

cleanwater
NASHVILLE

OVERFLOW ABATEMENT PROGRAM

METRO
WATER SERVICES

Standard Specifications

September 2022

FOR INFORMATION ONLY

**CLEAN WATER NASHVILLE
OVERFLOW ABATEMENT PROGRAM**

SPECIFICATIONS

<PROJECT NAME>

**PROJECT NUMBERS:
##-XX-#### XXX.X.##.##**

**Metropolitan Government of Nashville and Davidson County, TN
Department of Water and Sewerage Services**

<RFQ/RFP/ITB> SET

**VOLUME # OF #
DIVISION 01 THROUGH 48**

Month Year

Prepared By:
Consultant Name
Address
City, State Zip



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Table of Contents

SPECIFICATIONS – Volume # of # - <Project Name>

DIVISION 01: GENERAL REQUIREMENTS

SECTION 01 11 00	Summary of Work
SECTION 01 12 00	Contractor's Use of Premises
SECTION 01 14 14	Control of Work
SECTION 01 20 00	Application for Payment
SECTION 01 25 00	Substitution Procedures
SECTION 01 26 63	Contract Change
SECTION 01 26 64	Weather Delays
SECTION 01 29 01	Measurement and Payment (Unit Price)
SECTION 01 29 02	Measurement and Payment (Lump Sum Price)
SECTION 01 29 73	Schedule of Values
SECTION 01 31 19	Project Meetings
SECTION 01 32 16	Construction Progress Schedules (Small Project)
SECTION 01 32 17	Construction Progress Schedules (Large Projects)
SECTION 01 32 23	Pre- and Post-construction Surveys
SECTION 01 32 33	Construction Videos
SECTION 01 33 00	Submittals
SECTION 01 35 23	Safety and Health
SECTION 01 35 24	Building Sewer Backup Cleanup
SECTION 01 35 43	Protection of Environment
SECTION 01 42 00	Reference Standards
SECTION 01 42 16	Definitions
SECTION 01 43 00	Quality Requirements
SECTION 01 45 23	Testing & Laboratory Services Provided by the Contractor
SECTION 01 45 33	Performance Testing and Inspections
SECTION 01 48 34	Structural Tests and Inspections
SECTION 01 50 00	Temporary Facilities
SECTION 01 55 26	Traffic Control
SECTION 01 57 13	Erosion and Sediment Control and Containment of Construction
SECTION 01 61 00	Control of Materials and Spare Parts
SECTION 01 61 16	Web-based Information Management
SECTION 01 66 10	Delivery, Storage and Handling
SECTION 01 73 29	Cutting, Coring and Patching
SECTION 01 77 00	Contract Closeout
SECTION 01 78 23	Operation and Maintenance Data
SECTION 01 78 24	Training
SECTION 01 81 00	Sustainability
SECTION 01 92 00	Maintenance of Facility Operations during Construction

DIVISION 02: EXISTING CONDITIONS

SECTION 02 01 20	Protecting Existing Underground Utilities
SECTION 02 01 30	Connections to Existing Buried Pipelines
SECTION 02 41 00	Demolition

DIVISION 03: CONCRETE

SECTION 03 05 10	Leakage Testing of Concrete Containment Structures
SECTION 03 10 00	Concrete Formwork
SECTION 03 15 00	Concrete Joints and Accessories
SECTION 03 21 00	Reinforcement Bars
SECTION 03 30 00	Cast-in-Place Concrete

DIVISION 13: SPECIAL CONSTRUCTION

SECTION 13 16 24	Prestressed Concrete Tanks
------------------	----------------------------

DIVISION 26: ELECTRICAL

SECTION 26 05 10	Electrical Work - General
SECTION 26 29 23	Variable Frequency Motor Controllers

DIVISION 31: EARTHWORK

SECTION 31 23 00	Excavation and Fill
SECTION 31 23 19	Dewatering
SECTION 31 23 33	Trenching and Backfill
SECTION 31 50 00	Trench Safety Systems

DIVISION 32: EXTERIOR IMPROVEMENTS

SECTION 32 12 00	Flexible Paving
SECTION 32 13 00	Rigid Paving
SECTION 32 13 13	Pervious Concrete Pavement
SECTION 32 15 00	Tree Protection and Pruning
SECTION 32 16 00	Curbs, Gutters, Sidewalks, Driveway Ramps, and Driveways
SECTION 32 17 00	Paving Specialties
SECTION 32 31 19	Decorative Metal (Picket) Fences and Gates
SECTION 32 84 00	Landscape Irrigation System
SECTION 32 92 00	Turf and Grasses
SECTION 32 93 00	Landscape Plantings

DIVISION 33: UTILITIES

SECTION 33 01 30	Post-rehabilitation Sanitary Sewer CCTV Inspection
SECTION 33 01 40	Cured-In-Place Sewer Pipe Lining
SECTION 33 01 44	Manhole Rehabilitation and Lining
SECTION 33 01 48	Flow Control of Sewer Lines
SECTION 33 01 51	Pre-rehabilitation Sanitary Sewer CCTV Inspection
SECTION 33 01 53	Pipe Bursting Sewer Lining
SECTION 33 01 88	Sewer Service Lateral Lining
SECTION 33 01 89	Internal Point Repairs

DIVISION 33: UTILITIES

SECTION 33 01 90	Internal Point Repairs (Large Diameter Pipe)
SECTION 33 05 16.17	Valve Boxes, Meter Boxes, and Vaults
SECTION 33 11 00.11	Polyvinyl Chloride (PVC) Pipe and Fittings
SECTION 33 11 13.13	Ductile Iron Pipe and Fittings
SECTION 33 12 16.19	Air Release and Vacuum Relief Valves
SECTION 33 30 10	Sanitary Sewerage Utilities - Small Diameter (<36-inches)
SECTION 33 31 00	Gravity Sewer Mains
SECTION 33 31 13.17	Reinforced Concrete Pipe and Fittings
SECTION 33 31 13.18	Fiberglass Reinforced Polymer Mortar Pipe and Fittings
SECTION 33 31 61	Acceptance Testing for Sanitary Sewer
SECTION 33 34 00	Sewer Force Mains
SECTION 33 35 20	Sewer Line Cleaning for Preparation of Sewer Rehabilitation
SECTION 33 39 13	Manholes
SECTION 33 40 00	Storm Drainage Utilities

DIVISION 40: PROCESS INTEGRATION

SECTION 40 23 19.04	Ductile Iron Pipe and Fittings for Process Piping
---------------------	---

DIVISION 43: LIQUID HANDLING EQUIPMENT

SECTION 43 21 00.07	Wet Pit Submersible Pumps and Appurtenances
---------------------	---

DIVISION 46: WATER AND WASTEWATER EQUIPMENT

SECTION 46 42 26.02	Channel Grinders and Appurtenances
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FOR INFORMATION ONLY

Professional Engineer's Certification

This is to certify that the following sections of the Specifications for the xxxxx project dated month year were prepared under my direction and supervision.

<Name>, P.E.
Tennessee Registration No. #####

Date

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SECTION ## ## ##	Name
SECTION ## ## ##	Name
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FOR INFORMATION ONLY

SECTION 01 11 00
SUMMARY OF WORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Project Information
- C. Work covered by Contract Documents
- D. Project Milestones
- E. Access to the Site
- F. Contract Drawings
- G. General Arrangement
- H. Time of Work
- I. Davis-Bacon Wage Requirements
- J. American Iron and Steel

1.02 RELATED SECTIONS <PROJECT SPECIFIC>

- A. Division 01 - Division ##

1.03 WORK COVERED BY CONTRACT DOCUMENTS

- A. The Work of Project is defined by the Contract Documents and consists of the following:
<DESIGN ENGINEER TO INSERT ITEMS REQUIRED FOR CONSTRUCTION> – <SEE SAMPLE BELOW>
 - 1. The principal features of the Work to be performed under this Contract include, but are not limited to, the following items:
 - a. Structural, mechanical, and electrical removals and demolition
 - b. Excavation support systems
 - c. Foundation and concrete work, including piles, foundation slabs, walls, suspended slabs, beams, columns, and other miscellaneous concrete work
 - d. Chemical feed systems and piping, including metering pumps, instrumentation, storage tanks, valves, gauges, and other appurtenances
 - e. Architectural buildings, including block, brick, doors, windows, skylights, and associated artistic additions

- f. Electrical motor control centers, conduit, wiring, panel boards, lighting, and other electrical systems
- g. General site work, including paving, yard piping, grading, drainage, fencing, signage, painting, etc.
- h. Rehab of sewer pipes and manholes, including sewer system renewals, point repairs, and cleanouts
- i. Installation of new or replacement of sewer, including pipe, manholes, junction structures and service connections
- j. Surface restoration of paved and turf areas as defined by the specifications
- k. Erosion, dust, and traffic control during construction

SAMPLE REHAB SCOPE OF WORK <PROJECT SPECIFIC>

B. The Work of Project is defined by the Contract Documents, includes, but is not limited to, and consists of the following:

- a. Safe performance of all Work for protection of life of workers, observers, and the public
- a. Installation of cured-in-place pipe lining for existing 8-inch through 18-inch <Verify Size> diameter sanitary sewers
- b. All prelining point repairs, CCTV, cleaning, excavatable sewer service replacements, and trenchless service line renewals
- c. Sewer diversion pumping and service cleanout installation
- d. Manhole rehabilitation with cementitious and epoxy type linings, including any manhole repairs or repairs of manhole frames and covers
- e. Miscellaneous related items, including repair of existing sewer service cleanouts or replacements
- f. Pavement, turf, and property restoration as defined by the specifications
- g. All testing required by the Contract Documents to complete the Work
- h. Erosion, dust, and traffic control during construction
- i. Supervision, coordination, and construction management of all work done by subcontractors.

1.04 PROJECT MILESTONES

A. Milestone 1 – CCTV Data Collection, Sewer Rehabilitation Projects Only

1. Perform mainline CCTV inspections, perform CCTV service lateral launch inspections, locate and access missing manholes, and provide the data electronically to the Construction Manager within **120 days** after the Notice-to-Proceed. This milestone provides the data necessary for the Construction Manager to evaluate and determine the

most feasible and/or time and cost-effective service renewal methodology for the project. If the Work is not completed within 120 days, the Contractor will be assessed **\$500/day** for non-attainment of a critical project milestone until such time as the CCTV and manhole location work is complete and the data has been submitted. A milestone non-compliance assessment will be deducted from periodic payments. This milestone non-compliance assessment may, at Metro's discretion, be reimbursed to the Contractor in the final payment if the Contractor meets the original Substantial Completion date.

<DESIGN ENGINEER TO DELETE IF NOT A REHABILITATION PROJECT>

B. Milestone 2

1. Install, test and place into successful operation... <DESIGN ENGINEER TO COMPLETE>

C. All remaining Work shall be completed within the overall Contract Time.

1.05 ACCESS TO THE SITE

- A. Limit the use of the Project site to areas within the Contract limits indicated. Do not disturb portions of Project site beyond the areas in which Work is indicated.

1.06 CONTRACT DRAWINGS

- A. The Work is indicated on the set of Contract Drawings entitled <INSERT TITLE, PROJECT NUMBERS AND DATE>. The numbers and titles of all Contract Drawings appear on the index sheet of the Contract Drawings. Contract Drawings shall be considered an integral part of the Contract Documents as defined herein.
- B. In this Section and in other Sections of these Contract Specifications, the Contract Drawings are usually referred to as "Contract Drawings."

1.07 GENERAL ARRANGEMENT

- A. Contract Drawings indicate the extent and general arrangement of the Work. If the Contractor deems any departures from the Contract Drawings necessary, details of such departures and reasons therefore shall be submitted as soon as known for approval via the Request for Information or submittal process as appropriate. No such departures shall be made without prior written approval.

1.08 TIME OF WORK <TO BE VERIFIED/REVISED FOR EACH PROJECT>

- A. The normal time of Work for this Contract shall be **Monday through Friday** except legal holidays observed by Metro and between the hours of **7:00 a.m.** and **6:00 p.m.**, local time, **and Saturdays between 8:00 am and 3:30 pm**, local time. <PROJECT SPECIFIC>
- B. If it shall become necessary to perform Work at night or during hours other than those noted above, the Construction Manager shall be informed in writing no later than two (2) work days in advance of the beginning of such Work. No Work may commence until approval of the proposed work hours has been obtained from the Construction Manager. Temporary lighting and all other necessary facilities for performing and inspecting the Work shall be provided and maintained by the Contractor.

1.09 DAVIS-BACON ACT WAGE REQUIREMENTS <DESIGN ENGINEER TO DELETE IF NOT AN SRF-FUNDED PROJECT AND IN 1.01>

- A. The Davis-Bacon Act as amended, requires that each contract over \$2,000 to which the United States is a party for the construction, alteration, or repair of public buildings or public works shall set forth the minimum wages to be paid to various classes of laborers and mechanics employed under the contract. Under the provisions of the Act, contractors or their subcontractors are to pay workers employed directly upon the site of the work no less than the locally prevailing wages and fringe benefits paid on projects of similar character. The Davis-Bacon Act directs the Secretary of Labor to determine such local prevailing wages. Because this construction contract is funded by the Tennessee Department of Environment and Conservation's State Revolving Fund Loan Program on behalf of the United States Environmental Protection, said minimum current wage provisions will apply.
- B. Additional information concerning the Davis-Bacon Act and current wage rate determinations can be obtained at the following websites: www.gpo.gov/davisbacon/referncemat.html and www.wdol.gov/.
- C. See the separate SRF Contract Requirements document package for explicit SRF provisions and the link to current wage rates for this project.

1.10 AMERICAN IRON AND STEEL <DESIGN ENGINEER TO DELETE IF NOT AN SRF-FUNDED PROJECT AND IN 1.01>

- A. This project is being funded by a State Revolving Fund loan on or after 2014 EPA Fiscal Year. The loan recipient must be in compliance with all applicable American Iron and Steel requirements.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 12 00

CONTRACTOR'S USE OF PREMISES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope
- B. Submittals
- C. Measurement and Payment
- D. General
- E. Rights-of-Way
- F. Private Property Necessary for the Work
- G. Private Property Convenient for the Work
- H. Local Streets and Alleys
- I. State and Federal Rights-of-Way
- J. Railroad Rights-of-Way
- K. Other Utilities, Satellite Jurisdictions, and Other Entities

1.02 SCOPE

- A. Contractor's Use of Premises

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00, Submittals.
- B. Agreements with private property owners to access or use property related to the project.

1.04 MEASUREMENT AND PAYMENT

- A. Consider expenses for Contractor's use of premises to be incidental to the Work with no separate payment allowed.
- B. If damages occur, restore to pre-construction condition or an approved betterment at no cost to MWS.

1.05 GENERAL

- A. Before beginning Work, coordinate working hours with the proper agencies.

- B. At least forty-eight hours prior, but not more than two weeks prior, to construction for any acquired rights of entry, provide written notification to the Construction Manager and the residents of the affected properties.
- C. Dispose of waste materials at Metro approved sites.
- D. Do not burn waste materials on the project site.

1.06 RIGHTS-OF-WAY

- A. Confine access, operations, and storage areas to properly acquired rights of entry and easements; trespassing on abutting property or other areas is not allowed.
- B. Maintain access for emergency vehicles, including access to fire hydrants.
- C. Maintain access for US Postal Service mail delivery, package delivery services, and scheduled trash services to impacted parcels.
- D. Avoid obstructing drainage ditches or inlets; when obstruction is unavoidable due to requirements of the Work, provide regulatory approved grading and temporary drainage structures to maintain unimpeded flow.
- E. Locate and protect private lawn sprinkler systems that may exist on rights of entry within the site. Repair or replace damaged systems to condition equal to or better than pre-construction condition.
- F. Perform daily cleanup of all disturbed areas. Keep streets, driveways, and sidewalks clean of dirt, debris, and scrap materials. Do not leave buildings, roads, streets, or other construction areas unclean overnight.

1.07 PRIVATE PROPERTY NECESSARY FOR THE WORK

- A. Where the Work for new facilities, sewers, water mains or force mains encroaches upon private property, MWS will obtain necessary preliminary permits, approvals, contracts, rights of entry, and/or easements as presented in the Bidding Documents.
- B. Secure and obtain Final Permits, approvals, rights of entry as required.
- C. For sewer or water main rehabilitation work that encroaches upon private property, the Contractor is allowed to use existing easements. MWS generally will not obtain additional easements and rights of entry to accomplish the Work.
- D. Comply with all stipulations outlined in agreements between a property owner and MWS as well as the limits shown on the Drawings and/or conditions described.
- E. Repair or replace any damages to pre-construction condition or better.
- F. Perform daily cleanup of all disturbed areas. Keep driveways and improved parking areas clean of dirt, debris, scrap materials, and Contractor's workers-generated trash. Do not leave turf areas, driveways, improved parking areas, or other construction areas unclean overnight.

1.08 PRIVATE PROPERTY CONVENIENT FOR THE WORK

- A. Obtain written agreements from private property owners for additional areas deemed convenient but not necessary for the Work and submit a copy of the agreement to Construction Manager. Such written agreements shall comply with all Metro ordinances and restrictions.
- B. Make arrangements for temporary use of private properties and indemnify and hold harmless MWS against claims or demands arising from use of properties outside of rights-of-way.
- C. Repair or replace any damages to pre-construction condition or better.

1.09 LOCAL STREETS AND ALLEYS

- A. Secure permits and obtain operational procedures from the Metropolitan Department of Public Works or Metropolitan Nashville satellite jurisdiction entity before closing or starting construction within rights-of-way of any public street or alley.
- B. Construct and maintain temporary detours, ramps, and roads and traffic control to provide traffic flow when use of local roads or streets is closed by necessity of the Work.
- C. Provide mats or other means to prevent overloading or damage to existing roadways from tracked or heavy equipment.
- D. Maintain ingress/egress to driveways or entrances at all times.

1.10 STATE AND FEDERAL RIGHTS-OF-WAY

- A. Where the Work encroaches upon rights-of-way under the jurisdiction of the Tennessee Department of Transportation (TDOT), MWS will obtain necessary permits, approvals, contracts, and/or easements. This applies to new facilities and the rehabilitation, replacement, or new construction of sewer lines, water lines, stormwater improvements and force mains.
- B. Obtain permits and approvals where sewer or water main rehabilitation Work encroaches upon rights-of-way under the jurisdiction of TDOT unless said rights-of-way are included in the bid documents.
- C. Comply with stipulations outlined in agreements between TDOT and MWS and in permit conditions.

1.11 RAILROAD RIGHTS-OF-WAY

- A. Where the Work encroaches upon the rights-of-way of a Railroad Company or private rail spur, MWS will make applications for and may obtain necessary permits, approvals, contracts, and/or easements. Documents will be included in the bid documents. The Contractor will be required to obtain final permits and approvals.
- B. Comply with stipulations outlined in agreements between the Railroad Company, private spur owner, rail service provider, and MWS.
- C. Furnish insurance documentation and satisfy requirements of the Railroad Company or rail service provider prior to entering the railroad rights-of-way.

- D. Pay expenses and/or charges for the permitting, monitoring, flagging, inspection, and/or other services assessed by the Railroad Company or rail service provider.

1.12 OTHER UTILITIES, SATELLITE JURISDICTIONS, AND OTHER ENTITIES

- A. Where the Work encroaches upon the rights-of-way and/or jurisdiction of other utilities or Metropolitan Nashville satellite jurisdictions or entities, MWS will obtain necessary preliminary permits, approvals, contracts, and/or easements as presented in the Bidding Documents. This applies to new facilities and the rehabilitation, replacement, or new construction of sewer lines, water lines, stormwater improvements, and force mains.
- B. Secure and obtain Final Permits, approvals, rights of entry as required.
- C. Comply with stipulations outlined in agreements between other utilities or entities, Metropolitan Nashville satellite jurisdictions and MWS.
- D. Satisfy requirements of other utilities or entities or Metropolitan Nashville satellite jurisdictions prior to entering rights-of-way.
- E. Pay expenses and/or charges for the permitting, monitoring, flagging, inspection, and/or other services assessed by other utilities or entities or Metropolitan Nashville satellite jurisdictions.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 14 14
CONTROL OF WORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Coordination of the Work
- C. Interference with Existing Works
- D. Protecting and Relocating Existing Structures and Utilities
- E. Property Care and Protection
- F. Occupying Private Land
- G. Pipe Locations
- H. Dimensions for Existing Structures
- I. Open Excavations
- J. Test Pits
- K. Traffic Control
- L. Parking Control
- M. Project Signs
- N. Weather Protection
- O. Security Program
- P. Security Badges
- Q. Security Fence
- R. Low-impact Pavement Marking

1.02 RELATED SECTIONS <PROJECT SPECIFIC>

- A. Division 01 – Division ##

1.03 COORDINATION OF THE WORK

- A. The Contractor shall be solely responsible for coordinating all Work. The Contractor shall supervise, direct, and cooperate fully with all subcontractors, manufacturers, fabricators, suppliers, distributors, installers, testing agencies, and all others whose services, materials, or equipment are required to ensure that the Work is completed within the Contract Time.

