roadway to the satisfaction of the RE/COR.
- E. All excavations must be backfilled by the end of each workday. Do not leave any open trenches overnight, on weekends or on holidays.
- F. If trenching operation restricts access to a burial section, provide plywood and safety fencing across open trench to allow access to burial section. Provide access to the satisfaction of the RE/COR.
- G. Excavated material is generally satisfactory for backfill. Backfill will be free from rubbish, vegetable matter, frozen materials, and stones larger than 2-inches in maximum dimension. Remove material not suitable for backfill. Backfill placed next to pipe will be free of sharp objects that may damage the pipe.
- H. Enclose pipe and wiring beneath roadways, walks, curbs, etc. in sleeves. Backfill sleeves in the following manner:
 - 1. Backfill trench using excavated material in 6-inch layers. Minimum compaction of backfill for sleeves shall be a minimum 95% Standard Proctor Density, ASTM D698-78. Backfill to bottom of road base under roads or to finish grade under walks and curbs.
- I. Backfill mainline pipe, lateral pipe and wiring in turf areas in the following manner:

1. Backfill the trench by depositing the backfill material equally on both sides of the pipe or wire in 6-inch layers and compacting to the density of surrounding soil.
- J. Enclose pipe and wiring beneath roadways, walks, curbs, etc., in sleeves.
- K. Dress backfilled areas to original grade. Remove excess backfill to on-site location as directed by the RE/COR.
- L. Where utilities conflict with irrigation trenching and pipe work, contact the RE/COR for trench depth adjustments.
- M. Where existing or new trees conflict with irrigation trenching and pipe work, maintain a 5-feet clearance from centerline of tree. If this clearance conflicts with other site features, contact RE/COR for adjustments.

3.4 SLEEVING AND BORING

- A. Install sleeving at a depth that permits the encased pipe or wiring to remain at the specified burial depth.
- B. Extend sleeve ends a minimum of 12-inches beyond the edge of the paved surface. Cover pipe ends and mark edge of pavement with a chisel or saw.
- C. Verify that sleeve sizing is adequate prior to installation. Note that sleeves required for pipe with restrained casing spacers are larger than twice the diameter of the pipe.

3.5 ASSEMBLING PIPE AND FITTINGS

- A. General:
 1. Keep pipe free from dirt and pipe scale. Cut pipe ends square and deburr. Clean pipe ends.
 2. Keep ends of assembled pipe capped. Remove caps only when necessary to continue assembly.
 3. Trenches may be curved to change direction or avoid obstructions within the limits of the curvature of the pipe. Minimum radius of curvature and offset per 20-foot length of mainline and lateral pipe by pipe size are shown in the following table. All curvature results from the bending of the pipe lengths. No deflection will be allowed at a pipe joint.

SIZE	RADIUS	OFFSET PER 20' LENGTH
1 ½"	25'	7'-8"
2"	25'	7'-8"
2 ½"	100'	1'-11"
3"	100'	1'-11"
4"	100'	1'-11"
6"	150'	1'-4"
8"	200'	1'-0"

B. Mainline Pipe and Fittings:

1. PVC Rubber-Gasketed Pipe:

- a. Use pipe lubricant. Join pipe in the manner recommended by manufacturer and in accordance with accepted industry practices.
- b. Ductile iron fittings will not be struck with a metallic tool. Cushion blows with a wood block or similar shock absorber.

2. PVC Solvent Weld Pipe:

- a. Use primer and solvent cement. Join pipe in manner recommended by manufacturer and in accordance with accepted industry practices.
- b. Cure for 30 minutes before handling and 24 hours before pressurizing.

3. Fittings: The use of cross type fittings is not permitted.

C. Lateral Pipe and Fittings:

1. PVC Solvent Weld Pipe:

- a. Use primer and solvent cement. Join pipe in manner recommended by manufacturer and in accordance with accepted industry practices.
- b. Cure for 30 minutes before handling and 24 hours before pressurizing or installing with vibratory plow.
- c. Snake pipe from side to side within trench.

2. Fittings: The use of cross type fittings is not permitted.

3. Lateral Pipe and swing joints installed in Pre-Placed Crypt sections:

- a. Lateral pipe and fittings may be installed prior to backfill over pre-placed crypts to ensure correct placement and depth.
- b. Contractor responsible for locating the correct tee or el fitting locations in pre-placed crypt areas by using GPS survey grade equipment or installing the pipe and measuring the distance from the crypt ends prior to backfill. All tee locations to be staked and approved by RE/COR.
- c. Cap all swing joint ends prior to backfill.
- d. Mark swing joint locations prior to backfill and final grade using 30-inch length of 1-inch PVC pipe or other approved method. Submit alternate method with submittal review if applicable. Note that grid markers are typically set after the final grade and will typically not be available for reference in location sprinkler locations in pre-placed crypt sections.

D. Specialized Pipe and Fittings:

1. Mechanical joint connections: Install fittings, fasteners and gaskets in manner recommended by manufacturer and in accordance with accepted industry practices.
2. PVC Threaded Connections:
 - a. Use only factory-formed threads. Field-cut threads are not permitted.

- b. Apply thread sealant in manner recommended by component, pipe and sealant manufacturers and in accordance with accepted industry practices.
 - c. Use plastic components with male threads and metal components with female threads where connection is plastic-to-metal.
- E. Joint Restraint Harness:
 - 1. Restrain length of pipe at valves and changes in pipe direction as presented in the installation details and per the joint restraint manufacturer recommendations.
 - 2. Install harness in the manner recommended by the manufacturer and in accordance with accepted industry practices.
 - 3. Use restrained casing spacers for gasketed pipe routed through sleeving. Install harness in the manner recommended by the manufacturer and in accordance with accepted industry practices. Install self-restraining casing spacers at all gasketed pipe bell joints and every 10-feet along the gasketed mainline pipe installed through sleeving. Provide correct number and type of restraints per manufacturer's requirements.
- F. Detectable Warning Tape:
 - 1. Install warning tape per manufacturer's recommendations above all mainline pipe.

3.6 INSTALLATION OF MAINLINE COMPONENTS

- A. Isolation Gate Valve Assembly:
 - 1. As presented in the installation details, per manufacturer's instructions.
 - 2. Install where indicated in the irrigation plans.
 - 3. Brand "GV" in 2-inch high by 3/16-inch deep letters on valve box lid.
- B. Air/Vacuum Relief Valve Assembly:
 - 1. As presented in the installation details, per manufacturer's instructions.
 - 2. Install where indicated in the irrigation plans.
 - 3. Brand "AV" in 2-inch high by 3/16-inch deep letters on valve box lid.
- C. Quick Coupling Valve Assembly:
 - 1. As presented in the installation details, per manufacturer's instructions.
 - 2. Install where indicated in the irrigation plans.
 - 3. Brand "QC" in 2-inch high by 3/16-inch deep letters on valve box lid.
- D. Flower Watering Station Hydrant Connection Assembly:
 - 1. As presented in the installation details, per manufacturer's instructions.
 - 2. Stations will be installed at locations indicated on drawings. If necessary, adjust sprinkler location such that no sprinkler is within 10-feet of a Flower Watering Station. .
 - 3. Route adjacent piping around stations. No mainline or lateral pipe is to be installed under Flower Watering Stations.
 - 4. Brand "FW" in 2-inch high by 3/16-inch deep letters on valve box lid.

3.7 INSTALLATION OF SPRINKLER IRRIGATION COMPONENTS

A. Remote Control Valve Assembly:

1. Mainline Flushing:

- a. Thoroughly flush mainline before installation of Remote Control Valve Assemblies.
 - b. Identify remote control valve service tee(s) to be used for mainline flushing. Plug service tees not being used for flushing.
 - c. Connect 2-inch pipe to flushing service tee(s). Use pipe to direct water away from trench and into drainage swale, curb section or storm sewer, i.e. to an area that will direct the water away from the work area. Direct water so that it does not disrupt the cemetery operations.
 - d. Use a volume of water such that the velocity in the largest pipe flushing to this point is 3 FPS.
 - e. Multiple points may be flushed simultaneously.
 - f. Flush for a minimum of 20 minutes. Continue flushing until the water is clear of all debris.
 - g. RE/COR will review the flushing operation and clarity of water before stopping the flushing operation.
 - h. Disconnect pipe from service tee(s) and install remote control valve(s).
2. Install per manufacturer's recommendations where indicated on the drawings.
 3. Adjust valve to regulate the downstream operating pressure to 70 PSI for rotor sprinklers, 35 PSI for spray sprinklers.
 4. Wire connectors and waterproof sealant will be used to connect control wires to solenoid wires. Install connectors and sealant per the manufacturer's recommendations.
 5. Install only one remote control valve to a valve box. Locate valve box 5-feet from and align square with nearby edges of paved areas.
 6. Attach ID tag with controller station number to control wiring at solenoid.
 7. Brand controller and station number in 2-inch high by 3/16-inch deep letters on valve box lid.

B. Pop-Up Gear-Driven Rotary Sprinkler Assembly:

1. Thoroughly flush lateral pipe before installing sprinkler assembly. Water must be clear of any debris before flushing operation stops.
2. Install per the installation details at locations shown on the drawings.
3. Install sprinklers perpendicular to the finish grade.
4. Install swing joint with the appropriate angle between the lateral pipe and the lay length nipple per the installation details.
5. Supply appropriate nozzle or adjust arc of coverage of each sprinkler for best performance.
6. Adjust the radius of throw of each sprinkler for best performance.
7. Install 2-foot square piece of sod around all rotary sprinklers in areas to be seeded.

C. Pop-Up Spray Sprinkler Assembly:

1. Thoroughly flush lateral pipe before installing sprinkler assembly. Water must be clear of any debris before flushing operation stops.
2. Install per the installation details at locations shown on the drawings.
3. Install sprinklers perpendicular to the finish grade.
4. Install swing joint with the appropriate angle between the lateral pipe and the lay length nipple per the installation details.
5. Supply appropriate nozzle or adjust arc of coverage of each sprinkler for best performance.
6. Adjust the radius of throw of each sprinkler for best performance.

3.8 INSTALLATION OF CONTROL SYSTEM COMPONENTS

A. Control Units:

1. Install new control unit at location shown in plans.
2. Install all electrical connections per control system manufacturer's recommendations.
3. Lightning protection: Drive grounding rod into soil its full length. Connect #6 AWG copper grounding wire to rod and plate using CADWELD connections. Brand "GR" in 2-inch high by 3/16-inch deep letters on valve box lid.
4. Connect electrical service in accordance with local codes.
5. Attach wire markers to the ends of control wires inside the controller unit housing. Label wires with the identification number (see drawings) of the remote-control valve to which the control wire is connected.
6. Connect new control wire to the corresponding control unit terminal.
7. Complete site RF survey to confirm that new control units are functional with existing central control system antenna.

