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. Pavement sealing.
   3. Cold milling.
   4. Pervious paving.
   5. 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/D46323M-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.

1.3 PREINSTALLATION MEETINGS

A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.
   1. Required Participants:
      a. Contracting Officer's Representative (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 State Highway Department requirements.
   2. Asphalt cement complying with State of New Hampshire Highway Department requirements.
   3. Job-mix certification that mix equals or exceeds State of New Hampshire Highway Specification.
E. Qualifications: Substantiate qualifications comply with specifications.
   1. Manufacturer with project experience list.
   2. Land Surveyor.
F. One copy of State of New Hampshire Highway Department Specifications (Latest Edition).

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.
    a. Project Experience List: Provide contact names and addresses for completed projects.

B. 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 State Highway Department.
3. Porous Asphalt and Asphalt Base/Surface Course:
    a. Test aggregate source, gradation, soundness loss, percentage of wear, and other properties required by State Highway Department.
4. Job Mix Formula:
    a. Test required by State of New Hampshire Highway Department.

1.6 FIELD CONDITIONS

A. Environment:
1. Do not begin asphaltic concrete material placement when atmospheric temperature is below 10 degrees C (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. Subbase Aggregate: NHDOT 12 inch Crushed Gravel(304.2)

C. Base Aggregate: NHDOT 6 inch Crushed Gravel (304.3)

2.2 PERVIOUS PAVING AGGREGATES

A. Aggregate for Infiltration Beds: 50 to 25 mm (2 to 1 inch) uniformly graded coarse aggregate, with wash loss of maximum 0.5 percent, AASHTO size number 3 per AASHTO Standard Specifications, and have 40 percent voids as measured by ASTM C29/C29M. Choker base course aggregate for beds to have 10 to 19 mm (3/8 to 3/4 inch) uniformly graded coarse aggregate AASHTO size number 57 per Table 4, AASTHO Standard Specifications.

2.3 NON-WOVEN GEOTEXTILE FABRIC

A. Fabric: Needled nonwoven polypropylene fibers with the following properties:
   1. Grab Tensile Strength (ASTM D4632) ≥ 55 kg (120 lbs.).
   2. Mullen Burst Strength (ASTM D3786) ≥ 1550 kPa (225 psi).
   3. Flow Rate (ASTM D4491) ≥ 360 l/min/0.09 sq. m (95 gal/min/sq. ft.).
   4. UV Resistance after 500 hours (ASTM D4355) ≥ 70 percent.
   5. Heat-set or heat-calendared fabrics are not acceptable.

2.4 ASPHALTS

A. Comply with Asphalt Institute Specification SS2:
   1. Asphalt cement: Penetration grade 50/60.
   2. Prime coat: Cut-back type, grade MC-250.
   3. Tack coat: Uniformly emulsified, grade SS-1H.

2.5 NON-POROUS PAVING ASPHALT MIX

A. Binder Course: NHDOT 2-1/2 inch Superpave binder course
B. Wearing Course: NHDOT 1-1/2 inch Superpave wearing course

2.6 POROUS PAVING ASPHALT MIX

A. Bituminous Surface Course: 64 mm (2-1/2 inches) thick with bituminous mix of 5.75 to 6percent by weight dry aggregate. Maximum binder drain down of 0.3percent according to ASTM D6390. If more absorptive aggregates such as limestone, are used in mix, then base bitumen amount on NAPA P-33 testing procedures or DOT equivalent.
B. Neat Asphalt Binder: Modified with elastomeric polymer to produce binder meeting AASHTO M320 PG 76-22 requirements. Apply styrene-butadiene-styrene (SBS) elastomer polymer, or approved equal, at rate of 3percent by weight of total binder. Thoroughly blend composite materials at asphalt refinery or terminal before loading transport vehicle. Polymer modified asphalt binder to be heat and storage stable.
C. Asphalt: Minimum 90 percent crushed material with gradation as follows:

U.S. Standard Sieve Size	Percent Passing.
a. 1/2 (12.5mm)	100.
b. 3/8 (9.5 mm)	92-98.
c. 4 (4.75 mm)	34-40.
d. 8 (2.36 mm)	14-20.
e. 16 (1.18 mm)	7-13.
f. 30 (0.60 mm)	0-4.
g. 200 (0.075 mm)	0-2.

D. Hydrated Lime: ASTM C977 Add at dosage rate of 1.0 percent by weight of total dry aggregate to mixes containing granite. Additive must prevent separation of asphalt binder from aggregate and

achieve required tensile strength ratio (TSR) of minimum 80percent on asphalt mix when tested according to AASHTO T283. Test asphaltic mix for resistance to stripping by water according to ASTM D-1664. If estimated coating area is not above 95 percent, add anti-stripping agents to asphalt.

E. Do not install pervious pavement on wet surfaces or when ambient air temperature is 10 degrees C (50 degrees F) or lower. Bituminous mix temperature to be between 148 degrees and 177 degrees C (300 degrees F and 350 degrees F), based on asphalt supplier's recommendations.

2.7 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 State Highway Specifications, State Specifications take precedence.

2.8 ANCILLARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by EPA. Provide in granular, liquid or wettable powder form.

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: 143 degrees C (290 degrees F) minimum, 160 degrees C (320 degrees F) maximum.
2. Temperature at time of placing: 138 degrees C (280 degrees F) minimum.

3.3 SUBGRADE

A. Shape to line and grade and compact with self-propelled rollers.

B. Fill depressions developed under rolling with acceptable material and re-roll area.

C. Remove soft areas, fill with acceptable materials and re-roll area.

D. If subgrade becomes rutted or displaced before the placing of subbase, rework subgrade to bring to line and grade.

E. Proof-roll subgrade with maximum 45 tonne (50 ton) gross weight dump truck as directed by COR. If pumping, pushing, or other movement is observed, rework area to provide stable and compacted subgrade.

F. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rate and written instructions. Apply to dry subgrade of surface of compacted aggregate base before applying paving materials.

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 mm (0.0 inches) to plus 12.7 mm (0.5 inch).

D. Smoothness Tolerance: Lines and grades shown on Drawings within 5 mm in 3 m (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 Architect.

C. Receipt of Asphaltic Concrete Materials:
   1. Do not accept material unless covered with tarpaulin until unloaded, and unless material is minimum 130 degrees C (280 degrees F).
   2. Do not begin asphaltic concrete material placement when atmospheric temperature is below 10 degrees C (50 degrees F), nor during fog, rain, or other unsuitable conditions.

D. Spreading:
   1. Spread material with minimal handling.
   2. For finished paving 76 mm (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: 3 mm in 1.8 m (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 Architect.

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. Mill to 38 mm (1-1/2 inches) deep.

3.8 PATCHING

A. Hot Mix Asphalt Pavement: Sawcut patch perimeter and excavate existing pavement to sound base. Excavate rectangular or trapezoidal patches, extending 300 mm (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 0.2 to 0.7 L/sq. m. (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.

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SECTION 32 14 16
BRICK UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick pavers set in mortar on a rigid base.

1.2 RELATED REQUIREMENTS

A. Color and Texture of Mortar Brick: Section 09 06 00, SCHEDULE FOR FINISHES.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. ASTM International (ASTM):

1. C144-11 - Aggregate for Masonry Mortar.
2. C150/C150M-16 - Portland Cement.
3. C207-06(2011) - Hydrated Lime for Masonry Purposes.
4. C270-14a- Mortar for Unit Masonry.
5. C902-15 - Pedestrian and Light Traffic Paving Brick.

1.4 SUBMITTALS

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

B. Submittal Drawings:

1. Show brick paving layout and patterns.
2. Show special brick shapes.

C. Manufacturer's Literature and Data:

1. Description of each product.

D. Samples:

1. Brick: Full size of each type and color.
   a. Minimum five individual samples to show full color and texture range.
2. Mortar: Samples of brick with mortar joints of each color.

1.5 QUALITY ASSURANCE

A. Mockups: Provide mockup of size indicated on drawings to confirm paving materials and pattern and to establish workmanship quality.

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 masonry materials under waterproof covers on planking clear of ground.

B. Protect products from damage during handling and construction operations.

1.8 FIELD CONDITIONS

A. Environment:

1. Product Temperature: Minimum 4 degrees C (40 degrees F) for minimum 48 hours before installation.

1.9 WARRANTY

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

PART 2 - PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Design brick complying with specified performance:

1. Slip Resistance: ASTM C902.

2.2 PRODUCTS - GENERAL

A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.

B. Provide each paving system component from one manufacturer and from one production run.

2.3 BRICK

A. Paving Brick: ASTM C902; Class SX, Type I.

1. Manufacturing Tolerances: Application PS.

2.4 MORTAR

A. ASTM C270, Type S, cement-lime proportion specification mix. Admixtures and Type N lime are not acceptable.

B. Hydrated Lime: ASTM C207 Type S.

C. Sand: ASTM C144.

D. Portland Cement: ASTM C150/C150M.

E. Coloring Pigments: Pure mineral pigments, lime proof and non-fading; added to mortar by the manufacturer. Job colored mortar is not acceptable.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.

1. Verify substrate depth accommodates brick paving installation thickness.

B. Protect existing construction and completed work from damage.

1. Prevent damage from contact with mortar.

C. Clean substrates. Remove contaminants capable of affecting subsequently installed product's performance.

3.2 INSTALLATION - GENERAL

A. Install products according to manufacturer's instructions and approved submittal drawings.

3.3 BRICK INSTALLATION

A. Do not use bricks with chips, cracks, discoloration, or other visible defects.

B. Layout brick paving according to pattern indicated on drawings.

C. Installation with Portland Cement Mortar:

1. Install brick in full bed joint. Remove excess mortar. Strike joints flush with top surface of brick and tool slightly concave.
2. Cure mortar by maintaining damp condition for seven days.

D. Installation Tolerances:

1. Finished surface true to plane within 1 mm in 1000 mm (1/8 inch in 10 feet), non-cumulative.
2. Joint width deviation maximum 25 percent of dimension indicated.

3.4 CLEANING

A. Remove excess mortar before fully set.

B. Clean exposed brick and mortar surfaces. Remove contaminants and stains.

3.5 PROTECTION

A. Protect brick paving from traffic and construction operations.

B. Cover brick paving with reinforced kraft paper, and plywood or hardboard.

C. Remove protective materials immediately before acceptance.

D. Repair damage.

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SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. 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.

B. Paint Color: Section 09 06 00, SCHEDULE FOR FINISHES.

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: 200 mm (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 13 degrees C (55 degrees F) for minimum 48 hours before installation.

a. Surface to be painted and ambient temperature: Minimum 10 degrees C (50 degrees F) and maximum 35 degrees C (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-1952.

2.2 PRODUCTS - GENERAL

A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.

B. 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 painted surfaces. Compressor to provide minimum 0.08 cu. m/s (150 cfm) of air at pressure of minimum 625 kPa (90 psi) at each nozzle used.

2.4 PAINT APPLICATOR

A. Apply marking paint with approved mechanical equipment. Provide equipment with 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. Equipment to have manual control

to apply continuous lines of varying length and marking widths as indicated on Drawings. Provide pneumatic spray guns for hand application of paint in areas where mobile paint applicator cannot be used. Use separate piece of equipment when equipment does not have glass bead dispenser. Adjust and synchronize equipment with paint applicator to distribute reflective beads on paint lines uniformly within ten seconds without any waste.

2.5 PAINT

A. Paint: MPI No. 97. For obliterating existing markings comply with Fed. Spec. TT-P-1952. Provide minimum 18 L (5 gallons) containers.

2.6 REFLECTIVE GLASS BEADS

A. Beads: Comply with Fed. Spec. TT-B-1325, Type I, Gradation A. In regions of high humidity, coat beads with silicone or other suitable waterproofing material to ensure free flow. Provide glass beads in containers suitable for handling and strong enough to prevent loss during shipment.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify substrate suitability for product installation.
   1. Allow new pavement surfaces to cure for period of 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 Contracting Officer's Representative.
   3. As an option, comply with Fed. Spec. TT-P-1952 for removal of existing paint markings on asphalt pavement. Apply black paint in as many coats as necessary to completely obliterate existing markings.
   4. Scrub affected areas with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application, where oil or grease are present on old pavements to be marked.
      a. After cleaning, seal oil-soaked areas with cut shellac to prevent bleeding through new paint.
   5. Clean and dry surface before pavement marking. Do not begin any marking until Contracting Officer's Representative 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 Contracting Officer's Representative. After temporary marking has served its purpose and when so ordered by Contracting Officer's Representative, remove temporary marking by carefully controlled sandblasting, approved grinding equipment, or other approved method to prevent damage on applied surface.

B. 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. Continuous durability and effectiveness of such marking is required during period for which its use is required. Remove any unsatisfactory tape type marking and replace with painted markings.

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 Contracting Officer's Representative consideration.

3.4 PAINT APPLICATION

A. Apply uniformly painted and reflective pavement marking of required colors, length, and width with true, sharp edges and ends on properly cured, prepared, and dried surfaces.

B. Comply with details as indicated on drawings and established control points.

C. Apply paint at wet film thickness of 0.4 mm (0.015 inch). Disperse reflective glass beads evenly on wet paint at rate of 720 g/L (6 pounds per gal.) of paint. Apply paint in one coat. When directed by Contracting Officer's Representative, apply additional coats at markings showing light spots. 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.

D. When deficiency in marking drying occurs, discontinue paint operations until cause of slow drying is determined and corrected.

E. Remove and replace marking applied less than minimum material rates, deviates from true alignment, exceeds stipulated length and width tolerances, or shows light spots, faulty distribution of beads, smears, or other deficiencies or irregularities.

F. Remove marking by carefully controlled sandblasting, approved grinding equipment, or other approve method to prevent damage on applied surface.

3.5 DETAIL PAVEMENT MARKING APPLICATION

A. Apply Detail Pavement Markings, exclusive of actual traffic lane marking as follows:

1. At exit and entrance islands and turnouts.
2. On curbs.
3. At crosswalks.
4. At parking bays.

5. Other locations as indicated on drawings.

B. Apply International Handicapped Symbol at indicated 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.

C. Install detail pavement markings of colors, widths and lengths, and design pattern at locations indicated on drawings.

3.6 TOLERANCES

A. Length and Width of Lines: Plus or minus 75 mm (3 inches) and plus or minus 3 mm (1/8 inch), respectively, in case of skip markings.

B. Length of intervals exceeding line length tolerance are not acceptable.

3.7 CLEANING

A. Remove excess paint before paint sets.

3.8 PROTECTION

A. Protect pavement markings from traffic and construction operations.

1. Protect newly painted markings from vehicular traffic until paint is dry and track free.
2. Place warning signs at beginning of wet line, and at points well in advance of marking equipment for alerting approaching traffic from both directions.
3. Place small flags or other similarly effective small objects near freshly applied markings at frequent intervals to reduce crossing by traffic.

B. Repair damage.

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SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Chain link fence, gates and accessories.

1.2 RELATED REQUIREMENTS

A. Temporary Construction Fence: Section 01 00 00, GENERAL REQUIREMENTS.

B. Grounding: Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

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. A491-11 - Aluminum Coated Steel Chain Link Fence Fabric.
4. A817-12 - Metal-Coated Steel Wire for Chain-Link Fence Fabric and Marcelled Tension Wire.
5. B429 - Aluminum-Alloy Extruded Structural Pipe and Tube.
6. F567-14a - Installation of Chain-Link Fence.
7. F626-14 - Fence Fittings.
8. F668-11 - Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain Link Fence Fabric.
9. F900-11 - Industrial and Commercial Swing Gates.
10. F1184-16 - Industrial and Commercial Horizontal Slide Gates.
11. F1664-08(2013) - Polyvinyl Chloride (PVC) and Other Conforming Organic Polymer Coated Steel Tension Wire used with Chain Link Fence.
12. F1665-08(2013) - Polyvinyl Chloride (PVC) and Other Conforming Organic Polymer Coated Steel Barbed Wire used with Chain Link Fence.
13. F2200-14 - Automated Vehicular Gate Construction.
14. F1043-16 - Strength and Protective Coatings on Steel Industrial Fence Framework.
15. F1083-16 - Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.

C. Chain Link Fence Manufacturing Institute (CLFMI):

1. Product Manual.

D. Federal Specifications (Fed. Spec.):

1. FF-P-110J - Padlock, Changeable Combination.

E. Master Painters Institute (MPI):
   1. No. 18 - Primer, Zinc Rich, Organic.

1.4 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
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.
D. Certificates: Certify each product complies with specifications.
   1. Fence alignment.
   2. Zinc-coating.
E. Qualifications: Substantiate qualifications comply with specifications.
   1. Manufacturer
   2. Installer with project experience list.

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. 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/D1.1M. AWS D1.3/D1.3M.

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."

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

A. Basis of Design: Section 09 06 00, SCHEDULE FOR FINISHES.

B. Provide fences and gates from one manufacturer.

2.2 CHAIN-LINK FENCING AND GATES

A. General: Conform to CLFMI Product Manual.

B. Chain Link Fabric: As indicated on Drawings.

1. Zinc-Coated Steel Fabric: ASTM A392, hot dipped galvanized before or after weaving.
   a. Class 2 - 610 g/sq. m (2.0 oz/sq. ft.).
2. Aluminum-Coated Steel Fabric (Aluminized): ASTM A491.
3. Polymer Coated Steel Fabric: ASTM F668.
   a. Class 2a extruded and adhered.
   b. Color: Black.
4. Fabric Selvage: K&T, Knuckle finish at one end, twist at other.
   a. Fabric less than 1.8 m (72 inches) width, knuckle finish top and bottom.

C. Fence Framework:

1. Round Steel Pipe and Rail: ASTM F1043, Group IA Heavy Industrial Fence Framework, ASTM F1083 schedule 40 galvanized pipe.
   a. Line post: 60 mm (2.375 inch) diameter.
   b. End, Corner, Pull post: 60 mm (2.375 inch) diameter.
   c. Brace rails, top, bottom, and intermediate rails, 42 mm (1.660 inch) diameter, 3.38 kg/m (2.27 lb./ft.).
2. Polymer Coated Framework: ASTM F668 PVC or Polyolefin coating fused and adhered to the exterior zinc coating of the post or rail.
   a. Coating Thickness (Minimum):
      1) PVC and Polyolefin: 0.25 mm (10 mils).
   b. Color: Match fabric or black

2.3 TENSION WIRE

A. Metallic Coated Steel Marcelled Tension Wire: ASTM A817, 4.5 mm (0.177 inches) marcelled wire.

B. Polymer Coated Steel Tension Wire: ASTM F1664, 4.5 mm (0.177 inches) wire. Wire gauge specified is the core wire gauge.

2.4 FITTINGS

A. General: ASTM F626.

B. Tension and Brace Bands: Galvanized pressed steel.

C. Terminal Post Caps, Line Post Loop Tops, Rail and Brace Ends, Boulevard Clamps, Rail Sleeves: Pressed steel galvanized.
D. Truss Rod Assembly: Steel truss rod with a pressed steel tightener.
E. Tension Bars: Galvanized steel one-piece length 50 mm (2 inches) less than the fabric height.
F. Polymer Coated Color Fittings: Polymer coating minimum thickness 0.15 mm (0.006 inches) fused and adhered to zinc coated fittings and match color to fence system.

2.5 TIE WIRE and HOG RINGS

A. Galvanized: Minimum zinc coating 366 g/sq. m (1.20 oz./sq. ft.); 3.76 mm (0.148 inch) diameter steel wire.
B. Polymer coated; match coating, class and color to that of the chain link fabric.

2.6 GATES

A. Swing Gates: ASTM F900 double swing type.
    1. Galvanized steel:
        a. Frame: ASTM F1043 and ASTM F1083 Group IA schedule 40 pipe 48.3 mm (1.900 inches) OD. Apply galvanized repair paint on welded joints.
            1) Vertical and Horizontal Spacing: Maximum 2400 mm (8 ft.).
        b. Hardware:
            1) Hinges: 180 degree gate hinges per leaf.
            2) Positive locking gate latch, 7.9 mm (5/16 inches) thick by 44 mm (1 3/4 inches).
    2. Polymer Coated Frames and Posts: Match fence. Field coat hardware with liquid polymer touch up.
B. Horizontal Slide Gates: ASTM F1184.
    1. Frame: ASTM F1043 and ASTM F1083 Group IA schedule 40 pipe 48.3 mm (1.900 inches) OD. Apply galvanized repair paint on welded joints.
        a. Vertical and Horizontal Spacing: Maximum 2400 mm (8 ft.).
        b. Class 2 - Internal Roller Design: ASTM F1043 and ASTM F1083, Group IA, Schedule 40 pipe Design gates to open or close by applying an initial pull force no greater than 18 kg (40 lbs.). Design internal truck assemblies to handle required forces for gate size opening and height.
    2. Polymer Coated Gates and Posts: Match fence.

2.7 CONCRETE

A. Concrete: As specified in Section 03 30 00, Cast-in-Place Concrete.

2.8 FINISHES

A. Steel Paint Finish:
    1. Powder-Coat Finish: Manufacturer's standard two-coat finish system as follows:
        a. One coat primer.

b. One coat thermosetting topcoat.
c. Dry-film Thickness: 0.05 mm (2 mils) minimum.
d. Color: Refer to Section 09 06 00, SCHEDULE FOR FINISHES.

B. Finish exposed surfaces after fabrication.
C. Aluminum Anodized Finish: NAAMM AMP 500.
1. Clear Anodized Finish: AA-C22A41; Class I Architectural, 0.018 mm (0.7 mil) thick.
2. Color Anodized Finish: AA-C22A42 or AA-C22A44; Class I Architectural, 0.018 mm (0.7 mil) thick.
3. Clear Anodized Finish: AA-C22A31; Class II Architectural, 0.01 mm (0.4 mil) thick.
4. Color Anodized Finish: AA-C22A32 or AA-C22A34; Class II Architectural, 0.01 mm (0.4 mil) thick.

2.9 ACCESSORIES

A. Primers:
B. Barrier Coating: ASTM D1187/D1187M.
C. Welding Materials: AWS D1.1/D1.1M, type to suit application.
D. Galvanizing Repair Paint: MPI No. 18.
E. Touch-Up Paint: Match shop finish.

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 fences and gates to permit new installation.
1. Dispose of removed materials.
D. Apply barrier coating to steel surfaces in contact with dissimilar metals and cementitious materials to minimum 0.7 mm (30 mils) dry film thickness.

3.2 INSTALLATION

A. Layout fence and locate position of post.
B. Installation:
1. General: Comply with ASTM F567.
2. Framework:
a. Posts: Set plumb in concrete footings with 600 mm (24 inches) minimum depth.
1) Minimum Footing Diameter: Four times largest cross section of post, up to 100 mm (4 inches) O.D. and three times largest cross section of post greater than 100 mm (4 inches). O.D.

2) Provide larger footings for gate posts. Top of post concrete footing, at grade crowned to shed water away from the post.
3) Space line posts not exceeding 3 m (10 ft.) on center.

b. Top rail: Install 6.4 m (21 ft.) lengths of rail continuous thru line post or barb arm loop top. Splice rail using top rail sleeves minimum 150 mm (6 inches) long.
1) Secure rail to terminal post by brace band and rail end.
2) Field cut and secure bottom rail or intermediate rail to line posts with boulevard bands or rail ends and brace bands.
3) Provide mid rail for fences 3.7 m (12 feet) high or higher.

c. Terminal posts: Brace and truss end, corner, pull and gate posts for fence 1.8 m (6 ft.) and higher and for fences 1.5 m (5 ft.) in height without top rail.

d. Tension wire: Install tension wire 100 mm (4 inches) up from bottom of fabric. Fences without top rail, install tension wire 100 mm (4 inches) down from the top of the fabric.
1) Stretched taut tension wire independently, between terminal posts and secure with brace band.
2) Secure tension wire to chain link fabric with 3.76 mm (0.15 inch) hog rings 450 mm (18 inches) on center and to each line post with tie wire.