- B. In the event of any conflict, discrepancy, or inconsistency between any of the documents which make up this Contract, the following shall control:
1. Between figures given on plans and scaled measurements, the figures shall govern.
 2. Between large scale plans and small scale plans, the large scale plans shall govern.
 3. Between plans and specifications, the requirements of the specifications shall govern.
- C. The Contractor shall cooperate fully with Metro and its representatives and all other contractors employed on the Work, including utility service companies to effect proper coordination and progress to complete the Project on schedule and in proper sequence.
- D. Other major construction contracts may be in progress at the Site and may impact the Work. The Contractor shall plan and coordinate their Work to coordinate with other contractors' work. The Contractor shall conduct and arrange its Work so as not impede or interfere with Metro's operation of the facility or the work by other Contractors working at the Site in the same or adjacent areas.
- E. The Contractor shall allow Metro or its representatives and other Project contractors or their representatives with access to the Contractor's work areas to complete any work necessary for the facility's normal operation and/or to complete other contractor's work. A 24-hour notice shall be provided for non-emergency situations whenever possible.
- F. Contractor shall prepare layout and coordination drawings that shall supplement the Contract Documents and the working and shop drawings, as required, to coordinate various trades' work. Layout and coordination drawings shall be submitted for approval upon request by the Construction Manager.
- G. The Contractor shall make all minor changes in duct, pipe, or conduit routings that do not affect the intended function; however, items may not be resized or the exposed items may not be relocated without Metro's approval. No changes shall be made in any wall locations, ceiling heights, door swings or locations, windows or other openings, or other features affecting the building's function or aesthetic effect without Metro's approval. If conflicts or interferences cannot be resolved by the Contractor, the Construction Manager shall be notified. Any coordination problems requiring architectural or structural design changes shall be submitted to the Construction Manager for resolution. No extra compensation shall be paid for removing, relocating, re-fabricating, or changing any duct, pipe, conduit routing, or other material or equipment that has been fabricated or installed without the proper coordination among all trades involved. Any failure by the Contractor to properly coordinate the Work shall not be a cause for any additional costs or increases in Contract Time to Metro.
<PROJECT SPECIFIC – DELETE WHEN NOT REQUIRED>
- H. The prime Contractor shall have a qualified representative on site at all times that contract work is being conducted.

1.04 INTERFERENCE WITH EXISTING WORKS <PROJECT SPECIFIC>

- A. The Contractor shall, at all times, conduct their operations so as to interfere as little as possible with existing works.
- B. All Work connecting with, cutting in to, and reconstructing existing pipes or structures shall be planned so that it interferes with the existing facility's operation for the shortest possible time and when the demands on the facility best permit such interference even though it may be necessary to work outside normal working hours to meet these requirements. Before starting

work that will interfere with the existing facility's operation, the Contractor shall do all possible preparatory work and shall ensure that all tools, materials, and equipment are made ready and are at hand. The Contractor shall submit a formal shut-down and tie-in plan to the Construction Manager for approval in advance of any shut-down.

- C. The Contractor shall have no claim for additional compensation due to a delay or inconvenience in adapting their operations to the need for continuous sewage flow.
- D. The Contractor shall have no claim for additional compensation due to a delay or inconvenience in adapting their operations to the need for continuous wastewater treatment at an existing plant.
- E. The Contractor shall have no claim for additional compensation due to a delay or inconvenience in adapting their operations to the need of the pumping station. The Contractor may request data on the pump stations(s) such as capacity, run times, flow data, etc., via the Request for Information process.
- F. The Contractor shall have no claim for additional compensation due to a delay or inconvenience in adapting their operations to the need for wastewater detention at existing equalization facilities.

1.05 PROTECTING AND RELOCATING EXISTING STRUCTURES AND UTILITIES

- A. The Contractor shall assume full responsibility for protecting the following, including, but not limited to, buildings, structures, and utilities—public or private, including poles, signs, services to buildings, utilities in the street, gas pipes, petroleum pipes, water pipes, hydrants, sewers, force mains, drains, electric cables, data cables, fiber cables, and telephone cables whether or not they are shown on the Drawings. The Contractor shall carefully support and protect all such structures and utilities from injury of any kind. Any damage resulting from the Contractor's operations shall be repaired by the Contractor at their expense or as required by the facility's owner at the Contractor's expense.
- B. Assistance shall be given to the Contractor in determining the location of existing services to the degree normally provided by the utility owner. The Contractor, however, shall bear the full responsibility for obtaining all locations of underground structures and utilities, including existing water services, drain lines, and sewers. Services to buildings shall be maintained, and all costs or charges resulting from damage thereto shall be paid by the Contractor.
- C. Protection and temporary removal and replacement of existing utilities and structures as described in this Section shall be part of the Work under the Contract, and all costs in connection therewith shall be included in the Total Price Bid in the Bid Form.
- D. If, in Metro's opinion, permanent utility relocation is required, Metro may direct the Contractor in writing to perform the Work. Work so ordered shall be paid at the Contract unit prices, if applicable, or as extra work. If relocating a privately owned utility is required, the owner shall notify the utility to perform the work and request that the work be performed as expeditiously as possible. The Contractor shall fully cooperate with the property owner and utility and shall have no claim for delay due to such relocation.
- E. The Contractor shall notify all utility companies in writing at least 72 hours (excluding Saturdays, Sundays and legal holidays) before excavating in any public way. The Contractor shall also notify Tennessee One-Call, telephone number 811, at least 72 hours prior to starting Work.

F. Supplying Equipment, Plants and Appurtenances

Furnish construction equipment and any mobile plants or appurtenances that shall be efficient, appropriate, and large enough to secure a satisfactory Work quality and a progress rate to ensure that the Work is completed within the Contract time. If at any time such supplied equipment, mobile plants, or appurtenances appear to the Construction Manager to be inefficient, inappropriate, or insufficient for securing the work quality required or for producing the aforesaid progress rate, the Contractor may be required to substantiate the current equipment, plants, and appurtenances that the chosen items shall allow the Contractor to meet the Contract's schedule requirements. The Construction Manager's failure to give such notification shall in no way relieve the Contractor from their obligations to secure the required Work quality and progress rate.

1.06 PROPERTY CARE AND PROTECTION

- A. The Contractor shall be responsible for preserving all public and private property and shall use every precaution necessary to prevent damage thereto. If any direct or indirect damage is done to public or private property by or on account of any act, omission, neglect, or misconduct in executing the Work on the Contractor's part, such property shall be restored by the Contractor, at its expense, to a condition similar or equal to that existing before the damage was done, or the Contractor shall make good the damage in another manner acceptable to the Construction Manager.

1.07 OCCUPYING PRIVATE LAND

- A. The Contractor shall not (except after written consent from the proper parties) enter or occupy with workers, tools, materials, or equipment any land outside of Metro's rights-of-way, easements, or property. A copy of the written consent shall be given by the Contractor to the Construction Manager prior to entering or occupying the property.

1.08 DIMENSIONS FOR EXISTING STRUCTURES

- A. Where the dimensions and locations for the existing structures are important for installing or connecting any Work part, the Contractor shall verify such dimensions and locations in the field prior to fabricating any material or equipment that depends on such information's correctness. Any material or equipment fabricated to incorrect dimensions shall be replaced at the Contractor's expense.

1.09 PIPE LOCATIONS

- A. Exterior pipelines shall be located substantially as indicated on the Drawings, but the right is reserved for Metro, acting through the Engineer and/or Construction Manager, to make such modifications in location as may be found desirable to avoid interference with existing structures or for other reasons.
- B. Small interior piping is diagrammatically indicated on the Drawings, and the exact location is to be determined in the field. Piping shall be arranged in a neat, compact, and workmanlike manner, with a minimum of crossing and interlacing to prevent interfering with equipment or access ways, and, in general, without diagonal runs.

1.10 DIMENSIONS FOR EXISTING STRUCTURES

- A. Where the dimensions and locations for the existing structures are important for installing or connecting any Work part, the Contractor shall verify such dimensions and locations in the

field before fabricating any material or equipment that depends on such information's correctness.

1.11 OPEN EXCAVATIONS

- A. In accordance with Section 01 35 23,- Safety and Health, all open excavations shall be adequately safeguarded by providing temporary barricades, fencing, caution signs, lights, and other means to prevent accidents to persons and damage to property. The Contractor shall, at their own expense, provide suitable and safe bridges and other crossings for accommodating travel by pedestrians and workers. Bridges provided for access during construction shall be removed when no longer required. The excavation's length or size shall be controlled by the particular surrounding conditions but shall always be confined to the limits prescribed by Contract requirements. If the excavation becomes a hazard or if it excessively restricts traffic at any point, the Construction Manager may require special construction procedures such as limiting the open trench length or requiring the trench to not remain open overnight or to be covered with steel plates.
- B. The Contractor shall take precautions to prevent injury to the public due to open trenches. All trenches, excavated material, equipment, or other obstacles that could be dangerous to the public shall be fully barricaded.

1.12 TEST PITS

- A. Test pits for locating underground pipelines or structures prior to the commencement of construction shall be excavated and backfilled by the Contractor at the Construction Manager's direction. Test pits shall be backfilled immediately after their purpose has been satisfied, and the surface shall be restored and maintained in a manner satisfactory to the Construction Manager.

1.13 TRAFFIC CONTROL

- A. The Contractor shall keep all streets and traffic ways within the Project limits and adjacent areas in such condition as to adequately accommodate traffic and pedestrian passage during the construction period unless otherwise approved by Metro. The Contractor shall keep roadway portions being used by Metro and public travelers free from irregularities and obstructions that may represent a hazard to Metro's operations and in such condition that traffic shall be adequately accommodated. When directed by Metro, irregularities in the adjacent pavement and holes in the adjacent hard surface pavement (potholes) shall be repaired using approved asphalt patching material.
- B. The Contractor shall provide maintenance and protection for traffic on public roadways in strict accordance with the Metropolitan Department of Public Works (Metro Public Works) and the Tennessee Department of Transportation (TDOT) regulations and permit conditions.
- C. For controlling moderate traffic, the Contractor shall provide an adequate number of flag persons employed at no additional expense to Metro.
- D. As required by Metro Public Works or the Tennessee Department of Transportation, whenever and wherever traffic is sufficiently congested or public safety is endangered, the Contractor shall furnish uniformed police officers when required to direct traffic and keep traffic off the roadway or highway area affected by the construction operations. Such officers shall be in addition to the security guards required under other Contract provisions.
- E. Whenever and wherever traffic is sufficiently congested or public safety is endangered, the Contractor, as required in the Construction Manager's opinion, shall furnish uniformed special

officers to direct traffic and to keep traffic off the roadway or highway area affected by its construction operations.

- F. The cost for such special officers shall be invoiced under the appropriate item in the Bid. If special officers qualified to direct traffic are direct employees, the Contractor shall ensure that these special officers are included under its Workers' Compensation Policy. In acquiring their Workers' Compensation coverage, the Contractor shall specifically include all such special officers in the workers' classification. If a security/traffic control firm provides these services as a subcontractor, the Contractor shall ensure that the firm has Workers' Compensation coverage. In addition, the Contractor shall make all necessary payments for such special officers.
- G. The employment or presence of traffic flag persons, special officers, or police shall in no way relieve the Contractor from any responsibility or liability under the Contract Document terms.
- H. Signs, Signals and Devices
1. Post-mounted and Wall-mounted Traffic Control and Informational Signs. As approved by the authority having jurisdiction
 2. Automatic Traffic Control Signals. As approved by the authority having jurisdiction
 3. Traffic Cones and Drums, Flares, and Lights. As approved by the authority having jurisdiction
 4. Flag person Equipment. As required by the authority having jurisdiction
- I. Flares and Lights. Use flares and lights during low visibility hours to delineate traffic lanes and to guide traffic.
- J. Haul Routes
1. Consult with the authority having jurisdiction to establish public thoroughfares to be used for haul routes and site access.
 2. Provide traffic control at critical haul route areas to regulate traffic and to minimize interference with public traffic.
 3. Comply with all roadway haul weight restrictions to prevent roadway damage.
- K. Traffic Signs and Signals
1. Provide signs at approaches to the Site and onsite, at crossroads, detours, parking areas, and elsewhere as needed to direct construction and affected public traffic.
 2. Provide, operate, and maintain automatic traffic control signals to direct and maintain orderly traffic flow in areas under the Contractor's control and in areas affected by the Contractor's operations.
 3. Relocate as Work progresses to maintain effective traffic control.
 4. The Contractor shall coordinate removing and replacing traffic loops and signals if required to perform the Work and at no additional cost to Metro.

L. Removal

1. Remove equipment and devices when no longer required.
2. Repair damage caused by the installation.
3. Remove post settings to a 2-foot depth.

1.14 PARKING CONTROL <REVISE BASED ON PROJECT REQUIREMENTS>

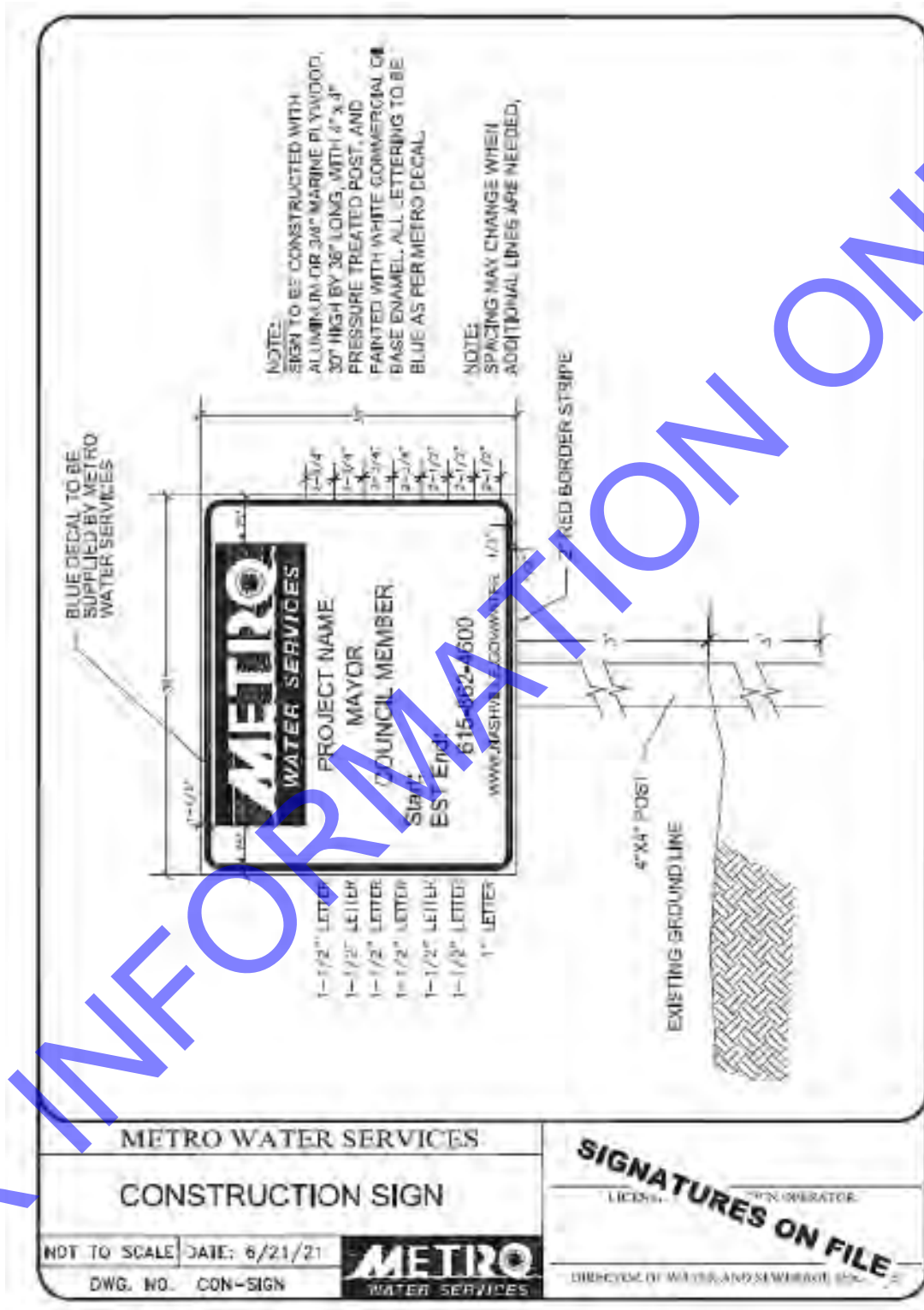
- A. Contractor shall secure any needed area(s) for offsite parking for construction and employee vehicles. <Areas to be defined are Project-specific>
- B. Parking is not allowed on the shoulders of any public road.

1.15 PROJECT SIGNS <PROJECT SPECIFIC>

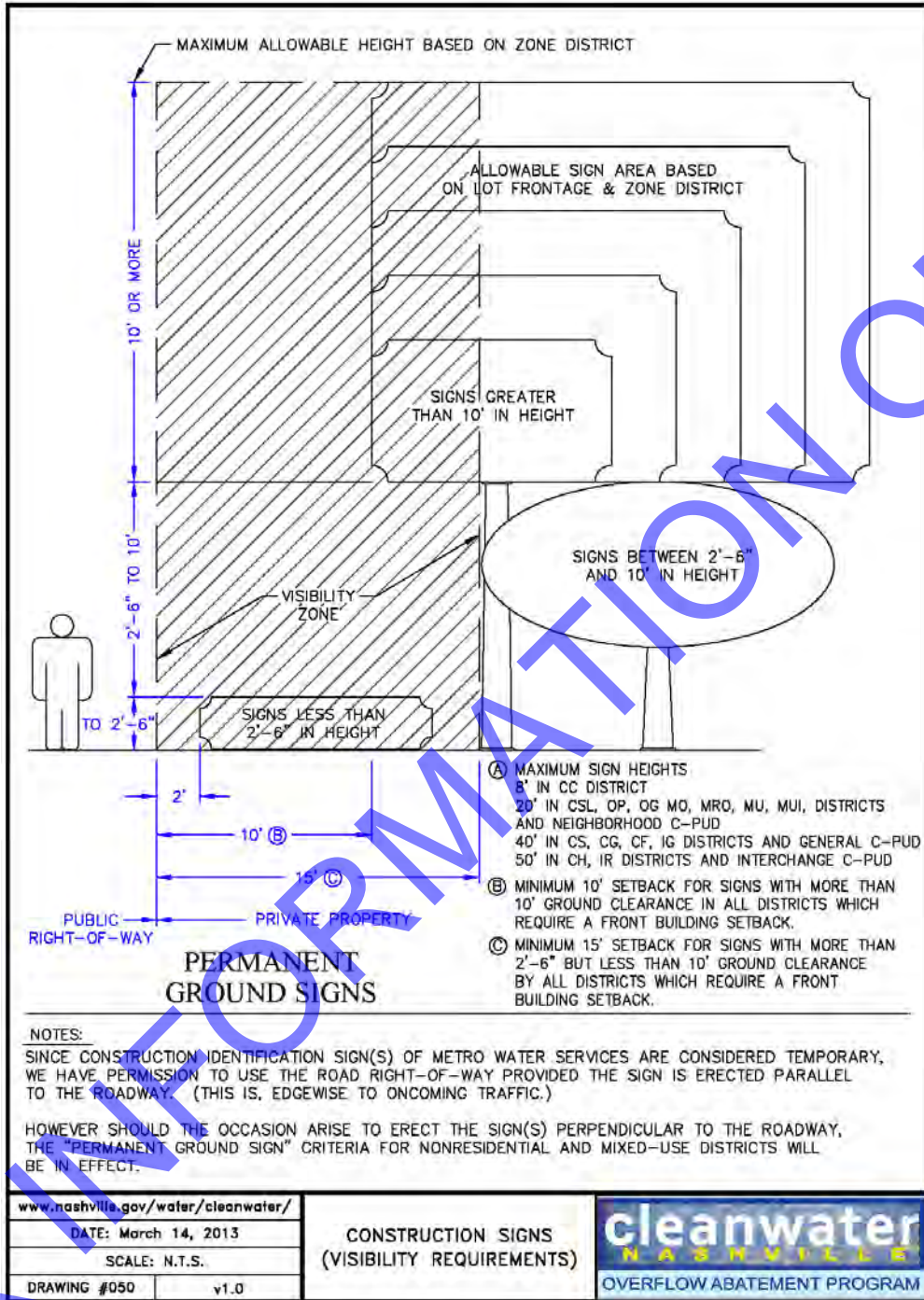
- A. Provide all labor, materials, equipment, and incidentals as shown, specified, and required for installing and maintaining temporary Project construction signs when commencing the Work. The signs are temporary for each work site. No other commercial or advertising signs will be allowed on the site of the Work or on public property in the vicinity of the Work.
<PROJECT-SPECIFIC – DEFINE WHERE THE PROJECT SIGN(S) FOR EACH DISTRICT WILL BE INSTALLED>
- B. Provide a stationary Project sign for each council district in the Project area. A set of portable signs shall be posted for each crew activity in the roadway areas and moved with daily operations, including the subcontractors' work.
- C. The content should include
 1. Project number, title, logos, and Metro information as indicated in the Contract Documents
 2. Names and titles for authorities
 3. Company name and titles of the Construction Manager, Design Engineer, and Contractor
 4. Name and local phone number for 24 hour access using Metro's 615-862-4600 emergency access number
 5. Graphic Design, Colors, Lettering Style as designated by Metro
- D. Design the sign and structure to withstand 60-mile per hour wind velocity.
- E. Sign Painter. Must be experienced as professional sign painter
- F. Finishes, Painting. The entire woodwork front, rear, and edges shall be given a priming coat of oil gloss white paint. The lettering shall be blue and neatly centered as shown on the schematic provided in this Section.
- G. Show the content, layout, lettering, color, foundation, structure, sizes, and grades for support members. The decal required on the sign shall be furnished by Metro.