B. Power Wire:

1. Route power wire as directed on plans. Install with a minimum number of field splices. If a power wire must be spliced, make splice with recommended connector, installed per manufacturer's recommendations. Locate all splices in a separate 12-inch standard valve box. Coil 2 feet of wire in valve box. Brand "WS" in 2-inch high by 3/16-inch deep letters on valve box lid.
2. All power wire shall be laid in trenches. The use of a vibratory plow is not permitted.
3. Green wire shall be used as the common ground wire from power source to all satellites.
4. Carefully backfill around power wire to avoid damage to wire insulation or wire connectors.
5. Unless noted on plans, install wire parallel with and below mainline pipe. Install wire a minimum 2-inches below top of PVC mainline pipe.
6. Encase wire not installed with PVC mainline pipe in electrical conduit with a continuous run of warning tape placed in the backfill, 6-inches above the wiring.
7. Connect wire to power source per NEC and local governing codes.

C. Control Wire:

1. Bundle control wires where two or more are in the same trench. Bundle with pipe wrapping tape spaced at 10-foot intervals.
2. Control wiring may be chiseled into the soil utilizing a vibratory plow device specifically manufactured for pipe pulling and wire installation. Appropriate chisel must be used so that wire is fed into a chute on the chisel, and wire is not subject to pulling tension. Minimum burial depth must equal minimum cover previously listed.
3. Provide a 24-inch excess length of wire in an 8-inch diameter loop at each 90-degree change of direction, at both ends of sleeves, and at 100-foot intervals along continuous runs of wiring. Do not tie wiring loop. Coil 24-inch length of wire within each remote-control valve box.
4. Install common ground wire and one control wire for each remote-control valve. Multiple valves on a single control wire are not permitted.
5. If a control wire must be spliced, make splice with wire connectors and waterproof sealant, installed per the manufacturer's instructions. Locate splice in turf areas using a valve box that contains an irrigation valve assembly, or in a separate valve box. Use same procedure for connection to valves as for in-line splices. If a separate valve box is used for wire splices, brand "WS" in 2-inch high by 3/16-inch deep letters on valve box lid.
6. Unless noted on plans, install wire parallel with and below mainline pipe.
7. Protect wire not installed with PVC mainline pipe with a continuous run of warning tape placed in the backfill 6-inches above the wiring.
8. Cap all exposed wire ends with wire nuts.

3.9 INSTALLATION OF OTHER COMPONENTS

A. Tools and Spare Parts:

1. Prior to the Review at completion of construction, provide operating keys, servicing tools, spare parts, and any other items indicated on the drawings.

B. Other Materials: Install other materials or equipment shown on the drawings or installation details that are part of the irrigation system, even though such items may not have been referenced in these specifications.

3.10 MAINTENANCE AND OPERATION INSTRUCTIONS

A. Irrigation System Maintenance:

1. Prior to Final Inspection, provide two training sessions to operating personnel on proper operation and maintenance of the irrigation system. Training sessions should be for a period of not less than 4-hours each, scheduled on different days and cover aspects of maintaining, operating and repairing the new irrigation system components.
2. Unless otherwise noted, provide irrigation operation and maintenance information in a 3-ring binder with table of contents and index sheet. Provide sections that are indexed and labeled. Provide the following information:

- a. Catalog cut sheets for control system, valves, sprinklers, pipe and fittings, wire and wire connectors, ID tags, shop drawings, and all other irrigation equipment shown or described on the drawings and within these specifications.
 - b. Manufacturer's Operation and Maintenance manuals.
 - c. Manufacturer's Technical Service Bulletins.
 - d. Manufacturer's Warranty Documentation.
 - e. Recommended routine maintenance inspections for weekly, monthly and annual inspections, recommended actions for the inspections, recommended method for recording the findings of the inspections and proper winterization techniques.
 - f. Predictive schedule for component replacement.
 - g. Listing of technical support contacts.
3. Operation and maintenance submittal package must be complete prior to being reviewed by the RE/COR. Incomplete submittals will be returned without review.
- B. Control System Programming:
1. Create and program each controller with a peak season irrigation schedule for the areas being irrigated by the controller.
 2. Using the precipitation rate results of the Distribution Uniformity tests calculate the peak season run time for each station.
 3. Programming of controllers to be completed by control system manufacturer's certified individual and same individual to verify operation of program.
 4. Prepare a memorandum documenting the details and assumptions of the programming. Turn over memorandum to RE/COR. Completion of the memorandum is a prerequisite for final inspection and operational testing of the irrigation system.

3.11 COLORED CONTROLLER CHARTS:

- A. Draft using a CADD program. Each type of sprinkler to have a unique color. All pipe within a zone, and the control valve for that zone are to be of a single color, distinguished from the colors of adjacent zones.
- B. On this drawing include a table that lists for each zone:
1. Zone number, coordinated with indication on as-built drawing
 2. Remote control valve size
 3. Sprinkler complement (model, quantity, nozzle)
 4. Regulated discharge pressure of remote control valve
 5. Flow
 6. Precipitation rate, inches per hour
 7. Initial schedule (minutes per cycle, days/week, and application depth per cycle)
- C. Draft of chart to be submitted prior to the request for final inspection. Correct all missing or incorrect information on charts during final inspection. Submit for final approval subsequent to

final inspection. Upon approval by RE/COR, deliver laminated chart and PDF of chart to RE/COR for cemetery use.

3.12 PROJECT RECORD DRAWINGS

- A. The Contractor is responsible for documenting installed system and all changes to the design. Maintain on-site and separate from documents used for construction, one complete set of contract documents as Project Documents. Keep documents current. Do not permanently cover work until as-built information is recorded.
- B. Record irrigation components, pipe and wiring network alterations. Record work that is installed differently than shown on the construction drawings. Record accurate reference dimensions, measured from at least two permanent reference points, of each irrigation system valve, each controller or control unit, each stub-out for future pipe or wiring connections, and other irrigation components enclosed within a valve box.
- C. Prior to project completion label each sheet of the project drawings (redlines) as "Record Drawing" and turn over to RE/COR for delivery to Engineer. Completion of the Record Drawings is a prerequisite for Final Inspection.

3.13 WINTERIZATION AND SPRING START-UP

- A. Winterize the new irrigation system the first fall after completion of construction of the irrigation system and start up in the first spring after completion of construction. Repair any damage caused in improper winterization at no additional cost to the Owner. Coordinate the winterization and start-up with the cemetery landscape maintenance personnel.

3.14 MAINTENANCE

- A. Operate and maintain irrigation system for a duration of 30 calendar days from Final Inspection. Make periodic examinations and adjustments to irrigation system components to achieve the most desirable application of water.

3.15 CLEANUP

- A. Upon completion of work, remove from the site all machinery, tools, excess materials, and rubbish. Restore site to normal or original condition.

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**SECTION 32 90 00
PLANTING**

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Plants, soils, turf, and landscape materials and accessories.

1.2 RELATED REQUIREMENTS

- A. Topsoil Materials, Stripping and Stockpiling: Section 31 20 00, EARTH MOVING.
- B. Topsoil Testing: Section 01 45 29, TESTING LABORATORY SERVICES.
- C. Erosion control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
- D. Protection of Trees and Plantings: Section 02 41 10, DEMOLITION AND SITE CLEARING.
- E. Topsoil Placement and Compaction Test: Section 31 20 00, EARTH MOVING.
- F. Landscape Irrigation: Section 32 84 00, PLANTING IRRIGATION.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American National Standards Institute (ANSI) Publications:
 - 1. ANSI Z60.1-2014 - Nursery Stock.
 - 2. ANSI Z133.1-2012 - Tree Care Operations-Pruning, Trimming, Repairing, Maintaining, and Removing Trees and Cutting Brush- Safety Requirements.
- C. ASTM International (ASTM):
 - 1. C33/C33M-16-Concrete Aggregates.
 - 2. C136/C136M-14 - Sieve Analysis of Fine and Coarse Aggregates.
 - 3. D698-12 - Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³)).
 - 4. D977-13e1 - Emulsified Asphalt.
 - 5. D2028/D2028M-15 - Cutback Asphalt (Rapid-Curing Type).
- D. Hortus Third, most current edition: A Concise Dictionary of Plants Cultivated in the United States and Canada.
- E. National Cemetery Administration (NCA):
 - 1. Handbook 3410 - Integrate Pest Management.
 - 2. Handbook 3420-11 - Turfgrass Maintenance.
- F. Turfgrass Producers International (TPI):
 - 1. 2006 Guideline Specifications to Turfgrass Sodding.
- G. United States Department of Agriculture (USDA):
 - 1. Federal Seed Act-2011 - Rules and Regulations of the Secretary of Agriculture.
- H. United States Environmental Protection Agency (EPA):
 - 1. 40 CFR Part 503-1993 - Biosolids Rule.

1.4 PREINSTALLATION MEETINGS

- A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.
 - 1. Required Participants:
 - a. Resident Engineer/Contracting Officer's Representative (RE/COR).
 - b. Architect/Engineer (A/E).
 - c. Contractor.
 - d. Installer.
 - 2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
 - a. Inspection of planting materials.
 - b. Installation schedule.
 - c. Installation sequence.
 - d. Preparatory work.
 - e. Protection before, during, and after installation.
 - f. Installation.
 - g. Inspecting.
 - h. Environmental procedures.
 - 3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

- A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Description of each product.
 - a. Seeds.
 - b. Sod.
 - c. Soil amendments.
 - d. Antidesiccant.
 - e. Erosion control materials.
 - f. Hydro mulch.
 - g. Non-Asphaltic Tackifier.
 - h. Herbicide.
 - i. Mulches.
 - 2. Plant list: List of local/regional suppliers for each species to be installed. Include quantities, plant dimension (height x spread) and container/root ball size. Certify in writing, confirmed orders for plants by submitting a Bill of Sale for each plant to be installed. Each plant of the same species shall be supplied by one grower only unless otherwise approved by RE/COR.

- a. Requests for substitutions of plants not available in size, quantity or type specified must be made within 30 days after contract award. Submit written evidence that a specified plant cannot be obtained and has been unobtainable since contract award.
 - b. Substitutions will only be authorized when a plant (or its alternates as specified) is not obtainable and RE/COR, in consultation with District Agronomist, authorizes a change order for use of nearest equivalent obtainable size or variety of plant having same essential characteristics with an equitable adjustment of contract price.
3. Warranty.
- C. Samples: Submit before beginning Work of this section:

Organic Mulch	5 lb. of each type to be used.
Imported Topsoils	5 lb. of each type to be used.
Organic Amendments	5 lb. of each type to be used.
All pesticides required such as preemergence or post emergence herbicides, insecticides, or fungicides.	EPA approved labeling and MSDS sheet for each such product selected for use.