C. Chain Link Fabric:
1. Install fabric inside of the framework with ground clearance of 50 mm (2 inches) maximum.
2. Stretch fabric between terminal posts and secure with tension bar.
3. Wrap tie wire around the post or rail. Attached to fabric wire picket on both sides. Wrap tie wire around post 360 degrees. Cut off and bend excess wire to prevent injury.

D. Gate:
1. Swing Gates: Comply with ASTM F567. Outward swing. Gates plumb in closed position with 75 mm (3 inches) bottom clearance. Install electrically operated gates according to manufacturer's instructions.
2. Horizontal Slide Gates: Install according to manufacturer's instructions.

E. Nuts and Bolts:
1. Bolts: Install carriage bolts with head on the secure side of the fence. Peened over all bolts shall be to prevent removal of the nut.

F. Electrical Grounding:
1. Grounding: Grounding, when required, as specified in Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS.

G. Touch up damaged factory finishes.
1. Repair galvanized surfaces with galvanized repair paint.
2. Repair painted surfaces with touch up primer.

3.3 CLEANING

A. Clean exposed fence surfaces. Remove contaminants and stains.

3.4 PROTECTION

A. Protect fence from construction operations.

B. Repair damage.

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SECTION 32 31 23
PVC FENCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This section includes the following:

1. Polyvinyl chloride (PVC) fence and gate components.
2. Gate hardware.
3. Reinforcing steel for concrete-filled, reinforced fence posts.
4. Concrete for post footings and for concrete filled reinforced fence posts

B. Related sections:

1. Section 312000 – Earth Moving for Structures and Pavement
2. Section 033000 – Cast-in-Place concrete

1.3 DEFINITIONS

A. “Posts” are the vertical structure support members of the fence.

B. “Rails” are the horizontal structural support members of the fence or gate frame.

C. “Pickets” are the vertical, non-structural members between bottom and top rails.

D. “Gate Uprights” are the vertical structural support members of the gate frame.

1.4 SUBMITTALS

A. General: Submit the following according to the conditions of the contract.

B. Product Data: In the form of manufacturer’s technical data, specifications, and installations for fence, posts, gate uprights, post caps, gates, gate hardware and accessories.

C. Samples for verification of PVC color in form of 3-inch lengths of actual product to be used in color selection.

D. Shop Drawings showing fence design.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has at least three years experience and has completed at least five PVC fence projects with same material and of similar scope to that indicated for this project with a successful construction record of in-service performance.

B. Single-Source Responsibility: Obtain PVC fences and gates, including accessories, fittings, and fastenings, from a single source.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify layout information for fences and gates shown on the drawings in relation to the property survey and existing structures. Verify dimensions by field measurements.

1.7 WARRANTY

A. Manufacturer's Warranty: Lifetime non-prorated limited warranty applies to original homeowner/consumer, or 30year non-prorated limited warranty applies to commercial applications.

PART 2 - PRODUCTS

2.1 FENCE MATERIALS

A. General: Provide PVC fence materials recognized to be of type indicated and tested to show compliance with indicated performances.

B. Available Manufacturer: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include:

1. Vinyl Fence product
    a. Manufacturer – Certainteed
    b. Model – Bufftech
    c. Style – Chesterfield Privacy with Smooth Texture
    d. Color –To be determined by owner
    e. Height – 6’
2. Substitutions allowed with prior approval in accordance to Section 013300.

2.2 MISCELLANEOUS MATERIALS

A. Stiffener Channels: Galvanized steel structural channel. Configure channels for concealed installation within PVC rails with pre-drilled holes for drainage. Aluminum extruded channel available upon request.

1. Cross Section: 3.00" x 3.00" x 1.500" hourglass shape to grip picket.
2. Thickness: 0.040 Gauge (minimum).

B. Fasteners and Anchorage: Stainless Steel. All fasteners to be concealed or colored heads to match. Provide sizes as recommended by fence manufacturer.

C. PVC Cement: As recommended by fence manufacturer.

2.3 GATE HARDWARE AND ACCESSORIES

A. General: Provide hardware and accessories for each gate according to the following requirements:

B. Hinges: Size and material to suit gate size, non lift-off type, self closing, glass filled nylon with adjuster plate, offset to permit 120 degree gate opening. Provide one pair of hinges for each gate.

1. Color: Black.

C. Latch: Manufacturers’ standard self latching, glass filled nylon and stainless steel composition single or dual access gravity latch. Provide one latch per gate.

1. Finish: Match gate hinge finish.

D. Hardware: Stainless Steel. Provide sizes as recommended by fence manufacturer.

1. Finish: Match gate hinge finish.

2.4 CONCRETE

A. Refer to Section 320523 for concrete.

2.5 REINFORCEMENT FOR FILLED POSTS

A. Reinforcing Steel:

1. Steel Reinforcing Bars: ASTM A 615. Grade 60. Deformed (#4 or ½"). Install 2 bars for each post to a length of 14".

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Install fence in compliance with manufacturer's written instructions. During installation, PVC components shall be carefully handled and stored to avoid contact with abrasive surfaces. Install components in sequence as recommended by fence manufacturer. Installation shall comply with ASTM F1999 - 00(2006) Standard Practice for Installation of Rigid Poly(Vinyl Chloride) (PVC) Fence Systems.

1. Install fencing as indicated on the drawings provided.
2. Variations from the installation indicated must be approved.
3. Variations from the fence and gate installation indicated and all costs for removal and replacement will be the responsibility of the contractor.

3.2 FENCE INSTALLATION

A. Excavation: Drill or hand-excavate (using post hole digger) holes for posts to diameters and spacing indicated, in firm, undisturbed or compacted soil.

1. If not indicated on drawings, excavate holes for each post to a minimum diameter of 30 inches.
2. Unless otherwise indicated, excavate hole depths not less than 30 inches or to frost line.

B. Posts: Install posts in one piece, plumb and in line. Space a maximum of 8 feet o.c. unless otherwise indicated. Enlarge excavation as required to provide clearance indicated between post and side of excavation.

1. Protect portion of posts above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment and hold in position during placement and finishing operations.
    a. Unless otherwise indicated, terminate top of concrete footings 4 inches below adjacent grade and trowel to a crown to shed water.
    b. Secure posts in position for manufacturers' recommendations until concrete sets.
    c. After installation of rails and unless otherwise indicated, install reinforcing in posts in opposing corners of post as shown and fill end and gate posts with concrete to

level as indicated. Concrete fill shall completely cover the reinforcing steel and gate hardware fasteners. Consolidate the concrete by striking the post face with a rubber mallet, carefully tamping around the exposed post bottom.

d. Install post caps. Use #8 screws, nylon washers and snap caps.

e. Remove concrete splatters from PVC fence materials with care to avoid scratching.

C. Top and Bottom Rails: Install rails in one piece into routed hole fabricated into posts to receive top and bottom rails, and middle where necessary. Except at sloping terrain, install rails level.

1. Prior to installation of rails into posts, insert concealed steel channel stiffeners in top rail, where necessary. Bottom rails shall include minimum (2) ¼" drainage holes.

2. At posts to receive concrete fill, tape rail ends to prevent seepage when filling post with concrete.

D. Middle Rails: Where necessary, install middle rails in one piece into routed hole in posts with larger holes facing down. Except at sloping terrain, install middle rails level. Secure mid rail to pickets with 2-#8 x 1-1/2" screws evenly spaced.

1. At posts to receive concrete fill, tape rail ends to prevent seepage when filling post with concrete.

E. Pickets: Install pickets in one piece as per manufacturer recommendations. Install pickets plumb.

F. Fence Installation at Sloping Terrain: At sloping terrain rails may be racked (sloped) or stepped to comply with manufacturers' recommendations.

3.3 GATE INSTALLATION

A. Prior to installation of rails into posts, apply PVC cement into sockets per manufacturer's recommendations. Bottom rail shall include minimum (2) ¼" drainage holes.

B. Assemble gate prior to fence installation to accurately locate hinge and latch post. Align gate horizontal rails with fence horizontal rails.

C. Install gates plumb, level, and secure for full opening without interference according to manufacturer's instructions.

D. Gate Latch Installation. Install gate latch according to manufacturer's instructions. Adjust for smooth, trouble-free operation.

E. Allow minimum 72 hours to let concrete set-up before opening gates.

3.4 ADJUSTING AND CLEANING

A. Remove all traces of dirt and soiled areas.

3.5 DEMONSTRATION

A. Instruct the owner's personnel on proper operation and maintenance of fence components.

- - - END - - -

SECTION 32 32 23
SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work includes furnishing and installing precast modular blocks (PMB) to the lines and grades shown on the plans and as specified herein. Also included is furnishing and installing appurtenant materials required for construction of the complete system.

B. The contractor is solely responsible for safety. The Engineer and Owner shall not be responsible for means or methods of construction or for safety of workers or the public.

1.2 REFERENCES

A. ASTM - American Society for Testing and Materials

B. ASTM C33 - Standard Specification for Concrete Aggregates

C. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

D. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregate

E. ASTM C1776 - Standard Specification for Wet-Cast Precast Modular Retaining Wall Units

F. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

G. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort

H. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles

I. ASTM D4595 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method

J. ASTM D5262 - Standard Test Method for Evaluating the Unconfined Creep Behavior of Geosynthetics

K. ASTM D6637 - Standard Test Method for Determining Tensile Properties of Geogrids by the Single or Multi-Rib Tensile Method

L. ASTM D6638 - Standard Test Method for Determining Connection Strength Between Geosynthetic Reinforcement and Segmental Concrete Units (Modular Concrete Blocks)

M. ASTM D6916 - Standard Test Method for Determining the Shear Strength Between Segmental Concrete Units

1.3 SUBMITTALS

A. Submit for review shop drawings and design calculations for the retaining wall system prepared by a Professional Engineer registered in the State of New Hampshire. The shop

drawings shall indicate the layout, height, and construction details of the retaining wall system. Design shall conform to relevant requirements and design methodologies of AASHTO Standard Specifications for Highway Bridges. Upon request, design calculations shall also be submitted.

B. If stain will be applied to the wall system, a sample shall be stained on site for review and approval by the Engineer. The color sample may be part of the completed wall, but shall be located in an inconspicuous area.

C. If an alternate geosynthetic reinforcement is included in the contractor's design, submit manufacturer's literature and test data for geosynthetic to be used in the reinforced wall system. Test data shall include connection strength data for geogrid with Stone Strong modular units determined in accordance with ASTM D6638, as well as geogrid tensile strength and creep data in accordance with ASTM D4595 and ASTM D5262.

D. Submit grain size test results for aggregates to be used for the wall base and for unit fill.

E. Submit test results on borrow material to be used for common backfill and for select backfill (if used) including Proctor and grain size or Atterberg limits results.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Contractor shall check the materials upon delivery to assure that proper materials have been received.

B. Contractor shall protect the materials from damage. Damaged material shall not be incorporated into the wall or the reinforced soil embankments.

C. Contractor shall prevent excessive mud, concrete, adhesives and other substances that may adhere from coming in contact with the materials.

D. Exposed faces of precast modular block units shall be reasonably free of chips, cracks, or stains when viewed from a distance of 10 feet.

PART 2 - MATERIALS

2.1 WALL UNITS

A. Basis of Design: Precast modular block units manufactured under license from Stone Strong LLC.

B. Wall units shall conform to ASTM C1776.

C. Dimension tolerances for precast modular blocks shall be +/- 1/8 inch for height, +/- 1/8 inch for length (along face), and +1/2 to -1/4 inch for width (face to tail).

D. Concrete for precast modular blocks shall have a minimum 28-day compressive strength of 4,000 psi. Entrained air content shall be between 5 and 7%.

E. Internal unit reinforcement or unreinforced units shall be provided according to published Stone Strong engineering guidance. Reinforced units shall be marked with the type of reinforcement.

F. The face pattern shall be selected from the manufacturer's standard molds. The color of the units shall be natural gray. A concrete stain may be field applied to color the units if specified by the Engineer or Owner.

2.2 GEOSYNTHETIC REINFORCEMENT

A. Geosynthetic strap reinforcement shall be Paraweb 2D-50 manufactured by Maccaferri, Inc.

B. Geogrid reinforcement shall be SF55 or SF110 manufactured by Synteen Technical Fabrics, Inc.

C. Substitution of a different type of geosynthetic shall not be allowed unless approved of the Architect/Engineer or Owner after submittal of shop drawings and test data.

2.3 WALL BASE

A. The wall base shall consist of dense graded crushed aggregate. A minimum of 75% of coarse material shall have 2 or more fractured faces. Wall base material shall meet the following gradation:

US Standard Sieve Size	Percent Passing
1-1/2"	80-100
3/4"	50-90
#4	0-40
#200	0-10

B. The contractor may substitute concrete with a minimum 28-day compressive strength of 3,000 psi for the granular base material. Concrete may be placed full thickness or as a topping over a compacted granular the base. If used as a topping, the concrete shall have a minimum thickness of 3 inches.

2.4 UNIT FILL

A. Unit fill shall consist of a screened crushed aggregate. A minimum of 75% of coarse material shall have 2 or more fractured faces. Unit fill material shall meet the following gradation:

US Standard Sieve Size	Percent Passing
1-1/2"	100
3/4"	50-90
#4	0-10
#8	0-5

2.5 BACKFILL

A. Structural Fill (see specification section 31 20 00)

2.6 DRAIN TILE

A. Drain tile shall be a perforated or slotted PVC or corrugated HDPE pipe. The drain tile should be connected to storm drains or daylighted at low points and/or periodically along the wall alignment as shown on the plans.

2.7 GEOTEXTILE FABRIC

A. Provide a geotextile filter for separation from backfill at the tails of the blocks. The geotextile shall be a needle punched non-woven fabric with a minimum grab tensile strength of 120 pounds. The geotextile may cover the entire back face of the blocks or may be cut in strips to cover the gaps between tail units with a minimum of 6 inches of overlap over the concrete tail on both sides.

2.8 CONCRETE FOR TAIL EXTENSIONS

A. Concrete for tail extensions shall have a minimum 28-day compressive strength of 4500 psi. Higher mix strength may be necessary to achieve a strength of 2,000 psi before the wall is backfilled above the level of the tail extension.

B. Concrete shall have entrained air content between 5% and 7%.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate as required for installation of the retaining wall system. Excavate to the base level for a sufficient distance behind the face to permit installation of the base.

B. Slope or shore excavation as necessary for safety and for conformance with applicable OSHA requirements.

3.2 WALL BASE

A. Foundation soils shall be excavated to the dimensions shown on the plans. Foundation soil shall be observed by the Geotechnical Engineer to confirm that the bearing soils are similar to the design conditions or assumptions.

B. Construct the wall base to the lines and grades shown on the plans. Place and consolidate concrete, strike, and finish plane and level. Over excavated areas shall be filled with additional concrete or granular base material. Compact granular base material to provide a hard and level surface to support the wall units. Base material shall be compacted to a minimum of 95 percent of the maximum dry density (ASTM D698, Standard Proctor). Final base elevation shall be within 0.1 feet of plan elevation.

C. Prepare and smooth the granular material to ensure complete contact of the first course with the base. The base may be dressed with fine aggregate to aid leveling.

3.3 UNIT INSTALLATION

A. Place the first course of units directly on the wall base. Check units for level and alignment. Units shall be within 1/8 inch of level from end to end and from front to back. Adjacent units should be in contact. If possible, begin placing units at the lowest section of the wall.

B. Fill all voids between and within the blocks with granular unit fill. Additional unit fill is not required behind the units, but may be placed for the convenience of the contractor.

C. Place backfill behind the units in maximum loose lifts of 8 inches and compact. Compact all backfill to a minimum of 95 percent of the maximum dry density (ASTM D698, Standard Proctor). For cohesive soils, the moisture content at the time of compaction should be adjusted to within -2 and +3 percent of optimum. Place backfill in successive lifts until level with the top of the facing unit.

D. Remove all excess aggregate and other materials from the top of the units before laying up the next course.

E. For Paraweb reinforced walls, place the correct Paraweb strap at the locations and elevations shown on the plans or the shop drawings. Paraweb reinforcement shall be placed horizontally on compacted backfill in a V-layout. The length of the Paraweb is measured from the embedded connector in the back of the facing unit. Wrap the Paraweb strap around the embedded connector at the point of the V-shaped strap layout. Paraweb straps may be spliced following the manufacturer's guidance.

F. Ends of the Paraweb straps shall be staked or held in place. Slack shall be removed from straps using an approved method.

G. Do not operate equipment directly on the Paraweb straps. A minimum backfill depth of 6 inches should be placed before operating equipment over the reinforcing straps.

H. For geogrid reinforced walls, place the correct geogrid at the locations and elevations shown on the plans or the shop drawings. Geogrid reinforcement shall be placed horizontally on compacted backfill. The length of the geogrid is measured from the front face of the wall. Extend the grid onto the front face flange of the facing unit. Orient the geogrid with the strong axis (machine direction) placed perpendicular to the wall face. Geogrid shall not be spliced by any means in the roll direction.

I. Geogrids shall be placed side by side to provide complete coverage along the wall face. No overlap is required between adjacent grids on straight sections of the wall. On convex curves, place a minimum of 3 inches of backfill material between overlapping geogrid layers.

J. Pull geogrids taught and stake or hold the loose end in place before placing the next course of backfill. Backfill shall be placed, spread, and compacted in such a manner that minimizes the development of wrinkles in the geogrid and/or movement of the geogrid. Do

not operate equipment directly on the geogrid. A minimum backfill depth of 6 inches should be placed before operating equipment over the grids.

K. Place the next course of precast modular block units in running bond with the previous course. Place the web recess over the alignment hoop protruding from the unit below, and pull the unit forward to contact the hoop. Batter should be within ¼ inch tolerance (4 inches from 24 SF unit below, 2 inches from 6 SF unit below).

L. Continue placing successive courses to the elevations shown on the plans. Construct wall in level stages, placing the units at each course for the entire length of the wall, if possible. Unit fill and backfill should be placed to the level of the top of the facing unit before placing the next course.

M. Provide temporary swales to divert runoff away from wall excavation and away from face.

N. Final grade above and below the retaining wall shall provide for positive drainage and prevent ponding. Protect completed wall from other construction. Do not operate large equipment or store materials above the wall that exceed the design surcharge loads.

O. Where tail extensions are indicated on the plans, concrete shall be placed in a continuous placement inside the side voids between the blocks extending to the minimum width behind the blocks indicated on the drawings. Tail extensions may formed or may be placed directly against a cut embankment. Tail extensions should be placed in lifts not to exceed 4½ feet until the previous lift has fully set. The tail extension should be allowed to reach 2,000 psi compressive strength before backfill is placed above the top of the extension.

PART 4 - CONSTRUCTION QUALITY CONTROL AND ASSURANCE

4.1 CONSTRUCTION QUALITY CONTROL

A. The contractor is responsible to ensure that all installation and materials meet the quality specified in the construction drawings.

B. The contractor shall verify that installation is in accordance with the specifications and construction drawings.

4.2 QUALITY ASSURANCE

A. The contractor is responsible to coordinate testing and inspection services to provide independent quality construction assurance. Testing and inspection services will be paid by the owner.

B. Compaction testing shall be done a minimum of every 1 foot of vertical fill and every 100 lineal feet along the wall.

C. Testing shall be done at a variety of locations to cover the entire backfill zone.

D. The independent inspection professional should perform sufficient testing and observation to verify that wall installation substantially conforms to the design drawings and specifications.

END

SECTION 32 90 00
PLANTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seed, soils, edging and landscape materials.

1.2 DEFINITIONS

A. Pesticide: Any substance or mixture of substances, including biological control agents, that may prevent, destroy, repel, or mitigate pests and is specifically labeled for use by U.S. Environmental Protection Agency (EPA). Also, any substance used as plant regulator, defoliant, disinfectant, or biocide.

B. Stand of Turf: 95 percent of established species.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. American Society for Testing and Materials (ASTM):

1. B221-14 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
2. B221M-13 - Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
3. C33/C33M-16-Concrete Aggregates.
4. C136/C136M-14 - Sieve Analysis of Fine and Coarse Aggregates.
5. C602-13a - Agricultural Liming Materials.
6. D5268-13 - Topsoil Used for Landscaping Purposes.

C. Hortus Third: Concise Dictionary of Plants Cultivated in United States and Canada.

D. Tree Care Industry Association (TCIA):

1. A300P1-2008 - Tree Care Operations - Trees, Shrubs and Other Woody Plant Maintenance Standard Practices (Pruning).
2. Z133.1-2012 - Arboricultural Operations - Safety Requirements.

E. Turfgrass Producers International (TPI):

1. 2006 Guideline Specifications to Turfgrass Sodding.

F. United States Department of Agriculture (USDA):

1. DOA SSIR 42-2014 - Soil Survey Laboratory Methods Manual.
2. Handbook No. 60 - Diagnosis and Improvement of Saline and Alkali Soils.

1.4 PREINSTALLATION MEETINGS

A. Conduct pre-installation meeting at project site minimum 30 days before beginning Work of this section.

1. Required Participants:
   a. Contracting Officer's Representative.

b. Contractor.
c. 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.
   2. Installation instructions.
   3. Warranty.
C. Samples:
   1. Filter Fabric: 300 by 300 mm (12 by 12 inches).
   2. Edging Materials and Accessories: Manufacturer's standard sizes.
D. Sustainable Construction Submittals:
   1. Recycled Content: Identify post-consumer and pre-consumer recycled content percentage by weight.
   2. Biobased Content:
      a. Show type and quantity for each product.
E. Test reports: Certify products comply with specifications.
F. Certificates: Certify products comply with specifications.
   1. Seed and Turf Materials: Notarized certificate of product analysis.
G. Qualifications: Substantiate qualifications comply with specifications.
   1. Installer, including supervisor with project experience list.
H. Operation and Maintenance Data:
   1. Care instructions for each plant material.

1.6 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.
3. Member in good standing of either Professional Landcare Network or American Nursery and Landscape Association.
4. Field supervisor certified in one of the following categories from Professional Landcare Network and submit one copy of certificate to Contracting Officer's Representative:
    a. Certified Landscape Technician (CLT) - Exterior, with installation maintenance irrigation specialty areas, designated CLT-Exterior.

B. Independent or university laboratory, recognized by State Department of Agriculture, with experience and capability to conduct testing indicated and that specializes in types of tests to be performed.

C. Material Test Reports: For standardized ASTM D5268 topsoil existing native surface topsoil existing in-place surface soil and imported or manufactured topsoil.
1. For each unamended soil type, provide soil analysis and written report by qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of soil.
2. Comply with USDA's Handbook No. 60 testing methods and written recommendations.
3. Soil-testing laboratory to oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Contracting Officer's Representative. Take minimum 1 representative samples from varied locations for each soil to be used or amended for planting purposes.
4. Report suitability of tested soil for plant growth.
5. Based on test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 92.9 sq. m (1000 sq. ft.) or volume per 0.76 cu. m (1 cu. yd.) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
6. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

1.7 DELIVERY

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

B. 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.
2. Install erosion control materials to prevent erosion or displacement of bulk products.

1.8 STORAGE AND HANDLING

A. Store seeds and other packaged materials in dry locations away from contaminants.

B. Topsoil: Before stockpiling topsoil, eradicate on site undesirable growing vegetation. Clear and grub existing vegetation three to four weeks before stockpiling existing topsoil.