- H. Sign Materials. The sign shall be fabricated of good quality 3/4-inch marine plywood or aluminum with a suitable mounting frame, post, or portable stand or steel I-post.
1. Structure and Framing. Wood or metal, structurally adequate
 2. Sign Surfaces. Exterior grade plywood with medium density overlay, minimum 3/4-inch thick, standard large sizes to minimize joints
 - a. Rough Hardware. Galvanized
 - b. Paint and Primers. Exterior quality, two coats; white sign background
 - c. Lettering. Exterior quality paint, contrasting colors as selected
- I. Installation
1. Install the Project identification sign within 15 days after the Notice to Proceed.
 2. Erect at the designated locations.
 3. Erect the supports and framing on a secure foundation, rigidly braced, and framed to resist wind loadings.
 4. Install the sign's surface plumb and level and with butt joints. Anchor securely.
 5. Paint the exposed surfaces of the sign, supports, and framing.
- J. Maintenance. Maintain the signs and supports in a clean condition. Repair deterioration and damage.
- K. Removal. Remove signs, framing, supports, and foundations at the Project's Final Completion, and restore the area.
- L. No commercial or advertising signs shall be allowed on the worksite or on public property in the Work's vicinity.

M. Sample Stationary Project Work Site Sign



N. Project Signs' Visibility Requirements



O. Sample Portable Sign



1.16 WEATHER PROTECTION

- A. The Contractor shall be responsible for initiating, maintaining, and supervising all weather protection precautions and programs in connection with the Work as required by the conditions contained in the Contract Specifications. Weather protection shall mean temporarily protecting the Work adversely affected by heat, moisture, wind, and cold by covering, enclosing, and/or heating/cooling. The Contractor shall be responsible for all costs, including heating, required for weather protection.

- B. Installing weather protection and heating devices shall comply with all safety regulations, including provisions for adequate ventilation and fire protection devices and shall be in accordance with all state, Metro, and federal regulations.
- C. Furnish and install one accurate Fahrenheit thermometer at each Work area as designated by Metro and/or Construction Manager. Furnish and install an accurate and freeze proof rain gauge at each work area as designated by the Construction Manager.
- D. Metro reserves the right to order that additional protection measures over and beyond those proposed by the Contractor be taken to safeguard all Project components. The Contractor shall not claim any compensation for such precautionary measures so ordered, nor can the Contractor claim any compensation from Metro for damage to the Work from weather elements.
- E. If temporary heat is required to protect the Work, the Contractor shall provide and install a suitable heating apparatus, provide adequate and proper fuel, and maintain heat as required.
- F. The temporary heating apparatus shall be installed and operated so that the finished work shall not be damaged. After the permanent heating system has been installed, tested, and made ready for operation, the Contractor may, at their own risk and expense, use it to provide heat for protecting the Work. Provide and pay for all fuel and care necessary, and, when the Work is ready for acceptance and at no additional cost to Metro, put the system into first-class condition even to the extent of replacing worn or damaged parts.

1.17 SECURITY PROGRAM

- A. The Contractor shall execute a security program to protect the Work, existing premises, and Metro's operations from theft, vandalism, and unauthorized entry. The Contractor shall maintain the program throughout the construction period until substantial completion has been awarded.
- B. The Contractor shall, at all times, monitor and control persons' access to the Project Site. Specifically, the Contractor shall:
 - 1. Restrict persons and vehicles from entering into Project site
 - 2. Allow entrance only to authorized persons with proper identification
 - 3. Maintain a log of workers and visitors that will be available upon request
- C. The Contractor shall control and prevent non-authorized persons and vehicles from entry. Metro and its representatives shall be allowed access to the Project Site for work associated with treatment, operations, and maintenance.

1.18 SECURITY BADGES

- A. The Contractor and subcontractors shall be required to provide to Metro a TORIS criminal background check for all employees who shall be onsite during construction at the Metro facilities such as plants, pumping stations, and detention tanks. All background checks must be submitted for interaction with the Metro's Security Department at least one week before an employee is scheduled to first be onsite. Once approved by Metro, the Contractor's personnel shall be issued Metro badge IDs that must be worn above the waist and visible at all times. Most Contractor employees shall be issued picture-less numbered badges. The Contractor shall be responsible for tracking badge use, distributing them in the morning, and collecting all

badges from personnel at the end of the shift and/or when leaving the site. These badges shall not leave the site.

- B. The Contractor's primary employees may be issued photo ID badges. The Contractor's primary employees may include the Contractors' Project Manager, Superintendent, Foremen/Supervisors, and a few selected other personnel who shall be onsite during construction at Metro facilities such as plants, pumping stations, and detention tanks. The badges for the Contractor's primary employees shall be allowed to stay with the Contractor's personnel and may leave the site.

1.19 SECURITY FENCE

- A. The Contractor shall be required to provide a permanent or temporary security fence as shown on the Contract Drawings, specifically Drawing <XXXX> in accordance with Specification Section ### ##. <PROJECT SPECIFIC - WILL NEED TO PROVIDE FENCE SPECIFICATION IF INCLUDED IN PROJECT>
- B. To preserve access control for the operating facility, the Contractor shall be required to provide security personnel for major secured treatment plant sites while security fences are relocated. <PROJECT SPECIFIC>

1.20 LOW-IMPACT PAVEMENT MARKING

- A. The Contractor shall use practices and marking materials for low-impact marking of pavements, sidewalks, curbs, gutters, and permanent features such as walls, building, etc., not replaced by construction. Furthermore, the Contractor shall, by final completion, remove all such markings placed by the Contractor and placed by others in the project area for their use such as those placed by utilities and/or utility marking services.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 20 00

APPLICATION FOR PAYMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Preparation of Application for each Progress Payment
- D. Substantiating Data for Progress Payments
- E. Submittal Procedures
- F. Sample Contractor's Payment Request form

1.02 RELATED SECTIONS

- A. Section 01 32 16/17 – Construction Progress Schedule <PROJECT SPECIFIC>
- B. Section 01 29 73 – Schedule of Values

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Submit applications for payments typed on Contractor's Payment Request forms provided by the Construction Manager. Provide itemized data on continuation sheets showing format, schedules, line items, and values. Submit applications to the Construction Manager for payment in accordance with the schedule established by the Contract Documents.
- B. Provide updated construction schedules in accordance with Section 01 32 16/17 - Construction Progress Schedule <PROJECT SPECIFIC> as the basis for payment.

1.04 PREPARATION OF APPLICATION FOR EACH PROGRESS PAYMENT

- A. A Contractor's Payment Request form may be obtained from the Construction Manager.
- B. Contractor's Payment Request Form:
 - 1. Complete the required information on the Contractor's Payment Request form.
 - 2. Execute the certification with the signature of a responsible officer of Contractor. An original signature should appear on each copy submitted.
 - 3. Attach to the Contractor's Payment Request form the Critical Path Method schedule and an updated submittal as required by Section 01 32 17 - Construction Project Schedule<PROJECT SPECIFIC – DELETE WHEN USING 01 32 16>.
 - 4. For payment of stored materials, the original invoices must be attached to the Contractor's Payment Request form. The Contractor shall submit documents from the

vendor indicating payment of such stored materials within 90 days following claim of stored materials.

5. List of subcontractors that have performed work onsite during the pay period
6. List of amounts paid to subcontractors

1.05 SUBSTANTIATING DATA FOR PROGRESS PAYMENTS

- A. When requested to provide substantiating data, submit suitable information with a cover letter identifying the following:
 1. Project
 2. Contractor's Payment Request number and date
 3. Detailed list of enclosures
 4. For stored products:
 - a. Item number and identification as shown on application
 - b. Description of specific material
 5. All documentation required in the Purchase Agreement "Contract Terms and Conditions" with the Request for Payment, including documentation as required by Metro's Equal Business Opportunity programs.
- B. Submit one copy of the data required in Paragraph 1.05.A and cover letter for each copy of a Contractor's Payment Request.
- C. Upon Substantial Completion, the Metropolitan Government shall pay the Contractor an amount sufficient to increase total payments to the Contractor to one hundred percent (100%) of the Contract Price less any amounts attributable to unit price item adjustments, allowance adjustments, damages, and deductions, including deduction of one hundred and twenty-five percent (125%) of the reasonable costs as determined by the Metropolitan Government for completing all incomplete work, correcting and bringing into conformity all defective and nonconforming work, and handling any outstanding or threatened claims.

1.06 SUBMITTAL PROCEDURES

- A. Submit the Payment Request on or before the tenth of each month.
- B. Submit three (3) hard copies of each payment application.
- C. Submit one (1) hard copy of the updated *Recap of Small Business/MWBE Participation on Metro Project Report with related invoices*.
- D. Submit an updated electronic Construction Progress Schedule in accordance with Section 01 32 16 – Construction Progress Schedule on or before the tenth of each month using the PMIS business process with each Application for Payment.
- E. When the Contractor's Request for Payment is determined to be properly completed and acceptable, including verification of the submittal of the SBE/MWBE recap report with

invoices and a schedule, the payment application will be transmitted by the Construction Manager to Metro for approval and payment.

1.07 ALLOWANCE REIMBURSEMENT AND FINAL PAYMENT TIME CONSTRAINTS

- A. Compensation reimbursement under contract Allowances, such as for Traffic Control, shall be made only for documented work submitted on periodic payment requests and within 90 days after the month of performance.
- B. Requests for reimbursement in excess of the contract Allowance amount shall only be considered by Metro if requested in writing within 90 calendar days after the month of the performance of the work.
- C. A Final Pay Application, complete with final quantities and supporting documentation for lump sum items, unit price items, allowance items, and change management items shall be submitted within 90 calendar days after the date of Substantial Completion.
- D. Payment Requests for the costs of uniformed officer traffic control submitted after 90 days of the month of performance, shall be considered waived by the Contractor and void by Metro and may not be reimbursed at Metro's discretion. Traffic control services provided by uniformed officers shall be in addition to, and not in lieu of, flaggers provided by the Contractor. Costs of traffic control services by uniformed officers for a re-work required as a result of sub-standard quality of the original work shall be borne by the Contractor.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

PART 4 - FORMS

1. Sample form provided for a Contractor's Payment Request

CONTRACTOR'S PAYMENT REQUEST

PROJECT: _____	PAYMENT APPLICATION NO: _____
ENGINEER: _____	PAYMENT APPLICATION DATE: _____ to _____
CONTRACTOR: _____	MWS ORDER NO: _____ MWS CONTRACT NO: _____
OAP PROJ NO: _____	CONTRACTOR PROJ NO: _____
TO OWNER: _____	REMIT TO: _____
ATTENTION: _____	PHONE: _____
MWS PROJ. NO: _____	FED TAX ID: _____

THIS REQUEST FOR PAYMENT IS FOR AMOUNT SHOWN BELOW IN CONNECTION WITH THE CONTRACT. CONTINUATION SHEET IS ATTACHED. THE PRESENT STATUS OF THE ACCOUNT FOR THIS CONTRACT IS AS FOLLOWS:

Current Period Amount Earned for Construction:	\$0.00	Original Contract Amount:	\$0.00
Current Amount for Stored Materials:	\$0.00	Net Change by Change Orders:	\$0.00
Less Retainage of 5%:	\$0.00	Current Contract Amount:	\$0.00
Total amount Payable due this period:	\$0.00		
Previous Amount Earned for Construction:	\$0.00	Total Amount Earned for Construction:	\$0.00
Previous Amount for Stored Materials:	\$0.00	Total Amount for Stored Materials:	\$0.00
Previous Retainage Billed:	\$0.00	Total Retainage:	\$0.00
		Total Contract Remaining:	\$0.00

THE UNDERSIGNED CONTRACTOR CERTIFIES THAT TO THE BEST OF HIS KNOWLEDGE, INFORMATION AND BELIEF, THE WORK COVERED BY THIS REQUEST FOR PAYMENT HAS BEEN COMPLETED IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, THAT ALL AMOUNTS HAVE BEEN PAID BY HIM FOR WORK WHICH PREVIOUS REQUESTS FOR PAYMENT WERE ISSUED AND PAYMENTS RECEIVED FROM THE OWNER, AND THAT THE CURRENT AMOUNT SHOWN HEREIN IS NOW DUE.

CONTRACTOR: _____

BY: _____ DATE: _____

IN ACCORDANCE WITH THE CONTRACT DOCUMENTS AND BASED ON ON-SITE OBSERVATIONS AND THE DATA COMPRISING THE ABOVE INVOICE, THE CONSTRUCTION MANAGER (CM) CERTIFIES TO THE OWNER THAT TO THE BEST OF THE CM'S KNOWLEDGE, INFORMATION AND BELIEF, THE WORK HAS PROGRESSED AS INDICATED, THE QUALITY OF THE WORK IS IN ACCORDANCE WITH THE CONTRACT DOCUMENTS, AND THE CONTRACTOR IS ENTITLED TO PAYMENT OF THE AMOUNT CERTIFIED.

CONSTRUCTION MANAGER: _____ OWNER
 BY: _____ DATE: _____ AMOUNT CERTIFIED: _____ SCM
 CONTRACTOR

OWNER: _____

BY: _____ DATE: _____

THIS INVOICE IS NOT NEGOTIABLE. IT IS PAYABLE ONLY TO THE PAYEE NAMED HEREIN AND ITS ISSUANCE, PAYMENT AND ACCEPTANCE ARE WITHOUT PREJUDICE TO ANY RIGHTS OF THE OWNER OR CONTRACTOR UNDER THEIR CONTRACT.

END OF SECTION

FOR INFORMATION ONLY

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Substitution Requirements
- D. Acceptable Equivalent Products, Materials and Equipment
- E. Quality Assurance
- F. Coordination
- G. Substitution Requests
- H. Form 01 25 00-1, Substitution Request

1.02 RELATED SECTIONS

- A. Section 01 33 00 – Submittals
- B. Section 01 61 16 – Web Based Information Management
- C. Section 01 43 00 – Quality Requirements
- D. Division 02 – ## <PROJECT SPECIFIC>

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Whenever an item of material or equipment is specified or described in the Contract Documents by using the name of a proprietary item or the name of a particular Supplier, the specification or description is intended to establish the type, function, appearance, and quality required. Unless the specification or description contains or is followed by words reading “no like, equivalent, “or equal” item, or substitution is permitted,” other items of material or equipment or material or equipment of other Suppliers may be submitted to the Construction Manager for review under the circumstances described in this Section.
- B. If a specific means, method, technique, sequence, or procedure of construction is expressly required by the Contract Documents, the Contractor may furnish or utilize a substitute means, method, technique, sequence, or procedure of construction only if approved by Metro in writing prior to implementation. The Contractor shall submit sufficient information to allow Metro, at Metro's sole discretion, to determine that the substitute proposed is equivalent to that expressly called for by the Contract Documents. The requirements for review by the Metro will be similar to those provided in Paragraph 3.01.
- C. “Or Equal” Items. If, at Metro's discretion, an item of material or equipment proposed by the Contractor is functionally equal to that named and is sufficiently similar so that no change in

the related Work will be required, it may be considered by Metro as an “or equal” item in which case the review and approval of the proposed item may, at Metro’s sole discretion, be accomplished without compliance with some or all of the requirements for approval of proposed substitute items. For the purposes of this Paragraph, a proposed item of material or equipment will be considered functionally equal to an item so named if, in the exercise of reasonable judgment, it is determined that:

1. It is at least equal in materials of construction, quality, durability, appearance, strength, and design characteristics.
 2. It will reliably perform the intended function at least equally well and achieve the results imposed by the design concept of the completed Project as a functioning whole.
 3. It has a proven record of performance, equivalent or less life cycle power consumption, and availability of responsive service.
 4. The Contractor certifies that, if approved and incorporated into the Work,
 - a. There will be no increase in cost to Metro or increase in Contract Times.
 - b. Any cost savings will be available to Metro.
 - c. It will conform substantially to the detailed requirements of the item named in the Contract Documents.
- D. Substitutions. If, at Metro’s sole discretion, an item of material or equipment proposed by the Contractor does not qualify as an “or equal” item under Paragraph C, it will be considered a proposed substitute item.
1. The Contractor shall submit sufficient information as described below to allow a determination about whether or not the item of material or equipment proposed is essentially equivalent to that named and is an acceptable substitute therefore. Requests for the review of the proposed substitute items of material or equipment will not be accepted from anyone other than the Contractor.
 2. The requirements for review as set forth in this Specification are in addition to additional stipulations Metro may decide are appropriate under the circumstances.
- E. Prior to ordering, installing, or implementing substitutions and “or equals”, the Contractor shall request and receive, in writing, approval from Metro accepting the proposed substitution.

1.04 SUBSTITUTION REQUIREMENTS

- A. Any material item, equipment, specific means, method, technique, sequence, or procedure of construction that the Contractor wants to substitute must follow this Section’s requirements.
- B. The Contractor may choose equipment from a manufacturer of an acceptable equivalent product; however, this shall be treated as a substitution, and the Contractor must follow the requirements in this Section. If the Contractor chooses to substitute equipment from someone other than a named manufacturer, any additional costs required to accommodate such equipment shall be made without a change in the Contract Price or Contract Time and at no additional cost to Metro.

- C. Metro reserves the right to determine when proprietary items have no equivalency and when the operations' uniformity, parts' interchangeability, standard parts inventory, etc., are in Metro's best interest.

1.05 ACCEPTABLE EQUIVALENT PRODUCTS, MATERIALS AND EQUIPMENT

- A. Requests for equivalency review shall be considered when sufficient information as described herein has been submitted to allow a complete review.
- B. Such requests shall not be accepted from anyone other than the Contractor. Such submission must be made prior to purchasing, fabricating, manufacturing, or using the equivalent items under consideration.
- C. The Contractor is responsible for all delays caused by their failure to submit complete and accurate information with any request for approval of any material, article, system, or subsystem as an equivalent.

1. Contractor Risk

- a. If the Contractor includes in their bid or later proposes any material, product, or equipment that they consider equivalent to that specified, the Contractor assumes all risks associated with the proposed equivalent item's acceptance or rejection.
- b. The Contractor shall have no right to make a claim based on their bid that included a proposed equivalent work item and resulted in a lower bid amount for said item or lower total bid.

2. Equivalency

- a. An item shall be considered equivalent to the item specified if:
 - 1) It is equal or better in design and strength in all subparts, quality, reliability and durability, operation, maintenance, and serviceability, as applicable, and
 - 2) It is equal or better in specified parameters of performance in all respects for the specific function indicated in the Contract Documents.

3. Supplemental Requirements

- a. The costs associated with an equivalency review shall be paid by the Contractor through a deduction to the Contract Amount.
- b. Any tests required by Metro to establish quality and performance standards shall be promptly conducted by or through the Contractor at no additional cost.
- c. The Contractor shall submit any additional data requested for the equivalency review.
- d. The Contractor shall satisfactorily accomplish all changes, including any engineering associated with the use of equivalent items, at no additional cost.
- e. The Contractor shall have no right to appeal any decision by Metro rejecting the equivalency of any item.

1.06 QUALITY ASSURANCE

- A. The Contractor must comply with the requirements specified in Section 01 43 00,- Quality Requirements.
- B. Substitutions Compatibility. The Contractor shall investigate and document the compatibility of the proposed substitution with related products and materials. At no cost to Metro, the Contractor shall engage a qualified testing agency to perform the compatibility tests recommended by the manufacturer.
- C. Metro may require the Contractor to furnish, at the Contractor's expense, a special performance guarantee or other surety with respect to any substitute.