- D. Test reports: Certify products comply with specifications.
 1. Imported Topsoil: Provide 5 lbs. representative sample from each proposed source for testing, analysis, and approval. Deliver samples to acceptable testing laboratory and have testing report sent directly to RE/COR. Testing reports to include following tests and recommendations according to Association of Official Agricultural Chemists standards:
 - a. Soil Composition: USDA particle size analysis indicating percentages of sand, silt and clay, and percent organic matter. Mechanical gradation (sieve analysis) and chemical (pH soluble salts) performed by public extension service agency, State Land Grant College, or certified private testing laboratory. Percentages of clay and silt to be determined by hydrometer.
 - b. Percent of organics to be determined by loss on ignition of oven-dried samples. Test samples to be oven-dried to constant weight at 230 degrees F, plus or minus 41 degrees F.
 - c. Macro and micro nutrient fertility tests as determined by Chemical analysis to include Macro and micro nutrient fertility tests as determined by pH, Salinity (EC), Nitrate Nitrogen, Ammonium Nitrogen, Phosphorus, Potassium, Calcium, Magnesium, Soluble

- Copper, Zinc, Manganese, Iron, Saturation Extract Boron, Aluminum, Soluble Salts, Exchangeable Sodium Percentage (ESP), and Cation Exchange Capacity (CEC).
- d. Tests, as specified, for gradation, organics, soil chemistry and pH to be performed by testing laboratory retained by National Cemetery Administration as described in Section 01 45 29, TESTING LABORATORY SERVICES.
 - e. Include recommendations for soil additives to correct soils deficiencies, as necessary, and for fertilizing and to adjust soil pH to optimum range for cool season turfgrass liming applications to support successful turfgrass growth.
2. Organic Soil Amendment:
- a. Testing: Provide testing by an independent laboratory, with the experience and capability to conduct the testing indicated following U.S. Composting Council Seal of Testing Assurance (STA) procedures, or equivalent.
 - b. Soil Amendment Analysis: Provide documentation from supplier that compost has reached a monitored temperature of 140 degrees Fahrenheit for at least one week. Engage an independent soil testing laboratory to test representative samples of compost and provide compost analysis report for the following parameters:
 - 1) Percent organic matter, percent moisture, percent inerts (foreign matter), pH, soluble salts, and particle size.
 - 2) Nutrient content, including: Nitrogen (N), Phosphorus (P), Potassium (K), Calcium (Ca), and Magnesium (Mg) and Sulfur (S).
 - 3) Trace Metals, including: Arsenic (As), Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), and Zinc (Zn).
 - 4) Maturity Indicator. Provide bioassay results. Provide Carbon-Nitrogen ratio.
 - 5) Stability Indicator: Provide respiration test results.
3. Amended Soil (in place): Following incorporation of amendments and additives, provide minimum six samples per 40,000 sq. ft., 6-inch depth by 3-inch diameter core samples of amended soil taken from project site for testing, analysis, and approval. Locate each sample as directed by RE/COR from areas designated to be planted in turfgrass. Deliver samples to testing laboratories and have testing report sent directly to RE/COR. Obtain amended soil sample acceptance before seeding or hydroseeding.
- E. Certificates: Certify products comply with specifications.
- F. Before delivery, submit notarized certificates for approval to RE/COR attesting that following materials meet specified requirements:
1. Plant Materials: Department of Agriculture certification by State Nursery Inspector from the state in which the plant material originates declaring material to be free from insects and disease.
 2. Fertilizers: Four certificates of analysis for each type of fertilizer.

3. Lime.
4. Gypsum.
5. Soil Sulfur.
6. Humate.
7. Mycorrhizae.
8. Peat.
9. Seed: Include guaranteed percentages of purity, weed content and germination of seed, and net weight and date of shipment.
10. Sod.
11. M-Binder.
12. Hydro Mulching: Number of kilograms (pounds) of materials to be used per liter (gallon) of water.

G. Maintenance Data:

1. Care instructions for each plant material.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Regularly installs specified materials and products.
2. Installed specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
 - b. A member with good standing of either the Professional Landcare Network (PLANET) the AmericanHort.
 - c. Maintain an experienced full-time supervisor on Project site when work is in progress.
 - d. Installer's field supervisor shall have certification in all of the following categories from the Professional Landcare Network and submit one copy of certificate to the RE/COR:
 - e. Certified Landscape Technician (CLT) - Exterior, designated CLT-Exterior.

B. Licenses: Submit licenses to RE/COR:

1. Arborist: One copy.
2. Pesticide Applicator: License in state of project, commercial.

1.7 DELIVERY

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, production run number, and manufacture date.
- C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.
- D. Bulk Products:

1. Deliver bulk products away from buildings, utilities, pavement, and existing turf and planted areas. Maintain dry bulk product storage away from contaminants. Protect products from weather.
2. Install erosion control materials to prevent erosion or displacement of bulk products.
- E. Notify RE/COR of delivery schedule five days in advance, minimum. RE/COR will inspect materials upon arrival. Remove unacceptable plant materials from project site immediately.
- F. Protect plants during delivery to prevent damage to root balls or desiccation of leaves.
- G. Protect trees during transport by covering root balls and tying branches.
- H. Machine dug plants are permitted provided root balls are sized according to ANSI Z60.1 and tops are protected from damage.
- I. Protect sod from drying out.

1.8 STORAGE AND HANDLING

- A. Store seeds, soil amendments, fertilizers, and packaged materials in dry locations away from contaminants.
- B. Keep sod moist and protect from exposure to wind and direct sunlight.
- C. Store plants not installed on day of arrival at project site as follows:
 1. Shade and protect plants from wind when stored outside.
 2. Protect plants by covering roots with moist wood chips, shredded bark, peat moss, or similar mulching material.
 3. Keep plants moist including those in containers, by watering with fine mist spray until planted.

1.9 FIELD CONDITIONS

- A. Seasons and Conditions:
 1. Perform landscape planting operations within following dates: From April 1 to November 15 for fall, but not before irrigation system installed, tested, and approved.
- B. Perform turfgrass installation operations within following dates, but not before irrigation system installed, tested, and approved.
 1. Turf (sod): From April 1 to October 31.
 2. Native Seed Blend (seed): April 15 to June 15.
- C. Restrictions: Do not plant when ground is frozen, snow covered, saturated or in otherwise unsuitable condition for planting. Special conditions may exist that warrant variance in specified planting dates or conditions. Submit written request for approval to RE/COR stating special conditions and proposal variance.

1.10 WARRANTY

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."
- B. Comply with "Warranty" requirements in Section 01 00 01, GENERAL REQUIREMENTS, including the following supplements:

1. One Year Plant and Turfgrass Warranty: Warranty begins when Government accepts plants and turfgrass but not before end of Landscape Plant and Turfgrass Establishment Period.
2. Replace any dead plant material and any areas void of turfgrass immediately during warranty period and during an active growing season. One-year warranty for replaced plants and turfgrass begins on day replacement work is completed and accepted.
3. Replacement of relocated plants, not furnished, is not required unless they die from improper handling and care. Loss due to improper handling, care, or negligence requires replacement in kind and size.
4. Government will inspect replacement plants and turfgrass at end of Warranty period. Replace any dead, missing, or defective plant material and turfgrass immediately and during growing season. Warranty ends on date of this inspection provided work specified in this section is complied.
5. Remove stakes, guys wires/straps at end of one-year warranty.

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

- A. Provide each product from one source or manufacturer.
- B. Plant and Turf Grasses: Comply with the varieties specified or shown in plant list.
- C. Warrant plants are true to botanical name as listed in Hortus Third.
- D. Maintain equipment, tools and machinery on project site in sufficient quantities and capacity for proper execution of Work.

2.2 ORGANIC SOIL AMENDMENT

- A. Organic Soil Amendment: Dark brown or black and capable of enhancing plant growth. Ninety-eight percent of material passes 1-inch screen. No admixture of refuse (i.e. noticeable inert contamination) or materials toxic to plant growth are permitted, free of all woody fibers, seeds, leaf structures, plastic, petroleum products, and toxic and non-organic matter.
 1. Acceptable Organic Soil Amendments: Peat moss, humus or peat, and commercially available combinations thereof.
 2. Acceptable Compost: Natural organic sources such as food or animal residuals, or yard trimmings.
 3. Unacceptable Sole Sources of Organic Matter: Untreated sludge from wastewater treatment plants, fresh manure, sawdust, and immature composts.
- B. Minimum Material Requirements:

Test Parameter	Acceptable Ranges
Organic Matter	27 to 80 percent
pH	5.5 to 8.5
Ash	20 to 65 percent

Test Parameter	Acceptable Ranges
Nitrogen	0.4 to 3.5 percent
Phosphorus	0.2 to 1.5 percent
Potassium	0.4 to 1.5 percent
C: N Ratio	25 to 30: 1
CEC	50 to 150 meq/100 g
Heavy Metals	Less than max. limits established by EPA 40 CFR Part 503
Inert Contents	Less than 1 percent by weight
Water-Holding Capacity	150 to 200 percent
Pathogen/Weed Seed Destruction	Proof of EPA minimum heating requirements

- C. Topsoil stripped and stockpiled on project site is acceptable provided, after testing and addition of necessary additives, meets above specification. Provide additional Organic Soil Amendment as required to complete work.
- D. Provide organic soil amendment in areas with organic matter content below 4 percent that will be seeded, sodded or sprigged after grading activities are completed to create satisfactory topsoil horizon.
- E. Spread and incorporate organic soil amendment into finished subgrade at depths indicated on Drawings to raise soil organic content to minimum four percent and maximum six percent. Allow for additional depth of organic soil amendment to bring all grades to required finished grades as shown on grading plans.

2.3 PLANTS

- A. Plants: ANSI Z60.1, except as otherwise stated in this section or shown on drawings. Where drawings or specifications are in conflict with ANSI Z60.1, drawings and specification will prevail.
 - 1. Provide well-branched and formed planting stock, sound, vigorous, and free of disease, sunscald, windburn, abrasion, harmful insects or insect eggs with healthy, normal, and unbroken root systems.
 - 2. Provide single stemmed trees, with a single leader, unless otherwise indicated.
 - 3. Provide trees and shrubs of uniform, symmetrical growth, with straight boles or stems, free from objectionable disfigurements, and with branch spread of branches typical of variety.
 - 4. Provide ground cover and vine plants with number and length of runners for size, and proper age for grade of plants specified. Provide well established plants in removable containers, integral containers, or formed homogeneous soil sections.
 - 5. Provide plants grown under climatic conditions similar to those in project locality.
- B. Minimum acceptable sizes of all plants, measured with branches in normal position, to conform to plant list and ANSI Z60.1. Larger plants with RE/COR's approval, at no additional cost to the

Government. Increase ball of earth or spread of roots according to ANSI Z60.1 when larger plants are provided.

- C. Do not handle plants by trunk or stem. Trees must be moved by lifting root ball, box or container.
- D. Container grown plants to have sufficient root growth to hold earth intact when removed from containers, but not be root bound.
- E. When existing plants are to be relocated, ball sizes to conform to ANSI Z60.1 requirements for collected plants, with plants dug, handled, and replanted according to applicable requirements of this section.

2.4 LABELS

- A. Legibly tag each plant, or group and bundles or containers of the species, variety, and size of plant with durable, waterproof and weather-resistant label indicating correct plant name and size specified in plant list. Labels to be securely attached and not removed until acceptance by the Government.