1.9 FIELD CONDITIONS

A. Environment:
1. Coordinate installation of planting materials during optimal planting seasons for each type of plant material required.

B. Weather Limitations: Install plantings only during current and forecasted weather conditions that are comply with plant requirements. Apply associated products in compliance with manufacturers' instructions.

1.10 WARRANTY

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

B. Manufacturer's Warranty: Warrant plantings and against material defects.
1. Warranty Period: Two years.
2. Plant and Turf Warranty Periods will begin from date of Government acceptance of project or phase for beneficial use and occupancy.
3. Contracting Officer's Representative will re-inspect plants and turf at end of Warranty Period. Replace any dead, missing, or defective plant material and turf immediately. Warranty Period will end on date of this inspection provided Contractor has complied with warranty work required by this specification. Comply with following requirements:
   a. Complete remedial measures directed by Contracting Officer’s Representative to ensure plant and turf survival.
   b. Repair damage caused while making plant or turf replacements.

PART 2 - PRODUCTS

2.1 PRODUCTS - GENERAL

A. Provide each product from one source or manufacturer.

B. Sustainable Construction Requirements:
1. Select products with recycled content to achieve overall Project recycled content requirement.
   a. Fertilizer.
   b. Weed control fabric.
2. Aluminum Recycled Content: 50 percent total recycled content, minimum.

3. Biobased Content:
   a. Organic Mulch: 100 percent.
   b. Peat: 100 percent.

2.2 SEED

A. Grass Seed: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
   1. ProScape Winning Colors Tall Fescue Blend by Lebanon Turf.
   2. Approved equal

2.3 PLANTING SOILS

A. Planting Soil: Evaluate soil for use as topsoil according to ASTM D5268. From 5 to 10 percent organic matter as determined by topsoil composition tests of Organic Carbon, 6A, Chemical Analysis Method described in USDA DOA SSIR 42. Maximum particle size, 19 mm (3/4 inch), with maximum 3 percent retained on 6 mm (1/4 inch) screen. Mix topsoil with following soil amendments and fertilizers as recommended by soils analysis.

B. Existing Planting Soil: Existing, native surface topsoil formed under natural conditions retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
   1. Supplement with another specified planting soil when quantities are insufficient.
   2. Mix existing, native surface topsoil with soil amendments and fertilizers as recommended by soils analysis.

C. Imported Planting Soil: Imported topsoil or manufactured topsoil from off-site sources are acceptable if sufficient topsoil is not available on site to meet specified depth. At least 10 days before topsoil delivery, notify Contracting Officer's Representative of topsoil sources. Obtain imported topsoil displaced from naturally well-drained construction or mining sites where topsoil is at least 100 mm (4 inches) deep. Topsoil from agricultural land, bogs, or marshes will be rejected.

2.4 INORGANIC SOIL AMENDMENTS

A. Lime: Commercial grade hydrated or burnt limestone containing calcium carbonate equivalent (CCE) specified in ASTM C602 of minimum 80 percent.

B. Sulfur: 100 percent elemental.

C. Iron Sulfate: 100 percent elemental.

D. Aluminum Sulfate: Commercial grade.

E. Perlite: Horticultural grade.

F. Agricultural Gypsum: Coarsely ground from recycled scrap gypsum board comprised of calcium sulfate dehydrate 91 percent, calcium 22 percent, sulfur 17 percent, minimum 96 percent passing

through 850 micrometers 20 mesh screen, 100 percent passing through 970 micrometers 16 mesh screen.

G. Coarse Sand: ASTM C33/C33M, clean and free of materials harmful to plants.

H. Vermiculite: Horticultural grade for planters.

I. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

J. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.5 ORGANIC SOIL AMENDMENTS

A. Organic Matter: Commercially prepared compost. Free of substances toxic to plantings and as follows:

1. Organic Matter Content: Wood cellulose fiber wood chips ground or shredded bark shredded hardwood bark peelings pine straw mulch pine needles from project site when available. Biobased content 100 percent. Wood cellulose fiber processed to contain no growth or germination-inhibiting factors, dyed with non-toxic, biodegradable dye to appropriate color to facilitate visual metering of materials application.
2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

B. Peat: Natural product of sphagnum moss peat peat moss hypnum moss peat reed sedge peat peat humus derived from fresh-water site, conforming to ASTM D4427 ASTM D5539 and containing no invasive species, including seeds. Shred and granulate peat to pass 12.5 mm (1/2 inch) mesh screen and condition in storage pile for minimum 6 months after excavation. Biobased content minimum 100 percent.

C. Composted Derivatives: Ground bark, nitolized sawdust, humus, or other green wood waste material free of stones, sticks, invasive species, including seeds, and soil stabilized with nitrogen and having following properties:

1. Particle Size: Minimum percent by weight passing:
   a. 4.75 mm (No. 4) mesh screen: 95.
   b. 2.36 mm (No. 8) mesh screen: 80.
2. Nitrogen Content: Minimum percent based on dry weight:
   a. Fir sawdust: 0.7.
   b. Fir or pine bark: 1.0.
3. Biobased Content: 100 percent.

D. Manure: Well-rotted, horse or cattle manure containing maximum 25 percent by volume of straw, sawdust, or other bedding materials; free of seeds, stones, sticks, soil, and other invasive species.

2.6 WEED CONTROL FABRIC

A. Roll Type Polypropylene or Polyester Mats: Woven, needle punched, or non-woven fabric treated for protection against deterioration due to ultraviolet radiation. Minimum 99 percent opaque to prevent photosynthesis and seed germination, fabric allows air, water, and nutrients to pass through to plant roots.
   1. Minimum weight: 0.11 kg per square meter (5 ounces per square yard).
   2. Minimum thickness: 0.50 mm (20 mils).

2.7 EDGING

A. Aluminum Edging: ASTM B221M (ASTM B221), manufactured from extruded aluminum alloy 6063-T6, in interlocking sections with punch-outs fabricated in each section for installation with stakes.
   1. Edging Size: As shown on drawings.
   2. Stakes: As shown on drawings per manufacturer.
   3. Paint Color: Black.

2.8 WATER

A. Water: Source approved by Contracting Officer's Representative and suitable quality for irrigation, containing no elements toxic to plant life, including acids, alkalis, salts, chemical pollutants, and organic matter. Use collected storm water or graywater when available.

2.9 PESTICIDES

A. Consider IPM (Integrated Pest Management) practices to minimize use of all pesticides and chemical products. Obtain Contracting Officer's Representative's approval for allowable products, product alternatives, scheduling and application procedures. Evaluate existing weather and site conditions before application. Apply products during favorable weather and site conditions according to manufacturer's instructions and warranty requirements.

2.10 FINISHES

A. Aluminum Anodized Finish: NAAMM AMP 500.
   1. Color Anodized Finish: AA-C22A32 or AA-C22A34; Class II Architectural, 0.01 mm (0.4 mil) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
   1. Verify that no materials that would inhibit plant growth are present in planting area. If such materials are present, remove soil and contaminants ad directed by Contracting Officer's Representative and provide new planting soil.
   2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.

3. Suspend soil spreading, grading, and tilling operations if soil moisture becomes excessive. Resume soil preparations when moisture content returns to acceptable level.
4. If soil is excessively dry, not workable, and too dusty, moisten uniformly.
5. Special conditions may exist that warrant variance in specified planting dates or conditions. Submit written request to Contracting Officer's Representative stating special conditions and proposed variance.

B. Proceed with planting operations only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect existing and proposed landscape features, elements, and site construction and completed work from damage. Protect trees, vegetation, and other designated features by erecting high-visibility, reusable construction fencing. Locate fence no closer to trees than drip line. Plan equipment and vehicle access to minimize and confine soil disturbance and compaction to areas indicated on drawings.

3.3 EDGING INSTALLATION

A. Uniformly edge beds of plants to provide clear cut division line between planted area and adjacent lawn. Construct bed shapes as indicated on drawings.

B. Metal Edging: Install aluminum edging material according to manufacturer's instructions. Install edging with minimum 25 mm (1 inch) visible above ground level.

3.4 SEEDING

A. Broadcast and Drop Seeding: Uniformly broadcast seed at rate recommended by manufacturer. Use broadcast or drop seeders. Sow one-half seed in one direction and sow remainder at right angles to first sowing. Cover seed uniformly to maximum 6 mm (1/4 inch) deep in clay soils and 13 mm (1/2 inch) deep in sandy soils by means of spike-tooth harrow, cultipacker, raking, or other approved device.

B. Rolling: Immediately after seeding, firm entire area, except for slopes in excess of 3 to 1, with roller not exceeding 130 kg/m (90 lb./ft.) of roller width. Eliminate rolling if seeding is done with cultipacker type seeder.

3.5 HYDROSEEDING

A. Mix water with wood cellulose fiber, paper fiber, or recycled paper at rate of 11.2 kg per 100 square meters (1,000 lb. per acre) dry weight. Add seed and fertilizer to fiber and water and mix to produce homogeneous slurry.

1. Broadcast seed mixture at rate recommended by manufacturer.
2. Hydraulically spray slurry to form uniformly impregnated grass seed cover. Spread with one application with no second application of mulch.

3.6 TURF MAINTENANCE

A. Mow turf to uniform finished height measured from soil. Perform mowing in manner that prevents scalping, rutting, bruising, uneven and rough cutting. Before mowing, remove and dispose of all rubbish, debris, trash, leaves, rocks, paper, and limbs or branches on turf areas. Sweep or vacuum clean adjacent paved areas.

B. Apply fertilizer in manner that promotes health, growth, vigor, color and appearance of cultivated turf areas. Determine method of application, fertilizer type and frequencies by results of laboratory soil analysis. Provide organic fertilizer. If organic fertilizer does not produce desired effect, contact Contracting Officer's Representative for approval before applying synthetic fertilizer. Apply fertilizer by approved methods and according to manufacturer's instructions.

C. Watering: Perform irrigation in manner that promotes health, growth, color, and appearance of cultivated vegetation, complying with Federal, State, and local water agency and authority directives. Prevent overwatering, water run-off, erosion, and ponding due to excessive quantities or rate of application.

3.7 CLEANING

A. Remove and legally dispose of all excess soil and planting debris.

3.8 PROTECTION

A. Protect plants from traffic and construction operations.

B. Provide temporary fences or enclosures and signage, at planted areas. Maintain fences and enclosures during maintenance period.

C. Remove protective materials immediately before acceptance.

D. Repair damage.

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SECTION 33 08 00
COMMISSIONING OF SITE UTILITY SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The requirements of this Section apply to all sections of Division 31.

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 REQUIRMENTS. A Commissioning Agent (CxA) appointed by the VA will manage the commissioning process.

1.2 RELATED WORK

A. Section 01 00 00 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 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 31 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 and of Division 31, is required in cooperation with the VA and the Commissioning Agent.

B. The Facility site utilities 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 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 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 31 shall be scheduled and documented in accordance with Section 01 00 00 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 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 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. The instruction shall be scheduled in coordination with the VA COR after submission and approval of formal training plans. Refer to Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS and Division 31 Sections for additional Contractor training requirements.

----- END -----

SECTION 33 10 00
WATER UTILITIES

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for construction of underground water distribution for domestic and/or fire supply systems outside the building that are complete and ready for operation. This includes piping, structures, appurtenances and all other incidentals.

1.2 RELATED WORK

A. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.

B. Concrete: Section 03 30 00, CAST IN-PLACE CONCRETE.

C. Fire Protection System connection: Section 21 12 00, FIRE-SUPPRESSION STANDPIPES.

D. General plumbing: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

E. Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

F. Metering: Section 25 10 10, ADVANCED UTILITY METERING SYSTEM.

G. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.3 DEFINITIONS

A. Water distribution system: Pipelines and appurtenances which are part of the distribution system outside the building for potable water and fire supply.

B. Water service line: Pipeline from main line to 5 feet outside of building.

1.4 ABBREVIATIONS

A. PVC: Polyvinyl chloride plastic.

B. DI: Ductile iron pipe.

C. WOG: Water, Oil and Gas.

1.5 DELIVERY, STORAGE AND HANDLING

A. Ensure that valves are dry and internally protected against rust and corrosion. Protect valves against damage to threaded ends and flange faces.

B. Use a sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

C. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

D. Protect stored piping from moisture and dirt by elevating above grade. Protect flanges, fittings, and specialties from moisture and dirt.

E. Store plastic piping protected from direct sunlight and support to prevent sagging and bending.

F. Cleanliness of Piping and Equipment Systems:

1. Care shall be exercised in the storage and handling of equipment and piping material to be incorporated in the work. Debris arising from cutting, threading and welding of piping shall be removed.
2. Piping systems shall be flushed, blown or pigged as necessary to deliver clean systems.

1.6 COORDINATION

A. Coordinate connection to water main with Public Utility company.

B. Coordinate water service lines with building contractor.

1.7 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.

B. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least three years. Digital electronic devices, software and systems such as controls, instruments or computer work stations shall be the current generation of technology and basic design that has a proven satisfactory service record of at least three years.

C. Regulatory requirements:
1. Comply with the rules and regulations of the public utility company having jurisdiction over the connection to public water lines and the extension and/or modifications to public utility systems.
2. Comply with the rules and regulations of the Federal State and/or Local Health Department Department of Environmental Quality having jurisdiction for potable water-service.
3. Comply with rules and regulations of Federal State and/or Local authorities having jurisdiction for fire-suppression water-service piping including materials, hose threads, installation and testing.

D. Provide certification of factory hydrostatic testing of not less than 500 psi (3.5 MPa) in accordance with AWWA C151. Piping materials shall bear the label, stamp or other markings of the specified testing agency.

E. Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualifications".

2. Comply with provisions of ASME B31 series "Code for Pressure Piping".
3. Certify that each welder has passed American Welding Society (AWS) qualification tests for the welding processes involved, and that certification is current.
4. All welds shall be stamped according to the provisions of the American Welding Society.

F. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the COR prior to installation.

G. Applicable codes:
1. Plumbing Systems: IPC, International Plumbing Code.
2. Electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.
3. Fire-service main products shall be listed in the FM Global “Approval Guide” or Underwriters Laboratories (UL) “Fire Protection Equipment Directory”.

1.8 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 National Standards Institute (ANSI):

MSS SP-60-2004 ..... Connecting Flange Joint Between Tapping Sleeves and Tapping Valves

MSS SP-108-2002 ..... Resilient-Seated Cast Iron, Eccentric Plug Valves

MSS SP-123-1998(R2006) ..... Non-Ferrous Threaded and Solder-Joint Unions for Use With Copper Water Tube

C. American Society of Mechanical Engineers (ASME):

A112.1.2-2004..... Air Gaps in Plumbing Systems (for Plumbing Fixtures and Water-Connected Receptors))

A112.6.3-2001..... Floor Drains

B16.1-2010..... Gray Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250

B16.18-2001..... Cast Copper Alloy Solder Joint Pressure Fittings

B16.22-2001..... Wrought Copper and Copper Alloy Solder Joint Pressure Fittings

B16.24-2006..... Cast Copper Alloy Pipe Flanges and Flanged Fittings; Classes 150, 300, 600, 900, 1500 and 2500

B31 ..... Code for Pressure Piping Standards

D. American Society for Testing and Materials (ASTM):

A36/A36M-08 ..... Carbon Structural Steel

A48/A48M-08(2008) ..... Gray Iron Castings

A536-84(2009) ..... Ductile Iron Castings

A674-10 ..... Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids

B61-08 ..... Steam or Valve Bronze Castings

B62-09 ..... Composition Bronze or Ounce Metal Castings

B88/B88M-09 ..... Seamless Copper Water Tube

C651-05 ..... Disinfecting Water Mains

C858-10e1 ..... Underground Precast Utility Structures

D1785-06 ..... Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D2239-03 ..... Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter

D2464-06 ..... Threaded Poly (Vinyl Chloride) PVC Pipe Fittings, Schedule 80

D2466-06 ..... Poly (Vinyl Chloride) (PVC) Pipe Fittings, Schedule 40

D2467-06 ..... Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80

D2609-02(2008) ..... Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe

D3350-10a ..... Polyethylene Plastics Pipe and Fittings Materials

F714-10 ..... Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

F1267-07 ..... Metal, Expanded, Steel

E. American Water Works Association (AWWA):

B300-10 ..... Hypochlorites

B301-10 ..... Liquid Chlorine

C104-08 ..... Cement–Mortar Lining for Ductile Iron Pipe and Fittings

C105/A21.5-10 ..... Polyethylene Encasement for Ductile Iron Pipe Systems

C110-08 ..... Ductile Iron and Gray-Iron Fittings

C111/A21.11-07 ..... Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings

C115/A21.11-11 ..... Flanged Ductile Iron Pipe with Ductile Iron or Gray-Iron Threaded Flanges

C151/A21.51-09 ..... Ductile Iron Pipe, Centrifugally Cast

C153/A21.53-11 ..... Ductile Iron Compact Fittings for Water Service

C502-05 ..... Dry-Barrel Fire Hydrants

C503-05 ..... Wet-Barrel Fire Hydrants

C504-10 ..... Rubber-Seated Butterfly Valves

C508-09 ..... Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS

C509-09 ..... Resilient-Seated Gate Valves for Water Supply Service

C510-07 ..... Double Check Valve Backflow Prevention Assembly

C511-07 ..... Reduced-Pressure Principle Backflow Prevention Assembly

C512-07 ..... Air Release, Air/Vacuum and Combination Air Valves

C550-05 ..... Protective Interior Coatings for Valves and Hydrants

C600-10 ..... Installation of Ductile Iron Mains and Their Appurtenances

C605-11 ..... Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water

C606-11 ..... Grooved and Shouldered Joints

C651-05 ..... Disinfecting Water Mains

C700-09 ..... Cold-Water Meters, “Displacement Type,” Bronze Main Case

C800-05 ..... Underground Service Line Valves and Fittings

C900-09 ..... Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution

C906-07 ..... Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 64 In. (1,600 mm), for Water Distribution and Transmission

C907-04 ..... Injection-Molded PVC Pressure Fittings, 4 Inch through 12 Inch (100 mm through 300 mm), for Water Distribution

M23-2nd Ed. ..... PVC Pipe, Design and Installation

M44-2nd Ed. ..... Distribution Valves: Selection, Installation, Field Testing and Maintenance

F. National Fire Protection Association (NFPA):

NFPA 24-2010 Ed. ..... Installation of Private Fire Service Mains and Their Appurtenances

NFPA 1963-2009 Ed. ..... Fire Hose Connections

G. NSF International (NSF):

NSF/ANSI 14 (2013) ..... Plastics Piping System Components and Related Materials

NSF/ANSI 61-2012 ..... Drinking Water System Components - Health Effects

NSF/ANSI 372-2011 ..... Drinking Water System Components – Lead Content

H. American Welding Society (AWS):

A5.8/A5.8M-2004 ..... Filler Metals for Brazing and Braze Welding

I. American Society of Safety Engineers (ASSE):

1003-2009 ..... Water Pressure Reducing Valves

1015-2009 ..... Double Check Backflow Prevention Assemblies and Double Check Fire Protection Backflow Prevention Assemblies

1020-2004 ..... Pressure Vacuum Breaker Assembly

1047-2009 ..... Performance Requirements for Reduced Pressure Detector Fire Protection Backflow Prevention Assemblies

1048-2009 ..... Performance Requirements for Double Check Detector Fire Protection Backflow Prevention Assemblies

1060-2006 ..... Performance Requirements for Outdoor Enclosures for Fluid Conveying Components

J. Underwriters' Laboratories (UL):

246 ..... Hydrants for Fire-Protection Service

262 ..... Gate Valves for Fire-Protection Service

312 .....Check Valves for Fire-Protection Service

405 .....Fire Department Connection Devices

753 .....Alarm Accessories for Automatic Water-Supply Control Valves for Fire Protection Service

789 .....Indicator Posts for Fire-Protection Service

1091 .....Butterfly Valves for Fire-Protection Service

1285 .....Pipe and Couplings, Polyvinyl Chloride (PVC), and Oriented Polyvinyl Chloride (PVCO) for Underground Fire Service

1.9 WARRANTY

A. 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 supplier's written guarantees and warranties covering materials and equipment furnished under this Contract.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Material or equipment containing a weighted average of greater than 0.25 percent lead shall not be used in any potable water system intended for human consumption, and shall be certified in accordance with NSF/ANSI 61 or NSF 372.

B. Plastic pipe, fittings, and solvent cement shall meet NSF/ANSI 14 and shall be NSF listed for the service intended.

2.2 FACTORY-ASSEMBLED PRODUCTS

A. Standardization of components shall be maximized to reduce spare part requirements. The contractor shall 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.

2.3 SAFETY GUARDS

A. All equipment shall have moving parts protected to prevent personal injury. Pump shafts and couplings shall be fully guarded by a sheet steel guard, covering coupling and shaft but not bearings. Material shall be minimum 16-gauge sheet steel; ends shall be braked and drilled and attached to pump base with minimum of four 1/4 inch (6 mm) bolts. Reinforce guard as necessary to prevent side play forcing guard onto couplings.

2.4 LIFTING ATTACHMENTS

A. Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.

2.5 DUCTILE IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi (2400 kPa).
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated, 350 psi (2400 kPa).
   1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Gaskets: AWWA C111, rubber.

C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, round-grooved ends.
   1. Grooved-End, Ductile-Iron Pipe Appurtenances: ASTM A47, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions matching pipe, 350 psi (3400 kPa).
   2. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions, Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
   3. Gaskets: AWWA C111.

D. Flanged Ductile Iron Pipe: AWWA C115/A21.11, with factory applied screwed long hub flanges.
   1. Flanges: ASME B16.1 for 125 psi (850 kPa) pressure ratings, as necessary.
   2. Wall Sleeve Castings, size and types shown on the drawings, shall be hot dipped galvanized per ASTM A123.
   3. Pipe and fittings exposed to view in the finished work are to be painted in accordance with Section 09 91 00, PAINTING. Pipe shall be shop primed with one coat of rust inhibitive primer. Final paint color shall match the final wall color.

E. Cement Mortar Internal Lining: Cement mortar lining and bituminous seal coat as per AWWA C104.

F. Exterior Pipe Coating: The exterior of pipe shall have the standard asphaltic coating.

2.6 POLYVINYL CHLORIDE PIPE AND FITTINGS

A. PVC, Schedule 40 Pipe: ASTM D1785.
   1. PVC, Schedule 40 Socket Fittings: ASTM D2466.

B. PVC, Schedule 80 Pipe: ASTM D1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D2464.

C. PVC, AWWA Pipe: AWWA C900, Class, with bell end with gasket, and with spigot end.
1. Comply with UL 1285 for fire-service mains if indicated.
2. PVC Fabricated Fittings: AWWA C900, Class 150 AND Class 200, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
3. PVC Molded Fittings: AWWA C907, Class 150, with bell-and-spigot or double-bell ends. Include elastomeric gasket in each bell.
4. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern.
a. Gaskets: AWWA C111, rubber.
5. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.7 PE PIPE AND FITTINGS

A. PE, ASTM Pipe: ASTM D2239, SIDR No. 5.3, 7, or 9; with PE compound number required to give pressure rating not less than 160 psi (1100 kPa).
1. Insert Fittings for PE Pipe: ASTM D2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
2. Molded PE Fittings: ASTM D3350, PE resin, socket- or butt-fusion type, made to match PE pipe dimensions and class.

B. PE, AWWA Pipe: AWWA C906, DR No. 7.3, 9, or 9.3; with PE compound number required to give pressure rating not less than 160 psi (1100 kPa)
1. PE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating not less than 160 psi (1100 kPa).

C. PE, Fire-Service Pipe: ASTM F714, AWWA C906, or equivalent for PE water pipe; FMG approved, with minimum thickness equivalent to FMG Class 150 and Class 200.
1. Molded PE Fittings: ASTM D3350, PE resin, socket-or butt-fusion type, made to match PE pipe dimensions and class.