1.07 COORDINATION

- A. The Contractor shall revise or adjust the affected Work, as necessary, to integrate the Work for the approved substitutions at no cost to Metro.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 SUBSTITUTION REQUESTS

- A. Submit a copy of each request for consideration in accordance with the Contract Documents. Identify the product, fabrication, or installation method to be replaced. Include the Specification Section numbers and titles and Drawing numbers and titles.
- B. Documentation. Show compliance with the requirements for substitutions and the following, as applicable:
 - 1. Provide justification for using the proposed equivalent item, including evidence, as applicable, that the Contract-specified material, product, or equipment is unobtainable or unobtainable within an acceptable time for Contract completion.
 - 2. Submit a statement indicating why the specified product, fabrication, or installation cannot be provided, if applicable.
 - 3. Supply coordination information that will be needed as a result of the change or revision, including a list with changes or revisions to other parts of the Work and to the construction performed by Metro and separate contractors who shall be necessary to accommodate the proposed substitution.
 - 4. Provide a document comparing the proposed substitution's qualities in detail with those of the Work specified. Include an annotated copy of the applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, electrical characteristics, visual effect, specified sustainable design characteristics, warranties, and specific features and requirements indicated and specified. Indicate deviations, if any, from the Work specified.

- FOR INFORMATION ONLY
5. Submit product data, including drawings and descriptions for the products and fabrication and installation procedures.
 6. Supply samples, when applicable or requested.
 7. Provide certificates and qualification data, when applicable or requested.
 8. Furnish a list of similar installations for completed projects, including the project names and addresses and the names, telephone numbers, and addresses for engineers and owners, when requested.
 9. Submit material test reports from a qualified testing agency indicating and interpreting test results for compliance with the requirements indicated, when requested.
 10. Supply research reports evidencing compliance with the building codes in effect for the Project, when requested.
 11. Provide a detailed comparison of the Contractor's construction schedule using the proposed substitution with products specified for the Work, including the effect on the overall Contract Time.
 12. Provide any additional labor costs associated with the proposed substitution.
 13. Submit cost information, including a change proposal, if any reduction, in the Contract Price.
 14. Furnish a list of any effects that the proposed change shall have on Metro's operation and maintenance costs, when applicable.
 15. Supply a Contractor's certification stating, "The proposed substitution complies with the requirements of the Contract Documents except as indicated in this substitution request, is compatible with related materials, and is intended for the applications indicated."
 16. The Contractor shall not be entitled to any additional payment or time that may subsequently become necessary because the proposed substitution failed to produce the indicated results.
- C. If necessary, additional information or documentation shall be requested for evaluation within 10 days after receiving a request for substitution. The Construction Manager shall notify the Contractor in writing about Metro's acceptance or rejection of the proposed substitution within 21 days after receiving the request or within seven days after receiving additional information or documentation, whichever is later. If the Contractor does not receive a response in the allotted time, the Contractor shall use the item of material or equipment originally specified.
- D. Changes caused by substitutions will be noted on all applicable drawings within the set of record drawings.

PART 4 - FORMS

1. Form 01 25 00-1 Substitution Request

SUBSTITUTION REQUEST

The Undersigned certifies:

- The proposed substitution has been fully investigated and determined to be equal or superior in all respects to the specified product.
- The same warranty shall be furnished for the proposed substitution as for specified product.
- The same maintenance service and replacement part source, as applicable, is available.
- The proposed substitution shall have no adverse effect on other trades and shall not affect or delay the Progress Schedule.
- Claims for additional costs related to the accepted substitution that may subsequently become apparent are to be waived by the Contractor.
- The proposed substitution does not affect any dimensions or functional clearances.
- The Contractor shall pay for changes to the design, including the Engineering design, detailing, and construction costs caused by the substitution.
- The coordination, installation, and changes in the Work, as necessary, for the accepted substitution shall be complete in all respects.

Submitted: _____

Signature: _____

Firm: _____

Address: _____

Telephone: _____

Attachments: _____

Additional Comments: Contractor Subcontractor Supplier Manufacturer Engineer Other:

REVIEW AND ACTION

- Substitution approved – Make submittals in accordance with Specification Section 01 25 00.
- Substitution approved as noted – Make submittals in accordance with Specification Section 01 25 00.
- Substitution rejected – Use specified materials.
- Substitution Request received too late – Use specified materials.

Signature: _____

Date: _____

SUBSTITUTION REQUEST

Project: _____	Submittal Number: _____
To: _____	From: _____
RE: _____	Date: _____
CWNOAP Project Number: _____	Metro Project Number: _____

Specification Title: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No. _____

Installer: _____ Address: _____ Phone: _____

History: New product 1-4 years old 5-10 years More than 10 years old

Differences between proposed substitution and specified product:

Point-by-point comparative data attached – REQUIRED

Reason for Substitution Request: _____

Similar Installation: <i>Use additional pages as necessary</i>	Construction Manager: _____
Project: _____	Owner: _____
Address: _____	Date Installed: _____

Proposed substitution affects other part of Work: No Yes

Explain: _____

Savings to Metro for accepting substitution: _____

Proposed substitution's impact to Construction Schedule: None Yes

Provide a detailed explanation, including proposed adding or deducting days: _____

Supporting data attached: Drawings Product Data Samples Tests Reports

Name of supporting data: _____

END OF SECTION

SECTION 01 26 63

CONTRACT CHANGE

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Definitions
- C. Authorized Changes in the Work
- D. Differing Subsurface or Physical Conditions
- E. Unauthorized Changes in the Work
- F. Claims
- G. Allowable Costs for Authorized Changes
- H. Unit Price Work
- I. Costs for Compensable Schedule Impact
- J. Change Proposals
- K. Contractor's Price Proposals
- L. Preparation of Change Orders, Field Authorizations and Change Authorizations
- M. Correlation with Contractor's Submittals

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 32 16/17 – Construction Progress Schedule <PROJECT SPECIFIC>

1.03 DEFINITIONS

- A. Minor Changes. Minor Changes are minor variations from the requirements of the Contract Documents that do not involve an adjustment in the Contract Price or the Contract Time and are compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
- B. Field Authorizations. Field Authorizations are those changes that may be made in the field with prior written approval or modification to the contract.
- C. Change Authorizations. Change Authorizations are changes that are out of scope or that exceed the Field Authorization limit on a single occurrence or that equal or exceed the pre-defined Field Authorization allowance.

- D. Change Orders. Change Orders are formal modifications to the contract used when the change does not meet the criteria of Field Authorizations or Change Authorizations or the cumulative changes result in an increase that exceeds pre-established limits.
- E. Claims. Claims are a demand or assertion by Metro or the Contractor seeking an adjustment of Contract Price or Contract Times or both or other relief with respect to the terms of the Contract.

1.04 AUTHORIZED CHANGES IN THE WORK

- A. At any time, Metro may order additions, deletions, or revisions in the Work by a Change Order or other appropriate documents as described in paragraph 1.03. Upon the receipt of any such document, the Contractor shall promptly proceed with the Work involved that will be performed under a Field Authorization, Change Authorization, or Change Order.
- B. Payment shall be made for approved Field Authorizations and/or Change Authorizations upon completion of the additional Work up to the Contract Price.
- C. Whenever the amount of the Field Authorization(s) equals the Field Allowance, a Change Authorization will be prepared. The Purchasing Agent may then authorize additional Field Authorizations until the Field Allowance is again equaled, at which time another Change Authorization must be submitted, and approval for additional Field Authorizations must be obtained.
- D. No payment will be made by Metro for the cumulative Work, approved Field Authorizations, and /or approved Change Authorizations in excess of the Contract Price without an executed Change Order that modifies the terms of the Contract
- E. Authorized minor changes shall be documented by formal written requests and the Work shall proceed, but no change to the contract documents shall be required.
- F. Change Order Limits
 - 1. Change Orders shall be prepared whenever the change does not meet the criteria for a change to be ordered for Field Authorization or Change Authorization.
 - 2. Change Orders shall be prepared when the Price of the Change or cumulative total of Change Authorizations equals ten percent (10%) of the Contract Price if the Price is less than one million dollars (\$1,000,000.00) or five percent (5%) of the Contract Price if the Price is one million dollars (\$1,000,000.00) or more (as provided in Metropolitan Government Mayoral Administrative Order 91-01).
 - 3. Prior to the final payment, a Change Order shall be prepared that reflects all changes to the Contract Price resulting from Field Authorizations or Change Authorizations not already reflected in a previous Change Order.

G. Summary of Contract Change Documents Requirements

Original Contract Price	Field Allowance/Proposed Change Amount	Contract Change Document
0 to \$999,999.99	\$10,000 or 5% of Original Contract whichever is greater	Field Authorization
\$1,000,000 to \$1,999,999.99	\$50,000.00	Field Authorization
Greater than \$2,000,000	1.25% of original Contract Price	Field Authorization
All	Greater than the Field Authorization Allowance	Change Authorization
0 to \$999,999.99	Change Authorizations are greater than 10% of the Contract Price	Change Order
Greater than \$1,000,000	Change Authorizations are greater than 5% of the Contract Price	Change Order
All	Interim change is greater than the Change Authorization amount	Change Order
All	Final Payment Closeout	Change Order

1.05 DIFFERING SUBSURFACE OR PHYSICAL CONDITIONS

- A. If the Contractor believes that any subsurface or physical condition that is uncovered or revealed at the site either:
1. Is of such a nature as to establish that any Technical Data on which Contractor is entitled to rely upon in the listed Contract Documents is materially inaccurate, or
 2. Is of such a nature as to require a change in the Drawings or Specifications, or
 3. Differs materially from that shown or indicated in the Contract Documents, or
 4. Is of an unusual nature and differs materially from conditions ordinarily encountered and generally recognized as inherent in work of the character provided for in the Contract Documents:

Then the Contractor shall promptly, after becoming aware thereof and before further disturbing the subsurface or physical conditions or performing any Work in connection therewith (except in an emergency), notify the Construction Manager in writing about such condition. Contractor shall not further disturb such condition or perform any Work in connection therewith (except in an emergency) until receipt of a written statement from the Construction Manager permitting Contractor to do so and invocation of the Contract Change process outlined in Claims (Paragraph 1.07).

1.06 UNAUTHORIZED CHANGES IN THE WORK

The Contractor shall not be entitled to an increase in the Contract Price or an extension of the Contract Times with respect to any Work performed that is not required by the Contract Documents as amended, modified, or supplemented by a Field Authorization, Change Authorization, or Change Order.

1.07 CLAIMS

- A. Claims shall be addressed as stated in Section 17, Claims of the Contractor, in the Purchase Agreement.
- B. Written notice stating the general nature of each Claim shall be delivered to Metro. The responsibility to substantiate a Claim shall rest with the party making the Claim.
- C. Failure to provide a notice of Claim within said period or failure to provide a complete Claim submittal within the time required in accordance with this Section shall bar the Claim.
- D. A comprehensive determination of the amount or extent of the Claim with supporting data shall be delivered to the Construction Manager within thirty (30) days of providing formal notice.
- E. A Claim for an adjustment in the Contract Price shall be prepared in accordance with the provisions for calculating the costs presented in paragraph 1.08 below. The decision of Metro in evaluating the merit of the Claim shall be final, subject to local codes and regulations.
- F. No Claim from the Contractor's subcontractor may be submitted without a complete written Claim analysis, including an independent cost proposal.
- G. For all Contractor Claims seeking an increase in the Contract Price or Contract Times, the Contractor shall submit with the Claim an affidavit certifying that:
 1. The Claim is made in good faith, and the amount claimed accurately reflects the adjustments in the Contract Price or Contract Time for which the Contractor believes that Metro is liable and covers all direct, supplemental, indirect consequential, serial, and cumulative costs and delays to which the Contractor is entitled as a result of the occurrence of the claimed event.
 2. Supporting Cost and Pricing Data are current, accurate, and complete and represent the best of the of the Contractor's knowledge and belief.
- H. All Claims for time shall be supported by an analysis of the Progress Schedule detailing the impact of the claimed Work.

1.08 ALLOWABLE COSTS FOR AUTHORIZED CHANGES

- A. **Costs Included.** When the value of any Work covered by a Change Order or when a Claim for an adjustment in Contract Price is determined on the basis of cost of the Work, the costs to be reimbursed to Contractor will be only those additional or incremental costs required because of the change in the Work or because of the event giving rise to the Claim. Such costs shall be in amounts no higher than those prevailing in the locality of the Project, shall not include any of the costs specifically excluded in this Paragraph, and shall include only the following items:
 1. Payroll costs for employees in the direct employ of Contractor in the performance of the Work under schedules of job classifications agreed upon by Metro and Contractor.

Such employees shall include, without limitation, superintendents, foremen, and other personnel employed full time on the Work. Payroll costs shall include, but not be limited to, salaries and wages plus the cost of fringe benefits, including social security contributions; unemployment, excise, and payroll taxes; workers' compensation; health and retirement benefits; bonuses; and sick leave, vacation, and applicable holiday pay.

2. Cost of all materials and equipment furnished and incorporated in the Work, including costs of transportation and storage, and Suppliers' field services required.
3. Payments made by Contractor to subcontractors for Work performed by subcontractors
4. Supplemental costs as approved by Metro, including special consultants, transportation, expenses, taxes, fuel costs, and additional bond or insurance premiums

B. Costs Excluded

1. Payroll costs and other compensation of the Contractor's officers, executives, principals (of partnerships and sole proprietorships), general managers, safety managers, engineers, architects, estimators, attorneys, auditors, accountants, purchasing and contracting agents, expeditors, timekeepers, clerks, and other personnel employed by Contractor, whether at the Site or in Contractor's principal or branch office for general administration of the Work and not specifically included in the agreed upon schedule of job classifications referred to in paragraph 1.08.A.1 above
2. Expenses of the Contractor's principal and branch offices other than the Contractor's office at the Site
3. Any part of the Contractor's capital expenses, including interest on the Contractor's capital employed for the Work and charges against the Contractor for delinquent payments
4. Costs due to the negligence of the Contractor or any subcontractor, including the correction of defective Work, disposal of materials or equipment wrongly supplied, and making good any damage to property
5. Other overhead or general expense costs of any kind and the costs of any item not specifically and expressly included in Paragraph 1.08.A above

C. Contractor's Fee

1. Where the Contract Documents provide that all or part of the Work is to be done on a Unit Price Basis and the change may be quantified in additional units, each unit price will be deemed to include an amount considered by the Contractor to be adequate to cover the Contractor's overhead and profit for each separately identified item.
2. Where the Contract Documents are structured for all of the Work to be performed on the basis of cost-plus, the Contractor's fee for additional Work shall be determined at the rates set forth in the Agreement.
3. In all other instances, the Contractor's shall receive a fixed fee for additional Work calculated based upon the following percentages:
 - a. 15% of direct labor, materials, and equipment costs defined in paragraphs 1.08.A.1 and 1.08.A.2 above

- b. 5% of payments made to first tier subcontractors as defined in paragraph 1.08.A.3 above. Note that, in the event that multiple tiers of subcontracts are involved, the subcontractor actually performing the Work is entitled to a fee of 15% of its direct labor, equipment, and material costs, and each higher tier culminating in the General Contractor is entitled to a percentage of 5% of the lowest tier subcontractor's price.
 - c. No fee is due for the supplemental costs or excluded costs defined in paragraphs 1.08.A.4 and 1.08.B respectively.
4. A Time and Materials (T&M) oriented change is not preferred but may be used where the estimate of the cost impacts is difficult to quantify, such as for investigative work. If the change is a T&M change, the Construction Manager will agree on labor and equipment rates, as necessary, and establish a not-to-exceed amount.

1.09 UNIT PRICE WORK

- A. Where the Contract Documents provide that all or part of the Work is to be Unit Price Work, initially the Contract Price will be deemed to include for all Unit Price Work an amount equal to the sum of the unit price for each separately identified item of Unit Price Work times the estimated quantity of each item as indicated in the Agreement.
- B. The estimated quantities of items of Unit Price Work are not guaranteed and are solely for the purpose of comparison of Bids and determining an initial Contract Price. Determinations of the actual quantities and classifications of Unit Price Work performed by Contractor will be made by the Construction Manager in accordance with Section 01 29 01, Measurement and Payment (Unit Prices).
- C. Each unit price will be deemed to include an amount considered by Contractor to be adequate to cover the Contractor's overhead and profit for each separately identified item.

1.10 COSTS FOR COMPENSABLE SCHEDULE IMPACT

Should a rigorous time impact analysis as required by Specification Section 01 32 16/17, – Construction Progress Schedule <PROJECT SPECIFIC> substantiate an impact to the Construction Schedule that extends the critical path of the Work, and, further, that the impact is judged as compensable by the terms of the Agreement, the Contractor shall be compensated for reasonable overhead costs associated with an extension of a site presence beyond the anticipated duration of the Work. Total compensation will be negotiated based upon an auditable substantiation of the Contractor's financial impact.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 CHANGE PROPOSALS

- A. Metro may initiate changes by submitting a Request for Proposal (RFP) to the Contractor. The request will include:
1. A detailed description of the change, products, and location of the change in the project
 2. Supplementary or revised Contract Drawings and Specifications
 3. The projected time span for making the change and a specific statement as to whether overtime work is, or is not, authorized
 4. Such a request is for information only and is not an instruction to execute the changes or to stop the Work in progress.
- B. The Contractor may initiate changes by submitting a written change request containing:
1. A description of the proposed changes
 2. A statement of the reason for proposing the changes
 3. A statement of the effect on the Contract Price and the Contract Time
 4. A statement of the effect on the Work on Metro, utilities, or other Contractors
 5. Documentation supporting any change in Contract Price or Contract Time

3.02 CONTRACTOR'S PRICE PROPOSALS

- A. Nothing contained herein precludes the Contractor from requesting or proposing a change in the Work in accordance with Paragraph 3.01.B. above.
- B. The Construction Manager will evaluate the Contractor's change requests. If it is determined that a proposed change has validity, the Construction Manager will request a price proposal from the Contractor.
- C. The Contractor's price proposals shall become due within fifteen (15) days after the receipt of Metro's RFP or the Construction Manager's recommendation for the Contractor to proceed with submitting a price proposal for the Contractor's proposed changes (unless Metro allows an additional period of time). Any delay in submission will not justify or constitute a basis for an increase in Contract Price or Contract Time.
- D. The Contractor's price proposal shall certify in writing that the amounts included cover all direct, indirect, supplemental, consequential, serial, and cumulative costs and delays, as applicable, and that those delay costs were or will be incurred. These costs include the following:
1. Labor required
 2. Equipment required

3. Products required
 - a. Recommended source of purchase and unit cost
 - b. Quantities required
4. Taxes, insurance, and bonds
5. Credit for the Work deleted from Contract similarly documented
6. Overhead and profit
7. Justification for any change in Contract Time

3.03 PREPARATION OF CHANGE ORDERS, FIELD AUTHORIZATIONS AND CHANGE AUTHORIZATIONS

- A. Metro will prepare each change document with technical requirements provided by the Construction Manager.
- B. Change Orders, Field Authorizations, and Change Authorizations will describe changes in the Work, both additions and deletions, with attachments of revised Contract Documents to define details of the change.
- C. Change Orders will provide an accounting of the adjustment in the Contract Price and in the Contract Time.
- D. Field Authorizations and Change Authorizations will describe the changes in the Work and/or memorialize agreements.
- E. The Contractor shall promptly sign, date, and return the original Change Order.

3.04 CORRELATION WITH CONTRACTOR'S SUBMITTALS

- A. Revise the Schedule of Values and Contractor's Payment Request forms to record each change as a separate item of Work. The Contract Price will be changed only when a change order has been fully executed by both Metro and the Contra and to record the adjusted Contract Price.
- B. Revise the Construction Schedule monthly to reflect each change in Contract Time.
 1. Revise sub-schedules to show changes for other items of Work affected by the changes.
- C. Upon completion of Work, the Contractor shall enter pertinent changes in the Project as-builts.

END OF SECTION

SECTION 01 26 64

WEATHER DELAYS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Extension of Contract Time
- C. Standard CWNOAP Baseline for Adverse Weather
- D. Adverse Weather and Weather Delay Days
- E. Claims

1.02 RELATED SECTIONS

- A. Section 01 26 63 – Contract Changes
- B. Section 01 32 16/17 – Construction Progress Schedule <PROJECT SPECIFIC>

1.03 EXTENSION OF CONTRACT TIME

- A. If a claim is made for an extension of time based on weather delays, an extension may be granted only for the number of abnormal, adverse Weather Delay Days on the Progress Schedule’s Critical Path in excess of the number of calendar days listed for the applicable month in the Standard CWNOAP Baseline. Any proposed changes to contract time shall be considered in accordance with the procedures set forth under Section 01 26 63, Contract Change.