2.5 TOPSOIL

- A. Topsoil: Provide well-graded soil of good uniform quality, natural, friable soil representative of productive soils in project vicinity. Topsoil to be free of subsoil, foreign matter, objects larger than 1 inch in any dimension, toxic substances, weeds and any material or substances that may be harmful to plant growth and have pH value of minimum 6.0 and maximum 7.0, and be best suited to region, climate and plant material specific to project.
- B. Obtain material from stockpiles established under Section 31 20 00, EARTH MOVING, subparagraph, Stripping Topsoil that meet general requirements stated above. Amend topsoil not meeting pH range specified by the addition of pH adjusters.
- C. When sufficient topsoil is not available on project site to specified depth, provide additional topsoil. Minimum 10 days before topsoil delivery, notify RE/COR of sources from which topsoil will be furnished. Obtain topsoil meeting general requirements stated above and comply with requirements specified in Section 01 45 29, TESTING LABORATORY SERVICES. Amend topsoil not meeting pH range specified by adding pH adjusters.

2.6 INORGANIC SOIL AMENDMENTS

- A. Lime: Agricultural limestone, minimum 90 percent calcium and magnesium carbonates. Grind lime fineness, minimum 90 percent passes No. 8 mesh and minimum 25 percent passes No. 100 mesh. Maximum moisture, 10 percent.
 - 1. Dolomitic Lime: Natural, agricultural limestone (calcium and magnesium carbonate), minimum of 20 percent calcium and 11 percent magnesium and as follows:
 - a. Screen Analysis: 100 percent passing through No.30 sieve; 70 percent passing through No. 100 sieve; minimum 30 percent passing through No.325 sieve. Provide lime in form of granulated, prilled, dolomitic limestone.

2. Calcitic Lime: Natural, agricultural limestone (calcium carbonate), minimum of 36 percent calcium and as follows:
 - a. Screen Analysis: minimum of 100 percent passing through No. 10 sieve; minimum of 80 percent passing through No. 100 sieve. Provide lime in form of granulated, prilled, limestone.
3. Agricultural Gypsum: Finely ground, minimum of 90 percent calcium sulfate, or 85 percent calcium sulfate dihydrate.
4. Sulfur: Granular, biodegradable, minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.
5. Iron Sulfate: Granulated ferrous sulfate minimum of 20 percent iron and 10 percent sulfur.
6. Aluminum Sulfate: Commercial grade, unadulterated.
7. Sand: Clean washed river sand, free of calcium, chlorides and other deleterious substances.
8. Humates: Derived from mined Gypsum and with guaranteed minimum analysis; Calcium Sulfate dihydrate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) 35.00%; Calcium (Ca) 7.00%; Sulfur (S) 5.00%, plus Humic Acids 1.5% derived from Leonardite. Pelletized product used for ease of application.
9. Mycorrhizae: Endomycorrhizal powder inoculum consisting of the following 4 species blend of propagules of arbuscular mycorrhizal fungi: Glomus intraradices, Glomus mosseae, Glomus aggregatum, and Glomus etunicatum. Minimum 100,000 spores/propagules per pound. The powder particle size shall be less than 300 microns (100 percent passing the #50 screen).

2.7 ORGANIC SOIL AMENDMENTS

- A. Peat: Natural product of sphagnum moss peat derived from fresh-water site conforming to Fed. Spec. Q-P-166, except as otherwise specified. Shred and granulate peat to pass 1/2-inch mesh screen and condition in storage piles for minimum six months after excavation.
- B. Perlite: Horticulture grade.
- C. Vermiculite: Horticultural grade, free of any toxic materials.
- D. Organic Matter: Commercially prepared compost, composted sufficiently to be free of all woody fibers, seeds, and leaf structures, and free of toxic and nonorganic matter.

2.8 PLANTING SOIL MIXTURE

- A. Ornamental Plantings: Planting soil mixture composed of 3 parts topsoil and 1 part compost.
- B. Native Plantings: 100 percent native on-site soil free of clods and subsoil. Do not amend soils intended for native planting.

2.9 PLANT FERTILIZERS

- A. Provide commercial grade plant fertilizer of uniform composition and complying with applicable state and federal regulations.
- B. For new plant material, provide uniform free-flowing granular complete analysis fertilizer based on recommendations of soils reports, containing minimum 10 percent nitrogen, phosphoric acid and

potash by weight with minimum 50 percent of nitrogen from controlled release source such as sulfur coated urea (SCU), polymer coated urea (PCU), and sulfur-coated/polymer coated urea (PCSCU).

- C. For existing trees, provide a uniform free-flowing granular fertilizer bearing manufacturer's warranted statement of analysis. Granular fertilizer to contain minimum 10 percent nitrogen by weight (50 percent from controlled release source such as sulfur coated urea), 10 percent available phosphoric acid, and 10 percent potash.

2.10 TURFGRASS FERTILIZER

- A. Provide commercial grade granular fertilizer, free flowing, uniform in composition, and complying with applicable state and federal regulations. Submit fertilizer manufacturer's warranted statement of analysis. Fertilizer contain minimum 20 percent nitrogen by weight (50 percent from controlled release source such as sulfur coated urea), 5 percent available phosphoric acid, and 15 percent potash. Liquid starter fertilizer for hydro mulch slurry, commercial type with 50 percent of nitrogen from controlled release source.

2.11 MULCH

- A. Mulch: Free of deleterious materials and stored to prevent inclusion of foreign material.
- B. Organic Mulch: Wood based products such as chips, nuggets or shredded hardwood:
 - 1. Straw for turfgrass seedbed mulch: Stalks from oats, wheat, rye, barley, or rice free of noxious weeds, mold or other objectionable material. Straw to be air-dried and suitable for placing with blower equipment.
 - 2. Wood cellulose fiber mulch for hydraulic application (Hydro mulch) with fertilizer: Specially prepared wood cellulose fiber, processed with no growth or germination-inhibiting factors, and dyed an appropriate color to facilitate visual metering of application of materials. Do not apply any turfgrass seed in this type mixture. Maximum 12 percent moisture dry weight, plus or minus three percent at time of manufacture. pH range from 3.5 to 5.0. Manufacture wood cellulose fiber for application as follows:
 - a. After addition and agitation in slurry tanks with fertilizers, water, and other approved additives, fibers will become uniformly suspended to form a homogenous slurry.
 - b. When hydraulically sprayed, material will form blotter-like cover.
 - c. Cover allows absorption of moisture and allow rainfall or applied water to percolate to underlying soil.
- C. Non-Asphaltic Tackifier:
 - 1. M-Binder: 100 percent organic, non-toxic, biodegradable, free of plant-growth or germination inhibitors; a botanical glue used in hydroseeding, to stabilize soils and for dust control. Derived from the seed of the plantago plant (*Plantago insularis*). Protein content: 1.62; Ash content: 2.70; Fiber: 4.00; pH: 6.8; Settleable solids: 5.00.

2.12 EROSION CONTROL

- A. Erosion Control Net: Heavy, twisted jute mesh weighing 1.22 lbs./sq. yd. with openings between strands approximately 1-inch square. Install erosion control net according to manufacturer's instructions.
- B. Erosion Control Blanket: Cellulose fiber blanket bonded to 1/4 inch square plastic net weighing 20 lbs./1000 sq. ft. in 50-inch wide rolls.

2.13 STAKES AND GUYING STRAPS

- A. Tree Support Stakes: Rough sawn wood, free of knots, rot, cross grain, or other defects that impair strength. Minimum 2 inches square by 8 feet long and pointed at one end.
- B. Hose Chafing Guards: New or used 2-ply reinforced rubber or plastic hose, all same color.
- C. Flags: White surveyor's plastic tape, 6 inches long, fastened to guying wires or cables.
- D. Guying Straps: Fabric designed specifically to guy newly planted trees. Wire will not be permitted.
- E. Turnbuckles: Galvanized or cadmium-plated steel with minimum 3-inch long openings fitted with screw eyes.
- F. Eye Bolts: Galvanized or cadmium plated steel with 1-inch diameter eye and minimum 1-1/2 inches screw length.
- G. Deadmen: 4-inch by 8 inch rectangular, or 8 inch diameter by 36 inch long sound wood.
- H. Anchors: Arrow shaped or auger iron anchors, noncorrosive, sized according to manufacturer's instructions.

2.14 WATER

- A. Water: Contains no elements toxic to plant life, obtained from on-site potable water supply as specified in Section 01 00 01, GENERAL REQUIREMENTS, Paragraph, Temporary Services.

2.15 ANTIDESICCANT

- A. Antidesiccant: Emulsion manufactured for agricultural use to provide protective film over plant surfaces permeable enough to permit transpiration.

2.16 SEED

- A. Seed: State-certified seed of latest season's crop delivered in original sealed packages, bearing producer's warranted analysis for percentages of mixtures, purity, germination, weed seed content, and inert material. Label complying with USDA Federal Seed Act and applicable state seed laws. Wet, moldy, or otherwise damaged seed will not be acceptable. Onsite seed mixing will only be acceptable in presence of RE/COR. Apply turfgrass seed separate from and before mulch material application.
- B. Minimum Acceptable Seed Quality Standards: Purity 95 percent, Germination 85 percent, Weed Seed Content less than 0.5 percent, Noxious Weeds 0.0 percent, Inert Material less than 3 percent, Germination Test Date no older than 6 months.

- C. All turfgrass seed mixtures, or sod composition to conform to species and cultivar requirements detailed here. Seed mixtures listed below are representative of an almost endless list of acceptable seed mixtures that roughly approximate these guidelines.

Cool Season Turfgrass Seed Mixtures	Percent by Weight
Primary Mixture	60 percent perennial rye grass, 40 percent Kentucky bluegrass
Primary Mixture Seeding Rate	8 lbs./1000 sq. ft.
Native Seed Blend for Upland Soils Mixture (per Michigan Department of Transportation (MDOT) Approved Roadside Seed Mixtures)	Big Bluestem (2 lbs/acre PLS), Indiangrass (2 lbs/acre PLS), Little Bluestem (2 lbs/acre PLS), Upland Wildflower Mixture (2 lbs/acre PLS)
Native Seed Blend for Wet Soils (per MDOT Approved Roadside Seed Mixtures)	Big Bluestem (2 lbs/acre PLS), Indiangrass (2 lbs/acre PLS), Little Bluestem (2 lbs/acre PLS), Lowland Wildflower Mixture (2 lbs/acre PLS)

1. Blend each species component with minimum two regionally adapted cultivars.
- D. Obtain approval of RE/COR and NCA Agronomist for deviations from these turfgrass species requirements.
- 2.17 SOD**
- A. Sod: Nursery grown, certified sod as classified in TPI "Guideline Specifications to Turfgrass Sodding." Sod must also conform to turfgrass species limitations as outlined in seeding mixtures above.
- 2.18 HERBICIDES AND OTHER PESTICIDES**
- A. Properly label and register pesticides with U.S. Environmental Protection Agency. Keep all pesticides in original labeled containers indicating analysis and method of use.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Examine and verify substrate suitability for product installation.
- B. Protect existing construction and completed work from damage.
- C. Examine areas to receive planting for compliance with requirements and other conditions affecting performance.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.
- E. Identify and review all underground utility locations before commencing work and exercise caution when working close to utilities. Notify RE/COR of apparent conflicts with construction and utilities to plan adjustment before installation.