2.8 COPPER TUBE AND FITTINGS

A. Soft Copper Tubing: ASTM B88, Type K water tube, annealed temper.

B. Hard Copper Tubing: ASTM B88, Type K water tube, drawn temper.

C. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper alloy, solder joint pressure fittings.

D. Brazing Alloy: AWS A5.8/A5.8M, Classification BCuP.

E. Bronze Flanges: ASME B16.24, Class 150, with solder joint ends. ASME B16.24, Class 300 flanges if required to match piping.

F. Copper Unions: ANSI MSS SP-123, cast copper alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

2.9 VALVES

A. Gate Valves: AWWA C509, Non-rising Stem, Resilient Seat, 200 psi (1380 kPa).
1. Valves 3 inches (75 mm) and larger: Resilient seat valve with gray- or ductile iron body and bonnet; cast iron or bronze double-disc gate; bronze gate rings; non-rising bronze stem and stem nut.
2. Interior and exterior coating: AWWA C550, thermo-setting or fusion epoxy.
3. Underground valve nut: Furnish valves with 2 inch (50 mm) nut for socket wrench operation.
4. Aboveground and pit operation: Furnish valves with hand wheels.
5. End connections shall be mechanical joint OR match main line pipe.

B. Gate Valve Accessories and Specialties
1. Tapping-Sleeve Assembly: ANSI MSS SP-60; sleeve and valve to be compatible with the drilling matching.
a. Tapping Sleeve: Ductile Iron or Stainless-Steel, two-piece bolted sleeve. Sleeve to match the size and type of pipe material being tapped.
b. Valve shall include one raised face flange mating tapping-sleeve flange.
2. Valve Boxes: AWWA M44 with top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel.
3. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut. (Provide two wrenches for Project.)
4. Indicator Posts: UL 789, FMG approved, vertical-type, cast iron body with operating wrench, extension rod, and adjustable cast iron barrel of length required for depth of burial of valve.

C. Swing Check Valves:
1. Valves smaller than 2 inches (25 mm): ASTM B61, resilient seat, bronze body and bonnet, pressure rating of 200 psi (1380 kPa). Ends to match main line piping.
2. Valves 2 inches (25 mm) or larger: AWWA 508, resilient seat valve with iron body and bonnet, pressure rating of 200 psi (1380 kPa).
3. Coating: AWWA C550, fusion epoxy coated.

D. Detector Check Valves
1. Galvanized cast iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable

seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set valve to allow minimal water flow through bypass meter when major water flow is required.

a. Standards: UL 312 and FMG approved, 175 psi (1207 kPa).

b. Water Meter: AWWA C700, disc type, at least one-fourth size of detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to detector check valve.

2. Iron body, corrosion-resistant clapper ring and seat ring material, flanged ends, with connections for bypass and installation of water meter.

a. Standards: UL 312 and FMG approved, 175 psi (1207 kPa).

E. Butterfly Valves

1. Rubber-Seated Butterfly Valve: AWWA C504.

a. Provide rubber seated butterfly valve cast or ductile iron body wafer or flanged, minimum pressure of 150 psi (1035 kPa).

2. UL Butterfly Valve: UL 1091 and FMG approved.

a. Provide metal on resilient material seating butterfly valves that are UL 1091 and FMG approved, cast or ductile iron body wafer or flanged minimum pressure of 175 psi (1207 kPa).

F. Plug Valves: ANSI MSS SP-108, resilient-seated eccentric plug valve, minimum pressure of 175 psi (1207 kPa).

G. Corporation Valves and Curb Valves

1. Service-Saddle Assemblies: AWWA C800.

a. Service Saddle: Copper alloy with seal and threaded outlet for corporation valve.

b. Corporation Valve: Bronze body and ground-key plug, with threaded inlet and outlet matching service piping material.

c. Manifold: Copper fitting with two to four inlets as required, with ends matching corporation valves and outlet matching service piping material.

2. Curb Valves: AWWA C800, bronze body, ground-key plug or ball, wide tee head, with inlet and outlet matching service piping material, minimum pressure of 200 psi (1375 kPa).

3. Service Boxes for Curb Valves: AWWA M44, cast iron telescoping top section; plug shall include lettering "WATER"; bottom section with base that fits over curb valve.

4. Shutoff Rods: Steel, tee-handle with one pointed end. Stem length shall extend 2 feet (600 mm) above top of valve box for operation of deepest buried valve, with slotted end matching curb valve.

H. Post-Indicator: NFPA 24 and be fully compatible with the valve and supervisory switches.

I. Relief Valves

1. Air-Release Valve: AWWA C512, Hydromechanical device to automatically release accumulated air.
2. Air/Vacuum Valve: AWWA C512, Direct-acting, float-operated, hydromechanical device with large orifice to automatically release accumulated air or to admit air during filling of piping.
3. Combination Air Valve: AWWA C512, Float-operated, hydromechanical device to automatically release accumulated air or to admit air during filling of piping.
4. Pressure Rating: 300 psi (2070 kPa)
5. Body material: Cast iron
6. Trim material: Stainless steel, brass or bronze
7. Water inlet size: as needed
8. Air outlet size: as needed
9. Orifice size: as needed
10. Design air-release capacity: as needed

J. Backflow Preventer
1. Backflow Preventer shall not be located in any area containing fumes that are toxic, poisonous or corrosive.
2. Direct connections between potable water piping and sewer connected wastes shall not exist under any condition with or without backflow protection.
3. Backflow Preventer shall be accessed and have clearances for the required testing, maintenance and repair. Access and clearances shall maintain a minimum of 1 foot (305 mm) between the lowest portion of the assembly and grace, floor or platform. Installations elevated more than 5 feet (1524 mm) above the floor or grade shall be provided with a permanent platform capable of supporting a tester or maintenance person.

K. Backflow Preventer Test Kits
1. Provide factory calibrated test kit with gauges, fittings, hoses and carrying case with test-procedure instructions.

2.10 WATER METER BOXES

A. Cast iron body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping.
1. Base section may be cast iron, PVC, PE, or other pipe.

B. Cast iron body and double cover for disc-type water meter, with lettering "WATER METER" in top cover; and with separate inner cover; air space between covers; and slotted, open-bottom base section of length to fit over service piping.

C. Polymer-concrete body and cover for disc-type water meter, with lettering "WATER METER" in cover; and with slotted, open-bottom base section of length to fit over service piping, vertical and

lateral design loadings of 15,000 lb minimum over 10 by 10 inches (6800 kg minimum over 254 mm by 254 mm) square.

2.11 CONCRETE VAULTS

A. Precast, reinforced-concrete vault: ASTM C858, designed for AASHTO H20-44 load designation.
   1. Ladder: ASTM A36, steel or polyethylene-encased steel steps.
   2. Drain: ASME A112.6.3, cast iron floor drain with outlet. Include body anchor flange, light-duty cast iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.
   3. Manhole Frame and Cover: ASTM A48, Class No. 35A minimum tensile strength, 24 inch (610 mm) minimum diameter, unless otherwise indicated.
   4. Manhole Frame and Cover: ASTM A536, Grade 60-40-18, ductile iron, 24 inch (610 mm) minimum diameter, unless otherwise indicated.

2.12 PROTECTIVE ENCLOSURES

A. Freeze-Protection Enclosures: Designed to protect aboveground water piping, equipment, or specialties from freezing and damage, with heat source to maintain minimum internal temperature of 40 deg F (4 deg C) when external temperatures reach as low as minus 34 deg F (minus 36 deg C) meeting the requirements of ASSE 1060.
   1. Class I, for equipment or devices other than pressure or atmospheric vacuum breakers.
   2. Class I-V, for pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
   3. Reinforced -aluminum or -fiberglass housing with dimensions indicated, but not less than those required for access and service of protected unit. Include a drain opening for units with drain connection; access doors with locking devices; insulation inside housing; and anchoring devices for attaching the housing to the concrete base.
   4. Include an electric heating cable or heater with self-limiting temperature control.

B. Weather-Resistant Enclosures: Un-insulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage meeting the requirements of ASSE 1060.
   1. Class III, for equipment or devices other than pressure or atmospheric vacuum breakers.
   2. Class III-V, for pressure or atmospheric vacuum breaker equipment or devices. Include drin opening in housing.
   3. Provide reinforced -aluminum or -fiberglass housing with dimensions indicated, but not less than those required for access and service of protected unit. Include a drain opening for units with drain connection; access doors with locking devices; insulation inside housing; and anchoring devices for attaching the housing to the concrete base.

C. Expanded-Metal Enclosures: ASTM F1267; designed to protect aboveground water piping, equipment, or specialties from damage; expanded metal side and top panels, of weight and with reinforcement of same metal at edges as required for rigidity.
   1. Type I, expanded.
   2. Class 2, hot-dip, zinc-coated carbon steel
   3. Provide a finish of the manufacturer's enamel paint. Size enclosure to match the dimensions indicated, but not less than those required for access and service of the protected unit. Include a locking device and lugs or devices necessary for securing enclosure to base.

D. Enclosure Bases: 6 inch (150 mm) minimum thickness precast concrete, extending at least 6 inches (150 mm) beyond edges of enclosure housings. Include openings for piping.

2.13 FLUSHING HYDRANTS

A. Post-Type Flushing Hydrants: Non-freeze and drainable, of length required for shutoff valve installation below frost line.
   1. Pressure Rating: 150 psi (1035 kPa) minimum
   2. Outlet: One, with horizontal discharge
   3. Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast iron cap with brass chain
   4. Barrel: Cast iron with breakaway feature
   5. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining
   6. Security: Locking device for padlock
   7. Exterior Finish: Red alkyd-gloss enamel paint.
   8. Inlet: NPS 2 (DN 50) minimum
   9. Operating Wrench: One for each unit

B. Ground-Type Flushing Hydrants: Non-freeze and drainable, of length required for shutoff valve installation below frost line.
   1. Pressure Rating: 150 psi (1035 kPa) minimum
   2. Outlet: One, with angle discharge
   3. Hose Thread: NPS 2-1/2 (DN 65), with NFPA 1963 external hose thread for use by local fire department, and with cast iron cap with brass chain
   4. Barrel: Cast iron
   5. Valve: Bronze body with bronze-ball or plunger closure, and automatic draining
   6. Inlet: NPS 2 (DN 50) minimum
   7. Hydrant Box: Cast iron with cover, for ground mounting
   8. Operating Wrench: One for each unit

C. Post-Type Sampling Station: Non-freeze and drainable, of length required for shutoff valve installation below frost line.

1. Pressure Rating: 100 psi (690 kPa) minimum
2. Sampling Outlet: One unthreaded nozzle with handle
3. Valve: Bronze body with bronze-ball or plunger closure. Include operating handle.
4. Drain: Tubing with separate manual vacuum pump
5. Inlet: NPS 3/4 (DN 20) minimum
6. Housing: Weatherproof material with locking device. Include anchor device
7. Operating Wrench: One for each unit

2.14 FIRE HYDRANTS

A. All hydrants shall have removable interiors capable of replacement without digging up the hydrant and be packable under pressure. Threaded joints or spindles shall be bronze and upper and lower barrels shall be of equal diameter. Upper barrel shall be of sufficient length to permit setting hydrant with barrel flange not more than 4 inches (100 mm) above finished grade. All fire hydrants shall have 6 inch (150 mm) bottom connection. Provide two sets of hydrant wrenches not less than 14 inches (350 mm) long. Pressure Rating: 150 psi (1035 kPa) minimum. Hydrant valve shall open by turning operating nut to left or counterclockwise. Exterior finish shall be red alkyd-gloss enamel paint, unless otherwise indicated. Outlet threads shall meet NFPA 1963, with external hose thread used by local fire department. Include cast iron caps with steel chains and Pentagon, 1-1/2 inch (38 mm) point to flat operating and cap nuts.

B. Dry-Barrel Fire Hydrants:
   1. AWWA C502, freestanding, one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4 inch (133 mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet; interior coating according to AWWA C550; cast iron body, compression-type valve opening against pressure and closing.
   2. UL 246, freestanding, one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4 inch (133 mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet; cast iron body, compression-type valve opening against pressure and closing.

C. Wet-Barrel Fire Hydrants:
   1. AWWA C503, freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet; interior coating according to AWWA C550.
   2. UL 246, freestanding, one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, NPS 6 (DN 150) threaded or flanged inlet, and base section with NPS 6 (DN 150) mechanical-joint inlet.

2.15 FIRE DEPARTMENT CONNECTIONS

A. Fire system base water supply must provide a minimum of 1000 gpm (3785 l/m) at 150 psi (1035 kPa) and 700 gpm (2650 l/m) at 200 psi (1380 kPa) at the Fire Department connection. For

hydraulic calculations, the calculated demand shall not fall less than 10 percent below the water supply curve.

B. Fire Department connections: UL 405, NFPA 1963, freestanding, cast bronze body, thread inlets, and matching local fire department hose threads, threaded bottom outlet, lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18 inch (460 mm) high brass sleeve; round escutcheon plate, meeting the requirements of UL 405.
   1. Connections: Two NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet
   2. Connections: Three NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet
   3. Connections: Six NPS 2-1/2 (DN 65) inlets and one NPS 6 (DN 150) outlet
   4. Inlet Alignment: Square
   5. Finish Including Sleeve: Rough chrome-plated Polished bronze
   6. Escutcheon Plate Marking: “AUTO SPKR” & “STANDPIPE”

2.16 ALARM DEVICES

A. Alarm Devices-General: UL 753 and FMG approved, of types and sizes to mate and match piping and equipment.

B. Water-Flow Indicators: Vane-type water-flow detector, rated for 250-psi (1725-kPa) working pressure; designed for horizontal or vertical installation; 2 single-pole, double-throw circuit switches to provide isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal when cover is removed.

C. Supervisory Switches: Single pole, double throw; designed to signal valve in other than fully open position.

D. Pressure Switches: Single pole, double throw; designed to signal increase in pressure.

2.17 DISINFECTION CHLORINE

A. Liquid chlorine: AWWA B301.

B. Sodium Hypochlorite: AWWA B300 with 5 percent to 15 percent available chlorine.

C. Calcium hypochlorite: AWWA B300 supplied in granular form of 5 g. tablets, and shall contain 65 percent chlorine by weight.

2.18 WARNING TAPE

A. Warning tape shall be standard, 4 mil. Polyethylene, 3 inch (76 mm) wide tape, detectable type, blue with black letters and imprinted with “CAUTION BURIED WATER LINE BELOW”.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Use pipe, fittings, and joining methods for piping systems according to the following applications.
   1. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.

2. Do not use flanges or unions for underground piping.
3. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.

B. Underground water-service piping NPS 3/4 to NPS 3 (DN 20 to DN 80) shall be any of the following:
1. Soft copper tube with copper, pressure-seal fittings; and pressure-sealed joints.
2. PE, ASTM pipe; molded PE fittings; and heat-fusion joints.

C. Underground water-service piping NPS 4 to NPS 8 (DN 100 to DN 200) Insert pipe size range shall be any of the following:
1. Ductile iron, mechanical-joint pipe; ductile iron, mechanical-joint fittings; and mechanical grooved-end pipe; ductile iron-pipe appurtenances; and grooved joints.
2. PE, AWWA pipe; PE, AWWA fittings; and heat-fusion joints.

D. Underground Fire-Service-Main Piping NPS 4 to NPS 12 (DN 100 to DN 300) shall be any of the following:
1. Ductile iron, mechanical-joint pipe; ductile iron, mechanical-joint fittings; and mechanical grooved-end pipe; ductile iron-pipe appurtenances; and grooved joints.

3.2 VALVE APPLICATIONS

A. Use mechanical-joint-end valves for NPS 3 (DN 80) and larger underground installation. Use threaded- or flanged-end valves for installation in vaults. Use UL/FMG, non-rising-stem gate valves for installation with indicator posts. Use corporation valves and curb valves with ends compatible with piping, for NPS 2 (DN 50) and smaller installation.

B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
1. Underground Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, non-rising-stem, resilient - seated gate valves with valve box.
2. Underground Valves, NPS 4 (DN 100) and Larger, for Indicator Posts: cast iron, non-rising-stem gate valves with indicator post.
3. Use the following for valves in vaults and aboveground:
a. Gate Valves, NPS 2 (DN 50) and Smaller: Bronze, non-rising rising stem.
b. Gate Valves, NPS 3 (DN 80) and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.
c. Check Valves: AWWA C508 swing type.

3.3 DUCTILE IRON PIPE

A. Install Ductile Iron, water-service piping according to AWWA C600 and AWWA M41-3rd Edition.
1. Install PE corrosion-protection encasement according to ASTM A674 or AWWA C105/A21.5.

B. Pipe shall be sound and clean before laying. When laying is not in progress, the open ends of the pipe shall be closed by watertight plug or other approved means.

C. When cutting pipe is required, the cutting shall be done by machine, leaving a smooth cut at right angles to the axis of the pipe. Bevel cut ends of pipe to be used with push-on bell to conform to the manufactured spigot end. Cement lining shall be undamaged.

D. Push on joints shall be made in strict accordance with the manufacturer's instruction. Pipe shall be laid with bell ends looking ahead.

3.4 PVC PIPE

A. PVC piping shall be installed in strict accordance with the manufacturer's instructions and AWWA C605. Place selected material and thoroughly compacted to one foot above the top of the pipe.

B. Install Copper Tracer Wire, No. 14 AWG solid, single conductor, insulated. Install in the trench with piping to allow location of the pipe with electronic detectors. The wire shall not be spiraled around the pipe nor taped to the pipe. Wire connections are to be made by stripping the insulation from the wire and soldering with rosin core solder per ASTM 828. Solder joints shall be wrapped with rubber tape and electrical tape. At least every 1000 feet (300 m) provide a 5 pound (2.3 kg) magnesium anode attached to the main tracer wire by solder. The solder joint shall be wrapped with rubber tape and with electrical tape. An anode shall also be attached at the end of each line.

C. Magnetic markers may be used in lieu of copper tracer wire to aid in future pipe location. Generally, install markers on 20 foot (6 m) centers. If pipe is in a congested piping area, install on 10 foot (3 m) centers. Prepare as-built drawing indicating exact location of magnetic markers.

3.5 COPPER PIPE

A. Copper piping shall be installed in accordance with the Copper Development Association's Copper Tube Handbook and manufacturer's recommendations.

B. Copper piping shall be bedded in 6 inches (150 mm) of sand.

3.6 ANCHORAGE INSTALLATION

A. Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include: concrete thrust blocks, locking mechanical joints, set-screw mechanical retainer glands, bolted flanged joints.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:

1. Gasketed-Joint, Ductile Iron, Water-Service Piping: According to AWWA C600.
2. Gasketed-Joint, PVC Water-Service Piping: According to AWWA M23.
3. Fire-Service-Main Piping: According to NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.7 VALVE INSTALLATION

A. AWWA Valves: Install each underground valve with stem pointing up and with valve box.
B. UL/FMG, Valves: Install each underground valve and valves in vaults with stem pointing up and with vertical cast iron indicator post.
C. MSS Valves: Install as component of connected piping system.
D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.
E. Pressure-Reducing Valves: Install in vault or aboveground between shutoff valves. Install full-size valved bypass.
F. Relief Valves: Install aboveground with shutoff valve on inlet.
G. Raise or lower existing valve and curb stop boxes and fire hydrants to finish grade in areas being graded.

3.8 DETECTOR-CHECK VALVE INSTALLATION

A. Install in vault or aboveground and for proper direction of flow. Install bypass with water meter, gate valves on each side of meter, and check valve downstream from meter.
B. Support detector check valves, meters, shutoff valves, and piping on brick or concrete piers.

3.9 FLUSHING HYDRANT INSTALLATION

A. Install post-type flushing hydrants with valve below frost line and provide for drainage. Support in upright position. Include separate gate valve or curb valve and restrained joints in supply piping.
B. Install ground-type flushing hydrants with valve below frost line and provide for drainage. Install hydrant box flush with grade. Include separate gate valve or curb valve and restrained joints in supply piping.
C. Install sampling stations with valve below frost line and provide for drainage. Attach weather-resistant housing and support in upright position. Include separate curb valve in supply piping.

3.10 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install ball drip valves at each check valve for fire department connection to mains.
B. Install protective pipe bollards on two sides of each fire department connection.

3.11 FIRE HYDRANT INSTALLATION

A. Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.
B. Install Wet-Barrel Fire Hydrants with valve below frost line. Provide for drainage.

3.12 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Install water service lines to a point of connection within approximately 5 feet (1500 mm) outside of building(s) to which service is to be connected and make connections thereto. If building services have not been installed provide temporary caps and mark for future connection.

3.13 FIELD QUALITY CONTROL

A. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Prior to final acceptance, provide a video record of all piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.

C. Perform hydrostatic tests at not less than one-and-one-half times working pressure for two hours.

1. Increase pressure in 50-psi (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psi (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

D. Prepare reports of testing activities.

3.14 IDENTIFICATION

A. Install continuous underground warning tape 12 inches (300 mm) directly over piping.

3.15 CLEANING

A. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.

B. Use purging and disinfecting procedure prescribed by local utility provider or other authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:

1. Fill the water system with a water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
2. Drain the system of the previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow system to stand for 3 hours.
3. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

C. Prepare reports of purging and disinfecting activities.

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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. Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing: Section 31 20 00, EARTH MOVING.

B. Concrete Work, Reinforcing, Placement and Finishing: Section 03 30 00, CAST-IN-PLACE CONCRETE.

C. General plumbing, protection of Materials and Equipment, and quality assurance: Section 22 05 11, COMMON WORK RESULTS FOR PLUMBING.

D. Fabrication of Steel Ladders: Section 05 50 00, METAL FABRICATIONS.

E. Materials and Testing Report Submittals: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

F. Erosion and Sediment Control: Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.

1.3 ABBREVIATIONS

A. HDPE: High-density polyethylene

B. PE: Polyethylene

1.4 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.

1.5 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.

1.6 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.

1.7 SUBMITTALS

A. Manufacturers' Literature and Data shall be submitted, as one package, for pipes, fittings and appurtenances, including jointing materials, hydrants, valves and other miscellaneous items.