1.04 STANDARD CWNOAP BASELINE FOR ADVERSE WEATHER

- A. The Standard CWNOAP Baseline is defined as the number of calendar days for each month during which critical path construction activity exposed to weather conditions is expected to be affected by adverse weather. The Contractor shall incorporate the expected adverse weather days into their schedule.
- B. Suspension of construction activity for the number of calendar days each month as listed in the Standard CWNOAP Baseline is included in the Work and is NOT eligible for an extension of time claim.
- C. Metro has established a Standard CWNOAP Baseline for projects within the Metro Water Services service area as follows:

Standard CWNOAP Baseline Calendar Days for Adverse Weather											
JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
13	6	7	6	6	6	6	5	5	4	5	9

1.05 ADVERSE WEATHER AND WEATHER DELAY DAYS

- A. Adverse Weather for the development of the Standard CWNOAP Baseline is defined as the occurrence of one or more of the following conditions within a twenty-four (24) day that prevents 1) construction activity exposed to weather conditions, 2) access to the site, or 3) construction activity within the existing sewer system:
 - 1. Precipitation (rain, snow, or ice) in excess of a one quarter (0.25) inch liquid measure
 - 2. Average daily temperatures that do not rise above thirty five degrees Fahrenheit (35 °F) or that exceeds eighty-five degrees Fahrenheit (85 °F)
 - 3. Sustained wind in excess of twenty-five miles per hour (25 mph)
- B. Dry-out (or Mud) days may be claimed for abnormal, adverse weather under the following conditions:
 - 1. More adverse precipitation days occur than are listed in the Standard Baseline, and
 - 2. There is a hindrance to site access or site work, and the Contractor has taken all reasonable accommodations to avoid such hindrance, and
 - 3. No more than one dry-out day is allocated for each additional day of precipitation greater than one (1.0) inch or more, liquid measure, unless specifically recommended by the Construction Manager.
- C. Excess Flow days may be claimed due to abnormal, adverse weather resulting in excess wastewater flows in the pumping station influent, to or from a wastewater storage or equalization facility, or in the conveyance trunk (12-inch diameter or greater) sewer resulting from precipitation greater than 3.37 inches in a 24-hour period (the CWNOAP 2 year, growth season Design Storm) that prevents critical path work from taking place.
- D. A Weather Delay Day may be counted if adverse weather prevents work on the project for 50% or more of the Contractor's scheduled work day and critical path construction activities were included and being performed in the day's schedule, including a weekend day or holiday if the Contractor has scheduled construction activities that day.

1.06 CLAIMS

- A. A request for extension of the Contract Time for abnormal weather delays in excess of the Standard CWNOAP Baseline days for adverse weather must be submitted in writing to the Construction Manager within thirty (30) calendar days after the end of the applicable claim month along with all required support information. Requests made after the 30-calendar day limitation will not be considered.
- B. Submit daily jobsite work logs or reports on a monthly basis showing which and to what extent critical path construction activities have been affected by abnormal, adverse weather
- C. Submit actual weather data from the nearest NOAA weather station to support the claim for abnormal weather in excess of the Standard CWNOAP Baseline days for adverse weather. Submit project site or MWS basin data station recording rain gauge weather data to substantiate that similar weather conditions were experienced.

- D. All claims for a time extension for abnormal, adverse weather shall be supported by an analysis of the Progress Schedule detailing the impact of the claimed Work on the critical path.
- E. All costs for time extensions for abnormal, adverse weather delays are non-compensable, if an extension is justified and granted by Metro.
- F. An extension for abnormal, adverse weather will be documented through the Field Authorization process and then formally recorded via a contract Change Order, if granted.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

FOR INFORMATION ONLY

SECTION 01 29 01

MEASUREMENT AND PAYMENT (UNIT PRICES)

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Measurement and Payment – General
- C. Bid Item A-# – Lump Sum Items
- D. Bid Items B-1 through B-# – Unit Price Items
- E. Bid Items C-1 through C-# – Allowance Items

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 33 00 – Submittals
- C. Section 01 29 73 – Schedule of Values
- D. Division 02 – Division ## <PROJECT SPECIFIC>

1.03 MEASUREMENT AND PAYMENT - GENERAL

- A. Whenever units of measure are mentioned in this Section, it shall be interpreted to mean the unit installed in accordance with the Contract plans and specifications and ready for use. Include in prices all costs for labor, materials, tools, equipment, supervision, testing, excavation, and other incidentals to complete the Work.
- B. The Construction Manager will verify all measurements and compute the quantities for payment.
- C. Provide any necessary equipment and/or skilled workers to the Construction Manager for assistance with calculating quantities.
- D. The prices for those items that involve excavation shall include compensation for the disposal of surplus excavated material, handling water, trench protection and the installation of all necessary sheeting, shoring, and bracing.

1.04 LUMP SUM COMPONENTS

- A. The Lump Sum payment will be full compensation for completing the Work in accordance with the Contract plans and specifications. The Lump Sum payment will be made in accordance with a well-balanced, detailed apportionment of the Lump Sum, prepared by the Contractor in accordance with the Schedule of Values required by the Contract and accepted by Metro.

1.05 BID ITEM: LUMP SUM FOR PROJECT MOBILIZATION AND EROSION CONTROL ESTABLISHMENT

A. Bid Item Number

1. A-1

B. Measurement: The Lump Sum payment will be full compensation for completing Project Mobilization and Erosion Control Establishment in accordance with the Contract plans and specifications. The Lump Sum payment will be made in accordance with a well-balanced, detailed apportionment of the Lump Sum, prepared by the Contractor in accordance with the Schedule of Values required by the Contract, and accepted by Metro.

C. Payment. The total price for Project Mobilization and Erosion Control Establishment shall not exceed a maximum amount of **\$200,000.00**. **<AMOUNTS PROJECT SPECIFIC – CONFIRM with CWNOAP>**

1. Payment will be made at the price shown above and in the Contract Documents for Project Mobilization, specifically, all costs related to establishing construction offices for the Contractor, subcontractors, and the Construction Manager; communications; and other temporary utilities the Contractor and subcontractors may require and transporting construction equipment to the site that will be utilized in the performance of the Work. Payment shall include compensation for all construction permits to be obtained by the Contractor, Project signs, erosion control, security measures, the construction of access road(s) for temporary facilities, and the site preparation required for the temporary facilities and utilities.
2. Upon acceptance by the Construction Manager of the Contractor's completion of Work in the paragraph above, fifty percent (50%) of the total Project Mobilization and Erosion Control Establishment amount will be paid.
3. Upon receipt and approval by the Construction Manager of the Contractor's Schedule of Values, the Submittal Schedule, and the Construction Progress Schedule submittals, forty-five percent (45%) of the Project Mobilization and Erosion Control Establishment amount will be paid.
4. Upon acceptance by the Construction Manager of the Contractor's site demobilization and restoration, five percent (5%) of the Project Mobilization and Erosion Control Establishment amount will be paid.

1.06 BID ITEM: LUMP SUM FOR INCIDENTAL PROJECT SURFACE RESTORATION

A. Bid Item Number

1. A-2

B. Measurement: The Lump Sum payment will be full compensation for completing Incidental Project Surface Restoration in accordance with the Contract plans and specifications. The Lump Sum payment will be made in accordance with a well-balanced, detailed apportionment of the Lump Sum, prepared by the Contractor in accordance with the Schedule of Values required by the Contract and accepted by Metro.

C. Payment: The total price for Incidental Project Surface Restoration shall not exceed a maximum amount of **\$75,000.00**. <Verify \$\$ with CWNOAP>

1. Payment will be made at the price shown above and in the Contract Documents for Incidental Project Surface Restoration, specifically, all costs related to the performance of the Work. Payment shall include compensation for surface restoration required under the roadway and outside of the roadway surface restoration areas for access, flow control, manhole rehabilitation, pavement marking restoration, stream bank restoration in water conveyances and restoration not otherwise delineated.
2. Upon the Contractor's completion of the cured-in-place pipe lining, twenty-five percent (25%) of the total Incidental Project Surface Restoration amount will be paid.
3. Upon the Contractor's completion of the service renewals and replacement, twenty-five percent (25%) of the total Incidental Project Surface Restoration amount will be paid.
4. Upon the acceptance by the Construction Manager of the Contractor's site demobilization and restoration, fifty percent (50%) of the total Incidental Project Surface Restoration amount will be paid.

1.07 BID ITEM: SANITARY SEWER REHABILITATION BY CURED-IN-PLACE PIPE LINING

A. Bid Item Numbers and Pipe Sizes

1. B-#: 8-inch diameter
2. B-#: 10-inch diameter
3. B-#: 12-inch diameter
4. B-#: 15-inch diameter
5. B-#: 18-inch diameter
6. B-#: 21-inch diameter
7. B-#: 24-inch diameter
8. B-#: 27-inch diameter
9. B-#: 30-inch diameter
10. B-#: 36-inch diameter
11. B-#: 42-inch diameter
12. B-#: 48-inch diameter

B. Measurement. Each sanitary sewer is required to be rehabilitated by cured-in-place lining as shown on the drawings and specified under Bid Items B-# through B-#. The quantity of sanitary sewer rehabilitation that will be paid for under Bid Items B-# through B-# will be the computed linear feet of each size of sanitary sewer actually rehabilitated.

C. Payment. The unit price per linear foot paid for Bid Items B-# through B-# will be full compensation for all labor, materials, tools, equipment, bypass pumping, testing, supervision,

other accessories, or incidentals necessary to complete the sanitary sewer rehabilitation that is shown on the drawings or specified in the Contract Documents.

1.08 BID ITEM: SANITARY SEWER REHABILITATION BY PIPE BURSTING WITH HDPE

A. Bid Item Numbers and Pipe Sizes

1. B-#: 6-inch diameter with 8-inch diameter HDPE
2. B-#: 8-inch diameter with 8-inch diameter HDPE
3. B-#: 10-inch diameter with 10-inch diameter HDPE
4. B-#: 12-inch diameter with 12-inch diameter HDPE

B. Measurement. Each sanitary sewer is required to be rehabilitated by pipe bursting with HDPE as shown on the drawings and specified under Bid Items B-# through B-#. The quantity of sanitary sewer rehabilitation that will be paid for under Bid Items B-# through B-# will be the computed linear feet of each size of sanitary sewer actually rehabilitated.

C. Payment. The unit price per linear foot paid for Bid Items B-# through B-# will be full compensation for all labor, materials, tools, equipment, bypass pumping, testing, supervision, other accessories, or incidentals necessary to complete the sanitary sewer rehabilitation that is shown on the drawings or specified in the Contract Documents.

1.09 BID ITEM: SANITARY SEWER LINE PRE-REHABILITATION TELEVISION INSPECTION

A. Bid Item Numbers and Pipe Sizes

1. B-#: 8-, 10-, 12- inch diameter
2. B-#: 15- and 18-inch diameter
3. B-#: 21-inch diameter and larger <Designer: Consult with CWNOAP for other size items>

B. Measurement. Sanitary sewer television (CCTV) is required to be furnished pre-construction as required in the Contract Documents and specified under Bid Items B-# through B-#. The sanitary sewer CCTV that will be paid for Bid Items B-# through B-# will be computed based on the linear feet of televised lines.

C. Payment. The unit price per linear foot paid for Bid Items B-# through B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to furnish sanitary sewer CCTV data pre-construction, including a summary spreadsheet for the existing pipe diameter classes set forth in the proposal form.

1.10 BID ITEM: CCTV LATERAL LAUNCH FOR SANITARY SERVICE RENEWAL OR REPLACEMENT ASSESSMENT

A. Bid Item Number

1. B-#

B. Measurement. CCTV lateral launch inspection for sanitary sewer service renewals or replacement condition assessments are required to be provided for all active services. The

quantity paid for Bid Item B-# will be for each complete televised lateral as accepted by the Construction Manager. Bid Item B-# will be computed on a per each completed in place basis.

- C. Payment. The unit price paid for each CCTV lateral launch sanitary sewer service inspection for trenchless sewer service renewals or replacement condition assessments for Bid Item B-# will be full compensation for all labor; materials; tools; equipment; supervision; data submittals, other accessories or necessary incidentals, including lateral CCTV inspection to determine the condition of the lateral, the location of 6-inch to 4-inch diameter transitions prior to cleanout installation, size and location of fittings, and provide sufficient data for the Construction Manager to assess the data and determine the method of service renewal or replacement. This item also includes unit price payment per each CCTV push camera inspection ordered by the Construction Manager for lengths from existing cleanouts to the main for unsuccessful or incomplete lateral launches of excessive length or for other special conditions.

1.11 BID ITEM: SANITARY SEWER LINE POST REHAB TELEVISION INSPECTION AND TESTING

A. Bid Item Numbers and Pipe Sizes

- 1. B-#: 8-, 10-, 12- inch diameter
- 2. B-#: 15- and 18-inch diameter
- 3. B-#: 21-inch diameter and larger

- B. Measurement. Sanitary sewer television and segment air testing is required to be furnished post construction as required in Contract Documents and specified under Bid Items B-# through B-#. The sanitary sewer post television and segment air testing that will be paid for Bid Items B-# through B-# will be the computed linear feet tested.

- C. Payment. The unit price per linear foot paid for Bid Items B-# through B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to furnish sanitary sewer post television and segment air testing.

1.12 BID ITEM: SONDE LOCATION OF EXISTING BURIED SEWER MANHOLES

A. Bid Item Number

- 1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each completed sonde location in conjunction with pre-rehabilitation CCTV to locate existing sewer manholes as shown on the Drawings or as directed by the Construction Manager for buried manholes discovered in the completion of the work.

- C. Payment. The unit price for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work as shown on the Drawings or as directed by the Construction Manager.

1.13 BID ITEM: SANITARY SERVICE RENEWAL UNDER ROADWAY BY EXCAVATION/REPLACEMENT

A. Bid Item Numbers and Pipe Lengths

1. B-#: 15 feet or less in length
2. B-#: 15.1 feet or greater in length

B. Measurement. Sanitary sewer service renewals are required to be provided under roadways by excavation/replacement. The quantity paid for Bid Items B-# and B-# will be for each complete and ready-to-use sanitary sewer renewal as accepted by the Construction Manager.

C. Payment. The unit price paid for each sanitary sewer service renewal for Bid Items B-# and B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary, including internal reinstatement, piping, fittings, backfill, and cleanout assembly with box.

1.14 BID ITEM: SANITARY SERVICE RENEWAL OUTSIDE ROADWAY BY EXCAVATION/REPLACEMENT

A. Bid Item Numbers and Pipe Sizes

1. B-#: 15 feet or less in length
2. B-#: 15.1 feet to 30 feet in length
3. B-#: Greater than 30 feet in length

B. Measurement. Sanitary sewer service renewals outside of roadway are required to be provided by excavation/replacement for active services. The quantity paid for Bid Items B-# and B-# will be for each complete sanitary sewer renewal as accepted by the Construction Manager. The measurement for Bid Item B-# will be linear footage starting at 30.1 feet.

C. Payment. The unit price paid for each sanitary sewer service renewal for Bid Items B-# and B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary, including internal reinstatement, piping, fittings, backfill, and cleanout assembly with box. Compensation for Bid Item B-# for service line replacements greater than 30 feet in length will be on a linear foot basis rounded to the next tenth of a foot in addition to the base unit price of Bid Item B-# (15.1 feet to 30 feet).

1.15 BID ITEM: SANITARY SERVICE RENEWAL IN WET, FLOWING USGS BLUE LINE STREAM BY DIRECTED EXCAVATION/REPLACEMENT

A. Bid Item Numbers and Pipe Sizes

1. B-#: 15 feet or less in length
2. B-#: 15.1 feet or greater in length

B. Measurement. Sanitary sewer service renewals in wet, flowing USGS blue line streams are required to be provided by excavation/replacement for active services as directed by the Construction Manager. The quantity paid for Bid Items B-# and B-# will be for each complete sanitary sewer renewal as accepted by the Construction Manager.

- C. Payment. The unit price paid for each sanitary sewer service renewal for Bid Items B-# and B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary, including internal reinstatement, piping, fittings, backfill, concrete encasement, erosion protection, stream construction protection in compliance with the Best Management Practices specified by TDEC ARAP requirements and MWS guidance, restoration, stream bank restoration and protection, and cleanout assembly with box.

1.16 BID ITEM: CLEANOUT INSTALLATION FOR SANITARY SERVICE RENEWAL BY NON-EXCAVATION TRENCHLESS LINING

A. Bid Item Number

1. B-#

- B. Measurement. Cleanout installation for sanitary sewer service renewals are required to be provided for non-excavation trenchless lining of active services. The quantity paid for Bid Item B-# will be for each complete and ready-to-use cleanout installed by trenchless lining as accepted by the Construction Manager. Bid Item B-# will be computed on a per each completed in place basis.

- C. Payment. The unit price paid for each cleanout installation for trenchless sewer service renewal for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories or necessary incidentals, including up to 5 feet of 4-inch lateral replacement outside-of-roadway with 6-inch PVC, piping, fittings, backfill, and cleanout assembly with box.

1.17 BID ITEM: SANITARY SERVICE RENEWAL BY NON-EXCAVATION TRENCHLESS LINING

A. Bid Item Numbers and Pipe Sizes and Lengths

1. B-#: 8-, 10-, 12-inch diameter sanitary sewer service renewals 15 feet or less in length
2. B-#: 8-, 10-, 12-inch diameter sanitary sewer service renewals 15.1 feet to 30 feet in length
3. B-#: 15- and 18-inch diameter sanitary sewer service renewals 15 feet or less in length
4. B-#: 15- and 18-inch diameter sanitary sewer service renewals 15.1 feet to 30 feet in length
5. B-#: 21-inch and larger diameter sanitary sewer service renewals 15 feet or less in length
6. B-#: 21-inch and larger diameter sanitary sewer service renewals 15.1 feet to 30 feet in length
7. B-#: Sanitary sewer service renewals greater than 30 feet in length

- B. Measurement. Sanitary sewer service renewals are required to be provided by non-excavation trenchless lining for active services on the various main sewer sizes the lateral is connecting to and to the lengths directed for renewal. The quantity paid for Bid Items B-# through B-# will be for each complete and ready-to-use sanitary sewer renewal for the respective main diameter the lateral is connecting with to the length required as accepted by the Construction Manager. Bid Item B-# will be computed on a linear foot completed in place basis. The measurement

for Bid Item B-# will start at 30.1 feet and will be an additional payment for any line greater than 30.1 feet in length paid for under Bid Item B-#.

- C. Payment. The unit price paid for each sanitary sewer service renewal for Bid Items B-# through B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories or necessary incidentals, including internal reinstatement, service diversion pumping or containment, full wrap circumferential connection to the main, trenchless lateral lining, testing, and post CCTV lateral inspection. Services stubbed out from manholes will be paid as if on an 8-inch diameter line. Bid Item B-# will be compensation for trenchless lining greater than 30.1 feet on a linear foot basis for excessive sewer service lengths in addition to the payment of the appropriate diameter pipe unit price for sanitary service renewals of 15.1 to 30 feet in length.

1.18 BID ITEM: ADDITIONAL SANITARY SERVICE RENEWAL BY NON-EXCAVATION CIPP TRENCHLESS LATERAL LINING BY BLIND SHOT METHOD WITH NO CLEANOUT

A. Bid Item Number

1. B-#

- B. Measurement. Sanitary sewer service renewals are required to be provided by non-excavation CIPP trenchless lining by blind shot method with no cleanout. The quantity paid for Bid Item B-# will be for each complete and ready-to-use sanitary sewer renewal installed by blind shot methods with no cleanout installation as accepted by the Construction Manager.
- C. Payment. The unit price paid for each sanitary sewer service renewal for Bid Item B-# will be full compensation for all necessary labor, materials, tools, equipment, supervision, other accessories, or incidentals, including lateral lining, piping, and sealing and will be in addition to other above pay items for the appropriate pipe diameter and lateral length installed recognizing the level of difficulty and risk for a blind shot installation.

1.19 BID ITEM: ADDITIONAL CIPP TRENCHLESS LATERAL LINING OF EXISTING 4-INCH TO 6-INCH DIAMETER TRANSITIONS ON SERVICE LINES

A. Bid Item Number

1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each completed CIPP trenchless lateral lining of the transition from 4-inch to 6-inch diameter sewer service laterals, if required or directed by the Construction Manager, in addition to the payment for sanitary service renewal by non-excavation trenchless lining in the above items.
- C. Payment. The unit price for each 4-inch to 6-inch diameter CIPP transition lining completed for Bid Item B-# will be full compensation for all additional labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the sewer service lateral transition lining. All investigative work performed prior to the lining shall be paid under other line items. The run of lateral lining and all post-construction work shall be paid under other line items.

1.20 BID ITEM: ADDITIONAL PAYMENT FOR 6-INCH DIAMETER REPLACEMENT SEWER SERVICE LINE UPSIZING ON TRENCHLESS LATERALS FOR EXISTING 4-INCH DIAMETER SERVICE LINES

A. Bid Item Number

1. B-#

B. Measurement. The quantity paid under Bid Item B-# will be per linear foot for upsizing 4-inch diameter service lines to 6-inch diameter service lines when directed by the Construction Manager. The 6-inch diameter sewer service installation will be completed by excavation included with and in addition to the cleanout assembly in the above items beginning at the terminus of the 5.0 foot replacement footage and going to the transition of the existing 6-inch diameter lateral to be trenchless lined.

C. Payment. The linear foot unit price for additional 6-inch diameter replacement sewer service upsizing for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the sewer service replacement upsizing.

1.21 BID ITEM: SANITARY SERVICE RENEWAL BY NON-EXCAVATION TRENCHLESS LINING CUT AND BUFF WITH LATERAL SEALING

A. Bid Item Number

1. B-#

B. Measurement. Sanitary sewer service renewals are required to be provided by non-excavation trenchless lining cut and buff with 18-inch length lateral sealing. The quantity paid for Bid Item B-# will be for each complete and ready-to-use sanitary sewer renewal as accepted by the Construction Manager.