3.2 FINE GRADING AND ORGANIC AND INORGANIC SOIL AMENDMENT INCORPORATION

- A. Obtain RE/COR's written approval of previously completed rough grading work before incorporating organic soil amendments.
- B. Immediately before dumping and spreading approved organic soil amendment, clean subgrade of stones larger than 2 inches and debris or rubbish and remove from project site. Before spreading organic soil amendment, rip subgrades too compact to drain water or based upon compaction tests with claw 12 inches deep, pulled by bulldozer 24 inches on center, both directions, then regrade surface.
- C. Place and uniformly spread soil amendment materials humates and mycorrhizae over approved sub-grades. Apply inorganic soil amendments as recommended by soils report. Apply organic amendments to depth sufficiently greater than specified depth so after natural settlement and light rolling, specified minimum settled depth conform to lines, grades and elevations indicated on drawings. Incorporate soil amendment by disc harrowing, rototilling or other means in uniform manner. Incorporate upon organic matter deep enough to produce finished soil with organic matter content of between 4 and 6 percent. Provide additional organic soil amendment material, after in-place testing and approval, as required for organic matter content and finished grades at no additional cost to Government.
- D. Spread organic soil amendment material minimum 4 inches deep to finished grade at disturbed areas outside project limits.
- E. Do not handle subsoil or organic soil amendment material when wet or frozen.
- F. Set sufficient number of grade stakes to check finished grades. Set stakes in bottom of swales and at top of slopes. Connect contours and spot elevations with even slope.
- G. After incorporating soil amendments material into subsoil, prepare by scarifying or harrowing and hand raking. Remove large stiff clods, lumps, brush, roots, stumps, litter and other foreign matter. Remove stones over 1-1/2-inch diameter from amended soil bed. Amended soil also to be free of smaller stones in excessive quantities as determined by RE/COR.

3.3 EXCAVATION FOR PLANTING

- A. Compact whole surface with roller or by other suitable means to achieve 88 to 85 percent maximum dry density according to ASTM D698. During compaction process, fill all depressions caused by settling or rolling with additional organic soil amendment. Regrade and roll surface until presenting smooth and even finish corresponding to required grades. Acceptable finished soil grade condition for all new turfgrass areas is "fine textured and firm." Satisfactory firmness test requires surface soil not be fluffy or powdery and able to support weight of average adult person without creating visible depression.
- B. Verify location of underground utilities before plant pit or bed excavation. Repair damaged utility lines. Where lawns have been established before planting, cover and protect before beginning

excavations. Protect existing trees, shrubbery, and beds with barricades during project construction.

- C. Remove rocks and other underground obstructions to depth necessary to permit proper planting according to Drawings. Where underground utilities, construction, or solid rock ledges are encountered, RE/COR may select other locations for plant material.
- D. Dig plant pits by approved method to provide vertical sides and flat bottoms. When sides of pit become glazed, scarify glazed surface.
- E. Where ground cover and planting beds occur in existing turfgrass areas, remove turfgrass to depth that will ensure removal of entire root system. Prepare bed as follows:
 - 1. Where existing soil is to be used in place, till beds 12 inches deep. Spread soil amendment uniformly over bed 2 inches deep and thoroughly incorporate into existing soil 12 inches deep using a roto-tiller or similar equipment to obtain uniform and well pulverized soil mix. Where existing soil is compacted (former roadways, parking lots, etc.) till soil to necessary depth to support growth of new planting. Remove all sticks, stones, roots, and other objectionable materials. Bring plant beds to smooth and even surface to comply with established grades.
- F. In newly grading areas where existing soil will be removed and replaced to prepare new planting beds, remove 8 inches of existing soil and replace with topsoil. Bring plant beds to smooth and even surface to comply with established grades. Till 2 inches of soil amendment into topsoil as specified.
- G. Form earth saucers around plants with topsoil. Provide 2-inch high basins for shrubs and 4-inch high basins for trees.
- H. Treat plant saucers, shrub, and ground cover bed areas, before mulching, with approved preemergence granular ornamental herbicide. Apply herbicide at 200 lbs./acre before both early spring and early fall weed seed germination. Plant ground cover in areas to receive erosion control material through that material after material is in place.

3.4 SETTING PLANTS

- A. Move balled and burlapped and container-grown plants only by supporting ball or container. Remove container, taking care to prevent damage to plants or root system. Set plants plumb and hold in position until sufficient soil has been firmly placed around roots or ball. Set plants with root crown 4 inches above surrounding grade and remove all excess soil from top of rootball. Plant ground cover plants after mulch is in place. Avoid contaminating mulch with planting soil.
- B. Backfill balled and burlapped and container-grown plants with native soil removed from planting hole to approximately half ball depth, then tamp and water. Use native soil to backfill hole. Carefully fold back top half of burlap and remove tying materials. Completely remove all wire caging or similar material. Where plastic wrap or burlap is used, completely remove these

materials before backfilling. Tamp and water remainder of backfill, then form earth saucers or water basins around isolated plants with topsoil.

3.5 STAKING AND GUYING

- A. Stake and guy plants as indicated on drawings and as specified.
- B. Drive stakes vertically to depth of 2-1/2 to 3 feet into ground outside plant pit, unless otherwise shown on drawings Do not injure root ball.
- C. Place deadmen minimum 18 inches below ground surface, unless otherwise indicated on drawings.
- D. Install iron anchors according to manufacturer's instructions.
- E. Fasten flags securely to each guy strap approximately 2/3 of the distance above ground level.

3.6 EDGING PLANT BEDS

- A. Uniformly edge beds using machine to provide clear cut "V"-shaped trench between planted area and adjacent turfgrass. Fill trench with mulch.

3.7 MULCHING PLANTS

- A. Apply approved preemergence granular ornamental herbicide and mulch within 48 hours after planting. Apply before both early spring and early fall weed seed germination.
- B. Placing Organic Material: Spread wood-base mulch to uniform 2 to 3-inch thickness. Rake smooth. Flush mulch with adjacent lawn, curbs and paving. Taper mulch thickness 2 inches where planting beds meet adjacent areas.
- C. Keep mulch out of shrub crowns, away from tree trunks, and off buildings, sidewalks, light standards, and other structures.

3.8 PRUNING

- A. Do not prune new plants unless otherwise directed by arborist and approved by the RE/COR. Prune indicated existing plant material as follows:
 - 1. Remove dead, broken and crossing branches.
 - 2. Make cuts with sharp instruments as close as possible to branch collar. Do not make flush cuts.
 - 3. Do not make "Headback" cuts at right angles to line of growth. Do not pole trees or remove leader.
 - 4. Remove trimmings from project site.
 - 5. Do not apply tree wound dressing to cuts.
- B. Prune existing trees as indicated on Drawings. Perform tree pruning and cavity work by licensed arborist according to ANSI Z133.1. Remove 1/2-inch diameter or larger dead wood, branches interfering with or hindering healthy growth of trees, and diseased branches with clean cut made flush with branch collar. Prune trees according to their natural growth characteristics leaving trees well shaped and balanced. Use of climbing spurs is not acceptable. Remove stubs or limbs improper cuts or breaks.

3.9 FERTILIZATION OF EXISTING TREES

- A. Apply fertilizer to existing trees shown on drawings at rate recommended by soil test. Apply in 4-inch to 8-inch deep holes 1-1/2 to 2 inches in diameter, made by an earth auger, distributed evenly at maximum 2 feet on center throughout outer half of branch spread zone of each tree. Fertilize to within 4 inches of surrounding grade. Use topsoil to bring surface up to surrounding grade. When using fertilizer in packet, tablet, or wedge form, apply according to manufacturer's instructions.

3.10 TILLAGE FOR LAWN AREAS

- A. Thoroughly rip subgrades minimum 6 inches deep by scarifying, disking, harrowing, or other approved methods. Remove debris and stones on surface larger than 1 inch on surface after tillage. Do not till areas of 3: 1 slope ratio or greater. Scarify these areas to 1 inch depth and remove debris and stones.

3.11 FINISH GRADING

- A. After ripping subgrade for topsoil/subsoil bonding, spread topsoil evenly to minimum 6 inches deep. Incorporate topsoil at least 2 to 3 inches into subsoil to avoid soil layering. Spread additional topsoil as required to meet finish grades. Do not spread topsoil when frozen or excessively wet or dry. Correct irregularities in finished surfaces to eliminate depressions. Protect finished lawn areas from damage by vehicular or pedestrian traffic. Complete lawn work only after areas are brought to finished grade.

3.12 APPLICATION OF FERTILIZER AND SOIL AMENDMENTS FOR TURFGRASS AREAS

- A. Apply turfgrass fertilizer and adjust soil acidity as recommended by soil test results. Add soil conditioners as specified for suitable topsoil in PART 2.
- B. Spread soil amendments as recommended by soil test results.
- C. Incorporate soil amendments into soil to minimum 4 inches deep in finish grading operation. Lightly mix starter fertilizer with top 1/2 inch of soil. Immediately restore soil an even condition before seeding or sod placement.

3.13 HYDRO-MULCHING

- A. Hydro-Mulching: Mix slow release starter fertilizer and approved wood cellulose mulch material, and tackifier in required amount of water to produce homogenous slurry. Uniformly apply slurry under pressure to deliver recommended quantity of fertilizer per 1000 sq. ft.

3.14 SODDING

- A. Place sod according to TPI Guideline Specifications for sodding. Lay sod at right angles to slope or the flow of water. On slope areas, start at bottom of slope.
- B. Finishing: After sodding, blend edges of sod smoothly into surrounding area. Roll with lightweight roller to eliminate air spaces between sod and firmed soil.

3.15 WATERING

- A. Watering: Start watering turfgrass areas immediately after installation at sufficient rate to ensure thorough wetting of soil to minimum 2 inches deep. Supervise watering operation to prevent run-off. Supply necessary pumps, hoses, pipelines, and sprinkling equipment. Repair all areas damaged by water operations. Keep soil surface constantly moist, not wet, until turfgrass plants are well established.
- B. Deep water all trees twice each week during Plant Establishment Period, providing water penetration throughout root zone to full depth of planting pits, as verified by RE/COR. Discontinue watering at first hard frost in fall and resume at ground thaw in spring.

3.16 EROSION CONTROL MATERIAL

- A. Install and maintain erosion control material on designated areas as shown on drawings. Prepare, fertilize and vegetate areas to be covered, before erosion material is placed. Immediately following planting operations, lay erosion control material evenly and smoothly and in contact with soil throughout. Omit straw mulch from all seeded areas receiving erosion control material.
- B. For waterways, unroll erosion control material in direction of water flow. When two or more strips are required to cover ditch area, overlap strips minimum 4 inches. For strips to be spliced lengthwise, overlap ends minimum 6 inches with upgrade section on top.
- C. On slopes, place erosion control material either horizontally or vertically to slope with edges and ends of adjacent strips butted tightly against each other.
- D. Staple each erosion control strip in three rows (each edge and center with center row alternately spaced) with staples spaced maximum 4 feet longitudinally. For two or more strips side by side on slopes, install common row of staples on adjoining strips. Staple all end strips at 12-inch intervals at end. Firmly embed staples in underlying soil.
- E. Provide erosion control maintenance to repair damage by erosion, wind, or any other cause. Maintain, protect, repair, or replace erosion control material until Termination of the Plant and Warranty Period.