1.8 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):

A185/A185M-07 ..... Steel Welded Wire Reinforcement, Plain, for Concrete

A242/A242M-04(2009)..... High-Strength Low-Alloy Structural Steel

A536-84(2009) ..... Ductile Iron Castings

A615/A615M-09b ..... Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

A760/A760M-10 ..... Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains

A798/A798M-07 ..... Installing Factory-Made Corrugated Steel Pipe for Sewers and Other Applications

A849-10..... Post-Applied Coatings, Paving, and Linings for Corrugated Steel Sewer and Drainage Pipe

A929/A929M-01(2007)..... Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe

B745/B745M-97(2005)..... Corrugated Aluminum Pipe for Sewers and Drains

B788/B788M-09 ..... Installing Factory-Made Corrugated Aluminum Culverts and Storm Sewer Pipe

C14-07..... Non-reinforced Concrete Sewer, Storm Drain, and Culvert Pipe

C33/C33M-08..... Concrete Aggregates

C76-11..... Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

C139-10 ..... Concrete Masonry Units for Construction of Catch Basins and Manholes

C150/C150M-11..... Portland Cement

C443-10 ..... Joints for Concrete Pipe and Manholes, Using Rubber Gaskets

C478-09 .....Precast Reinforced Concrete Manhole Sections

C506-10b .....Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe

C507-10b .....Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe

C655-09 .....Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

C857-07 .....Minimum Structural Design Loading for Underground Precast Concrete Utility Structures

C891-09 .....Installation of Underground Precast Concrete Utility Structures

C913-08 .....Precast Concrete Water and Wastewater Structures

C923-08 .....Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals

C924-02(2009) .....Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method

C990-09 .....Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

C1103-03(2009) .....Joint Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines

C1173-08 .....Flexible Transition Couplings for Underground Piping Systems

C1433-10 .....Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers

C1479-10 .....Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations

D448-08 .....Sizes of Aggregate for Road and Bridge Construction

D698-07e1 .....Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft3 (600 kN-m/m3))

D1056-07 .....Flexible Cellular Materials—Sponge or Expanded Rubber

D1785-06 .....Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120

D2321-11 ..... Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications

D2751-05 ..... Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings

D2774-08 ..... Underground Installation of Thermoplastic Pressure Piping

D3034-08 ..... Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings

D3350-10 ..... Polyethylene Plastics Pipe and Fittings Materials

D3753-05e1 ..... Glass-Fiber-Reinforced Polyester Manholes and Wetwells

D4101-11 ..... Polypropylene Injection and Extrusion Materials

D5926-09 ..... Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems

F477-10 ..... Elastomeric Seals (Gaskets) for Joining Plastic Pipe

F679-08 ..... Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings

F714-10 ..... Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

F794-03(2009) ..... Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter

F891-10 ..... Coextruded Poly(Vinyl Chloride) (PVC) Plastic Pipe With a Cellular Core

F894-07 ..... Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe

F949-10 ..... Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe With a Smooth Interior and Fittings

F1417-11 ..... Installation Acceptance of Plastic Gravity Sewer Lines Using Low-Pressure Air

F1668-08 ..... Construction Procedures for Buried Plastic Pipe

C. American Association of State Highway and Transportation Officials (AASHTO):

M190-04 ..... Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches

M198-10 ..... Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants

M252-09 ..... Corrugated Polyethylene Drainage Pipe

M294-10 ..... Corrugated Polyethylene Pipe, 12 to 60 In. (300 to 1500 mm) Diameter

D. American Water Works Association(AWWA):

C105/A21.5-10 ..... Polyethylene Encasement for Ductile iron Pipe Systems

C110-08 ..... Ductile-Iron and Gray-Iron Fittings

C219-11 ..... Bolted, Sleeve-Type Couplings for Plain-End Pipe

C600-10 ..... Installation of Ductile iron Mains and Their Appurtenances

C900-07 ..... Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm), for Water Transmission and Distribution

M23-2nd ed ..... PVC Pipe ”Design And Installation”

E. American Society of Mechanical Engineers (ASME):

A112.6.3-2001..... Floor and Trench Drains

A112.14.1-2003..... Backwater Valves

A112.36.2M-1991..... Cleanouts

F. American Concrete Institute (ACI):

318-05 ..... Structural Commentary and Commentary

350/350M-06 ..... Environmental Engineering Concrete Structures and Commentary

G. National Stone, Sand and Gravel Association (NSSGA): Quarried Stone for Erosion and Sediment Control

1.9 WARRANTY

A. 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. The Contractor shall 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 ABS PIPE AND FITTINGS

A. ABS Sewer Pipe and Fittings: Pipe and fittings shall conform to ASTM D2751, with bell-and-spigot ends for gasketed joints.
   1. NPS 3 to NPS 6 (DN 80 to DN 150): SDR 35.
   2. NPS 8 to NPS 12 (DN 200 to DN 300): SDR 42.

B. Gaskets: ASTM F477, elastomeric seals.

2.3 PE PIPE AND FITTINGS

A. Corrugated PE drainage pipe and fittings, NPS 3 to NPS 10 (DN 80 to DN 250); ASTM F714, SDR 21 with smooth waterway for coupling joints.
   1. Silt-tight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
   2. Soil-tight Couplings: AASHTO M252, corrugated, matching tube and fittings.

B. Corrugated PE pipe and fittings, NPS 12 to NPS 60 (DN 300 to DN 1500); AASHTO M294, Type S ASTM F714, SDR 21 for pipes 3 to 24 inches (300 to 600 mm) with smooth waterway for coupling joints. Pipe shall be produced from PE certified by the resin producer as meeting the requirements of ASTM D3350, minimum cell class 335434C.
   1. Silt-tight Couplings: PE sleeve with ASTM D1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.
   2. Soil-tight Couplings: AASHTO M252, corrugated, matching tube and fittings.
   3. Water tight joints shall be made using a PVC or PE coupling and rubber gaskets as recommended by the pipe manufacturer. Rubber gaskets shall conform to ASTM F477. Soil tight joints shall conform to requirements in AASHTO HB-17, Division II, for soil tightness and shall be as recommended by the manufacturer.

C. Profile Wall PE Pipe: Pipe shall comply with ASTM F894, Class 160.
   1. Profile Wall PE Plastic Pipe Joints: Joints shall be as per ASTM F894, gasket or thermal weld type with integral bell.

D. PVC Pipe and Fittings
   1. PVC Cellular-Core Pipe and Fittings: ASTM F891, Sewer and Drain Series, PS 50 minimum stiffness, PVC cellular-core pipe with plain ends for solvent-cemented joints.
   2. Fittings: ASTM D3034, SDR 35, PVC socket-type fittings.

E. PVC Corrugated Sewer Piping
1. Pipe: ASTM F949, PVC, corrugated pipe with bell-and-spigot ends for gasketed joints.
2. Fittings: ASTM F949, PVC molded or fabricated, socket type.
3. Gaskets: ASTM F477, elastomeric seals.

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

G. PVC Type PSM Sewer Piping
1. Pipe: ASTM D3034, SDR 35 PVC Type PSM sewer pipe with bell-and-spigot ends.
2. Fittings: ASTM D3034, PVC with bell ends.
3. Gaskets: ASTM F477, elastomeric seals.

H. PVC Gravity Sewer Piping
1. Pipe and fittings shall be ASTM F679, T-1 or T-2 wall thickness, PVC gravity sewer pipe with bell-and-spigot ends.
2. Gaskets: ASTM F477, elastomeric seals for gasketed joints.

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.
4. Unshielded, Flexible Couplings: Couplings shall be an elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

C. Shielded, flexible couplings shall be elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-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 EXPANSION JOINTS AND DEFLECTION FITTINGS

A. Ductile iron flexible expansion joints: Compound fitting with combination of flanged and mechanical-joint ends complying with AWWA C110. Include two gasketed ball-joint sections and

one or more gasketed sleeve sections, rated for 250-psi (1725-kPa) minimum working pressure and for offset and expansion indicated.

B. Ductile iron expansion joints: Three-piece assemblies of telescoping sleeve with gaskets and restrained-type, ductile iron or steel with protective coating, bell-and-spigot end sections complying with AWWA C110. Include rating for 250-psi (1725-kPa) minimum working pressure and for expansion indicated.

C. Ductile iron deflection fittings: Compound-coupling fitting, with ball joint, flexing section, gaskets, and restrained-joint ends, complying with AWWA C110. Include rating for 250-psi (1725-kPa) minimum working pressure and for up to 15 deg of deflection.

2.6 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
   1. Top-Loading Classification(s): H-20 loading
   2. Pipe fitting and riser to cleanout shall be same material as main pipe line.

B. Plastic Cleanouts shall have PVC body with PVC threaded plug. Pipe fitting and riser to cleanout shall be of same material as main line pipe.

2.7 DRAINS

A. Cast-Iron Area Drains: ASME A112.6.3, gray-iron round body with anchor flange and round secured grate. Include bottom outlet with inside calk or spigot connection, of sizes indicated.
   1. Top-Loading Classification(s): H-20

B. Grate openings shall be 1/4 inch (6.4 mm) circular or slots.

2.8 ENCASEMENT FOR PIPING

A. Material: AWWA C105 Linear low-density polyethylene film of 0.008 inch (0.20 mm) or high-density, cross-laminated polyethylene film of 0.004 inch (0.10 mm) minimum thickness.

B. Form: Sheet or tube

C. Color: Black or natural

2.9 MANHOLES AND CATCH BASINS

A. Standard Precast Concrete Manholes:
   1. Description: ASTM C478 (ASTM C478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   2. Diameter: 48 inches (1200 mm) 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 (150 mm) minimum thickness for floor slab and 4-inch (102 mm) minimum thickness for walls and base riser section, and separate base slab or base section with integral floor.
5. Riser Sections: 4 inch (102 mm) 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 (ASTM C990M), bitumen or butyl rubber.
8. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), 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 (1500 mm). Individual FRP steps or FRP ladder Individual FRP steps; FRP ladder; or ASTM A615, deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D4101, PP ASTM A615, deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D4101, PP, width of 16 inches (400 mm) minimum, spaced at 12 to 16 inch (300 to 400 mm) intervals.
10. Adjusting Rings: Reinforced-concrete rings, 6 to 9 inch (150 to 225 mm) 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. Designed Precast Concrete Manholes:
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 (ASTM C990M), bitumen or butyl rubber.
4. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.
5. Steps: If total depth from floor of manhole to finished grade is greater than 60 inches (1500 mm). Individual FRP steps or FRP ladder Individual FRP steps; FRP ladder; or ASTM A615, deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D4101, PP ASTM A615 deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D 4101, PP, width of 16 inches (400 mm) minimum, spaced at 12 to 16 inch (300 to 400 mm) intervals.
6. Adjusting Rings: Reinforced-concrete rings, 6 to 9 inch (150 to 225 mm) 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. Fiberglass Manholes:
1. Description: ASTM D3753.
2. Diameter: 48 inches (1200 mm) minimum unless otherwise indicated.

3. Ballast: Increase thickness of concrete base as required to prevent flotation.
4. Base Section: Concrete, 8 inch (203 mm) minimum thickness.
5. Resilient Pipe Connectors: ASTM C923 (ASTM C923M), cast or fitted into manhole walls, for each pipe connection.
6. Steps: If total depth from floor of manhole to finished grade is greater than 60 inches (1500 mm). Individual FRP steps or FRP ladder Individual FRP steps; FRP ladder; or ASTM A615, deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D4101, PP ASTM A615, deformed, 1/2 inch (13 mm) steel reinforcing rods encased in ASTM D4101, PP, width of 16 inches (400 mm) minimum, spaced at 12 to 16 inch (300 to 400 mm) intervals.
7. Adjusting Rings: Reinforced-concrete rings, 6 to 9 inch (150 to 225 mm) 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.

D. Manhole Frames and Covers:
1. Description: Ferrous; 24 inch (610 mm) ID by 7 to 9 inch (175 to 225 mm) riser with 4 inch (102 mm) minimum width flange and 26-inch (600 mm) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
2. Material: ASTM A536, Grade 60 ductile ASTM A48/A48M, Class 35 gray iron unless otherwise indicated.

2.10 CONCRETE FOR MANHOLES AND CATCH BASINS

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

B. Concrete Design Mix: 4000 psi (27.6 MPa) minimum, compressive strength in 28 days.
1. Reinforcing Fabric: ASTM A185, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A615, Grade 60 (420 MPa) 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 three-fourths 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.

2.11 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-3, screen opening 2 inches (51 mm).
   2. Average Size: NSSGA No. R-4, screen opening 3 inches (76 mm).
   3. Average Size: NSSGA No. R-5, screen opening 5 inches (127 mm).

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 (2721-kg) average weight armor stone, unless otherwise indicated.

2.12 RESILIENT CONNECTORS AND DOWNSPOUT BOOTS FOR BUILDING ROOF DRAINS

A. Resilient connectors and downspout boots: Flexible, watertight connectors used for connecting pipe to manholes and inlets, and shall conform to ASTM C923.

2.13 WARNING TAPE

A. Standard, 4-Mil polyethylene 3 inch (76 mm) wide tape detectable type, purple with black letters, and imprinted with “CAUTION BURIED STORM SEWER BELOW”.

PART 3 - EXECUTION

3.1 PIPE BEDDING

A. The bedding surface of the pipe shall provide a firm foundation of uniform density throughout the entire length of pipe. Concrete pipe requirements are such that when no bedding class is specified, concrete pipe shall be bedded in a soil foundation accurately shaped and rounded to conform with the lowest one-fourth of the outside portion of circular pipe. When necessary, the bedding shall be tamped. Bell holes and depressions for joints shall not be more than the length, depth, and width required for properly making the particular type of joint. Plastic pipe bedding requirements shall meet the requirements of ASTM D2321. Bedding, haunching and initial backfill shall be either Class IB or Class II material. Corrugated metal pipe bedding requirements shall conform to ASTM A798.

3.2 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 60 inch (1520 mm) minimum cover unless otherwise 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 layers of shading to a depth of 12 inches (300 mm) over the crown of the pipe.
7. Warning tape shall be continuously placed 12 inches (300 mm) 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. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

G. Install gravity-flow, nonpressure drainage piping according to the following:
1. Install piping pitched down in direction of flow.
2. Install piping NPS 6 (DN 150) and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fittings; or cast in-place concrete supports or anchors.
3. Install hub-and-spigot cast iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
4. Install ductile iron piping and special fittings according to AWWA C600.
5. Install corrugated steel piping according to ASTM A798.
6. Install corrugated aluminum piping according to ASTM B788.
7. Install ABS sewer piping according to ASTM D2321 and ASTM F1668.
8. Install PE corrugated sewer piping according to ASTM D2321 with gasketed joints.
9. Install PVC cellular-core piping, PVC sewer piping, and PVC profile gravity sewer piping, according to ASTM D2321 and ASTM F1668.

3.3 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, the Contractor shall 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.

3.4 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.

3.5 DRAIN INSTALLATION

A. Install type of drains in locations indicated.
   1. Use H-20 loading in all areas.

B. Embed drains in 4 inch (102 mm) minimum concrete around bottom and sides.

C. Set drain frames and covers with tops flush with pavement surface.

D. Assemble trench sections with flanged joints and embed trench sections in 4 inch (102 mm) minimum concrete around bottom and sides.

3.6 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 of manholes that occur in pavements. Set tops 2 inches (76 mm) above finished surface elsewhere unless otherwise indicated.

C. Circular Structures:
   1. Precast concrete segmental blocks shall lay true and plumb. All horizontal and vertical joints shall be completely filled with mortar. Parge interior and exterior of structure with 1/2 inch (15 mm) or cement mortar applied with a trowel and finished to an even glazed surface.
   2. 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.

3. Precast reinforced concrete manhole risers and tops. Install as specified for precast reinforced concrete rings.

D. Rectangular Structures:

1. Precast concrete structures shall be placed on a 8 inch (200 mm) reinforced concrete pad, or be provided with a precast concrete base section. Structures provided with a base section shall be set on an 8 inch (200 mm) 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. Seal all joints with preform flexible gasket material.
2. Do not build structures when air temperature is 32 deg F (0 deg C), or below.
3. Invert channels shall be smooth and semicircular in shape conforming to inside of adjacent sewer section. Make changes in direction of flow with a smooth curve of as large a radius as size of structure will permit. Make changes in size and grade of channels gradually and evenly. Construct invert channels by one of the listed methods:
   a. Forming directly in concrete base of structure.
   b. Building up with brick and mortar.
4. Floor of structure outside the channels shall be smooth and slope toward channels not less than 1 to 12 or more than 1 to 6. Bottom slab and benches shall be concrete.
5. The wall that supports access rungs or ladder shall be 90 deg vertical from the floor of structure to manhole cover.
6. Install steps and ladders per the manufacturer's recommendations. Steps and ladders shall not move or flex when used. All loose steps and ladders shall be replaced by the Contractor.
7. Install manhole frames and covers on a mortar bed, and flush with the finish pavement. Frames and covers shall not move when subject to vehicular traffic. Install a concrete collar around the frame to protect the frame from moving until the adjacent pavement is placed. In unpaved areas, the rim elevation shall be 2 inches (50 mm) above the adjacent finish grade. Install an 8 inch (203 mm) thick, by 12 inch (300 mm) concrete collar around the perimeter of the frame. Slope the top of the collar away from the frame.

3.7 CATCH BASIN INSTALLATION

A. Construct catch basins to sizes and shapes indicated.

B. Set frames and grates to elevations indicated.

3.8 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section FACILITY STORM DRAINAGE PIPING.

B. Encase entire connection fitting, plus 6 inch (150 mm) overlap, with not less than 6 inches (150 mm) of concrete with 28-day compressive strength of 3000 psi (20.7 MPa).

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 (DN 100 to DN 500). Remove section of existing pipe, install wye fitting into existing piping.
3. Make branch connections from side into existing piping, NPS 21 (DN 525) or larger, or to underground manholes and structures by cutting into existing unit and creating an opening large enough to allow 3 inches (76 mm) 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.
2. Use pressure-type pipe couplings for force-main joints.

3.9 CLOSING ABANDONED STORM DRAINAGE SYSTEMS

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
1. Close open ends of piping with at least 8 inch (203 mm) thick, brick masonry bulkheads.
2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Abandoned Manholes and Structures: Excavate around manholes and structures as required and use one procedure below:
1. Remove manhole or structure and close open ends of remaining piping.
2. Remove top of manhole or structure down to at least 36 inches (915 mm) below final grade. Fill to within 12 inches (300 mm) of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

C. Backfill to grade according to Division 31 Section EARTH MOVING.

3.10 IDENTIFICATION

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

3.11 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Prior to final acceptance, provide a video record of all piping from the building to the municipal connection to show the lines are free from obstructions, properly sloped and joined.
   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.

3.12 TESTING OF STORM SEWERS:

A. Submit separate report for each test.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Test completed piping systems according to requirements of authorities having jurisdiction.
   3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours advance notice.
   4. Submit separate report for each test.
   5. Air test gravity sewers. Concrete Pipes conform to ASTM C924, Plastic Pipes conform to ASTM F1417, all other pipe material conform to ASTM C828 or C924, after consulting with pipe manufacturer. Testing of individual joints shall conform to ASTM C1103.
   6. Test force-main storm drainage piping. Perform hydrostatic test after thrust blocks, supports, and anchors have hardened. Test at pressure not less than 1-1/2 times the maximum system operating pressure, but not less than 150 psi (1035 kPa).
      a. Ductile iron Piping: Test according to AWWA C600, "Hydraulic Testing" Section.
      b. PVC Piping: Test according to AWWA M23, "Testing and Maintenance" Chapter.

C. Leaks and loss in test pressure constitute defects that must be repaired. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.13 CLEANING

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

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SECTION 33 63 00
STEAM ENERGY DISTRIBUTION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies materials and procedures for construction of underground steam distribution and condensate return piping system, including manholes, outside the buildings. System shall be: pre-engineered, direct-buried, drainable-dryable-testable (DDT).

B. A complete listing of common acronyms and abbreviations are included in Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION.

C. Definitions:

1. System: The complete underground steam and condensate distribution system including all components such as carrier piping, pipe supports, insulation, protective enclosures, anchors, corrosion protection, stress analysis, and accessories.
2. Pre-Engineered Direct-Buried System: A factory-fabricated system.
3. Drainable-Dryable-Testable (DDT) Pre-Engineered Direct-Buried System: A factory-fabricated system.
4. Concrete Shallow Trench: A system with removable concrete cover in sections located at grade.
5. Walk-through Concrete Tunnels: A system located below grade with sufficient space for carrier pipes, other services, and space to walk upright along the entire length of the system.
6. Carrier Pipe: Pipe carrying the steam or condensate.

1.2 RELATED WORK

A. Section 01 00 00, GENERAL REQUIREMENTS.

B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA AND SAMPLES.

C. Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS: Erosion and Sediment Controls.

D. Section 01 74 19, CONSTRUCTION WASTE MANAGEMENT.

E. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS.

F. SECTION 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.

G. Section 03 30 00, CAST-IN-PLACE CONCRETE: Concrete Work, Reinforcing, Placement and Finishing.

H. Section 05 50 00, METAL FABRICATIONS: Steel for trench and tunnel pipe supports.

I. Section 09 91 00, PAINTING, Painting exposed steel and other surfaces.

J. Section 23 05 10, COMMON WORK RESULTS FOR BOILER PLANT AND STEAM GENERATION

K. Section 26 42 00, CATHODIC PROTECTION: Cathodic Protection of DDT Pre-Engineered Direct-Buried Systems.

L. Section 31 20 00, EARTHWORK: Excavation, Trench Widths, Pipe Bedding, Backfill, Shoring, Sheeting, Bracing.

M. Section 33 08 00, COMMISSIONING OF SITE UTILITY SYSTEMS.

1.3 APPLICABLE PUBLICATIONS

A. The publications listed below form a part of this specification to the extent referenced. The publications are referred in the text by the basic designation only. Where conflicts occur these specifications and the VHA standard will govern.

B. American Association of State Highway and Transportation Officials (AASHTO):

M300-03-UL-2007 ..... Standard Specification for Inorganic Zinc-Rich Primer

M273-11-UL-2011 ..... Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 Feet of Cover Subjected to Highway Loadings

C. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):

90.1-2013 ..... Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings

D. American Society of Mechanical Engineers (ASME):

B1.20.1-2013..... Pipe Threads, General Purpose (Inch)

B16.5-2013..... Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

B16.9-2012..... Factory-Made Wrought Buttwelding Fittings

B16.11-2011..... Forged Fittings, Socket-Welding and Threaded

B16.21-2011..... Nonmetallic Flat Gaskets for Pipe Flanges

B18.2.1-2012..... Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

B31.1-2014..... Power Piping

B31.9-2014..... Building Services Piping

B40.100-2013..... Pressure Gauges and Gauge Attachments

ASME Boiler and Pressure Vessel Code -

BPVC Section VIII-1-2015 ..... Rules for Construction of Pressure Vessels, Division 1

BPVC Section IX-2015..... Welding, Brazing, and Fusing Qualifications

E. American Society for Testing and Materials (ASTM):

A36/A36M-2014 ..... Standard Specification for Carbon Structural Steel

A53/A53M-2012 ..... Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless

A105/A105M-2014 ..... Standard Specification for Carbon Steel Forgings for Piping Applications

A106/A106M-2015 ..... Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service

A126-2004 (R2014)..... Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings

A139/A139M-2016 ..... Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

A193/A193M-2016 ..... Standard Specification for Alloy-Steel and Stainless-Steel Bolting for High Temperature or High-Pressure Service and Other Special Purpose Applications

A194/A194M-2015a ..... Standard Specification for Carbon Steel, Alloy Steel, and Stainless-Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both

A234/A234M-2015 ..... Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service

A240/A240M-2015b ..... Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications

A733-2015..... Standard Specification for Welded and Seamless Carbon Steel and Austenitic Stainless-Steel Pipe Nipples

B61-2015..... Standard Specification for Steam or Valve Bronze Castings

C177-2013 ..... Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus

C411-05 ..... Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation

C552-07 ..... Cellular Glass Thermal Insulation

C655-2015 ..... Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe

C920-2014a ..... Standard Specification for Elastomeric Joint Sealants

C1728-2013 ..... Standard Specification for Flexible Aerogel Insulation

E84-2015b.....Standard Test Method for Surface Burning Characteristics of Building Materials

F. American Welding Society (AWS):

B2.1/B2.1M-2014 .....Specification for Welding Procedure and Performance Qualification

D10.12M/D10.12-2000.....Guide for Welding Mild Steel Pipe

Z49.1-2012.....Safety in Welding and Cutting and Allied Processes

G. Federal Specifications (Fed. Spec.):

A-A-60005-2015.....Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole

L-S-125-1987 .....Screening, Insect, Nonmetallic

H. Manufacturer's Standardization Society (MSS):

MSS SP-58-2009 .....Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application and Installation

I. Military Specifications (Mil. Spec.):

MIL-S-901-1989 .....Shock Tests H.I. (High Impact) Shipboard Machinery, Equipment and Systems, Requirements for

J. NACE International (NACE):

SP0169-2013 .....Control of External Corrosion on Underground or Submerged Metallic Piping Systems

K. National Fire Protection Association (NFPA):

255-2006. .....Standard Method of Test of Surface Burning Characteristics of Building Materials

L. Society for Protective Coatings (SSPC):

SP-2-2004 .....Hand Tool Cleaning

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 63 00, STEAM ENERGY DISTRIBUTION", with applicable paragraph identification.