C. Payment. The unit price paid for each sanitary sewer service renewal for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary, including internal reinstatement, lateral lining piping, and sealing.

1.22 BID ITEM: SANITARY SEWER SERVICE CONFIRMATION INVESTIGATION FOR ABANDONMENT AND NON-RE-INSTATEMENT ON INACTIVE SERVICE OPENINGS

A. Bid Item Number(s) <TO BE COMPLETED BY SPEC WRITER>

1. B-#: <DESCRIPTION>

2. B-#: <DESCRIPTION>

B. Measurement. Sanitary sewer service confirmation and investigation for the abandonment and non-re-instatement of inactive service openings are required to be provided in accordance with the Contract plans and specifications. The quantity paid for Bid Items B-# through B-# will be for will be for each confirmation and investigation as accepted by the Construction Manager.

C. Payment. The unit price paid for each sanitary sewer service confirmation and investigations, Bid Items B-# through B-#, will be full compensation for all labor, materials, tools, equipment, supervision, testing and other accessories, or incidentals necessary.

1.23 BID ITEM: REHABILITATION OF EXISTING SEWER EXTERNAL DROP ASSEMBLIES WITH CURED-IN-PLACE PIPE LINER

A. Bid Item Number

1. B-#

B. Measurement. The rehabilitation of the existing sewer external drop assemblies is required to be provided with cured-in-place pipe liner. The quantity paid for Bid Item B-# will be for each complete and ready-to-use sewer external drop assembly as accepted by the Construction Manager.

C. Payment. The unit price paid for the rehabilitation of each existing sewer external drop assemblies with cured-in-place pipe liner, Bid Item B-#, will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary, including internal reinstatement, piping, drop assembly lining and sealing.

1.24 BID ITEM: DIRECTED HEAVY CLEANING OF SEWER LINES FOR LARGE DEPOSITS OF DEBRIS OR HEAVY ROOT GROWTH

A. Bid Item Numbers and Pipe Sizes

1. B-#: 8-, 10-, 12-inch diameter sewer lines

2. B-#: 15- and 18-inch diameter sewer lines

3. B-#: 21-inch and larger diameter sewer lines

B. Measurement. Directed heavy cleaning of sewer lines for large deposits of debris or heavy root growth is required to be provided in accordance with the Contract plans and specifications. The quantity paid for Bid Items B-# through B-# will be for will be the computed linear feet for the respective pipe diameters as accepted by the Construction Manager.

C. Payment. The unit price paid for the directed heavy cleaning of sewer lines Bid Items B-# through B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary.

1.25 BID ITEM: SANITARY SEWER 4-FOOT INSIDE DIAMETER MANHOLE REHABILITATION BY CEMENTITIOUS REPAIR AND SEALING

A. Bid Item Numbers and Rehabilitation Depth

1. B-#: 0.00 to 6.00 feet in depth

2. B-#: 6.01 to 8.00 feet in depth

3. B-#: 8.01 to 10.00 feet in depth

4. B-#: 10.01 to 11.99 feet in depth

B. Measurement. The rehabilitation of sanitary sewer manholes for Bid Items B-# through B-# will be completed by the cementitious repair and sealing of the manhole base, invert, walls, corbel/cone, and chimney as defined in the Contract Documents. The quantity paid under Bid Items B-# through B-# will be for each manhole rehabilitated.

- C. Payment. The unit price for each manhole rehabilitated under Bid Items B-# through B-# will be full compensation for all labor, materials, tools, equipment, supervision, testing, and other accessories or incidentals necessary to perform and successfully complete the manhole rehabilitated.

1.26 BID ITEM: SANITARY SEWER 4-FOOT INSIDE DIAMETER MANHOLE REHABILITATION BY EPOXY/URETHANE REPAIR AND SEALING

A. Bid Item Numbers and Rehabilitation Depth

- 1. B-#: 0.00 to 6.00 feet in depth
- 2. B-#: 6.01 to 8.00 feet in depth
- 3. B-#: 8.01 to 10.00 feet in depth
- 4. B-#: 10.01 feet and deeper

- B. Measurement. The rehabilitation of sanitary sewer manholes for Bid Items B-# through B-# will be completed by epoxy/urethane repair and sealing of the manhole base, invert, walls, corbel/cone, and chimney as defined in the Contract Documents. The quantity paid under Bid Items B-# through B-# will be for each manhole rehabilitated.

- C. Payment. The unit price for each manhole rehabilitated under Bid Items B-# through B-# will be full compensation for all labor, materials, tools, equipment, supervision, testing, and other accessories or incidentals necessary to perform and successfully complete the manhole rehabilitated. Manholes not identified in the Drawings Tabulation as being over 20 feet in depth or with an incorrect depth over 20 foot shall be negotiated with the Construction Manager for payment compensation.

<Instruction to Designer: Consult with CWNOAP if there are more than 10 manholes over 10 feet in depth. If there are more than 10 manholes and/or excessive depth for several, CWNOAP may direct that an additional depth class(es) be established for payment. Text must be modified then also.>

1.27 BID ITEM: SANITARY SEWER 5-FOOT INSIDE DIAMETER MANHOLE AND LARGER REHABILITATION BY EPOXY/URETHANE REPAIR AND SEALING

A. Bid Item Numbers and Rehabilitation Depth

- 1. B-#: 0.00 to 6.00 feet in depth
- 2. B-#: 6.01 to 8.00 feet in depth
- 3. B-#: 8.01 to 10.00 feet in depth
- 4. B-#: 10.01 feet and deeper

- B. Measurement. The rehabilitation of sanitary sewer manholes for Bid Items B-# through B-# will be completed by epoxy/urethane repair and sealing of the manhole base, invert, walls, corbel/cone, and chimney as defined in the Contract Documents. The quantity paid under Bid Items B-# through B-# will be for each manhole rehabilitated.

- C. Payment. The unit price for each manhole rehabilitated under Bid Items B-# through B-# will be full compensation for all labor, materials, tools, equipment, supervision, testing, and other

accessories or incidentals necessary to perform and successfully complete the manhole rehabilitation. Manholes not identified in the Drawings Tabulation as being over 20 feet in depth or with an incorrect depth over 20 foot shall be negotiated with the Construction Manager for payment compensation.

<Instruction to Designer: Consult with CWNOAP if there are more than 10 manholes over 20 feet in depth. If there are more than 10 manholes and/or excessive depth for several, CWNOAP may direct that an additional depth class(es) be established for payment. Text must be modified then also.>

1.28 BID ITEM: 8-, 10-, OR 12-INCH DIAMETER SEWER LINE POINT REPAIRS BY EXCAVATION, 0 TO 6 FEET IN LENGTH, INSIDE PAVED AREAS

A. Bid Item Numbers and Depths

1. B-#: 0 to 10 feet deep
2. B-#: Deeper than 10 feet

B. Measurement. Sewer line point repairs by excavation, 0 to 6 feet in length and 0 to 10 feet deep or deeper than 10 feet inside paved areas, complete-in-place, may be required. The quantity paid under Bid Items B-# and B-# will be for each point repair completed.

C. Payment. The unit price for each point repair for Bid Items B-# and B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the point repair.

1.29 BID ITEM: 8-, 10-, OR 12-INCH DIAMETER SEWER LINE POINT REPAIRS BY EXCAVATION, 0 TO 6 FEET IN LENGTH, OUTSIDE PAVED AREAS

A. Bid Item Numbers and Depths

1. B-#: 0 to 10 feet deep
2. B-#: Deeper than 10 feet

B. Measurement. Sewer line point repairs by excavation, 0 to 6 feet in length and 0 to 10 feet deep or deeper than 10 feet outside paved areas, complete-in-place, may be required. The quantity paid under Bid Items B-# and B-# will be for each point repair completed.

C. Payment. The unit price for each point repair, Bid Items B-# and B-#, will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the point repair.

1.30 BID ITEM: 15-INCH DIAMETER SEWER LINE POINT REPAIRS BY EXCAVATION, 0 TO 6.00 FEET IN LENGTH, INSIDE PAVED AREAS

A. Bid Item Numbers and Depths

1. B-#: 0 to 10 feet deep
2. B-#: Deeper than 10 feet

B. Measurement. Sewer line point repairs by excavation for 15-inch diameter pipes, 0 to 6 feet in length and 0 to 10 feet deep or deeper than 10 feet inside paved areas, complete-in-place, may

be required. The quantity paid under Bid Items B-# and B-# will be for each point repair completed.

- C. Payment. The unit price for each point repair under Bid Items B-# and B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the point repairs.

1.31 BID ITEM: 15-INCH DIAMETER SEWER LINE POINT REPAIRS BY EXCAVATION, 0 TO 6.00 FEET IN LENGTH, OUTSIDE PAVED AREAS

A. Bid Item Numbers and Depths

- 1. B-#: 0 to 10 feet deep
- 2. B-#: Deeper than 10 feet

- B. Measurement. Sewer line point repairs by excavation for 15-inch diameter pipes, 0 to 6 feet in length and 0 to 10 feet deep or deeper than 10 feet, outside paved areas, complete-in-place, may be required. The quantity paid under Bid Items B-# and B-# will be for each point repair completed.

- C. Payment. The unit price for each point repair under Bid Items B-# and B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the point repair.

1.32 BID ITEM: 8-, 10-, OR 12-INCH DIAMETER SEWER LINE POINT REPAIRS BY TRENCHLESS MEANS, 0 TO 6.00 FEET IN LENGTH

A. Bid Item Number

- 1. B-#

- B. Measurement. Sewer line point repairs by trenchless means for 8-, 10-, or 12-inch diameter sewer lines, 0 to 6 feet in length, complete-in-place, may be required. The quantity paid under Bid Item B-#, will be for each point repair completed.

- C. Payment. The unit price for each point repair under Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the point repair.

1.33 BID ITEM: 15-INCH DIAMETER AND LARGER SEWER LINE POINT REPAIRS BY TRENCHLESS MEANS, 0 TO 6.00 FEET IN LENGTH

A. Bid Item Number

- 1. B-#

- B. Measurement. Sewer line point repairs by trenchless means for pipe diameters 15 inches and larger, 0 to 6 feet in length, may be required. The quantity paid under Bid Item B-# will be for each point repair completed.

- C. Payment. The unit price for each point repair under Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the point repair.

1.34 BID ITEM: SEWER SERVICE LINE POINT REPAIRS BY EXCAVATION INSIDE PAVED AREAS

A. Bid Item Number

1. B-#

B. Measurement. Sewer service line point repairs by excavation inside paved areas may be required. The quantity paid under Bid Item B-# will be for each point repair completed.

C. Payment. The unit price for each sewer service line point repair by excavation inside paved areas, Bid Item B-#, will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the point repair.

1.35 BID ITEM: SEWER SERVICE LINE POINT REPAIRS BY EXCAVATION OUTSIDE PAVED AREAS

A. Bid Item Number

1. B-#

B. Measurement. The quantity paid under Bid Item B-# will be for each sewer service line point repair completed by excavation outside paved areas.

C. Payment. The unit price for each sewer service line point repair by excavation outside paved areas, Bid Item B-#, will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the point repair.

1.36 BID ITEM: INTERNAL PREPARATORY TRENCHLESS POINT REPAIRS, INCLUDING THE REMOVAL OF PROTRUDING TAPS, CUTTING OF OFFSET JOINTS, AND DROPPED PIPE SECTIONS

A. Bid Item Number

1. B-#

B. Measurement. The quantity paid under Bid Item B-# will be for each completed internal preparatory trenchless point repair, including the removal of protruding taps, cutting of offset joints, and dropped pipe sections.

C. Payment. The unit price for each internal preparatory trenchless point repairs, including the removal of protruding taps, cutting of offset joints, and dropped pipe sections, Bid Item B-#, will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the point repair.

1.37 BID ITEM: INSTALL CAST IRON SEWER SERVICE CLEANOUT BOX IN PAVEMENT AREAS IN LIEU OF COPOLYMER SEWER SERVICE CLEANOUT BOX

A. Bid Item Number

1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each completed installation of a cast iron sewer service cleanout box in pavement areas in lieu of a copolymer service cleanout box as directed by the Construction Manager.
- C. Payment. The unit price for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work as directed by the Construction Manager.

1.38 BID ITEM: LIMITED RAISING OF EXISTING SEWER MANHOLE CASTINGS, ADJUSTMENT TO GRADE BY NECK ADJUSTMENT RINGS IF DISTANCE IS LESS THAN 12-INCHES AND RESTORE DISTURBED AREA

A. Bid Item Number

1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each completed limited raising of existing sewer manhole castings adjustment to grade by the addition of neck adjustment rings if the distance is less than or equal to 12-inches and restoration of the disturbed area as shown on the Drawings or as directed by the Construction Manager for buried manholes discovered in the completion of the work. Adjustment of manhole castings for distances greater than 12-inches or requiring manhole elements other than adjustment rings will be authorized and compensated under the manhole allowance items.
- C. Payment. The unit price for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work as shown on the Drawings or as directed by the Construction Manager.

1.39 BID ITEM: REPAIR/REPLACE EXISTING SEWER SERVICE CLEANOUT BOX, HUBS, ADJUSTED TO GRADE, AND RESTORE DISTURBED AREA

A. Bid Item Number

1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each completed repair replacement of the existing sewer service cleanout box, cleanouts hub(s), adjusted to grade, and restoration of the disturbed area as shown on the Drawings or as directed by the Construction Manager.
- C. Payment. The unit price for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work as shown on the Drawings or as directed by the Construction Manager.

1.40 BID ITEM: REPLACE EXISTING MANHOLE CASTING WITH NEW STANDARD WATERTIGHT FRAME AND COVER

A. Bid Item Number

1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each completed replacement of an existing manhole casting with new standard watertight frame and cover.

- C. Payment. The unit price for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.41 BID ITEM: REPLACE EXISTING MANHOLE CASTING OR EXISTING AREA DRAIN LID WITH NEW STANDARD MANHOLE FRAME AND SOLID COVER

A. Bid Item Number

1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each completed replacement of an existing manhole casting or existing area drain lid with new standard manhole frame and solid cover.

- C. Payment. The unit price for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.42 BID ITEM: SURFACE RESTORATION IN NON-PAVEMENT AREAS FOR SANITARY SEWER SERVICE RENEWALS AND CLEANOUTS

A. Bid Item Number

1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each completed surface restoration in non-pavement areas for sanitary sewer service renewals, sanitary sewer service replacements, point repairs, and cleanout installations.

- C. Payment. The unit price for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work exclusive of pavement restoration items.

1.43 BID ITEM: ASPHALTIC DRIVEWAY RESTORATION FOR SANITARY SEWER SERVICE RENEWALS AND POINT REPAIRS

A. Bid Item Number

1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each square yard of asphaltic driveway restored to match existing or with minimum 4" thickness for sanitary sewer service renewals and point repairs completed.

- C. Payment. The unit price for each square yard completed under Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.44 BID ITEM: CONCRETE DRIVEWAY RESTORATION FOR SANITARY SEWER SERVICE RENEWALS AND POINT REPAIRS

A. Bid Item Number

1. B-#

- B. Measurement. The quantity paid under Bid Item B-# will be for each square yard of concrete driveway restored to match existing or with a minimum 4" thickness for sanitary sewer service renewals and point repairs completed.
- C. Payment. The unit price for each square yard completed under Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.45 BID ITEM: CONCRETE SIDEWALK AND/OR RAMP REMOVAL AND REPLACEMENT WITH NEW CONCRETE SIDEWALK AND/OR RAMP

- A. Bid Item Number
 - 1. B-#
- B. Measurement. The quantity paid under Bid Item B-# will be for each square yard of concrete sidewalk and/or ramp removed and replaced with new concrete sidewalk and/or ramp completed.
- C. Payment. The unit price for each square yard completed under Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.46 BID ITEM: ASPHALTIC ROADWAY BASE RESTORATION WITH BINDER

- A. Bid Item Numbers and Binder Depth
 - 1. B-#
- B. Measurement. Asphaltic roadway base restoration with various thicknesses of binder may be required. The quantity paid under Bid Item B-# will be for each computed ton completed.
- C. Payment. The unit price for each ton completed for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.47 BID ITEM: ASPHALTIC ROADWAY SURFACE RESTORATION WITH SURFACE COURSE

- A. Bid Item Number
 - 1. B-#
- B. Measurement. Asphaltic roadway surface restoration with topping mix may be required. The quantity paid under Bid Item B-# will be for each computed ton completed.
- C. Payment. The unit price for each ton completed for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.48 BID ITEM: ASPHALTIC ROADWAY FULL-WIDTH SURFACE RESTORATION PREPARATION BY COLD PLANE MILLING, 1.5-INCH DEPTH FOR SURFACE COURSE REPLACEMENT

A. Bid Item Number

1. B-#

B. Measurement. Asphaltic roadway full-width surface restoration preparation by cold plane milling, 1.5-inch depth for surface course replacement, may be required. The quantity paid under Bid Item B-# will be for each square yard completed.

C. Payment. The unit price for each square yard completed for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.49 BID ITEM: FLOWABLE FILL BACKFILL AND CONCRETE ROADWAY BASE INSTALLATION BELOW ASPHALTIC SURFACE

A. Bid Item Number

1. B-#

B. Measurement. Flowable fill backfill and concrete roadway base installation below asphaltic surface may be required. The quantity paid under Bid Item B-# will be for each cubic yard completed.

C. Payment. The unit price for each cubic yard completed for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.50 BID ITEM: CONCRETE CURB AND/OR CONCRETE CURB AND GUTTER REPLACEMENT FOR ROADWAY RESTORATION

A. Bid Item Number

1. B-#

B. Measurement. Concrete curb and/or concrete curb and gutter replacement for roadway restoration may be required. The quantity paid under Bid Item B-# will be for each linear foot completed.

C. Payment. The unit price for each linear foot completed for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.51 BID ITEM: CONCRETE ENCASEMENT AND/OR CONCRETE CAP REPLACEMENT FOR SERVICES AND MAINS

A. Bid Item Number

1. B-#

B. Measurement. Concrete encasement and/or concrete cap replacement for insufficient pipe cover, wet weather conveyances, and blue line stream restoration and pipe protection may be

required. The quantity paid under Bid Item B-# will be for each cubic yard completed as directed by the Construction Manager.

- C. Payment. The unit price for each cubic yard completed for Bid Item B-# will be full compensation for all labor, materials, tools, equipment, supervision, other accessories, or incidentals necessary to perform and successfully complete the Work.

1.52 BID ITEM: ALLOWANCE FOR TRAFFIC CONTROL FEES

- A. Bid Item Number

1. C-1

- B. Measurement. The Contractor shall pay Metro Police or a Metro Public Works-approved Traffic Control firm invoices for commissioned officer traffic control where required by Metro Public Works on this Project. The actual invoice for the fees shall be the method for measurement for payment to the Contractor under this allowance and must be submitted and approved to be considered for payment.
- C. Payment. The actual paid invoice amount, and only this amount, shall be paid to the Contractor upon submission of an invoice marked "Paid" by the Metro Police Department or other appropriate Metro government office or a Metro Public Works-approved Traffic Control firm. No Contractor labor, materials overhead, or profit shall be paid under this allowance. The Allowance amount shall be **\$100,000.00**. <Verify \$\$ with CWNOAP>

1.53 BID ITEM: ALLOWANCE FOR ADDITIONAL MANHOLE WORK

- A. Bid Item Number

1. C-2

- B. Measurement. The payment for Bid Item C-2 is the amount to be paid for miscellaneous manhole work, including, but not limited to, locating manholes, raising castings, casting repair, excavation, crushed stone backfill and other miscellaneous directed service and mainline line and work not identified on the Drawings as a direct pay item. This is when the scope of the work exceeds the limits of the 2 Unit Price Items for sonde location of manholes and limited raising of manholes. Included in this allowance is reimbursement for TDEC and other state or federal regulatory agency application fees, annual permit renewal fees, and other associated permit costs directed by the Construction Manager to be addressed by the Contractor to facilitate project work commencement or continuance. The Work shall be completed in accordance with the Contract requirements.
- C. Payment. The actual paid amount shall be a lump sum amount negotiated and substantiated by personnel time sheets, material invoices, and any other documentation requested by the Construction Manager. The Allowance amount shall be **\$75,000.00**. <Verify \$\$ with CWNOAP >

1.54 BID ITEM: ALLOWANCE FOR AMERICANS WITH DISABILITIES ACT COMPLIANCE

- A. Bid Item Number

1. C-3

- B. Measurement. The payment for Bid Item C-3 is the amount to be paid for work, including, but not limited to, the restoration of sidewalks, curb ramps, driveway ramps, and ADA

directed project sidewalk, curb ramp, and driveway ramp modifications. The Work shall be completed in accordance with the Contract requirements.