3.17 LANDSCAPE PLANT AND TURFGRASS ESTABLISHMENT PERIOD

- A. Landscape Plant and Turfgrass Establishment Period: Begins immediately after installation, with RE/COR approval, and continues through growing season sufficiently long for turfgrass and landscape plant materials to become establish and provide satisfactory to District Agronomist and NCA. Conditions and appearance are as follows:
 - 1. Turfgrass has obtained minimum of 98 percent generally weed-free surface cover.
 - 2. Landscape Plant Materials are fully rooted, actively growing and healthy and planting beds generally weed-free.
 - 3. Maintain plant and turfgrass during establishment period.
 - 4. Plants and turfgrass will not be accepted until completion of acceptable establishment period.

5. During Landscape Plant and Turfgrass Establishment Period complete the following:
 - a. Water plants and turfgrass to maintain moist soil surface until plants and turfgrass are well established. Quantity of applied water required to achieve and maintain these conditions determined on site by District Agronomist in consultation with RE/COR.
 - b. Prune plants and replace mulch as required.
 - c. Replace and restore eroded plant saucers as required.
 - d. Remove grass, weeds, and other undesired vegetation, including root growth, before they reach 3 inches high in plant bed and saucers. After all unwanted vegetation has been removed, apply approved preemergence herbicides and remulch.
 - e. Spray with approved insecticides and fungicides to control pests and ensure plant survival in healthy growing condition, as directed by RE/COR in coordination with District Agronomist.
 - f. Provide the following during turfgrass establishment:
 - 1) Eradicate weeds. Water, fertilize, overseed, and perform other operation necessary to promote growth of turfgrass.
 - 2) Mow turfgrasses as often as necessary to maintain NCA specified mowing height for each type of turfgrass before final acceptance. Begin mowing when cool season turfgrass is 4 inches high. For warm season turfgrasses, mow at appropriate heights for species and cultivar as directed by RE/COR in consultation with District Agronomist.
 - g. Replace dead, missing or defective plant material during establishment period and an active growing season. Immediately replace each plant with one of same size and species.
 - h. Replant areas void of turfgrass during an active growing season only.
 - i. Sod will be evaluated for species and health thirty days after laying last piece and reevaluated each 15 days during the establishment period. A satisfactory stand of grass plants from sod operation will be living sod, uniform in color and leaf texture. Bare spots to be maximum 2 sq. inches. Joints between sod pieces to be tight and free of weeds and other undesirable growth.
 - j. Seeding will be evaluated for species and health thirty days after final planting and reevaluated each 15 days during the establishment period. A satisfactory stand of grass plants from seeding operation will be 98 percent coverage uniform in color and leaf texture. Bare spots to be maximum 2 sq. inches. Reseed unsatisfactory areas within seven days during an active growing season.
 - k. Complete remedial measures as directed by RE/COR in consultation with District Agronomist to ensure plant and turfgrass survival.
 - l. Repair damage caused while making plant or turfgrass replacements.

3.18 LANDSCAPE PLANT AND TURFGRASS ACCEPTANCE

- A. Landscape plant and turfgrass acceptance will occur after completion of LANDSCAPE PLANT AND TURFGRASS ESTABLISHMENT PERIOD. Contractor to have completed, located, and installed all plants and turfgrass according to drawings and specifications. All plants and turfgrass are expected to be living and in healthy condition at time of inspection and acceptance. Make written request two weeks before final inspection of landscape plants and turfgrass. Upon inspection, when work is found to not meet specifications, PLANT AND TURFGRASS ESTABLISHMENT PERIOD will be extended at no additional cost to Government until work has been satisfactorily completed, inspected and accepted.
- B. Criteria for Acceptance of Landscape Plants:
 - 1. Planter beds and earth mound water basins are properly mulched and free of weeds.
 - 2. Tree support stakes, guys, and turnbuckles are in good condition.
 - 3. Total plants on site as required by specifications and required replacements have been installed.
 - 4. Remedial measures directed by RE/COR have been completed.
- C. Criteria for Acceptance of Turfgrass:
 - 1. Sod: Living sod grass plants uniform in color and leaf texture and well rooted into soil below so that gentle pulling of turfgrass leaves by hand does not dislodge sod. Bare spots to be maximum 2 sq. inches. Joints between sod pieces shall be tight and free from weeds and other undesirable growth.
 - 2. Seed: Living turfgrass plants with 98 percent coverage, uniform in color and leaf texture. Bare spots to be maximum 0.5 sq. ft.

3.19 CLEANING

- A. Remove and legally dispose of all debris, rubbish, and excess material from project site.
- B. Where existing or new turfgrass areas have been damaged or scarred, restore disturbed areas to original condition.
- C. In areas where planting and turfgrass work have been completed, clear the area of all debris, spoil piles, and containers.
- D. Maintain minimum one paved pedestrian access route and one paved vehicular access route to each building clean at all times.
- E. Clear other paved areas when work in adjacent areas are completed.

3.20 PROTECTION

- A. Protect plants and turfgrass areas from traffic and construction operations. Erect barricades, as required, and place approved signs at appropriate intervals until final acceptance.
- B. Remove protective materials immediately before acceptance.
- C. Repair damage.

3.21 ENVIRONMENTAL PROTECTION

- A. All work and operations to comply with requirements of Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

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**SECTION 33 30 00
SANITARY SEWERAGE UTILITIES**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Outside, underground sanitary sewer system, complete, ready for operation, including all pressure (force) lines, frames, covers, structures, appurtenances, and connections to service lines, existing sanitary sewer lines, and existing sanitary structures, and all other incidentals.

1.2 RELATED WORK

- A. Section 01 00 01, GENERAL REQUIREMENTS.
- B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- C. Section 01 42 19, REFERENCE STANDARDS.
- D. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- E. Section 03 30 53, CAST-IN-PLACE CONCRETE.
- F. Section 05 50 00, METAL FABRICATIONS: Fabrication of Steel Ladders.
- G. Section 31 20 00, EARTH MOVING: Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing.
- H. Section 32 90 00, PLANTING: Seeding, Topsoil.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Society for Testing and Materials (ASTM):
 - A615/A615M-2015a Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 - C139-2014 Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
 - C150/C150M-2015 Standard Specification for Portland Cement
 - C478-2015 Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
 - C857-2014 Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
 - C990-2009 (R2014) Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
 - D698-2012e2 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft³ (600 kN-m/m³))

- D2412-2011 Standard Test Method for Determination of External Loading
Characteristics of Plastic Pipe by Parallel-Plate Loading
- D3212-2007 (R2013) Standard Specification for Joints for Drain and Sewer Plastic
Pipes Using Flexible Elastomeric Seals
- D3261-2012e1 Standard Specification for Butt Heat Fusion Polyethylene (PE)
Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing
- D3350-2014 Standard Specification for Polyethylene Plastics Pipe and
Fittings Materials
- D4101-2014 Standard Specification for Polypropylene Injection and Extrusion
Materials
- F477-2014 Standard Specification for Elastomeric Seals (Gaskets) for
Joining Plastic Pipe
- F714-2013 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-
PR) Based on Outside Diameter
- F894-2013 Standard Specification for Polyethylene (PE) Large Diameter
Profile Wall Sewer and Drain Pipe
- C. American Water Works Association (AWWA):
- C906-2015 Polyethylene (PE) Pressure Pipe and Fittings, 100 mm through
1650 mm (4 Inches through 65 Inches), for Waterworks

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 33 30 00, SANITARY SEWERAGE UTILITIES", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Submit the following as one package:
1. Pipe, Fittings, and, Appurtenances.
 2. Jointing Material.
 3. Manhole and Structure Material.
 4. Frames and Covers.
 5. Steps and Ladders.
- E. Submit the following as one package: Shop drawings of the equalization tank, pumps, flow inducer tower, piping and control panel.

- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

1.5 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
 - 2. Nameplates: Nameplate bearing manufacturer's name, or identifiable trademark, including model number, securely affixed in a conspicuous place on equipment, or name or trademark, including model number cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
- B. Comply with the rules and regulations of the Public Utility having jurisdiction over the connection, extension, and modification to Public Sanitary Sewer lines and Public Utility Systems as applicable.

1.6 AS-BUILT DOCUMENTATION

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be inserted into a three-ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing Contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD provided on CD or DVD. Should the installing Contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.

- D. Certification documentation shall be provided to Resident Engineer/Contracting Officer's Representative (RE/COR) 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

PART 2 - PRODUCTS

2.1 PIPING

- A. Pressure (Force) Lines (Pipe and Fittings):
1. All pipe and fittings used in the construction of force mains shall be rated for a minimum of 150 psi.
 2. High Density Polyethylene (HDPE) pipe and fittings shall be manufactured from PE 3608, high density, extra high molecular weight polyethylene meeting the requirements of ASTM D3350. Pipe shall be manufactured in accordance with ASTM F714, and shall be Class 160 (DR 11). Molded fittings shall be manufactured in accordance with ASTM D3261 and subject to the test required under ASTM D3261. Fabricated fittings shall be made by heat fusion jointing of machined shapes cut from pipe, sheet stock, or molded fittings. Molded and fabricated fittings shall be rated for a minimum working pressure equivalent to the pipe. Joints shall be heat fusion butt joints, flange adapters, or mechanical couplings.
 - a. Flange adapters shall have adequate through-bore length to be clamped in a butt fusion jointing machine without the use of a stub-end holder. The sealing surface of the flanged shall be machined with a series of V-shaped grooves to restrain the gasket against blow out. Back-up rings and flange bolts shall be rated equal to or greater than the mating pipe. All flange adapters shall be equipped with a stainless steel internal pipe stiffener.
 - b. Mechanical couplings shall be sleeve style, restrained coupling.

2.2 JOINTING MATERIAL

- A. Pressure (Force) Main:
1. High Density Polyethylene (HDPE) pipe and fittings shall be fusion butt welded, flanged, or mechanical couplings as recommended by the manufacturer. Restrained joints shall be limited to fusion welded and flanged.

2.3 FLOW EQUALIZATION TANK

- A. Submersible Pump
1. An Orenco Systems, Inc. submersible pump shall be furnished, Model PF501512 105 HP, 230V acetyl impeller, or equal. Each pump shall be equipped with a hermetically sealed and insulated motor.
 2. Pump and all fastening hardware shall be 316 Stainless Steel.
- B. Equalization Tank System

1. The equalization tank system shall consist of one 2,300-gallon minimum pre-cast concrete single compartment dosing tank as shown on drawings. Tank manufacturer or installer shall certify the water tightness of the tank in accordance with section 9.2, Testing for Leakage, of ASTM C12221-97A, Standard Specifications for Pre-cast Concrete septic tanks
 2. A pump flow inducer tower, Orenco Model FITD-D99 or equal, shall be provided.
- C. Electrical Control Panel
1. The control panel furnished shall be a duplex control panel, Model No. MVPDAX2ROPTHTSA Manufactured by Orenco, or equal. The UL-Listed, NEMA 4 panel must be located within 50ft of the pumps and within view.
 2. Two NEMA 6 Orenco Model SBEX junction boxes shall be furnished and mounted to the dosing riser.
- D. Equalization Tank Controls
1. An Orenco model MVPDAX2ROPTHTSA, or equal, mechanical float type liquid level control shall be furnished for proper pump and alarm operation.
 - a. Supply four Orenco Model "P" mechanical float switches. Housing shall be impact resistant, non-corrosive PVC and float cord shall be flexible 2-conductor (UL, CSA) SJOW, water resistant (CPE), neoprene coating.
 - b. Each float switch shall be attached to a schedule 40 PVC 1" float staff. The float staff shall be connected to the float bracket on the flow inducer tower.
- E. Operation of System
1. On liquid level rise in the pump vault, the lowest level mechanical switch will energize, the next level switch will initiate the timer enable float allowing time dosed volumes of wastewater to be sent to the drain field. If the liquid level reaches the third float, the pump will run on demand until the liquid level in the tank drops below the third override float. If the liquid level reaches the fourth float, an audio and visual alarm will engage.
- F. Factory Testing
1. Before shipping, all component parts shall be tested for the compliance with the hydraulic, mechanical, and electrical requirements of the specifications.
- G. Supervision of the installation and initial start-up and adjustment shall be provided by a field trained representative of the manufacturer.