C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements and will fit the space available.

D. If equipment is submitted which differs in arrangement from that shown, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract.

E. Prior to submitting shop drawings for approval, contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.

F. Installing Contractor shall provide lists of previous installations for selected items of equipment. Contact persons who will serve as references, with telephone numbers and e-mail addresses shall be submitted with the references. COMMON WORK RESULTS FOR PLUMBING", with applicable paragraph identification.

G. Manufacturers' Literature and Data including: Full item description and optional features and accessories of the complete system including, but not limited to, dimensions, weights, materials, applications, standard compliance, model numbers, size and capacity. Submit as one package for pipes, fittings and appurtenances, including jointing materials, insulation, hangars, expansion and power set fasteners, and other miscellaneous items.

H. Submittals and shop drawings for interdependent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.

I. Coordination/Shop Drawings:
   1. Submit complete consolidated and coordinated shop drawings for all new systems, and for existing systems that are in the same areas.
   2. The coordination/shop drawings shall include plan views, elevations and sections of all systems and shall be on a scale of not less than 1:32 (3/8 inch equal to one foot). Clearly identify and dimension the proposed locations of the principal items of equipment. The drawings shall clearly show the proposed locations and adequate clearance for all equipment, controls, piping, pumps, valves and other items. All equipment requiring service shall be provided with an access door sized for the complete removal of device, component, or servicing of the equipment. Access for service and access for removal of components may be separate as necessary. Provide detailed coordination/shop drawings and loading calculations for all piping systems. The drawings should include all lockout/tagout points for all energy/hazard sources for each piece of equipment. Coordinate lockout/tagout procedures and practices with local VA requirements.
   3. Do not install equipment foundations, equipment or piping until coordination/shop drawings have been approved.

J. 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.

K. Completed System Readiness Checklist provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 33 08 00, COMMISSIONING OF SITE UTILITY SYSTEMS. This shall include pressure testing and cleaning of piping systems.

1.5 QUALITY ASSURANCE

A. Products Criteria:
1. Standard Products: Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture, supply and servicing of the specified products for at least 5 years. However, digital electronics devices, software and systems such as controls and instruments, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least 5 years.
2. All items furnished shall be free from defects that would adversely affect the performance, maintainability and appearance of individual components and overall assembly.
3. The products and execution of work specified in Division 33 shall conform to the referenced codes and standards as required by the specifications. Local codes and amendments shall be enforced, along with requirements of local utility companies. The most stringent requirements of these specifications, local codes, or utility company requirements shall always apply. Any conflicts shall be brought to the attention of the COR.
4. 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.
5. Assembled Units: Manufacturers of equipment assemblies, which use components made by others, assume complete responsibility for the final assembled product.
6. 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 cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.
7. Asbestos products or equipment or materials containing asbestos shall not be used.

B. Contractor shall restore damaged items to as-new operating condition or replace damaged items as directed by the COR, at no additional cost or time to the Government.

C. Welding Qualifications: Before any welding is performed, contractor shall submit a certificate certifying that welders comply with the following requirements:
1. Qualify welding processes and operators for piping according to ASME BPVC Section IX, AWS Z49.1 and AWS B2.1/B2.1M.

2. Comply with provisions in ASME B31.9.
3. Certify that each welder and welding operator has passed AWS qualification tests for welding processes involved and that certification is current and recent. Submit documentation to the COR.
4. All welds shall be stamped according to the provisions of the American Welding Society.

D. ASME Compliance: Comply with ASME B31.9 for materials, products, and installation. Safety valves and pressure vessels shall bear appropriate ASME labels.

1.6 DELIVERY, STORAGE AND HANDLING

A. Equipment and material placed on the job site shall remain in the custody of the Contractor until phased acceptance, whether or not the Government has reimbursed the Contractor for the equipment and material. The Contractor is solely responsible for the protection of equipment and material against damage or theft.

B. Protect piping systems against the entry of water, mud or other foreign substances by installing watertight covers on open ends at all times. Both inside and outside shall be cleaned before painting or placing equipment in operation. Protect direct-buried system coatings from ultraviolet light (sunlight). Existing equipment worked on by the Contractor or in the Contractor's working area shall be considered to be in the custody and responsibility of the Contractor and shall be protected as required for new work.

C. Damaged equipment shall be replaced with an identical unit as determined and directed by the COR. All insulated piping systems exposed to water must be replaced prior to installation at no additional cost or time to the Government.

1.7 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, VA approved substitutions and construction revisions shall be in electronic version on CD or DVD 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. 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. Provide record drawings as follows:
   1. As-built drawings are to be provided, with a copy of them on AutoCAD version 2011 provided on CD or DVD. The CAD drawings shall use multiple line layers with a separate individual layer for each system.
D. The as-built drawings shall indicate the location and type of all lockout/tagout points for all energy sources for all equipment and pumps to include breaker location and numbers, valve tag numbers, etc. Coordinate lockout/tagout procedures and practices with local VA requirements.
E. Certification documentation shall be provided to COR 21 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 provide documentation/certification that all results of tests were within limits specified. Test results shall contain written sequence of test procedure with written test results annotated at each step along with the expected outcome or setpoint. The results shall include all readings, including but not limited to data on device (make, model and performance characteristics), normal pressures, switch ranges, trip points, amp readings, and calibration data to include equipment serial numbers or individual identifications, etc.

1.8 COORDINATION

A. Coordinate exterior steam lines and associated systems and connections to building services up to the actual extent of building wall.

1.9 UTILITY LOCATION SERVICES

A. Prior to any demolition or excavation, provide for utility location services to mark on the ground with fluorescent paint the location of existing underground utilities, and their identification. The term "utility(ies)" includes both public utilities and VA-owned utilities, for all underground services.

PART 2 - PRODUCTS

2.1 STEEL PIPES AND FITTINGS

A. Steel Pipe: ASTM A53/A53M, Type E, Grade A, black with plain ends.
B. Forged Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.
C. Steel Welding Fittings: ASME B16.9/ASTM A234/A234M, seamless or welded.

1. Welding Filler Metals shall comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Nipples: ASTM A733, Standard Weight, seamless, carbon-steel pipe.

E. Pipe-Flange Gasket Materials: ASME B16.21, suitable for chemical and thermal conditions of piping system contents, nonmetallic, flat, asbestos free, 3.2 mm (1/8 inch) maximum thickness unless thickness or specific material is indicated.
   1. For flat-face, Class 125 flanges.
   2. For raised-face, Class 250 steel flanges.

F. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.2 PRE-ENGINEERED, FACTORY-FABRICATED, DIRECT-BUIRED, DRAINABLE-DRYABLE-TESTABLE (DDT) SYSTEMS

A. Complete factory-fabricated steam and condensate piping system with carrier pipes, carrier pipe insulation with jackets and banding, air space, 6 mm (1/4 inch) thick steel casing, fusion-bonded epoxy casing coatings, cathodic protection, accessories. Do not locate condensate pipes in casings that contain steam pipes.

B. All components of system shall be suitable for carrier pipe pressures and temperatures as follows:
   1. Steam System: 1035 kPa (150 psig); 185 degrees C (366 degrees F).
   2. Condensate System: 345 kPa (50 psig); 154 degrees C (310 degrees F).

C. Steam Carrier Pipes and Condensate Carrier Pipes: No piping joints are allowed in factory-fabricated straight sections of pre-engineered direct-buried systems.

D. Carrier Pipe Insulation:
   1. Conform to minimum thickness and type of insulation listed in Tables 1 and 2 below as required for service temperature in carrier pipe as listed below.

   2. Section A: Steam temperature is 338 degrees F, steam pressure is 100 psig. Pumped condensate temperature is 93 degrees C (200 degrees F). Drip return temperature is 100 degrees C (212 degrees F).
   3. Allowable Carrier Pipe Insulation Type and Minimum Insulation Thickness:

TABLE 1
Minimum Pipe Insulation Thickness mm (inches)
For Steam 110 to 2800 kPa (16 to 406 psig) gauge

Nominal Pipe Diameter mm (inches)	Pre-Formed Mineral Wool	Calcium Silicate
25 (1)	65 (2-1/2)	100 (4)
40 (1-1/2)	65 (2-1/2)	100 (4)

50 (2)	90 (3-1/2)	115 (4-1/2)
65 (2-1/2)	90 (3-1/2)	115 (4-1/2)
75 (3)	100 (4)	125 (5)
100 (4)	100 (4)	125 (5)
125 (5)	100 (4)	125 (5)
150 (6)	115 (4-1/2)	140 (5-1/2)
200 (8)	115 (4-1/2)	140 (5-1/2)
250 (10)	125 (5)	150 (6)
300 (12)	125 (5)	150 (6)
355 (14)	125 (5)	150 (6)
406 (16)	125 (5)	150 (6)
457 (18)	125 (5)	150 (6)

Notes:

1. Submittals shall include manufacturer's certification that all insulation have passed the 96-hour boiling water test.
2. Pipes smaller than 25 mm (1 inch) shall have same insulation thickness as required for 25 mm (1 inch) pipe.

TABLE 2
Minimum Pipe Insulation Thickness mm (inches)
For Steam Less than 110 kPa (16 psig) gauge,
Condensate Return

Nominal Pipe Diameter mm (inches)	Pre-Formed Mineral Wool	Calcium Silicate
25 (1)	50 (2)	75 (3)
40 (1-1/2)	50 (2)	75 (3)
50 (2)	50 (2)	75 (3)
65 (2-1/2)	50 (2)	75 (3)
75 (3)	65 (2-1/2)	90 (3-1/2)
100 (4)	65 (2-1/2)	90 (3-1/2)
125 (5)	65 (2-1/2)	90 (3-1/2)
150 (6)	75 (3)	115 (4-1/2)
200 (8)	75 (3)	115 (4-1/2)
250 (10)	100 (4)	125 (5)
300 (12)	100 (4)	125 (5)

355 (14)	100 (4)	125 (5)
406 (16)	100 (4)	125 (5)
457 (18)	100 (4)	125 (5)

Notes:

1. Submittals shall include manufacturer's certification that all insulation have passed the 96-hour boiling water test which indicates that satisfactory performance in underground service can be expected.
2. Pipes smaller than 25 mm (1 inch) shall have the same insulation thickness as required for 25 mm (1 inch) pipe.

E. Insulation Banding and Jacket: 304 stainless steel bands and clips, at least 13 mm (1/2 inches) wide, maximum spacing 457 mm (18 inches). A minimum of two bands is required for each 1200 mm (4 foot) section of insulation.

F. Vinyl-coated Fiberglass Scrim Jacket: Fed. Spec. L-S-125, Type II, Class 2, with 18 x 16 mesh (number of filaments per inch) and made of 0.335 mm (0.013 inch) diameter vinyl-coated fibrous glass yarn. Install bands over the jacket to secure the insulation to the carrier pipe.

G. Casing: ASTM A139/A139M, smooth-wall steel, electric resistance welded. Plastic casings are prohibited. Use eccentric connectors as necessary between casing sections to provide continuous gravity drainage in bottom of casing between manholes and between manholes and buildings.

Casing Diameter mm (inches)	**Minimum Thickness mm (inches)**
150 - 1170 (6 – 46)	6.35 (0.250)

H. Casing End Seal Plates with Vents and Drains: ASTM A36/A36M, steel, minimum thickness 10 mm (3/8 inch) for casings up through 300 mm (12 inches) diameter and 13 mm (1/2 inch) for casings over 300 mm (12 inches) diameter. Provide 25 mm (1 inch) drain at the bottom and vent at the top. Construct with threaded steel half couplings. Install threaded brass plugs in drains.

I. Vent Riser Pipes: ASTM A53/A53M, Schedule 40, galvanized, extending through top of manhole and terminate 300 mm (12 inches) above grade with 180-degree bend. Provide stainless steel insect screen at pipe opening.

J. Gland seals are prohibited because of the possibility of water entering the system through the gland seal from a flooded manhole.

K. Provide continuous 25 mm (1 inch) minimum air space between carrier pipe insulation and casing.

L. Casing coating shall be dual layers of fusion-bonded epoxy, inner green-colored layer minimum thickness 0.5 mm (0.020 inch), outer black-colored layer minimum thickness 0.25 mm (0.010

inch). Rated by coating manufacturer for continuous service for at least 25 years at minimum temperature of 110 degrees C (230 degrees F) and having a coefficient of expansion similar to that of steel. Coating shall be applied in accordance to recommendations of coating manufacturer including surface preparation. Factory-inspect for holidays and make repairs as necessary.

M. Coating of end plates and casing sections extending in manholes shall be zinc-rich coating that conforms to AASHTO M300-03-UL, Type IA except that volatile organic compounds shall not exceed 0.34 kg per liter (2.8 pounds per gallon). The zinc rich coating shall be applied in accordance with the recommendations of the coating manufacturer including surface preparation. No additional top coat shall be applied.

N. Carrier pipe guides and supports shall be maximum spacing 3000 mm (10 feet) on centers, no greater than 1500 mm (5 feet) from pipe ends, minimum of three guides per elbow section. Designed to permit thermal expansion without damage, provide proper pipe guiding and support, and to allow horizontal movement in two directions as necessary at expansion loops and bends. Design of guides and supports must permit continuous drainage of water in bottom of casing. Pipe insulation shall extend through the pipe guides and supports and be protected by steel sleeves. Design of guides and supports shall be such that no metal-to-metal contact exists between the casing and the carrier pipe. Insulation or non-metallic material used to ensure no metal to metal contact shall be designed to not be compressed by the weight of the carrier pipe when full of water.

O. Anchor plates shall be ASTM A36/A36M steel, welded to carrier pipe and casing, 15 mm (1/2 inch) minimum thickness, passages for air flow and water drainage through the annular air space in the system. Coated with same coating material as the casing. Locate 900 to 1500 mm (3 to 5 feet) from piping entrance to manhole or building wall. Walls of manholes and buildings cannot be utilized as anchor points.

P. Field connection of casing sections shall be steel section conforming to casing specification, welded to casing sections, coated on all surfaces with system manufacturer's coating field repair compound, and covered with a 1.3 mm (0.05 inch) minimum thickness polyethylene shrink sleeve designed for a service temperature exceeding 80 degrees C (176 degrees F).

Q. Manhole and building wall penetrations shall provide steel leak plates welded to wall sleeves or to casings. Where a wall sleeve is utilized, allow sufficient annular space between the sleeve and the casing and install a watertight seal, rated for 121 degrees C (250 degrees F) minimum. Manhole and building walls cannot be used as anchor points.

R. Provide sacrificial anode type cathodic protection system with dielectric isolation devices and test stations for all systems. Design system for 25 years of service, assume two percent bare metal. System shall comply with NACE SP0169.

S. Provide embossed brass or stainless-steel tag hung by a brass or stainless-steel chain at each end of each casing or insulated piping in the manholes and buildings. The tag shall identify system manufacturer's name, date of installation, government contract, and manufacturer's project number.

T. All branch piping connections must be located in manholes.

U. Ensure the DDT manufacturer is responsible for the complete design of the DDT system, including, but not limited to, the product to be supplied, fabrication, installation, supervision, and testing of the system within the design parameters established by the contract documents, and in compliance with the detailed design. The complete design of the system shall be sealed by a Professional Engineer in the employ of the DDT manufacturer.

V. Furnish thermal expansion calculations for the steam and condensate piping using the design characteristics indicated in this section and installation temperature no higher than the ambient temperature at the site: 45 degrees F).

W. DDT manufacturer shall submit a complete description of the design and assembly of the system, materials of construction and field installation instructions. Include sufficient system details to show that the specified minimum insulation thickness has been met. A detailed design layout of the system (plan and elevation views) showing size, type, elevations and location of each component to be used in the system, the design and location of anchors, pipe guides, pipe supports, expansion loops, Z-bends, L-bends, end seals, leak plates, joint locations, pipe and insulation thickness and sizes, types, and movements, connection to manhole and building wall penetrations, and including, if applicable, details of transition point to aboveground or other type systems. Detailed design layout drawings shall be stamped by a registered Professional Engineer.

X. Expansion Loops and Bends: Pipe-stress and system-expansion calculations for each expansion compensation elbow using a finite element computer generated 3-dimensional analysis (FEA). Demonstrate with calculations that pipe stresses from temperature changes are within the allowable requirements in ASME B31.1 and that the anchors and the guides will withstand the resultant forces. Detailed design layout drawings shall include all analysis node points. As a minimum, computer analysis results shall include node stresses, forces, moments and displacements. Calculations shall be stamped by a registered Professional Engineer in the employ of the DDT manufacturer.

Y. Reinforced Concrete Manholes: Not less than 200 mm (8 inches) thick. Pour monolithically where possible. Place waterproof membrane between mud slab and bottom concrete slab, and continue up sides to top of sidewalls. Joints between manhole walls and casings or concrete trench sections shall be watertight. Steel manholes or prefabricated concrete manholes are prohibited.

Z. Accessories for Manholes: Cast iron manhole frames and solid covers, not less than 711 mm (28 inches) clear openings. Unless otherwise shown on the drawings, frames and covers shall be as follows:
   1. For non-traffic applications:
      a. Fed. Spec. A-A-60005 NOT1, Frame Type IV, Size 28
      b. Fed. Spec. A-A-60005 NOT1, Cover Type E, Size 28, cast identification “STEAM”.
   2. For traffic applications:
      a. Fed. Spec. A-A-60005 NOT1, Frame Type I, Style A, Size 27A.
      b. Fed. Spec. A-A-60005 NOT1, Cover Type A, Size 27A, cast identification “STEAM”.
   3. Manhole steps shall be standard, cast iron.

AA. Manhole Ventilation: As indicated on Drawings. Construct ventilation ducts of galvanized steel sheet metal and in accordance with ASHRAE Handbook recommendations for low pressure ducts. Gravity ventilators shall be factory-fabricated of aluminum or galvanized steel and arranged as indicated on drawings. Ventilating pipes shall be standard weight black steel and installed as shown on drawings.

BB. Drainage as shown on drawings. Provide a 600 mm (24 inches) square by 600 mm (24 inches) deep sump pit in each manhole where indicated on drawings. Provide larger sump pit if necessary to accommodate required electric sump pumps.

CC. Electric Sump Pumps with Automatic Controls and High-Water Alarm:
   1. Type: High temperature submersible duplex pumps and automatic controls.
   2. Service: Continuous operation at required flows and pressures while completely submerged at 93 degrees C (200 degrees F). All pumps and pump controls shall have demonstrated 200,000 cycles of operation while totally submerged in 93 degrees C (200 degrees F) water.
   3. Capacity and Pressure: Pumps shall be capable of passing 10 mm (3/8 inch) spheres.
   4. Pumps: Epoxy-coated cast iron casing, cast iron impeller, stainless steel shaft, carbon/ceramic shaft seal, stainless steel hardware, permanently lubricated bearings, screened inlets. Schedule 80 discharge pipe protected from corrosion.
   5. Motors: Non-overloading at all points on the pump performance curve. Include overload protection.
   6. Controls: Automatic alternating lead-lag, with damp-proof electrical service. Mount non-submerged control components in a NEMA 4 enclosure on adjacent wall or dedicated galvanized steel support stand.
   7. High Water Alarm Switch: Set at level below lowest steam or condensate pipe in the manhole. Switch shall activate weatherproof red alarm light mounted above grade as shown. Provide contacts and coordinate with the owner to tie into the existing control system.

2.3 STEAM PIPING

A. Pipe: ASTM A106/A106M, Grade B, electric resistance welded, Schedule 80. Grade F, furnace butt-welded pipe is prohibited. Use Schedule 80 pipe and fittings for threaded joints.

B. Joints:
   1. In trenches: Butt-weld joints. Socket weld is required for pipe sizes 50 mm (2 inches) and less.
   2. In tunnels, manholes, and open areas: Butt weld pipe sizes 65 mm (2-1/2 inches) and greater; thread or socket weld pipe sized 50 mm (2 inches) and less. Use Schedule 80 pipe and fittings for threaded joints.

C. Fittings:
   1. Butt welded joints: ASTM A234/A234M or ASME B16.9, steel, Grade B, same schedule as adjoining pipe. All elbows shall be long radius unless otherwise indicated. Tees shall be full size or reducing as required, having interior surfaces smoothly contoured.
   2. Threaded joints: ASME B16.11, forged steel fittings, Class 2000. Use Schedule 80 pipe only.
   3. Socket welded joints: ASME B16.11, forged steel, 13,800 kPa (2000 psig) class.

D. Flanges and Bolts: ASTM A105/A105M, pressure class 1035 kPa (150 psig). Bolts shall be high strength ASTM A193/A193M, Class 2, Grade B7. Nuts shall be ASTM A194/A194M.

E. Unions: Pipe 50 mm (2 inches) and less shall be threaded, steel, 2050 kPa (297 psig) class.

2.4 STEAM CONDENSATE PIPING

A. Pipe: ASTM A53/A53M, seamless, Grade B, Schedule 80. Grade F, furnace butt-welded pipe is prohibited. Use Schedule 80 pipe and fittings for threaded joints.

B. Joints:
   1. In trenches: Butt weld joints. Socket weld is required for pipe sizes 50 mm (2 inches) and less.
   2. In tunnels, manholes, and open areas: Butt weld pipe sizes 65 mm (2-1/2 inches) and greater. For system pressures of 103 kPa (15 psi) or less, thread or socket weld pipe sizes 50 mm (2 inches) and less. For system pressures of 103 kPa (15 psi) and no greater than 700 kPa (100 psig), socket weld pipe sizes 25 mm (1 inch) and greater, and thread pipe sizes less than 25 mm (1 inch). For higher system pressure, socket weld pipe sizes of 50 mm (2 inches) or less.

C. Fittings:
   1. Welded joints: ASTM A234/A234M, steel, Grade B, or ASME B16.9, same schedule as adjoining pipe.
   2. Threaded joints: ASME B16.11, forged steel fittings, Class 2000. Use Schedule 80 pipe and fittings only.
   3. Socket welded joints: ASME B16.11, forged steel, 13,800 kPa (2000 psig) class.

D. Unions (Except in Trenches): Pipe 50 mm (2 inches) and less, 2050 kPa (297 psig) steel.
E. Flanges: Weld neck ASME B16.5 or ASTM A105/A105M, forged steel, 1035 kPa (150 psig).

2.5 EXPANSION LOOPS AND BENDS

A. Stresses: Less than the maximum allowable stress in accordance with ASME B31.1. Submit shop drawings and stress and anchor force calculations for all loops and bends. Show locations of all anchors, guides and supports. Base calculations on 1035 kPa (150 psig) and 185 degrees C (366 degrees F) for steam line loops and bends and 345 kPa (50 psig) and 154 degrees C (310 degrees F) for condensate return line loops and bends. Base calculations on actual pressures and temperatures if they are higher than those listed above. Stress analysis shall cover all conditions under which the system can conceivably experience during its lifetime.
B. Steam systems 103 kPa (15 psig) and less: ASME B31.9, base calculations for steam and condensate on 103 kPa (15 psig) and 121 degrees C (250 degrees F).