- C. Payment. The actual paid amount shall be a lump sum amount substantiated by personnel time sheets, material invoices, and any other documentation requested by the Construction Manager. The Allowance amount shall be **\$35,000.00**. <Verify \$\$ with CWNOAP>

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

FOR INFORMATION ONLY

SECTION 01 29 02

MEASUREMENT AND PAYMENT (LUMP SUM PROJECTS)

PART 1 - GENERAL

1.01 SECTION INCLUDES <SAMPLE>

- A. Related Sections
- B. Bid Item No. 1 – <INSERT TITLE>
- C. Bid Item No. 2 – <INSERT TITLE CONTINUE AS NEEDED>

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 33 00 – Submittals
- C. Section 01 29 73 – Schedule of Values
- D. Section 01 32 16/17 – Progress Schedule <PROJECT SPECIFIC>

1.03 BID ITEM NO. # – LUMP SUM COMPONENTS <SAMPLE> (BID ITEM NO. ## <INSERT NUMBER>)

- A. The lump sum payment shall be full compensation for completing the Work in accordance with the Contract Documents. The lump sum payment shall be made in accordance with a well-balanced, equitable distribution of value and detailed apportionment for the lump sum, prepared by the Contractor in accordance with the Schedule of Values required by the Contract, and accepted by Metro.
- B. Mobilization
 - 1. The total price for mobilization shall not exceed five percent (5%) of the Contract Price or a maximum \$250,000 amount. <PROJECT SPECIFIC>
 - 2. Payment shall be made at the price shown in the Schedule of Values for mobilization, specifically, all costs related to establishing construction offices for the Contractor and its subcontractors, the Construction Manager; communications; other temporary utilities that the Contractor, and subcontractors may require; and the transportation of construction equipment to the site to be used in performing the Work. Payment shall include compensation for all construction permits to be obtained by the Contractor, project signs, erosion control, security measures, access road(s) installation for temporary facilities, and the site preparation required for temporary facilities and utilities. The mobilization payment shall be issued for completion of the work and submission of submittals as provided below.
 - 3. When the Construction Manager accepts the Contractor's Completion of the Work in Paragraph 1.03.B.2 for construction permits, project signs, erosion control, security measures, access road(s) installation for temporary facilities, and the site preparation required for temporary facilities and utilities, fifty percent (50%) of the mobilization cost shall be paid.

4. When the Construction Manager receives and approves the Contractor's Schedule of Values, Submittal Schedule, and Construction Progress Schedule submittals, forty-five percent (45%) of the mobilization cost shall be paid.
5. When the Construction Manager accepts the Contractor's site demobilization and restoration, five percent (5%) of the mobilization cost shall be paid.

1.04 BID ITEM NO. # – UNIT PRICE COMPONENTS – <SAMPLE>

- A. Measurement. The <INSERT WORK> is required to be furnished and installed as shown on the drawings and specified under Bid Item No. # <INSERT NUMBER>. The quantity for that item shall be paid per the appropriate measurement. Bid Item No. # shall be the computed number for <INSERT QUANTITY> placed within the limits ordered by Metro or Metro's representative.
- B. Payment. The unit price per <INSERT QUANTITY> for Bid Item No. # <INSERT NUMBER> is full compensation for all labor, materials, tools, equipment, supervision, compaction, testing, and incidentals necessary to furnish and install the <DESCRIPTION> as ordered by Metro or Metro's representative.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 29 73
SCHEDULE OF VALUES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Form and Content

1.02 RELATED SECTIONS

- A. Section 01 20 00 – Application for Payment
- B. Section 01 29 01/02 – Measurement and Payment <PROJECT SPECIFIC>
- C. Section 01 32 16/17 – Construction Progress Schedule <PROJECT SPECIFIC SMALL (LIMITED COMPLEXITY) OR LARGE PROJECTS>
- D. Section 01 43 00 – Quality Requirements
- E. Division 02 – Division ## < PROJECT SPECIFIC >

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Submit an initial Schedule of Values in the format discussed at the Pre-construction Meeting allocated to the various Lump Sum portions of the work in accordance with the Contract Documents and within 21 days of receipt of the Notice to Proceed.
- B. Unit Price items do not require a Schedule of Values listing. Unit Price item breakdowns will not be considered.
- C. The initial Schedule of Values submitted by the Contractor will be reviewed and returned to the Contractor within 14 days of its submittal. After completing any revisions, the Contractor will submit a revised schedule. Upon the receipt of an approved Schedule of Values and progress schedule, the Contractor may then submit its first request for payment.
- D. Upon the request of the Construction Manager, support values with data that will substantiate their correctness.
- E. All accounts in the Schedule of Values shall be tied to related activities in Section 01 32 16 - Construction Progress Schedule (Limited Complexity Projects) and/or Section 01 32 17 - Construction Progress Schedule (Large Projects) <PROJECT SPECIFIC >

1.04 FORM AND CONTENT

- A. Provide the following information on the Schedule of Values form:
 - 1. Title of project and location

2. Contract number
 3. Name and address of Contractor
 4. Date of submission
- B. List the component parts of the work, including the uninstalled and installed value of the material component parts of the work in sufficient detail to serve as a basis for computing the values for progress payments during construction as approved by the Construction Manager.
- C. Identify each line item with the number of major products or operations, labor, quantities, and unit prices under the item.
- D. For the various portions of the work:
1. Each item shall include a directly proportional amount of the Contractor's overhead and profit.
 2. For items on which progress payments will be requested for stored materials, break down the value into the following items:
 - a. The cost of the delivered materials because paid invoices are required for stored materials
 - b. The total installed value
- E. Include separate line item total cost and the proportional share of general overhead and profit for the following:
1. Mobilization
 2. Contract Closeout work, including demobilization, site cleanup, etc.
 3. Bonds and Insurance Premiums
 4. Coordination and Closeout Documents
 5. Monthly costs of construction facilities
 6. Testing
 7. Final site cleaning and restoration
 8. **<PROJECT SPECIFIC ITEMS MAY BE ADDED SUCH AS INSTRUMENTATION TESTING>**
- F. The sum of all values listed in the schedule shall equal the total Contract Sum.
1. Allowances. Provide a separate line item in the schedule of values for each allowance. Show the line-item value of unit-cost allowances as a product of the unit cost multiplied by the estimated quantity. Use the information indicated in the Contract Documents to determine quantities.
 2. Each item in the Schedule of Values and Application for Payment shall be complete.

3. Temporary facilities and other major cost items noted in Paragraph 1.04.E that are not direct costs of the actual work-in-place may be either shown as separate line items in the Schedule of Values or distributed as general overhead expense unless otherwise requested by the Construction Manager.
4. Schedule Updating. Update and re-submit the Schedule of Values before the next Application for Payment when Field Authorizations, Change Authorizations, or Change Orders result in a change in the Contract Price.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

FOR INFORMATION ONLY

SECTION 01 31 19

PROJECT MEETINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Pre-construction Conference
- C. Progress Meetings
- D. Other Project Meetings

1.02 RELATED SECTIONS

- A. Section 01 61 16 Web-based Information Management
- B. Section 01 29 73 – Schedule of Values
- C. Section 01 32 16 – Construction Progress Schedules
- D. Section 01 33 00 - Submittals
- E. Section 01 35 23 - Safety and Health
- F. Section 01 43 00 - Quality Requirements

1.03 PRE-CONSTRUCTION CONFERENCE

- A. Prior to the Notice to Proceed date and before any work is started at the site, a meeting shall be coordinated and conducted by the Construction Manager in accordance with the Contract Documents. The Construction Manager shall inform the Contractor of the location for this meeting.
- B. The intent for the Pre-construction Conference is to review the Contract Requirements, including:
 - 1. Contractor's organization, project personnel, subcontractors, and contact information
 - 2. Metro's Representatives, including the Program Manager, Engineer, and Construction Manager
 - 3. Contract schedule requirements (Specification Section 01 32 16, Construction Progress Schedules)
 - 4. Procedures for processing Requests for Information (RFIs), shop drawings, and other submittals, Change Orders, and Applications for Payment
 - 5. Metro's Office of Minority and Women Owned Business Assistance (BAO) reporting requirements

6. Orientation and use of the web-based project electronic data information system (PMIS)
7. Contractor's Quality Control Plan (Specification Section 01 43 00, Quality Requirements)
8. Contractor's *Safety and Health Plan* (Specification Section 01 35 23, Safety and Health)
9. Metro's requirements for using the Project site, including cleanup and security
10. Project testing
11. Special Inspections by the Construction Manager
12. Contractor's general approach to the work
13. Contractor's responsibility to the community
14. Permits
15. Field Surveying and Engineering
16. Coordination with other site Projects and utilities
17. Environmental Controls
18. Temporary Facilities
19. Training
20. Record Documents
21. Project Closeout

1.04 PROGRESS MEETINGS

- A. Attend progress meetings as scheduled and administered by the Construction Manager while performing the Work for this Contract. The Contractor shall be notified about the first progress meeting at the Pre-construction Conference. Meetings shall be bi-weekly unless the Construction Manager establishes an alternate schedule. The Construction Manager may request additional participants.
- B. The Construction Manager shall preside at the meetings and shall record and distribute minutes to the meeting attendees.
- C. At the Pre-construction Conference, the Construction Manager shall identify the location(s) for the progress meetings.
- D. The Contractor shall be prepared to discuss the following issues:
 1. Safety and Security issues
 2. Project Quality Control
 3. Progress of the Work in relation to the Contract Schedule

4. Discuss the proposed work activities, work schedule (days/hours) and staffing levels, including subcontractors for the forthcoming period. Provide a written three-week look-ahead schedule in accordance with Sections 01 32 16/17, Construction Progress Schedules. <PROJECT SPECIFIC>
5. Coordination of work impacting the daily operations
6. Site issues such as environmental and erosion control, site maintenance, or laydown areas
7. Status for RFIs, submittals, Change Orders, action items, and Applications for Payment
8. Review and approval for previous progress meeting minutes, including action items
9. Status for pending issues, including, but not limited to, issues affecting the Progress Schedule
10. Deviations from the Contract Documents and noted deficiencies and corrective actions

1.05 OTHER PROJECT MEETINGS

- A. Conduct other meetings in accordance with the Contract Documents throughout the time the Work is being performed onsite. The meetings may include, but are not limited to, pre-installation, major equipment coordination, diversion pumping, and shutdown meetings.
- B. The Construction Manager shall preside at each meeting and record and distribute minutes to the meeting attendees, as appropriate.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 32 16

CONSTRUCTION PROGRESS SCHEDULE <(LIMITED COMPLEXITY) PROJECT
SPECIFIC – SCHEDULE TO BE SELECTED DURING DESIGN PHASE>

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Format
- D. Content
- E. Using Float
- F. Early Completion
- G. Float Suppression
- H. Revisions to Schedules and Contract Time
- I. Submittals
- J. Schedule Recovery

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 20 00 – Application for Payment
- C. Section 01 29 73 – Schedule of Values
- D. Section 01 33 00 – Submittals
- E. Section 01 43 00 – Quality Requirements
- F. Section 01 61 16 – Web Based Information Management
- G. Division 02 – Division ## <PROJECT SPECIFIC>

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. The Work under this Contract shall be planned, scheduled, executed and reported by the Contractor using a CPM (Critical Path Method) schedule within a Work Breakdown Structure.
- B. Seasonal weather conditions shall be considered and included when planning and scheduling all Work influenced by high or low ambient temperatures and/or precipitation to ensure all Work is completed within the Contract Time.

- C. Seasonal and wet weather sewer system flow conditions shall be considered and included when planning and scheduling all Work influenced by precipitation to ensure all Work is completed within the Contract Time.

1.04 FORMAT

- A. The Contractor shall use software to produce the Contract schedules and reports as specified. This software shall run on Windows compatible equipment, be commercially available for lease or purchase, and be able to process and plot schedule data as specified in this Section. The schedule files shall be in a format compatible with Primavera P6 Project Planner.
- B. The schedule shall be in a Critical Path Method (CPM) format.

1.05 CONTENT

- A. Show complete construction sequence by activity, with dates for beginning and completing each construction element.
- B. Identify Work for separate stages and other logically grouped activities, such as: **<SAMPLE BELOW – NEED TO PROVIDE PROJECT SPECIFIC TASKS>**
 - 1. Submittal, procurement, and approval activities
 - 2. Performance Tests and supervisory activity
 - 3. Piping, duct work and wiring installation
 - 4. Demolition
 - 5. Construction activities for various facilities or pipe or rehabilitation work. Each activity is intended to last 20 days or less. If an activity is expected to exceed the 20-day timeframe, the activity needs to be divided into additional activities that are 20 days or less in duration. The examples below are not intended to be all-inclusive:
 - a. Site clearing
 - b. Blasting
 - c. Structure excavation(s)
 - d. Foundation installations
 - e. Tunneling, boring or jacking pipe for major crossings
 - f. All sewer work, including cleaning, connections and installations
 - g. Sewer connections
 - h. All water main work, including installation, testing, and connections
 - i. All storm sewer work, including appurtenances
 - j. Subcontractor's work
 - k. Sewer service renewals

- l. All manhole work
 - m. Surface and pavement restoration
 - n. Testing/post TV
 - o. Final cleanup
- C. Show each item's accumulated percentage of completion as directed by the Construction Manager and as reflected on the most recent approved payment application.
- D. Provide separate schedule with submittal dates for shop drawings, product data and samples.
- E. Schedule shall clearly show the Notice to Proceed date for the project, date of Substantial Completion, date of Final Completion, and any major milestone dates during construction such as major subcontractor mobilization/demobilization.
- F. Show changes occurring since previous schedule submittal, including:
- 1. Major Changes in Scope
 - 2. Activities modified since previous submittal
 - 3. Revised progress and completion projections
 - 4. Other identifiable changes

1.06 USING FLOAT

- A. Total float is the number of days part of the Work in the Progress Schedule may be delayed from its early dates without necessarily extending the Contract Time. Contract float is the number of days between the Contractor's anticipated date for completing the Work early or specified part and the corresponding Contract Time.
- B. Total float and Contract float belong to the Project and are not for any party's exclusive benefit. They shall be available to Metro and the Contractor to accommodate changes in the Work or to mitigate event effects that may delay performance or completion. The Contractor shall monitor and optimize using contract and total float to benefit the Project.

1.07 EARLY COMPLETION

- A. An early completion schedule anticipates completing all or specified Work parts before the corresponding Contract Time.
- B. Since the contract float belongs to the Project, the Contractor shall not be entitled to any extension in Contract Time or recovery for any delay incurred due to extensions in an early completion date until the entire contract float is used or consumed and the Work performance or completion extends beyond the corresponding Contract Time.

1.08 FLOAT SUPPRESSION

- A. The Contractor shall remove any float suppression techniques, e.g., preferential sequencing (crew movements, equipment use, for reuse, etc.), extended durations, imposed dates, scheduling non-critical work, artificial logic, and others as a prerequisite to a request an increase in contract price or Contract Time.

- B. The use of any type of schedule constraints must be identified to the Construction Manager for acceptance.

1.09 REVISIONS TO SCHEDULE AND CONTRACT TIME

- A. Indicate each activity's progress up to the submittal date and projected completion date.
- B. Identify activities modified since the previous submittal, major scope changes, and other identifiable changes.
- C. Contractor shall not be entitled to an adjustment in Contract Price or Contract Times for delays within the Contractor's control. Delays attributable to and within a subcontractor or Supplier's control shall be deemed to be delays within the Contractor's control.
- D. An adjustment in Contract Time shall be based solely on net increases in the time required to perform or complete the part of the Work controlling Critical Path achievement. However, even if the time required for performing or completing the critical path is extended, an extension in Contract Time shall not be granted until all available total float is consumed and the critical path performance extends beyond the Contract Time.

1.10 SUBMITTALS

- A. Submit the baseline schedule within 10 days after the Notice to Proceed date. All Contract schedules are prepared by the Contractor and reflect the Contractor's plan for the coordination of all activities and pursuing the Work. After review and return by Construction Manager for compliance with the Contract Documents, the Contractor will submit within seven days the revised electronic schedules modified to suit recommended changes.
- B. Submit updated electronic Progress Schedules with every Application for Payment. The Contractor's Progress Schedule shall be reviewed to ensure that the schedule complies with Contract requirements.
- C. Submit all schedules in the native electronic format (such as Primavera P6, Microsoft Project, Microsoft Excel) and in PDF, and submit one (1) hard copy.
- D. Submit a three-week look-ahead schedule updated for each Progress Meeting.

1.11 SCHEDULE RECOVERY

- A. If an updated Progress Schedule indicates the Project or a required Milestone falls 10 or more workdays behind schedule and there is no change to support a time extension, Contractor shall prepare and submit a Recovery Schedule for acceptance by the Construction Manager five calendar days after the updated Progress Schedule. The Recovery Schedule shall include proposed revisions to the Contractor's Construction Progress Schedule demonstrating how the Contractor intends to achieve all contractual milestones, including contract completion dates, within the remaining Contract Time. The accompanying narrative shall describe the cause for the problems and the actions planned by the Contractor to recover lost time.
- B. The Contractor shall promptly undertake appropriate action to recover lost time at no additional cost to Metro. Appropriate recovery actions may include, but not be limited to, assigning additional labor and/or equipment, shift or overtime work, expediting submittals or deliveries, overlapping activities or sequencing changes to increase activity concurrence.
- C. Lack of Action. The Contractor's refusal, failure, or neglect to take appropriate recovery action or to submit a recovery schedule shall constitute reasonable evidence the Contractor is

not prosecuting the Work or separable part of the Work, with the diligence to ensure its completion within the applicable Contract Time. Such lack of action shall constitute sufficient basis for Metro to consider withholding some or all of any payment due, and shall be considered grounds for termination by Metro.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

FOR INFORMATION ONLY

SECTION 01 32 17

CONSTRUCTION PROGRESS SCHEDULE <(LARGER PROJECTS) PROJECT SPECIFIC –
SELECT SECTION DURING DESIGN>

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Software/Interface Requirements
- D. Quality Assurance
- E. Dealing with Substitutes
- F. Using Float
- G. Early Completion
- H. Float Suppression
- I. Non-compliance
- J. Contract Schedules – General Criteria
- K. Cost Loading
- L. Contractor's Mobilization Schedule
- M. Contractor's Baseline Construction Progress Schedule
- N. Schedule Update
- O. Schedule Narrative
- P. Schedule Impact Analysis
- Q. Schedule Development
- R. Monthly Update for the Contractor's Construction Progress Schedule
- S. Schedule Revisions
- T. Schedule Recovery
- U. Schedule Submissions and Reporting Requirements Table

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work

- B. Section 01 29 73 – Schedule of Values
- C. Section 01 33 00 – Submittals
- D. Section 01 43 00 – Quality Requirements
- E. Section 01 61 16 – Web-based Information Management
- F. Division 02 – Division ## <PROJECT SPECIFIC>

1.03 CONTRACTOR’S RESPONSIBILITIES

- A. The Contractor’s planning, scheduling and execution for the Contract Work shall be presented to the Construction Manager by submitting the progress schedule information and data specified in this Section.
- B. The Work under this Contract shall be planned, scheduled, executed, and reported by the Contractor using a cost-loaded CPM (Critical Path Method) schedule within a Work Breakdown Structure. The Contractor shall adhere to established technical standards for CPM scheduling using a computerized precedence diagram method.
- C. The Contractor is responsible for coordinating his and all its subcontractors’ schedules and activities.
- D. All schedules shall comply with the Contract requirements. Any review or acceptance of any schedule shall not relieve the Contractor from the responsibility for complying with the Contract requirements, adhering to the Work sequences indicated in or required by the Contract Documents, or from completing any Work omitted from the schedule within the Contract Time.
- E. Seasonal weather conditions shall be considered and included when planning and scheduling all Work influenced by high or low ambient temperatures and/or precipitation to ensure that all Work is completed within the Contract Time. Seasonal weather conditions shall be determined by an assessment of average historical climatic conditions based upon the preceding ten (10) year records published for the locality by the National Oceanic and Atmospheric Administration (NOAA) under and entitled, “National Climatic Data Center – Unedited Local Climatological Data, State of Tennessee and desired station: Nashville: Nashville International Airport (BNA).

1.04 SOFTWARE/INTERFACE REQUIREMENTS

- A. The Contractor shall use CPM scheduling software to produce the Contract schedules that shall be compatible with Oracle Primavera Project Planner P6 and be able to process and plot schedule data as specified in this Section.
- B. Within seven calendar days after the Execution of the Agreement, the Contractor shall submit for review and acceptance by the Construction Manager, descriptive information on the CPM software the Contractor intends to use to comply with this Section’s requirements. The Contractor’s Scheduler may be required to attend all meetings concerning the Project’s progress, alleged delays, and time impacts.

1.05 QUALITY ASSURANCE

- A. The Contractor shall perform the Work covered by this Section with personnel having substantive experience in using computer-based scheduling programs on construction projects.

- B. In preparing all Contract schedules, it is the Contractor's responsibility to work with each subcontractor and supplier to obtain the information pertinent to planning and updating their respective activities and schedules.