2.4 WARNING TAPE

- A. Standard, 4 mils polyethylene 3-inch wide tape detectable type, green with black letters and imprinted with "CAUTION BURIED SEWER LINE BELOW".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the RE/COR, the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 ABANDONED PIPING

- A. Piping outside of building areas shall be completely removed.
- B. Comply with all OSHA confined space requirements while working within existing manholes and structures.
- C. When the limit of the abandonment terminates in an existing manhole to remain, the flow line in the bench of the manhole to the abandoned line shall be filled with concrete and shaped to maintain the flowline of the lines to remain.

3.3 GENERAL PIPING INSTALLATION

- A. Lay pipes true to line and grade. Pressure (force) mains shall have the bells facing the direction of flow.
- B. Do not lay pipe on unstable material, in wet trench, or when trench and weather conditions are unsuitable for the work.
- C. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
- D. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
- E. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt, or other substances.
- F. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash, and excess jointing materials.
- G. Do not lay sewer pipe in same trench with another pipe or other utility. Sanitary sewers shall cross at least 2 feet below water lines.
- H. Do not walk on pipe in trenches until covered by layers of bedding or backfill material to a depth of 12 inches over the crown of the pipe.
- I. Warning tape shall be continuously placed 12 inches above sewer pipe.
- J. Installation of Pressure (Force) Mains
 - 1. Sections of piping listed on the drawings shall be fully restrained using approved joint restraint devices. Joint restraint devices shall be installed in accordance with the manufacturer's recommendations. For devices with twist of nuts, the twist of nuts shall be placed on top of the fitting for the Engineer's inspection. Torque test all bolts, set screws, identified by the RE/COR.

2. Thrust blocks are prohibited.
3. Install pressure (force) mains in accordance with the provisions of these specifications and the following standards:
 - a. High Density Polyethylene (HDPE) Piping: Per manufacturer's recommendations.

3.4 EQUALIZATION TANK

- A. Complete installation per manufacture's specifications. Set float controls as indicated on the details.
- B. Initial start-up and adjustments shall be done with a representative of the owner present

3.5 INSPECTION OF SEWERS

- A. Inspect and obtain the RE/COR's approval. Thoroughly flush out before inspection. Lamp test between structures and show full bore indicating sewer is true to line and grade.

3.6 STARTUP AND TESTING

- A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. Flow Equalization Tank
 1. All testing of the system shall be done in the presence of the engineer of record. Testing shall be scheduled at least 48 hours in advance.
 - a. The contractor is responsible for supplying the necessary materials for doing the tests, including but not limited to the following:
 - 1) Water for the dose chamber.
 - 2) Electrical testing tools for measuring voltage, amps, and resistance.
 - 3) Equipment for shutting off valves and turning on the valves.
 - 4) The necessary personnel for conducting the test.
 2. The existing distribution network shall be tested to see if the design squirt height of 5 ft detailed on the plan is achieved.
 3. After successful testing of the distribution network, the electrical components of the system shall be tested to insure the components are in proper working order.
 - a. The floats shall be tested to ensure that all (4) of the floats perform adequately. The float testing shall verify that the pump on and off switches work, the timer enable float works, and the high-water alarm will activate.
 - b. Conduct other system testing as recommended by the pump manufacturer.

3.7 TESTING OF SANITARY SEWERS

- A. Pressure (Force) Mains: Test at 100 psi for two hours. Leakage shall be per the following:

$$L=J*D*\sqrt{P/4500}$$

Where:

L = Maximum Allowable Leakage in Gallons per Hour

J = Number of Joints in Test Area

D = Diameter of Pipe in Inches

P = Average Test Pressure (Psi)

- B. Testing of Concrete Wet Well: No leakage with the wet well completely filled with water for a duration of 4 hours.

3.8 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for one hour to instruct each VA personnel responsible in the operation and maintenance of units.

--- E N D ---

**SECTION 33 40 00
STORM SEWER UTILITIES**

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section specifies materials and procedures for construction of outside, underground storm sewer systems that are complete and ready for operation. This includes piping, structures, and all other incidentals.

1.2 RELATED WORK

- A. Section 01 00 01, GENERAL REQUIREMENTS.
B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
C. Section 31 20 00, EARTH MOVING: Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing.

1.3 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. American Association of State Highway and Transportation Officials (AASHTO):
HB-17-2002.....Standard Specifications for Highway Bridges, 17th Edition
M190-2004.....Standard Specification for Bituminous-Coated Corrugated Metal
Culvert Pipe and Pipe Arches
M252-2009.....Standard Specification for Corrugated Polyethylene Drainage
Pipe
M294-2015.....Standard Specification for Corrugated Polyethylene Pipe, 300 to
1500 mm (12 to 60 In.) Diameter
- C. American Concrete Institute (ACI):
318-2014.....Building Code Requirements for Structural Concrete and
Commentary
350-2006.....Code Requirements for Environmental Engineering Concrete
Structures and Commentary
- D. American Society of Mechanical Engineers (ASME):
A112.6.3-2016.....Floor and Trench Drains
A112.14.1-2003.....Backwater Valves
A112.36.2M-1991.....Cleanouts
- E. American Society for Testing and Materials (ASTM):
A48/A48M-2003 (R2012).....Standard Specification for Gray Iron Castings
A242/A242M-2013.....Standard Specification for High-Strength Low-Alloy Structural
Steel
A536-1984 (R2014).....Standard Specification for Ductile Iron Castings

A615/A615M-2016	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
A760/A760M-2015	Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
A762/A762M-2015	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
A798/A798M-2013	Standard Specification for Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications
A849-2015	Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
A929/A929M-2001(2013)	Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
A1064/A1064M-2016	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
B745/B745M-2015	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
B788/B788M-2009 (R2014)	Standard Specification for Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe
C14-2015a	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
C33/C33M-2016	Standard Specification for Concrete Aggregates
C76-2015a	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
C150/C150M-2016	Standard Specification for Portland Cement
C443-2012	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
C478-2015	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
C506-2016a	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
C507-2015	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
C828-2011	Standard Test Method for Low-Pressure Air Test of Vitrified Clay Pipe Lines
C890-2013	Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures

C891-2011	Standard Practice for Installation of Underground Precast Concrete Utility Structures
C913-2008	Standard Specification for Precast Concrete Water and Wastewater Structures
C923-2008 (R2013) e1	Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
C990-2009 (R2014)	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
C1103-2014	Standard Specification for Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
C1173-2010 (R2014)	Standard Specification for Flexible Transition Couplings for Underground Piping Systems
C1433-2016a	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
C1479-2013	Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
D448-2012	Standard Classification for Sizes of Aggregate for Road and Bridge Construction
D698-2012e2	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft ³ (600 kN-m/m ³))
D1056-2014	Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber
D2321-2014e1	Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
D2661-2014	Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings
D3034-2015	Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
D3350-2014	Standard Specification for Polyethylene Plastics Pipe and Fittings Materials
D3753-2012e1	Standard Specification for Glass-Fiber-Reinforced Polyester Manholes and Wetwells
D4101-2014	Standard Specification for Polypropylene Injection and Extrusion Materials

- D5926-2015 Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets
for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm
Plumbing Systems
- F477-2014 Standard Specification for Elastomeric Seals (Gaskets) for
Joining Plastic Pipe
- F679-2015 Standard Specification for Poly(Vinyl Chloride) (PVC) Large-
Diameter Plastic Gravity Sewer Pipe and Fittings
- F714-2013 Standard Specification for Polyethylene (PE) Plastic Pipe (DR-
PR) Based on Outside Diameter
- F794-2003 (R2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile
Gravity Sewer Pipe and Fittings Based on Controlled Inside
Diameter
- F891-2010 Standard Specification for Coextruded Poly(Vinyl Chloride)
(PVC) Plastic Pipe With a Cellular Core
- F894-2013 Standard Specification for Polyethylene (PE) Large Diameter
Profile Wall Sewer and Drain Pipe
- F949-2015 Standard Specification for Poly(Vinyl Chloride) (PVC) Corrugated
Sewer Pipe With a Smooth Interior and Fittings
- F1417-2011a (R2015) Standard Practice for Installation Acceptance of Plastic Non-
Pressure Sewer Lines Using Low-Pressure Air
- F1668-2008 Standard Guide for Construction Procedures for Buried Plastic
Pipe
- F. American Water Works Association (AWWA):
- C105-2010 Polyethylene Encasement for Ductile-Iron Pipe Systems
- C110-2012 Ductile-Iron and Gray-Iron Fittings
- C219-2011 Bolted, Sleeve-Type Couplings for Plain-End Pipe
- C600-2010 Installation of Ductile Iron Mains and Their Appurtenances
- C900-2007 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings,
4 In. Through 12 In. (100 mm Through 300 mm), for Water
Transmission and Distribution
- M23-2002 PVC Pipe: Design and Installation, Second Edition
- G. National Stone, Sand and Gravel Association (NSSGA):
- Quarried Stone for Erosion and Sediment Control
- H. Michigan Department of Transportation (MDOT) Standard Specifications for Construction.

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section
01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 33 40 00, STORM SEWER UTILITIES", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
- D. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.

1.5 QUALITY ASSURANCE

- A. Products Criteria:
 - 1. When two or more units of the same type or class of materials or equipment are required, these units shall be products of one manufacturer.
 - 2. A nameplate bearing manufacturer's name or trademark, including model number, shall be securely affixed in a conspicuous place on equipment. In addition, the model number shall be either cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Handle manholes, catch basins, and stormwater inlets according to manufacturer's written rigging instructions.

1.7 COORDINATION

- A. Coordinate connection to storm sewer main with the Public Agency providing storm sewer off-site drainage.
- B. Coordinate exterior utility lines and connections to building services up to the actual extent of building wall.

1.8 WARRANTY

- A. Guaranty: Warranty of Construction, FAR clause 52.246-21.
- B. The Contractor shall remedy any defect due to faulty material or workmanship and pay for any damage to other work resulting therefrom within a period of one year from final acceptance. Further, the Contractor will furnish all manufacturers' and suppliers' written guarantees and warranties covering materials and equipment furnished under this contract.