2.6 EXPANSION JOINTS

A. Provide factory-built or field-fabricated guides located along the pipelines to restrain lateral pipe motion and direct the axial pipe movement into the expansion joints.
B. Minimum Service Requirements:
    1. Pressure containment:
        a. Steam service 35 to 200 kPa (5 to 29 psig): Rated 345 kPa (50 psig) at 148 degrees C (298 degrees F).
        b. Steam service 214 to 850 kPa (31 to 123 psig): Rated 1035 kPa (150 psig) at 186 degrees C (366 degrees F).
        c. Steam service 869 to 1035 kPa (126 to 150 psig): Rated 1380 kPa (200 psig) at 194 degrees C (381 degrees F).
        d. Condensate service: Rated 690 kPa (100 psig) at 154 degrees C (309 degrees F).
    2. Number of full reverse cycles without failure: Minimum 1000.
    3. Movement: Allowed as recommended safety factor of the manufacturer.
C. Internally pressurized bellows shall have:
    1. ASTM A240/A240M, multiple corrugations, Type 304 or 321 stainless steel.
    2. Internal stainless-steel sleeve running the entire length of bellows.
    3. External steel equalizing rings for services exceeding 345 kPa (50 psig).
    4. Welded ends, flanged ends for 50 mm (2 inches) and greater pipes.
    5. External tie rods: Design to withstand pressure thrust force upon anchor failure if one or both anchors for the joint are at change in direction of pipeline and integral external cover.
D. Externally pressurized bellows shall have:
    1. ASTM A240/A240M, multiple corrugations, Type 304 stainless steel.

2. Internal and external guides integral with joint.
3. Design for external pressurization of bellows to eliminate squirm.
4. Welded ends, flanged ends for 50 mm (2 inches) and greater pipes.
5. Include threaded connection at bottom, 25 mm (1 inch) minimum, for drain or drip point and integral external cover and internal sleeve.

E. Slip type joints shall include:
1. Steel construction, except guides.
2. Base with integral anchor.
3. Internally and externally guided steel slip, chrome plated to reduce corrosion, ground to reduce friction.
4. Guides shall be non-ferrous, non-corroding, low friction, designed to prevent scoring or binding of the slip.
5. Welded ends, flanged ends for 50 mm (2 inches) and greater pipes.
6. Limit stop to prevent slip disengagement if pipe anchor fails.
7. Semi plastic, self-lubricating, injectable packing contained between sealing rings.
8. Injection devices to allow addition of packing under full line pressure. Provide one-year supply of packing.
9. Threaded connection at bottom, 25 mm (1 inch) minimum, for drain or drip point.

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F. Nameplate: Stamped brass or stainless-steel nameplate indicating on each expansion joint the manufacturer, the allowable movement, flow direction, design pressure and temperature, date of manufacture, and identifying the expansion joint by the identification number on the contract drawings.

G. Guides: Provide factory-built guides along the pipeline to permit axial movement only and to restrain lateral and angular movement. Guides must be designed to withstand the axial and lateral forces determined by stress analyses and water hammer calculations. Field-built guides may be used if detailed on the contract drawings. Optimum guide locations must conform to recommendations of expansion joint manufacturer and shall be determined through results of the stress analyses.

2.7 BALL JOINTS

A. Factory built devices, inserted in pipe line offsets in groups of two or three as shown to absorb cyclical pipe movement which results from thermal expansion and contraction.

B. Minimum service requirements shall be rated 1725 kPa (250 psig), 232 degrees C (450 degrees F), continuous on steam and condensate.

C. Submit independent certification that similar units have passed the following tests with no leaks.

1. Low Pressure Leakage Test: Minimum 41 kPa (6 psig) saturated steam for 60 days.
2. Life Cycle Flex Test: Minimum 8000 flex cycles at 1725 kPa (250 psig) saturated steam.
3. Thermal Cycling Test: Minimum 100 cycles from atmospheric pressure to operating pressure and back to atmospheric pressure with saturated steam.
4. Environmental Shock Test: MIL-S-901.
5. Vibration Test: Test for 170 hours on each of three mutually perpendicular axes at 25 to 125 Hz; 1 to 2 mm (0.04 to 0.08 inch) double amplitude on a single ball joint and on a three-ball joint offset.

D. Joints:
1. ASME B31.1, forged carbon steel with welded ends. Standard weight pipe wall thickness.
2. Minimum angular movement capability: 15 degrees and 360 degrees rotational movement.
3. Gaskets: Non-asbestos.
4. Packing injection devices, if provided: Allow injection under full line pressure. Provide one-year supply of packing.

2.8 VALVES

A. Gate Valves (ASTM A126):
1. Type 101:
   a. Type applies to steam valves with sizes 65 mm (2-1/2 inches) and greater.
   b. Steel body, rated 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chromium stainless steel flexible wedge and hard faced (stellite) or nickel copper alloy seats, 1035 kPa (150 psig) flanged ends, OS&Y, rising stem, bolted bonnet.
   c. Factory installed globe valved bypass on all steam valves greater than 75 mm (3 inches).
   d. Drill and tap bosses for connection of drains where shown.
2. Type 102 is not used.
3. Type 103:
   a. Type applies to condensate valves with sizes 65 mm (2-1/2 inches) and greater.
   b. Forged steel body, Class B, rated for 850 kPa (123 psig) saturated steam, 1380 kPa (200 psig) WOG, bronze or bronze face wedge and seats, 850 kPa (123 psig) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
4. Type 104:
   a. Type applies to condensate valves with sizes 50 mm (2 inches) and less.
   b. Forged steel body, rated for 1380 kPa (200 psig) saturated steam, 2758 kPa (400 psig) WOG, bronze wedges and Monel or stainless-steel seats, threaded ends, rising stem, union bonnet.
5. Type 105 is not used.

6. Type 106:
    a. Type applies to steam valves with sizes 50 mm (2 inches) and less.
    b. Forged steel body, rated for 2070 kPa (300 psig) at 216 degrees C (420 degrees F) minimum Class 4138 kPa (600 psig) or Class 5515 kPa (800 psig), hardened stainless steel or satellite wedge and seats, threaded ends, OS&Y, rising stem, bolted bonnet.

B. Globe Valves (ASTM A126):
1. Type 201:
    a. Type applies to steam valves with sizes 65 mm (2-1/2 inches) and greater.
    b. Carbon steel body, rated 1035 kPa (150 psig) at 260 degrees C (500 degrees F), 11-1/2 to 13 percent chromium stainless steel or stellite disc and seat, 1035 kPa (150 psig) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings. Drill and tap bosses for connection of drains.
2. Type 202 is not used.
3. Type 203:
    a. Type applies to condensate valves with sizes 65 mm (2-1/2 inches) and greater.
    b. Steel body, rated for 850 kPa (123 psig) saturated steam, 1380 kPa (200 psig) WOG, bronze or bronze-faced disc (Teflon or composition facing permitted) and seat, 850 kPa (123 psig) ASME flanged ends, OS&Y, rising stem, bolted bonnet, renewable seat rings.
4. Type 204:
    a. Type applies to steam valves and condensate valves with sizes 50 mm (2 inches) and less.
    b. ASTM B61, Forged steel body, rated for 1380 kPa (200 psig) saturated steam, 2758 kPa (400 psig) WOG, hardened stainless steel disc and seat, threaded ends, rising stem, union bonnet, renewable seat rings.

C. Check Valves (ASTM A126):
1. Type 401:
    a. Type applies to steam valves with sizes 65 mm (2-1/2 inches) and greater.
    b. Steel body, swing-type, rated for 1035 kPa (150 psig) at 260 degrees C (500 degrees F), stainless steel or stainless steel - faced disc and seat, 1035 kPa (150 psig) ASME flanged ends, bolted cover, renewable disc.
2. Type 402 is not used.
3. Type 403:
    a. Type applies to condensate valves with sizes 65 mm (2-1/2 inches) and greater.
    b. Forged Steel body, Class B, swing-type, rated for 850 kPa (123 psig) saturated steam, 1380 kPa (200 psig) WOG, bronze or bronze-faced disc and seat, 850 kPa (123 psig) ASME flanged ends, bolted cover, renewable disc and seat.

4. Type 404:
    a. Type applies to steam valves and condensate valves with sizes 50 mm (2 inches) and less.
    b. Forged Steel body, swing-type, rated for 1380 kPa (200 psig) saturated steam, 2758 kPa (400 psig) WOG, bronze disc, threaded ends, regrinding disc.

D. Ball Valves (ASTM A126).
1. Type 501 is not used.
2. Type 502:
    a. Type applies to steam valves and condensate valves with sizes 50 mm (2 inches) and less.
    b. Forged steel body, rated for 1035 kPa (150 psig) at 185 degrees C (365 degrees F), 1725 kPa (250 psig) at 121 degrees C (250 degrees F); reinforced TFE seat, stem seal and thrust washer; end entry, threaded ends, one-fourth turn to open.
3. Type 503 is not used.
4. Type 504:
    a. Type applies to steam valves and condensate valves with sizes 65 mm (2-1/2 inches) and greater.
    b. Carbon steel or ductile iron body, saturated steam service, rated for 1035 kPa (150 psig), stainless steel ball and stem, Polyfil seat, live-loaded stem seal, 1035 kPa (150 psig) ASME flanged ends.

2.9 STEAM TRAPS

A. Apply at steam line drip points.
B. Fixed orifice or Venturi type traps are prohibited.
C. Construct inverted bucket type with thermostatic vent in bucket, except closed-float-thermostatic on discharge side of pressure reducing stations. Each type furnished by a single manufacturer. Select the traps for pressures and capacities as shown or required.
D. Traps: Stainless steelbodies. Construction shall permit ease of removal and servicing working parts without disturbing connecting piping. Include stainless steel floats, hardened chrome steel valves, stainless steel mechanisms and bi-metallic air vent on inverted bucket traps.

E. Provide electronic trap performance monitoring devices that are compatible with the existing monitoring system. Trap malfunctions shall be automatically transmitted to and properly interpreted by the existing monitoring system. Provide all necessary power sources, transmitting and retransmitting devices and batteries to achieve a properly operating system. Coordinate with owner to incorporate new traps into the existing trap monitoring system.

F. All traps shall include ports for future installation of monitoring devices. To facilitate future removal of plugs, remove plugs, install Teflon tape on the threads, and reinstall the plugs.
G. Label each trap at the factory with an identification number keyed to the contract drawings. Label shall be a metal tag permanently attached to the trap.

2.10 STRAINERS, Y TYPE

A. Provide as shown on steam and condensate piping systems.
B. Include open end removable cylindrical screen and threaded blow off connection.
C. For steam service up to 1035 kPa (150 psig) and at drip traps, strainer shall be rated for minimum 1035 kPa (150 psig) saturated steam; rated for 1035 kPa (150 psig), flanged ends, steel, for pipe sizes greater than 50 mm (2 inches). Use forged steel, rated for 1725 kPa (250 psig) saturated steam, threaded ends, for pipe sizes 50 mm (2 inches) and less.
D. For condensate service, strainer shall be rated for 850 kPa (123 psig) saturated steam, 1200 kPa (175 psig) WOG. Provide steel, flanged ends, for pipe sizes greater than 50 mm (2 inches). Provide forged steel, threaded ends, for pipe sizes 50 mm (2 inches) and less.
E. Strainer screen shall be stainless steel, with a free area not less than 2-1/2 times flow area of pipe. Diameter of openings shall be 1.3 mm (0.05 inch) or less on steam service and 1.5 mm (0.06 inch) or less on water service.
F. Include gate type valve and quick couple hose connection on all blowoff connections.

2.11 SAFETY VALVES AND VENT CONNECTORS

A. Safety Valves: Conform to the requirements of ASME BPVC Section VIII, Unfired Pressure Vessels) and be approved by the National Board of Boiler and Pressure Vessel Inspectors.
B. Relieving Capacity: Not less than that shown on the drawings with a pressure rise above set pressure not to exceed 10 percent of set pressure.

2.12 PRESSURE GAUGES

A. Provide gauges immediately downstream of each steam line isolation valve, before and after each steam pressure reducing station and where shown on the drawings.
B. Gauges: ASME B40.100.
    1. Solid armored front between measuring element and dial, blowout back, bottom connection, phenol turret type.
    2. Non-corrosive, 115 mm (4-1/2 inches) diameter face with black markings on white background.
    3. Bourdon tube measuring element designed for service. Provide bellows for pressure ranges less than 103 kPa (15 psig).
    4. Stainless steel, rotary movement.
    5. Micrometer adjustable, black color pointer.
    6. Plastic window.

7. Provide liquid filled gauges at outlet of all pumps.
8. Factory calibrated and certified.

C. Accuracy: Grade 2A, 1/2 percent, on all gauges; except Grade A, one percent permitted on diaphragm actuated gauges, liquid filled gauges, and compound gauges.

D. Include:
1. Red set hands on gauges located at automatic pressure regulator valve outlets.
2. Needle valve or gauge cock rated for the service.
3. Syphon on all steam gauges.
4. Overload stop on all pressure gauges

E. Pressure gauge ranges shall be selected such that the normal operating pressure for each gauge is displayed near the midpoint of each gauge's range. Gauges with ranges selected such that the normal pressure is displayed at less than 30 percent or more than 70 percent of the gauge's range are prohibited. The units of pressure shall be psig.

2.13 THERMOMETERS, PIPE OR TANK MOUNTED

A. Thermometer locations are shown on the drawings.

B. Thermometers:
1. Industrial type, separable well and socket.
2. Red reading mercury combination Celsius/Fahrenheit scale, 225 mm (9 inches) long.
3. Stainless steel corrosion resistant case with safety glass front.
4. Adjustable angle for ease of viewing.
5. Wells sized to suit pipe diameter without restricting flow, or provide oversized pipe at well location. Snug sliding fit between socket and well. Well should be 316 stainless steel.
6. Accuracy shall be one percent of scale range.
7. 0 to 149 degrees C (32 to 300 degrees F).
8. Factory calibrated and certified.

2.14 PIPE HANGERS AND SUPPORTS

Requirements: MSS SP-58 and ASME B31.1.

A. Applies to all piping not in factory-fabricated direct-buried system. All systems shall be completely supported. Arrange supports so that all loads due to weight, thermal expansion, seismic shock (if applicable), and pressure are transferred from the support system to the structure. The design and location of supports shall at all times prevent excessive forces, moments, and stresses from being imposed on the equipment, structure, supported system, and supports. Heated systems generally require resilient or roller/slide supports.

B. Manufacturer Certification: Factory built products of a manufacturer whose principle business is pipe supports for 10 years. All components must have published load ratings. For concrete trenches, non-factory built products that comply with details may be utilized.

C. Components:
   1. Roller supports: MSS SP-58, Type 41. Provide vertical adjustment for Type 41 with threaded studs and nuts adjacent to the roller.
   2. Variable spring support assembly: MSS SP-58, Type 51 variable spring. Locate Type 51 variable spring within 300 mm (1 foot) above pipe attachment. Attach rod to top of variable spring with Type 14 clevis.
D. Spring Cushion Support Assembly: MSS SP-58.
   1. Double rod assembly: Type 41 and 49.
   2. Single rod assembly: Type 48 spring cushion. Locate spring cushion within 300 mm (1 foot) above pipe attachment.
E. Clevis Supports: MSS SP-58, Type 1.
F. Wall Brackets: MSS SP-58, Type 31.
G. Pipe Stands: MSS SP-58, Type 38.
H. Riser Clamp: MSS SP-58, Type 42.
I. Alignment Guides: Welded steel as shown to restrain movement perpendicular to the long axis of the piping. If not welded, provide steel spider clamped to pipe, enclosed within steel sleeve that is welded to structural support. Must provide lateral force equal to minimum of 15 percent of anchor loading.
J. Trapeze Supports: MSS SP-58, may be used where pipes are close together and parallel, structural steel channels or angles. Bolt roller supports to steel to support piping subject to horizontal thermal expansion. Attach other piping with “U” bolts.
K. Pipe Covering Protection Saddles: MSS SP-58, Type 39. Provide at all support points on insulated pipe except where Type 3 pipe clamps are provided.
L. Sliding Supports: MSS SP-58, Type 35. Welded steel attachments to pipe and structure with Teflon or graphite sliding surfaces bonded to the attachments. Provide steel guides, except at expansion bends, to prevent lateral movement of the pipe.
M. Pipe Racks and Miscellaneous Supports: ASTM A36/A36M, structural steel shapes. Manufactured strut systems are acceptable if they have the required load carrying ability.
N. Supports, including all structural steel, in trenches and manholes: Hot-dip galvanized.

2.15 BURIED UTILITY WARNING TAPE

A. Tape: 0.1 mm (0.004 inch) thick, 150 mm (6 inches) wide, yellow polyethylene with a ferrous metallic core, acid and alkali-resistant and shall have a minimum strength of 12,000 kPa (1740 psig) lengthwise and 10,300 kPa (1500 psig) crosswise with an elongation factor of 350 percent. Provide bold black letters on the tape identifying the type of system. Tape color and lettering shall be unaffected by moisture and other substances contained in the backfill material.

PART 3 - EXECUTION

3.1 GENERAL

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

B. Connect new work to existing work in a neat and workmanlike manner. Where an existing structure must be cut or existing utilities interfere, such obstruction shall be bypassed, removed, replaced or relocated, patched and repaired. Piping connections shall be made only in manholes, tunnels or buildings.

C. Coordinate the location of all items of equipment and work of all trades. Maintain operability and maintainability of the equipment and systems. The contractor at his cost shall perform any relocation of equipment or systems to comply with the requirement of operability and maintainability.

D. Unless otherwise shown in the contract documents, steam lines shall be graded downward not less than 50 mm in 12 meters (2 inches in 40 feet) in direction of the flow. Provide eccentric reducing fittings on steam mains and branches, (except on vertical piping). Install said fittings to maintain continuity of grade in bottom of pipeline. Provide risers with drip pockets and steam traps on steam lines where space restrictions prevent continuous grading. All steam traps must be located in manholes or tunnels.

3.2 DEMOLITION

A. Perform work in accordance with requirements for phasing and the Drawings. Phasing shown on drawings is an outline from which the contractor will use to provide more details in executing the work in each phase.

B. If asbestos containing materials are suspected to be present in the demolished items not identified in the drawings to be part of the asbestos abatement, the contractor shall secure the area, remove their personnel and refer the matter to COR immediately for resolution. Refer to Section 02 82 11, TRADITIONAL ASBESTOS ABATEMENT.

C. Completely remove all pipe, valves, fittings, insulation, and all hangers including the connection to the structure and any fastenings.

D. Seal all openings in manhole or building walls after removal of piping.

E. All material and equipment removed shall become the property of the Contractor and shall be removed from Government property and shall not be stored in operating areas unless designated as being turned over to the owner.

F. All flame cutting shall be performed with facility burn permit in place and adequate fire protection facilities available as required by safety codes and COR.

3.3 PIPING INSTALLATION

A. Drawings indicate general location and arrangement of piping systems. For field installed insulation, install piping insulation as specified herein and/or as recommended by the manufacturer.
B. Remove all standing water in the bottom of trench.
C. Pipe Bedding: Minimum 150 mm (6 inch) layer of sand. Provide compaction and leveling of virgin soil prior to installing bedding.
D. Clearance: Minimum 150 mm (6 inches) clearance between the external insulation/casing of pipes 300 mm (12 inches) or smaller, and if no valves and fittings are present along the pipes. Otherwise provide the required service clearances between valves/fittings on adjacent pipes to allow future replacement. Obtain minimum service clearances from valve/fitting manufacturer.
E. Testing: Do not insulate piping or backfill piping trench until field quality-control and cleaning, followed by testing has been completed and results approved by COR.
F. Grade:
    1. Install condensate piping at uniform grade of 0.4 percent downward in direction of flow.
    2. Install steam piping at uniform grade of 0.2 percent downward in direction of flow or as indicated on the Drawings.
G. Drain Valves and Air Vents: For carrier piping, install at low points and air vents at high points.
H. Install components with pressure rating equal to or greater than system design pressure.
I. Install piping free of sags and bends.
J. Install fittings for changes in direction and branch connections.
K. On direct-buried pipes, secure anchors with concrete thrust blocks.

3.4 DRAIN VALVES AND VENT VALVES

A. Provide 40 mm (1-1/2 inch) minimum pipe size drain valves on condensate return carrier pipes at all low points in manholes. Provide 25 mm (1 inch) minimum manual air vent valves in manholes at all high points in condensate return carrier piping.
B. Do not install any valves at the outer casing piping vents.

3.5 PIPE SUPPORT INSTALLATION (IN TRENCHES, TUNNELS, MANHOLES)

A. Coordinate support locations prior to erection of piping. Hanger parts must be marked at the factory with a numbering system keyed to hanger layout drawings. Layout drawings must be available at the site during construction.
B. Upper Attachments to Structure:
    1. New reinforced concrete construction shall have concrete inserts.
    2. For existing reinforced concrete construction, upper attachment shall be welded or clamped to steel clip angles that are expansion bolted to the concrete. Expansion bolting shall be located so that bolts are shear loaded.

3. For steel deck and structural framing, upper attachments shall be welded or clamped to structural steel members.

C. In existing concrete construction, expansion fasteners may be used for hanger loads up to one third the manufacturer's rated strength of the expansion fastener. Power set fasteners may be used for loads up to one fourth of rated load. When greater hanger loads are encountered, additional fasteners may be used and interconnected with steel members combining to support the hanger.

D. Special Supports:
1. Secure horizontal pipes where necessary to prevent vibration or excess sway.
2. Where hangers cannot be adequately secured as specified, make special provisions for hanging and supporting pipe to be submitted to COR for A/E review.
3. Do not attach pipe supports, hangers, clamps or anchors to equipment unless specified for that equipment or unless the COR gives written permission.

E. Locate spring hangar units within 300 mm (1 foot) of the pipe attachment, except in locations where spring assemblies interfere with pipe insulation.

F. Minimum Clearances in Tunnels and Trenches:
1. Floor to bottom of pipe support beam: 150 mm (6 inches).
2. Floor to bottom of pipe insulation jacket: 150 mm (6 inches).
3. Wall to side of pipe insulation jacket: 150 mm (6 inches.)
4. Ceiling to top of pipe insulation jacket: 150 mm (6 inches).
5. Greater clearances shall be provided to meet maintenance, repair/replacement, and service requirements of valves, fittings and equipment as recommended by their manufacturers.

3.6 PAINTING EXPOSED STEEL SURFACES IN MANHOLES, TUNNELS AND CONCRETE SHALLOW TRENCHES

A. For manholes and walk-through tunnels, provide surface cleaning and preparation in accordance with SSPC SP-2 and apply prime coat of rust resistant metal primer.

B. For concrete shallow trenches, provide surface cleaning and preparation in accordance with SSPC SP-2 and apply primer and finish coat of zinc-rich paint.

3.7 DIRECT-BURIED SYSTEM INSTALLATION

A. The Contractor shall deliver, store, install and test the system as per manufacturer’s recommendations. All work shall be in strict accordance with the requirements specified by the manufacturer. Printed instructions must be available on site prior to delivery of system components. Any changes required to the design and layout of the system due to site conditions must be approved in writing by the manufacturer and submitted for review by the COR. All branch piping connections, valves and drip traps must be located within manholes.

B. Excavation, Trenching, and Backfilling: Perform all excavation, trenching, and backfilling as required by the system manufacturer's design. Beach sand or any sand with large amounts of chlorides is prohibited. Install per manufacturers recommendations and as shown on contract drawings based on soil conditions. Foundation for system must be firm and stable. Foundation and backfill must be free from rocks. Concrete anchor and thrust blocks must be installed in undisturbed earth. Backfilling must not commence until elevations have been surveyed and accepted and system has been satisfactorily pressure tested and cleaned, including hydrostatic testing of carrier pipes and air testing of casings.

C. Maintain constant slope of carrier pipes as shown or specified. Prior to backfilling over the top of the casing, but after removal of temporary supports, Contractor shall measure and record elevations of top of casing in the trench. Elevations shall be taken at every field joint, 1/3 points along each pipe section, and at tops of elbows. These measurements shall be checked against contract drawings and shall confirm that the casing system has been installed to the elevations shown on the contract drawings unless approved by the COR. Slope shall be uniform within 0.1 percent. Measurements shall be recorded by the Contractor, accompanied with photo documentation of each piping with the elevation instrument reading visible, included in the direct-buried system manufacturer representative's daily report, and given to the COR prior to covering the top of the casing with backfill.

D. Provide cathodic protection for all steel casing systems and all buried exposed metal. Provide dielectric pipe flanges and unions and isolation devices at all points necessary. Provide test stations at grade on each section of the piping system. Isolation flanges and unions shall be rated for the carrier pipe service temperature and pressure.

E. Completely remove all dirt, scale, oil, coatings, and other foreign matter from inside the piping by use of a pipe swab, pipe "pig", brush, scrapers, or chemical cleaning before connecting pipe sections, valves, or fittings.

F. Sections of system that have been fully or partially submerged in water must be replaced. Moisture content of insulation during installation shall not exceed five percent by weight.

G. At each casing termination (end plate) in buildings and manholes, plug the casing drain openings with brass plugs and extend 25 mm (1 inch) pipe size galvanized vent pipes (ASTM A53/A53M) from the casing vents through the tops of the manholes or 300 mm (1 foot) above the casing in buildings. Terminate the outside vents in 180-degree bends.

H. Provide reports to the COR that include:

1. Daily Written Report: Prepared daily and signed by the Contractor. Submit the original report to the COR two days after it is prepared. Provide one set of field pictures of work daily. Format shall be in digital PDF files and hardcopy printout. Digital files can be submitted through email, FTP, USB stick or CD.

2. Report Contents: State whether or not the condition and quality of the materials used and the delivery, storage, installation and testing of the system are in accordance with the manufacturer's recommendations, changes to drawings and specifications, any corrective action that was taken of the system, identify any conditions that could result in an unsatisfactory installation.
3. Report Certification: Daily reports are to be reviewed, signed and sealed by the Professional Engineer responsible for the system installation.
4. Report Submittals and Stop Order: Daily reports shall be submitted with the payment requests. All work must stop if daily reports are not furnished and requests for payments shall be denied if the daily reports are not furnished.
5. Certification of Compliance: Upon completion of the work and 30 days prior to final acceptance, deliver to COR a notarized Certificate of Compliance signed by principal officers of Contractor, stating that the installation is satisfactory and in accordance with plans, specifications, and manufacturer's instructions.
6. The Contractor shall retain copies of all the daily reports and the Certificate of Compliance for 5 years after final acceptance of the system by the Government.

3.8 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
C. Threaded joints: ASME B1.20.1, tapered pipe threads. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified. Joints made with oil and graphite pipe joint compound shall have compound applied to male threads only.
    2. Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
    3. Pipe threads shall be cut to give proper engagement in threaded fittings. Clean pipe and fittings before installation and ream pipe after cutting threads. Threaded pipe shall have clean-cut threads; dull or damaged pipe dies shall not be used.
D. Construct Welded Joints: AWS D10.12M/D10.12, using qualified processes and welding operators according to paragraph, QUALITY ASSURANCE. Branch connections shall be made with either welding tees or welding outlet fittings. Welding outlet fittings shall be forged, integrally reinforced to provide 100 percent pipe strength, beveled for full penetration welding and funneled at inlet for full fluid flow.

E. Flanged Joints: Select gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Gaskets and bolting shall be applied in accordance with the recommendations of the gasket manufacturer and bolting standards of ASME B31.1. Strains shall be evenly applied without overstress of bolts. Gaskets shall cover entire area of mating faces of flanges.

F. Location, Spacing and Cold Set of Ball Joints: Conform to layout drawings approved by manufacturer of ball joints. Representative of manufacturer shall visit site and verify that installation is proper. Locate to allow access to all packing injection devices, when provided.

G. Expansion Joints (Bellows and Slip Type):
   1. Type, quantity and spacing of anchors and guides as recommended by manufacturer of expansion joint and as shown. A Professional Engineer shall verify in writing that anchors and guides are properly designed for forces and moments that will be imposed.
   2. Cold setting of joint travel at installation as recommended by the manufacturer for the ambient temperature during the installation.
   3. Prepare for service by cleaning all sliding surfaces, add packing as necessary. Remove all apparatus provided to restrain joint during shipping or installation.
   4. Expansion joints must be located in readily accessible manhole or in walk-through tunnel. Locate joints to permit access without removing piping or other devices. Allow clear space to permit replacement of joints and to permit access to devices for inspection of all surfaces and for adding packing.

H. Piping joints shall be assembled in sections.

I. All pipe intersections and changes in direction shall be made with factory-built-reinforced fittings. Field-fabricated fittings and miters are prohibited.

3.9 INSTALLATION – SAFETY VALVES

A. Valves must be upright and oriented so that lifting levers are accessible from nearest walkway.

B. Provide drip pan elbow as necessary. Support vent line from above. Provide drain line to nearest floor drain from drip pan elbow. Provide separate vent line from each safety valve to atmosphere unless otherwise shown. Piping weight on safety valve outlet shall not exceed that allowed by valve manufacturer.

C. Provide union or flanged connection at safety valve outlet to allow removal of safety valves without disassembling vents.

3.10 INSTALLATION – PRESSURE GAUGES

A. Locate at inlet and outlet of each pressure reducing station, on each pump discharge and suction, and after main stop valves (gate valves) on steam distribution lines. Orient gauges so that dials are upright and visible from nearest walkway and from the main steam stop valves. Provide

gauge cock. Provide siphon on steam service. Provide liquid filled gauges on pump discharge and suction.

3.11 INSTALLATION - THERMOMETERS

A. Orient thermometers so that scales are upright and visible from nearest walkway. Locate wells in flow stream.

3.12 INSTALLATION - VALVES

A. Do not locate valve stems below the horizontal centerline of the pipe.
B. Locate valves to permit access for operation, maintenance, and replacement.
C. Provide 20 mm (3/4 inch) globe-valved warm-up bypasses at all steam gate valves 75 mm (3 inch) pipe size and greater.
D. Provide 20 mm (3/4 inch) gate or ball-valved drains at each side of steam gate valves where condensate could collect, due to the slope of the pipeline, when the main valve is shut.

3.13 THERMAL INSULATION

A. Steam, condensate and drip return piping, other than in pre-engineered direct-buried systems, shall be insulated as follows:
    1. Piping in concrete trenches and manholes: Insulated with calcium silicate, cellular glass pipe insulation, or aluminum jacket.
    2. Piping in manholes: Insulated with calcium silicate or cellular glass pipe insulation, aluminum jacket.
    3. Minimum insulation thickness: Insulation thicknesses given in Table 1 and 2 are minimum nominal thickness.
B. Parts not to be insulated are:
    1. Threaded valves
    2. Steam traps
    3. Check valves
    4. Unions
    5. Threaded strainers
    6. Strainer basket removal cover and bolting
    7. Dielectric flanges and unions
    8. Expansion joints
    9. Flexible connectors
    10. Ball joints except piping between joints
C. Installation of Insulation:
    1. Pressure Tests: Complete all pressure tests and cleaning before installing.

2. Insulation Material: New, clean, dry and stored in a clean dry environment; jacketing materials to be clean and unmarred; store adhesives in original containers. Materials shall not have exceeded the predicted shelf life as set by manufacturer.
3. Identify all materials incorporated in the job on manufacturer's container by name, type and description.
4. Apply materials on clean, dry surfaces from which all dirt, loose scale, construction debris has been removed by wire brushing.
5. The installation shall be neat, thermally and structurally tight without sag, neatly finished at all hanger or other penetrations and shall provide a smooth finished surface primed as required to receive specified painting.
6. Do not use scrap insulation. Repair any work damaged by welding, burning, compressing due to concentrated construction loads.
7. Apply pipe covering protection saddles, MSS SP-58, Type 39, at all hanger points. Fill space between saddle and piping with high density insulation, thoroughly packed. Terminate jacket clear of saddle bearing area.
8. Insulation and jacket shall terminate hard and tight at all anchor points.
9. Insulation termination at piping facilities not to be insulated shall stop short, and be finished with 45-degree chamfered section of insulating and finishing cement, and covered with jacket.
10. Flanged fittings and valves shall be insulated with sections of pipe insulation cut, fitted and arranged neatly, and firmly wired in place. Insulating cement shall fill all cracks, voids and outer surface for covering with glass cloth. Insulation of valve bonnet shall terminate on valve side of bonnet flange to permit valve repair.
11. On calcium silicate, and cellular glass insulated piping systems, fittings shall be insulated with field or factory-shaped sections of insulation, finished with specified insulating and finishing cements and covered with specified jacket.
12. On mineral wool insulated piping systems fittings over 50 mm (2 inches) shall be insulated with specified molded pipe fitting insulation or compressed blanket, finished with specified insulating and finishing cements and covered with jacket. On sizes 50 mm (2 inches) and less apply insulating and finishing cements and cover with specified jacket.
13. Apply glass cloth jacket using an approved adhesive. Glass cloth shall be smooth, tight and neatly finished at all edges; prime cloth to receive paint.

3.14 WELDING

A. The Contractor is entirely responsible for the quality of the welding and shall:

1. Conduct tests of the welding procedures used on the project, verify the suitability of the procedures used, verify that the welds made will meet the required tests, and also verify that the welding operators have the ability to make sound welds under standard conditions.
2. Perform all welding operations required for construction and installation of the distribution system.

B. Welder Qualifications: All welders shall be qualified as per ASME B31.1, AWS B2.1/B2.1M, and AWS Z49.1.

C. Field Bevels and Shop Bevels: Done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.

D. Provide approved welding method for field joints on all carrier pipes greater than 50 mm (2 inches) to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe. Make field joints 50 mm (2 inches) and smaller with welding sockets.

E. Piping shall not be split, bent, flattened, or otherwise damaged either before, during, or after installation. Where the pipe temperature falls to 0 degrees C (32 degrees F) or lower, the pipe shall be heated to approximately 38 degrees C (100 degrees F) for a distance of 300 mm (1 foot) on each side of the weld before welding, and the weld shall be finished before the pipe cools to 0 degrees C (32 degrees F).

F. Replace and reinspect defective welds. Repairing defective welds by adding weld material over the defect or by peening are prohibited. Welders responsible for defective welds must be requalified.

G. Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during fabrication operations. Discard electrodes that have lost part of their coating.

H. An approved independent testing firm regularly engaged in radiographic testing shall perform radiographic examination of field welds in the steam and condensate piping of the systems, in manholes and in walk-through tunnels, in accordance with ASME B31.1. Perform radiographic examination of 50 percent of the first 10 welds made and 10 percent of all additional welds made. The COR reserves the right to identify individual welds for which the radiographic examination must be performed. All welds will be visually inspected by the COR. The VA reserves the right to require testing on additional welds up to 100 percent if more than 25 percent of the examined welds fail the inspection. Furnish a set of films or pictures showing each weld inspected, a report evaluating the quality of each weld, and a location plan showing the physical location where each weld is to be found in the completed project, prior to installing casing field joints, trench covers, backfilling and hydrostatic testing. All radiographs shall be reviewed and interpreted by an ASNT Certified Level III radiographer, employed by the testing firm, who shall sign the reading report.

The COR or their representative shall review all inspection records, and if any welds inspected are found unacceptable, they shall be removed, rewelded, and radiographically reexamined at no cost to the Government.

3.15 CLEANING OF PIPING

A. Clean pipe and fittings inside and outside before and after assembly. Remove all dirt, scale, and other foreign matter from inside the piping by use of a pipe swab, pipe “pig”, brush, scrapers or chemical cleaners before connecting pipe sections, valves, equipment or fittings. For carbon steel piping, use detergent to remove any oil and caustic solution to remove the mill scale.

B. Cleaning of piping shall be witnessed by the COR, their representative, or the Commissioning Agent.

3.16 IDENTIFICATION FOR UTILITY LOCATING

A. Install continuous plastic underground warning tapes during back filling of trenches for underground steam and condensate distribution piping. Locate tapes 300 mm (12 inches) below finished grade, directly over piping.

3.17 IDENTIFICATION TAGS

A. Valves: Provide laminated brass tags, with engraved lettering not less than 5 mm (3/16 inch) high, on all isolating valves on steam and condensate return system, identifying building or area served. Attach to the valves with corrosion-resistant chains.

B. Pipes: Label service of all pipes in manholes and walk-through tunnels every 7.6 m (25 feet) and at every change in direction. Label shall include flow direction arrows.

3.18 FIELD QUALITY CONTROL

A. Demonstrate leak-tightness of all piping systems by performing hydrostatic tests at 1-1/2 times the design pressure and operational tests. All labor, material and test instruments must be furnished by the Contractor. All instruments must be approved by the COR.

B. Pressure test direct-buried systems in conformance with requirements stated in this specification and in printed instructions for the system supplied. Tests must include carrier piping and casing.

C. Holiday testing of direct-buried system steel casings: Test entire surface of casings for faults in coating after installation in trench prior to backfilling. Use test method and voltage recommended by coating manufacturer. Repair any holidays found and retest. System shall not be backfilled until all holidays are eliminated.

D. Before conducting steam system operating test, remove steam trap elements or use bypass connections around traps; then flush lines with water until discharge shows no foreign matter to the satisfaction of COR.

E. Steam and condensate piping shall be tested hydrostatically before insulation is applied at field joints and shall be proved tight at a pressure 1-1/2 times the design pressure for a period not less than 2 hours with no pressure decay.

1. Test piping located in concrete trenches prior to installing trench covers. Test direct-buried systems prior to backfilling.
2. Remove or isolate any elements of the system such as expansion joints and spring hangers which are not designed for the test pressure.
3. Prior to acceptance of installation, Contractor shall subject system to operating tests as may be required by COR to demonstrate satisfactory functional and operating efficiency. These operating tests shall cover a period of not less than 8 hours for each portion of system tested. Conduct tests at times as the COR may direct.
4. Provide calibrated instruments, equipment, facilities and labor, at no additional cost or time to the Government. Test gauge shall read in increments not exceeding 1 kPa (0.15 psig).
5. Repeat tests when failures occur.
6. After completion of satisfactory test, replace all elements that have been removed prior to testing.

F. Pneumatic Testing of DDT System Casings:
1. Perform test on all sections of the system before field-coating the field joints and before back-filling.
2. Test shall be with compressed air at 103 kPa (15 psig) maximum for 2 hours with pressure source disconnected and with decay in pressure not to exceed 5 percent. Corrections to the readings are permissible to compensate for significant ambient temperature changes during the test period.
3. Pressure shall be measured with a gauge with reading increments of 1 kPa (0.15 psig).
4. Each casing field joint shall be tested for leaks by means of soap solution or equivalent.

G. NACE-accredited corrosion specialist shall test cathodic protection systems and demonstrate proper operation and protection in accordance with the recommendations and criteria in NACE SP0169.

H. Deficiencies discovered shall be corrected at the Contractor's expense, to satisfaction of COR. Major deficiencies or failure to correct deficiencies, to the satisfaction of the COR, may be considered cause for rejecting the entire installation.

I. Contractor will engage a qualified testing agency to perform tests and inspections.

J. Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations for the system.

K. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

L. Tests and Inspections:
1. Steam and condensate piping for testing: ASME B31.1 and ASME B31.9 and as follows:
a. Leave joints, including welds, uninsulated and exposed for examination during test.

b. Isolate equipment. Do not subject equipment to test pressure.
c. Install relief valve set at pressure no more than one-third higher than test pressure and replace safety valves of the appropriate pressure. Reset pressure setpoint of all relief valves to the appropriate pressures and replace safety valves after all tests have been completed. Contractor to provide written report of the reset with date and time stamp for each relief valve and replacement of the safety valves.
d. Fill system with normal temperature water between 4 degrees C (40 degrees F) and 32 degrees C (90 degrees F). Ensure the water filled pipe system is protected against freezing during the test such as providing heat tracing along the pipe.
e. Use vents installed at high points to release trapped air while filling system. Use drip legs installed at low points for complete removal of liquid.

2. Test steam and condensate piping as follows:
a. Subject steam and condensate piping to hydrostatic test pressure that is not less than 1-1/2 times the design pressure.
b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
3. Test outer casing as follows: Seal vents and drains and subject casing to 103 kPa (15 psig) of air for 4 hours with no loss of pressure. Repair leaks and retest as required.

M. Prepare and submit test and inspection reports to the COR within 5 working days of test completion and prior to covering the pipe.
N. All tests shall be witnessed by the COR, their representative, or the Commissioning Agent and be documented by each section tested, date tested, and list or personnel present.

3.19 STARTUP AND TESTING

A. Perform 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. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.

3.20 COMMISSIONING

A. Provide commissioning documentation in accordance with the requirements of Section 33 08 00, COMMISSIONING OF SITE UTILITY SYSTEMS.

B. Components provided under this section of the specification will be tested as part of a larger system.

3.21 DEMONSTRATION AND TRAINING

A. Provide services of manufacturer's technical representative for 4 hours to instruct each VA personnel responsible in operation and maintenance of the system.

B. Submit training plans and instructor qualifications in accordance with the requirements of Section 33 08 00, COMMISSIONING OF SITE UTILITY SYSTEMS.

3.22 APPENDIX I – ALLOWABLE SITE CHARACTERISTICS FOR CONCRETE SHALLOW TRENCH APPLICATION

ALLOWABLE SITE CHARACTERISTICS FOR CONCRETE SHALLOW TRENCH APPLICATION (SEE NOTE 1)			
SITE CONDITION	**GENERAL CONDITIONS OF GROUND WATER DURING THE WETTEST PERIOD OF THE YEAR**	**SURFACE WATER ACCUMULATION RAINFALL/ IRRIGATION**	**TRENCH CONSTRUCTION**
A. Fine grained impervious or semi pervious and coarse grained impervious	Water table generally 300 mm (1 foot) below lowest point of water entry **(See Note 5)** with not more than 25% of the length of the proposed concrete trench system showing water within 300 mm (1 foot) of the lowest point of water entry.	5 years - 7 day rainfall equal to or less than 250 mm (10 inches). **(See Note 2)**	Continuous wall and bottom.
B. Coarse grained semi pervious and pervious **(See Note 2)**	Same as for A. above.	5 years - 7 day rainfall equal to or less than 250 mm (10 inches).	Same as for A. above
	Water table generally 600 mm (2 feet) or more below point of water entry with not more than 10% of the length of trench system showing water within 600 mm (2 feet) but not closer than 300 mm (1 foot) to lowest point of water entry.	5 years - 7 day rainfall equal to or less than 200 mm (8 inches). **(See Note 2)**	Continuous wall; openings may be provided in trench bottom to provide drainage.
C. Swelling soils **(See Note 3)**	Same as for A. above.	Same as for A. above.	Same as for A. above plus design of joint spacing and joint details to accommodate movement.

NOTES:

1. Shallow concrete trench system shall not be used if any conditions defined by these criteria are exceeded.
2. As shown in U. S. Weather Bureau (USWB) Technical Paper 40 and confirmed with local data and local weather patterns
3. Swelling soils are materials with high swell potential when subjected to an increase in moisture content.
4. Precipitation rates for a specific site should be used to design drainage systems and select sump pumps.
5. Lowest point of water entry is defined as the joint between trench wall and trench bottom.

3.23 APPENDIX II – CLASSIFICATIONS FOR DIRECT-BURIED SYSTEMS

A. Groundwater Conditions:

CLASSIFICATIONS FOR DIRECT-BURIED SYSTEMS	
Site Classification	**General Conditions for Such Classifications**
A - Severe	1. The water table is expected to be frequently above the bottom of the system and surface water is expected to accumulate and remain for long periods in the soil surrounding the system, or
	2. The water table is expected to be occasionally above the bottom of the system and surface water is expected to accumulate and remain for long periods in the soil surrounding the system.
B - Bad	1. The water table is expected to be occasionally above the bottom of the system and surface water is expected to accumulate and remain for short periods (or not at all) in the soil surrounding the system, or
	2. The water table is expected never to be above the bottom of the system but surface water is expected to accumulate and remain for long periods in the soil surrounding the system.
C - Moderate	The water table is expected never to be above the bottom of the system but surface water is expected to accumulate and remain for short periods in the soil surrounding the system.
D - Mild	The water table is expected never to be above the bottom of the system and surface water is not expected to accumulate or remain in the soil surrounding the system.

B. System Temperature Classifications: High 127 to 232 degrees C (261 to 450 degrees F); Medium 94 to 126 degrees C (201 to 260 degrees F); Low 93 degrees C (200 degrees F) or lower.

C. Type of Underground System Allowed: Drainable-Dryable-Testable (DDT) shall be allowed for Site Classifications A, B, C, D.

D. Soil Conditions:
   1. Soil Corrosiveness Classification:
      a. The soil at the site should be classified as corrosive or noncorrosive on the basis of the following criteria:
      b. Corrosive: The soil resistivity is less than 30,000 ohm-cm or stray direct currents can be detected underground.
      c. Noncorrosive: The soil resistivity is 30,000 ohm-cm or greater and no stray direct currents can be detected underground.
      d. The classification should be made by an experienced corrosion engineer based on a field survey of the site carried out in accordance with recognized guidelines for conducting such surveys.
   2. Soil pH: If there is any reason to suspect that the soil pH will be less than 5.0 anywhere along the proposed path of the system, pH measurements should be made at pipeline depth at close intervals along the proposed route, and all locations at which the pH is less than 5.0 should be indicated in the contract documents. An experienced soils engineer, preferably the same engineer responsible for other soil engineering work, should determine soil pH.

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SECTION 34 71 13
PASSIVE VEHICLE BARRIERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Stationary anti-ram rated vehicle barriers

1.2 RELATED REQUIREMENTS

A. Concrete Site Walls, Islands, and Curbs: Section 03 30 53, (SHORT FORM) CAST-IN-PLACE CONCRETE.

B. Pipe Bollards: Section 05 50 00, METAL FABRICATIONS.

C. Concrete Driveway and Approach Paving: Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS.

D. Asphalt Driveway and Approach Paving: Section 32 12 16, ASPHALT PAVING.

1.3 APPLICABLE PUBLICATIONS

A. Comply with references to extent specified in this section.

B. ASTM International (ASTM):

1. F2656/F2656M-15 - Crash Testing of Vehicle Security Barriers.

C. United States Department of State (DS):

1. SD-STD02.01-Revision A - Vehicle Crash Testing of Perimeter Barriers and Gates.

1.4 SUBMITTALS

A. Submittal 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 dimensions and clearances between barriers and other adjacent permanent construction.
3. Include setting drawings and templates for anchors, sleeves, and other items embedded into concrete foundations.

1.5 FIELD CONDITIONS

A. Field Measurements: Verify field conditions affecting vehicle barrier fabrication and installation. Show field measurements on Submittal Drawings.

1. Coordinate field measurement and fabrication schedule to avoid delay.

1.6 WARRANTY

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

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Structural Vehicle Barriers:

1. Bollards: Steel pipe, concrete filled. See Section 05 50 00, METAL FABRICATIONS.
2. Foundations: Permanent concrete as indicated on drawings.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine and verify foundation suitability for product installation.

B. Coordinate delivery and installation of anchors, sleeves, and other items embedded in concrete foundations.

C. Coordinate barrier system layout and installation with vehicle control facilities including:

1. Driveway and approach paving. See Section 32 05 23, CEMENT AND CONCRETE FOR EXTERIOR IMPROVEMENTS Section 32 12 16, ASPHALT PAVING.

3.2 INSTALLATION

A. Bollard Installation: See Section 05 50 00, METAL FABRICATIONS.

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