PART 2 - PRODUCTS

2.1 FACTORY-ASSEMBLED PRODUCTS

- A. Standardization of components shall be maximized to reduce spare part requirements. Guarantee performance of assemblies of components and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.

2.2 PVC PIPE AND FITTINGS

- A. PVC Profile Sewer Piping:
 - 1. Pipe: ASTM F794, Series 46, gravity sewer pipe with bell-and-spigot ends.
 - 2. Fittings: ASTM D3034, PVC with bell ends.
 - 3. Gaskets: ASTM F477, elastomeric seals.

2.3 CONCRETE PIPE AND FITTINGS

- A. Reinforced concrete sewer pipe and fittings shall be ASTM C76.
 - 1. Bell-and-spigot ends and gasketed joints with ASTM C443 rubber gaskets.
 - 2. Class III:
 - 3. Class IV:

2.4 NONPRESSURE TRANSITION COUPLINGS

- A. Comply with ASTM C1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of same sizes as piping to be joined, and corrosion resistant metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
 - 1. For concrete pipes: ASTM C443, rubber.
 - 2. For plastic pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
 - 3. For dissimilar pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded, Flexible Couplings: Couplings shall be an elastomeric sleeve with stainless steel shear ring and resistant metal tension band and tightening mechanism on each end.
- D. Ring-type, flexible couplings shall be elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

2.5 MANHOLES AND CATCH BASINS

- A. Standard Precast Concrete Manholes:
 - 1. Description: ASTM C478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 2. Diameter: 48 inches minimum unless otherwise indicated.
 - 3. Ballast: Increase thickness of precast concrete sections or add concrete to base section as required to prevent flotation.
 - 4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.

5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
 6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated, and top of cone of size that matches grade rings.
 7. Joint Sealant: ASTM C990, bitumen or butyl rubber.
 8. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
 9. Steps: If total depth from floor of manhole to finished grade is greater than 60 inches. ASTM A615, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, width of 16 inches minimum, spaced at 12 to 16-inch intervals.
 10. Adjusting Rings: Reinforced concrete rings, 6 to 9-inch total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.
- B. Standard Precast Concrete Inlet Boxes and Yard Drains:
1. Description: ASTM C913; designed for A-16 (AASHTO HS20-44), heavy-traffic, structural loading; of depth, shape, and dimensions indicated, with provision for sealant joints.
 2. Ballast: Increase thickness of one or more precast concrete sections or add concrete to manhole as required to prevent flotation.
 3. Joint Sealant: ASTM C990, bitumen or butyl rubber.
 4. Resilient Pipe Connectors: ASTM C923, cast or fitted into manhole walls, for each pipe connection.
 5. Steps: If total depth from floor of structure to finished grade is greater than 60 inches. ASTM A615, deformed, 1/2-inch steel reinforcing rods encased in ASTM D4101, width of 16 inches minimum, spaced at 12 to 16-inch intervals.
 6. Adjusting Rings: Reinforced concrete rings, 3 to 6 inches total thickness, to match diameter of manhole frame and cover, and height as required to adjust manhole frame and cover to indicated elevation and slope.
- C. Manhole Frames and Covers:
1. Description: Ferrous; 24-inch ID by 7 to 9-inch riser with 4-inch minimum width flange and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
 2. Material: ASTM A48, Class 35 gray iron unless otherwise indicated.

2.6 CONCRETE FOR MANHOLES AND CATCH BASINS

- A. General: Cast-in-place concrete according to ACI 318, ACI 350, and the following:
1. Cement: ASTM C150/C150M, Type II.
 2. Fine Aggregate: ASTM C33/C33M, sand.
 3. Coarse Aggregate: ASTM C33/C33M, crushed gravel.
 4. Water: Potable.

- B. Concrete Design Mix: 4000 psi minimum, compressive strength in 28 days.
 - 1. Reinforcing Fabric: ASTM A1064, steel, welded wire fabric, plain.
 - 2. Reinforcing Bars: ASTM A615, Grade 60 deformed steel.
- C. Manhole Channels and Benches: Channels shall be the main line pipe material. Include benches in all manholes and catch basins.
 - 1. Channels: Main line pipe material or concrete invert. Height of vertical sides to 3/4 of pipe diameter. Form curved channels with smooth, uniform radius and slope. Invert Slope: Same slope as the main line pipe. Bench to be concrete, sloped to drain into channel. Minimum of 6-inch slope from main line pipe to wall sides.

2.7 AREA DRAINS

- A. General: Polyvinyl chloride (PVC) inlet drains, risers, and catch basins. ASTM F794 and F1336 mechanical property requirements for fabricated fittings, of dimensions, pipe connection, orientations, and depth indicated.
 - 1. Structures: PVC pipe stock reformed utilizing a thermos- molding process with specified inlet and outlet pipe connection stubs and risers sized to fit specified frame and grate.
 - 2. Joints: Fabricated fittings shall conform to ASTM D 3212 for watertight connections using flexible elastomeric seals. Flexible elastomeric seals shall conform to ASTM F477.
- B. Frame and grates: Grates shall be capable of supporting H-10 loading for pedestrian areas and be lockable. Metal used in the manufacture of the castings shall conform to ASTM A536 grade 70-50-05 for ductile iron, painted black, manufactured to fit specified PVC riser fittings. Size of openings shall meet requirements of American Disability Act.

2.8 PIPE OUTLETS

- A. Head walls: Cast-in-place reinforced concrete, with apron and tapered sides.
- B. Riprap basins: Broken, irregularly sized and shaped, graded stone according to NSSGA's "Quarried Stone for Erosion and Sediment Control."
 - 1. Average Size: NSSGA No. R-5, screen opening 5 inches.
- C. Filter Stone: NSSGA's "Quarried Stone for Erosion and Sediment Control," No. FS-2, No. 4 screen opening, average size graded stone.
- D. Energy Dissipaters: To be as per NSSGA's "Quarried Stone for Erosion and Sediment Control," No. A-1, 3-ton average weight armor stone, unless otherwise indicated.

2.9 FLARED END SECTIONS

- A. Flared End Sections: Sections shall be of standard design of reinforced concrete in accordance with Michigan Department of Transportation standards.

2.10 WARNING TAPE

- A. Standard, 4-Mil polyethylene 3-inch-wide tape non-detectable type, purple with black letters, and imprinted with "CAUTION BURIED STORM SEWER BELOW".

PART 3 - EXECUTION

3.1 GENERAL

- A. If an installation is unsatisfactory to the Resident Engineer/Contracting Officer's Representative the Contractor shall correct the installation at no additional cost or time to the Government.

3.2 PIPE BEDDING

- A. The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. Plastic pipe bedding requirements shall meet the requirements of ASTM D2321. Bedding, haunching and initial backfill shall be MDOT Class III material.

3.3 PIPING INSTALLATION

- A. Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping with minimum cover as shown on the Drawings.
- C. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
 - 1. Do not lay pipe on unstable material, in wet trench or when trench and weather conditions are unsuitable for the work.
 - 2. Support pipe on compacted bedding material. Excavate bell holes only large enough to properly make the joint.
 - 3. Inspect pipes and fittings, for defects before installation. Defective materials shall be plainly marked and removed from the site. Cut pipe shall have smooth regular ends at right angles to axis of pipe.
 - 4. Clean interior of all pipe thoroughly before installation. When work is not in progress, open ends of pipe shall be closed securely to prevent entrance of storm water, dirt or other substances.
 - 5. Lower pipe into trench carefully and bring to proper line, grade, and joint. After jointing, interior of each pipe shall be thoroughly wiped or swabbed to remove any dirt, trash or excess jointing materials.
 - 6. Do not walk on pipe in trenches until covered by a depth of 12 inches over the crown of the pipe.
 - 7. Warning tape shall be continuously placed 12 inches above storm sewer piping.
- D. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- E. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

- F. Install gravity-flow, nonpressure drainage piping according to the following:
1. Install piping pitched down in direction of flow.
 2. Install PVC profile gravity sewer piping, according to ASTM D2321 and ASTM F1668.
 3. Install reinforced concrete sewer piping according to ASTM C1479.

3.4 REGRADING

- A. Raise or lower existing manholes and structures frames and covers in regraded areas to finish grade. Carefully remove, clean and salvage cast iron frames and covers. Adjust the elevation of the top of the manhole or structure as detailed on the drawings. Reset cast iron frame and cover, grouting below and around the frame. Install concrete collar around reset frame and cover as specified for new construction.
- B. During periods when work is progressing on adjusting manholes or structures cover elevations, install a temporary cover above the bench of the structure or manhole. The temporary cover shall be installed above the high flow elevation within the structure and shall prevent debris from entering the wastewater stream.

3.5 CONNECTIONS TO EXISTING VA-OWNED MANHOLES

- A. Make pipe connections and alterations to existing manholes so that finished work will conform as nearly as practicable to the applicable requirements specified for new manholes, including concrete and masonry work, cutting, and shaping.

3.6 AREA DRAIN INSTALLATION

- A. Install type of drains in locations indicated.
- B. Install per manufacturers recommendation.
- C. Embed drains in 6-inch minimum concrete around bottom and sides.
- D. Set drain frames and covers with tops flush with pavement surface.

3.7 MANHOLE INSTALLATION

- A. Install manholes, complete with appurtenances and accessories indicated. Install precast concrete manhole sections with sealants according to ASTM C891.
- B. Set tops of frames and covers flush with finished surface.
- C. Circular Structures:
1. Precast reinforced concrete rings shall be installed true and plumb. The joints between rings and between rings and the base and top shall be sealed with a preform flexible gasket material specifically manufactured for this type of application. Adjust the length of the rings so that the eccentric conical top section will be at the required elevation. Cutting the conical top section is not acceptable.
 2. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

3. Structure shall be set on a 12-inch thick aggregate base course compacted to a minimum of 95 percent of the maximum density as determined by ASTM D698. Set precast section true and plumb.

3.8 INLET BOX AND YARD DRAIN INSTALLATION

- A. Install inlet boxes and yard drains, complete with appurtenances and accessories indicated. Install precast concrete inlet boxes with sealants according to ASTM C891
- B. Set tops of frames and covers flush with finished surface of inlet boxes that occur in pavements.

3.9 STORMWATER INLET AND OUTLET INSTALLATION

- A. Construct inlet head walls, aprons, and sides of reinforced concrete.
- B. Construct riprap of broken stone.
- C. Install outlets that spill onto grade, with flared end sections that match pipe.
- D. Construct energy dissipaters at outlets.

3.10 CONNECTIONS

- A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains.
- B. Encase entire connection fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
- C. Make connections to existing piping and underground manholes.
 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping.
 2. Make branch connections from side into existing piping, NPS 4 to NPS 20. Remove section of existing pipe, install wye fitting into existing piping.
 3. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall unless otherwise indicated. On outside of pipe, manhole, or structure wall, use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 4. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- D. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.
 - a. Unshielded flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.

- c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

3.11 IDENTIFICATION

- A. Install green warning tape directly over piping and at outside edge of underground structures.

3.12 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Damage: Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.

3.13 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Flush with water.

--- E N D ---