1.06 DEALING WITH SUBSTITUTES

- A. All Contractor-prepared schedules shall be based solely on the Work as awarded and shall not include any substitute proposals even if the Contractor pursues a substitution in accordance with the Contract provisions. Substitutions shall not be added into the Construction Progress Schedule until accepted.
- B. Final determination on any proposed substitutions shall not be made until after the Contractor's Construction Progress Schedule is prepared and accepted as provided in this Section. Acceptance for any substitutes by Metro neither relieves the Contractor from meeting the Contract dates nor allows the Contractor compensation for failure to meet the substituted times.

1.07 USING FLOAT

- A. Total float is the number of days by which part of the Work in the Construction Progress Schedule may be delayed from its early dates without necessarily extending the Contract Time. Contract float is the number of days between the Contractor's anticipated date for the Work's early completion or specified part and the corresponding Contract Time.
- B. Total float and Contract float belong to the Project and are not for any party's exclusive benefit. They shall be available to Metro and the Contractor to accommodate changes in the Work or to mitigate the effect from events that may delay performance or completion. The Contractor shall monitor and optimize using float for the Project's benefit.

1.08 EARLY COMPLETION

- A. An early completion schedule anticipates completing all or specified part(s) of the Work before the completion of the corresponding Contract Time.
- B. Since the Contract float belongs to the Project, the Contractor shall not be entitled to any extension in Contract Time or recovery for any delay incurred due to extensions in an early completion date until the entire Contract float is used or consumed and the performance or completion of the Work extends beyond the corresponding Contract Time.

1.09 FLOAT SUPPRESSION

- A. The Contractor shall remove any float suppression techniques (e.g., preferential sequencing of crew movements, equipment use, for reuse, etc.), extended durations, imposed dates, scheduling for non-critical work, artificial logic, and others as a prerequisite to a request for an increase in Contract price or Contract Time.
- B. Using any schedule constraint type must be identified to the Construction Manager.

1.10 NON-COMPLIANCE

- A. The Construction Manager may refuse to recommend all or part of any payment if, in the Construction Manager's opinion, the Contractor's failure, refusal, or neglect to provide the required schedule information precludes proper evaluation of the Contractor's progress. Metro may withhold a set-off from any payment if, in the Construction Manager's opinion, the Contractor's failure, refusal, or neglect to provide the required schedule information precludes

a proper evaluation about whether or not the Contractor is executing the Work with the diligence to ensure its completion within the Contract Time.

- B. Upon Metro's request, the Construction Manager may provide technical assistance in preparing a schedule overdue by more than 10 days, and the Contractor shall reimburse Metro for all associated costs. If the Contractor fails to pay those costs within 30 days after receiving an invoice from Metro, then Metro shall be entitled to a decrease in the Contract price, and Metro shall deduct said costs from periodic pay estimates. The Construction Manager's technical assistance with the schedule preparation shall not relieve the Contractor from his responsibilities for determining the methods, techniques, and sequences to perform the Work.
- C. Metro reserves the right to have a schedule prepared by a party other than the Contractor should the Contractor fail to comply with these requirements. The Contractor shall be required to cooperate fully in preparing this schedule and pay to Metro all costs associated with this schedule. Said costs shall be reimbursed to Metro in accordance with Paragraph 1.10.B in this Section. These remedies for the Contractor's failure, neglect, or refusal to comply with this Section's requirements are in addition to, and not in limitation of, those provided under other Sections in the Contract Documents.

PART 2 - PRODUCTS

2.01 CONTRACT SCHEDULES – GENERAL CRITERIA

- A. Contract schedules include the Contractor's Mobilization Schedule and all versions of the Contractor's Construction Progress Schedule including baselines, weekly updated schedules, monthly updated schedules, revised schedules, and recovery schedules. All Contract Schedules are prepared by the Contractor and reflect the Contractor's plans and status for the Work. The Contractor shall provide one copy of all Contract Schedules color plotted on 11-inch x 17-inch paper and in the designated electronic format compatible with Primavera Project Planner P6.
- B. The Contract Schedules shall show the breakdown of Work into activities and relationships only to the extent required to effectively manage the Work. The Contract Schedules shall show the division of the Work into activities and specify the progression from the Notice to Proceed to the completion of the Work. Each construction activity shown on the Contract Schedules shall have a respective budget value, a portion of the Contract price. The Contract Schedule shall include appropriate time allowances for submittals, items interfacing with Work performed by others, and specified construction, physical checkout, field test, functional test, startup, and performance test activities. Site-related activities shall not reflect a combining of work located in separate structures, work corresponding to different Specifications, work performed by different subcontractors (first and second tiers), or rough-in and finish work by the same trade. Power and control wiring shall not be scheduled together in the same activity. Work being performed by SBE firms shall be identified by a distinguishable coding. Unless authorized by the Construction Manager, a scheduled activity shall span 10 workdays or less, and have a value not exceeding \$100,000. All activity durations shall be in workdays.
- C. The Contractor's Construction Progress Schedule shall include all procurement related activities that lead to delivering permanent materials and equipment to the site. Procurement activities include, but may not be limited to, preparing shop drawings, shop drawing review and acceptance, materials fabrication, and materials delivery.

- D. The Contractor shall schedule those requisite duties and responsibilities by the Contractor and others (performing work for Metro) indicated in or required by the Contract Documents. The Contract Schedules shall incorporate the appropriate activities and sequences based on the information given in the Contract Documents and, if not given, as indicated by the Construction Manager in writing.
- E. The Contractor shall include all significant milestones in the schedule including the development and approval of Contractor documentation, the start or completion of specific Work items, or the completion of any specific action items required from Metro or the consultant team that would affect the schedule.
- F. The Contractor's Construction Progress Schedule shall include specific activities for permitting and coordination with regulatory and/or government agencies to the extent that these activities are within the Contractor's control.

2.02 COST LOADING

- A. All construction activities shall be cost and man-hour loaded by the Contractor. Procurement-related activities shall not be cost or man-hour loaded except as approved or directed by the Construction Manager. Cost fields shall be set to zero decimal places. Each field activity shall be assigned a budget value for labor, materials, and equipment. The sum for all budget values assigned shall equal the Contract total. The Contractor shall also assign estimated man-hours for each construction activity.
- B. The Contractor shall prepare a detailed Schedule of Values in accordance with Section 01 29 73 - Schedule of Values.

2.03 CONTRACTOR'S MOBILIZATION SCHEDULE

- A. The Contractor's Mobilization Schedule shall be submitted within fourteen days after the Notice to Proceed. The Contractor's Mobilization Schedule is to be a bar chart schedule covering the first ninety (90) calendar days of work to be performed starting with the Notice to Proceed. The Contractor's Mobilization Schedule shall be cost-loaded as described above and as directed by the Construction Manager and will be used as a basis for the initial Application for Payment.
- B. When the Contractor's Mobilization schedule is received and accepted by the Construction Manager, it becomes the basis for construction planning and updating until it is superseded by the accepted Contractor Construction Progress Schedule.

2.04 CONTRACTOR'S BASELINE CONSTRUCTION PROGRESS SCHEDULE

- A. The Contractor's Baseline Construction Progress Schedule shall be submitted within 45 days after the Notice to Proceed.
- B. The Contractor shall use a Work breakdown structure (i.e., project, facility and C.S.I. codes) and guidelines for developing the activity number and coding structures. The Contractor shall produce a Construction Progress Schedule that accurately represents the proposed means and methods for accomplishing the Work. This schedule shall show all logical relationships and constraints between activities.
- C. The Contractor's Construction Progress Schedule shall include, at a minimum, the following:
 - 1. A pure logic CPM Plot grouped by area, early start, and early finish. The plot must clearly and legibly show all activities and logical ties and shall display each activity's

number, description, original duration, remaining duration, and total float value. The plot must also show the critical path for completing the Work. The basic concept for Precedence Diagramming Method (PDM) network scheduling shall be followed to show how a given activity's start depends on completing preceding activities and how its completion may affect the following activities' start. The schedule's detail level shall define the day-to-day activities for the construction Work.

2. Tabular activity report sorted by:
 - a. Bid Item, Activity ID
 - b. Bid Item, Responsibility, Activity ID
 - c. Bid Item, Area, Early Start Date, Early Finish Date
 - d. Total Float, Early Start, Early Finish
 3. The Activity Reports shall include activity description, total duration, early start and finish dates, late start and finish dates, free float, total float, percent complete, and remaining duration
 4. A tabular logic report sorted by Activity ID including activity description, total duration, early start and finish dates, late start and finish dates, free float, total float, percent complete, remaining duration, and detailed predecessor and successor information for each activity including any lag.
 5. A tabular cost report sorted and sub-totaled by bid item, area, and responsibility showing activity number, activity description, budgeted cost, physical percent complete, actual cost to date, actual cost for the current period, and estimate to complete.
 6. A detailed list with any added or deleted activities, changed actual dates, changes made to schedule activity descriptions, original durations, budgets, or logic since the last revision.
 7. A histogram showing the earned value for man-hours as compared to the approved baseline schedule on a monthly and cumulative basis
 8. A schedule narrative as described in this Section shall be prepared and included with the original Construction Progress Schedule submission.
 9. Any other reports or plots requested by the Construction Manager.
 10. The exact layout for the above-required reports is subject to the Construction Manager's approval. Except for the CPM plot, all reports and charts shall be submitted electronically in accordance with Section 01 61 16 – Web-based Information Management.
- D. When the Contractor's Construction Progress Schedule is reviewed and accepted, it becomes the baseline Construction Progress Schedule. From then on, all activities and their relationships may not be changed, added, or deleted without the Construction Manager's consent.

2.05 SCHEDULE UPDATE

- A. Updating the Contractor's Construction Progress Schedule and scheduling changes and other events affecting the schedule is the Contractor's responsibility. The Contract Time (including

all contracted milestones) shall not be changed without a formal Change Order executed by Metro.

- B. The Contractor shall maintain the schedule, prepare bi-weekly updates, and prepare a complete updated Construction Progress Schedule for monthly review.
- C. The bi-weekly schedule update shall be submitted prior to or at the Project progress meeting specified in Section 01 31 19 - Project Meetings.
- D. Maintaining the Construction Progress Schedule shall include the following:
 - 1. Corrections to the Schedule. Each period, the Contractor shall make those corrections to the schedule that have been identified by the Construction Manager in the last bi-weekly progress meeting. Generally, these corrections shall include, but may not be limited to, correcting inaccurate actual dates, correcting logic for activities that did not start or finish as scheduled and are being driven by the data date, inaccurate representation for Contract milestones, missing actual start or completion dates, and out of sequence progress. The Contractor shall also correct any similar errors of which it is aware.
 - 2. Revisions to the Schedule. Schedule revisions are defined as any change to schedule activities or logic other than updating actual start and completion dates, percent complete, or remaining duration. No revisions to schedule activities and cost loading shall be made during the daily maintenance or weekly updates. Any revisions to the schedule due to, but not limited to, out of sequence work or mitigating delays should be proposed and discussed for acceptance by the Construction Manager with the monthly update submittal.
 - 3. Bi-weekly updates shall only include a bar-chart report showing one-week's progress and the three-week look-ahead.
- E. Updating the construction progress schedule monthly shall include the following:
 - 1. Updating the Activity Status. Each month, the Contractor shall enter the percent complete, remaining duration, actual start, and actual completion dates into the schedule and re-calculate the schedule based on the payment cutoff date for that month. The percent complete shall be the percent agreed to by the Construction Manager. The remaining duration shall be the Contractor's best estimate for the time required to complete the activities that have started but that have not been completed. The percent complete and remaining duration shall be independently determined for each activity. The retained logic method for schedule calculation shall be used to calculate the schedule unless otherwise approved by the Construction Manager.
 - 2. Corrections to the Schedule. Each month, the Contractor shall make corrections to the schedule identified by the Construction Manager since the last monthly update. Generally, these corrections shall include, but may not be limited to, correcting inaccurate actual dates, correcting logic for activities that did not start or finish as scheduled and are being driven by the data date, inaccurate representation of Contract milestones, missing actual start or completion dates, incorrect budget or actual cost amounts, and out of sequence progress. The Contractor shall also correct any similar errors of which it is aware and shall inform the Construction Manager about any such corrections made during the bi-weekly or monthly update.
 - 3. Revisions to the Schedule. Schedule Revisions are defined as any change to the schedule activities or logic other than updating the actual start and completion dates, percent complete, or remaining duration. No changes shall be made to the schedule or the cost

loading for activities unless agreed upon and directed by the Construction Manager. All schedule revisions, other than delays, must be accepted in advance by the Construction Manager. For delays to milestones or completion in the monthly progress update, the Contractor shall either submit a recovery schedule as described in this Specification Section or a time impact analysis prepared separately from the update. Schedule revisions shall be based upon the impact to the schedule for changes in the Work or other delays as agreed to by the Construction Manager during negotiations for the change or other impact in question. The specific activities added and their logical ties to existing schedule activities shall be explained in detail in the schedule narrative. After any schedule impact or change is negotiated and the specific activities and logic to be added have been approved, the Contractor shall incorporate the revision into the schedule prior to the next update. Added activities shall be coded as directed by the Construction Manager indicating to which Change Order they are associated. Revisions shall be man-hour and resource loaded. No cost shall be added to the schedule until after a Change Order, Field Authorization, or Change Authorization has been issued. Any authorized revisions to the schedule shall also ensure that the cost loading, including the corresponding totals for schedule of values and bid items, remains current.

- F. All monthly schedule updates shall include the same reports and plots required for the initial Contractor's Construction Progress Schedule submittal or as requested by the Construction Manager.
- G. The resource/cost percent complete field or its equivalent in scheduling software other than that accepted by the Construction Manager shall not be used. The amount payable to date for any activity shall always be equal to the physical percent complete for the activity multiplied by the budgeted value for the activity.

2.06 SCHEDULE NARRATIVE

- A. The Schedule Narrative accompanying the initial Contractor's Construction Progress Schedule submittal shall describe the following:
 - 1. Contract requirements and objectives
 - 2. Operation methods
 - 3. Resources to be employed
 - 4. General sequence of the Work
 - 5. Critical path
 - 6. Any long lead equipment
 - 7. Any physical constraints to completing the Work and any assumptions made in developing the schedule
 - 8. Time frames for constructing major systems, substantial completion, and for completing all Work
- B. When requested by the Construction Manager or, at a minimum, twice annually, a Schedule Narrative accompanying an update to the Contractor's Construction Progress Schedule shall be provided and, at a minimum, address the following:
 - 1. Milestones completed

2. A descriptive summary for each revision incorporated into the schedule since the last update and its effect on the schedule
3. Any change to the critical path
4. Any actual or anticipated problems with material or equipment delivery
5. Any problems with submittal approval
6. Any corrective action undertaken by the Contractor to address schedule problems
7. Anything impacting critical path, milestones, and contractual completion

2.07 SCHEDULE IMPACT ANALYSIS

- A. Whenever the Contractor requests an extension to the Contract Time or any Contract Milestone, the Contractor shall provide an analysis of the critical path. At a minimum, the analysis must contain the following (also refer Paragraph 3.05 in this Section for reporting and submission requirements):
 1. A detailed network analysis based on the last accepted schedule when the impact occurred. In the absence of an acceptable schedule, the impact analysis shall be prepared based on the last schedule update when the impact occurred with all of the recommended corrections to the schedule made in the applicable review.
 2. The Contract milestones affected and how many days extension are requested for each
 3. A plot starting at the timeline and showing the controlling path to each affected milestone before the change or delay in question
 4. A plot including the activities added to represent the change or delay starting at the timeline and showing the controlling path to each affected milestone after the change or delay in question
 5. A list with all activities and logic added, deleted, or changed to represent the impact from the change or other delay being analyzed
 6. An electronic copy with before and after schedules. The schedule files shall be in Primavera Project Planner or similar format as accepted by the Construction Manager.
- B. While the Contractor requests an extension to the Contract time or any Contract milestone, the Contractor continues to be obligated under the Contract as specified in the General Conditions to achieve the Contract milestone and time unless a time extension is negotiated and executed.

PART 3 - EXECUTION

3.01 SCHEDULE DEVELOPMENT

- A. Contractor's Mobilization Schedule.
 1. The activities, budget values, and progress from the Mobilization Schedule shall be carried forward into the Contractor's Construction Progress Schedule.

B. Contractor's Construction Progress Schedule

1. The Contractor shall submit its Construction Progress Schedule within 45 calendar days after the Notice to Proceed date. This schedule shall reflect the entire scope of the Contract Work as awarded and shall include all of the general criteria items listed in Paragraph 2.01 in this Section.
2. The Contractor's initial Construction Progress Schedule shall be submitted to Metro and the Construction Manager for review. The Contractor shall verify all data in its Construction Progress Schedule and assumes full responsibility for doing so. The Contractor's Construction Progress Schedule shall be reviewed to ensure that the schedule is coordinated with all of the activities and logic requirements of the Work.
3. The Construction Manager shall review and return written comments about the Contractor's Construction Progress Schedule to the Contractor within 30 calendar days.
4. If revisions are required, the Contractor shall make the appropriate adjustments or corrections and shall deliver to the Construction Manager its revised Construction Progress Schedule directing specific attention, in writing, to the adjustments or corrections made other than those made in response to the Construction Manager's comments about the previous submittal. The Construction Manager shall review and return written comments about the revised Contractor's Construction Progress Schedule within 15 calendar days. This step shall be repeated until the schedule is accepted. The Construction Manager's acceptance for the Contractor's Construction Progress Schedule shall be a condition precedent to processing any application for payment after the first full month.
5. The Construction Manager's review and comments shall be for conformance with the Contract Time and those Work sequences indicated in or required by the Contract Documents to record dates for milestones and for conformance with this Section's requirements and other information given in the Contract Documents that may have a bearing on the schedule. The Construction Manager's review shall also be for reasonableness and consistency in cost loading the schedule activities. The Construction Manager's review shall not extend to the Contractor's means, methods, or techniques, and the correctness for these shall remain the Contractor's sole responsibility.
6. Once the Contractor's Construction Progress Schedule is accepted by the Construction Manager, it becomes the baseline Contractor's Construction Progress Schedule for the Work and is the basis for a) monitoring the Contractor's progress against milestones and Contract Time and b) the evaluation and reconciliation of extensions in the Contract Time.

3.02 MONTHLY UPDATE FOR THE CONTRACTOR'S CONSTRUCTION PROGRESS SCHEDULE

- A. The Construction Manager shall determine the cut-off date for the payment application and schedule update.
- B. Schedule Status Submittals
 1. The Contractor's Construction Progress Schedule update is due monthly with (attached to) each Application for Payment. The receipt of the Contractor's Construction Progress Schedule by the Construction Manager will be a condition precedent to processing any application for payment.

2. Neither updating the Contractor's Construction Progress Schedule nor updating any report or schedule submitted to the Construction Manager by the Contractor under this Section shall amend or modify in any way the Contract Time, Contract Completion Date, or Contract Milestone Dates.
- C. Updates pertaining to past activities. Logic calculation configurations should be consistent throughout the Project.
1. Use the retained logic option.
 2. Calculate the start-to-start lag by using the Early Start option.
 3. Calculate the Early Start by using the contiguous activity duration option.
 4. Calculate the total float using the most critical option.
- D. Monthly Reviews **<PROJECT SPECIFIC>**
1. Monthly review meetings between the Contractor and Metro/Construction Manager shall be held the third Thursday each month or a time agreed upon by the Contractor and Construction Manager. In this meeting, participants finalize the percent to be paid for activities completed or in progress and review and discuss any required corrections and proposed revisions to the schedule.
 2. Prior to the monthly review meeting, the Contractor shall update the status for each activity in progress or completed with actual or estimated actual start and finish dates, physical percent complete, and the remaining duration for activities started but not completed, and calculate the CPM.
 3. Schedule update through payment cut-off date. The Contractor shall provide an electronic copy of the updated schedule to the Construction Manager three workdays prior to the schedule review meeting. The Contractor shall provide the appropriate reports as defined by the Construction Manager at the monthly review meeting.
 4. After the monthly schedule review meeting, the Contractor shall revise the status of activities as directed by the Construction Manager and submit the payment application along with the requested number of final updates to the Contractor's Construction Progress Schedule and reports within seven calendar days.

3.03 SCHEDULE REVISIONS

- A. All schedule revisions must be presented at the biweekly progress meeting for the Construction Manager's coordination and acceptance. The Contractor shall provide a separate sub-network schedule for each proposed revision showing the revised activities and how it proposes to tie these activities into the Contractor's Construction Progress Schedule.

3.04 SCHEDULE RECOVERY

- A. If an updated Progress Schedule indicates that the Project or a Milestone requirement falls 10 or more workdays behind schedule and that there is no excusable delay or change to support a time extension, the Contractor shall prepare and submit a Recovery Schedule for acceptance by the Construction Manager five calendar days after the updated Progress Schedule. The Recovery Schedule shall include proposed revisions to the Contractor's Construction Progress Schedule demonstrating how the Contractor intends to achieve all contractual milestones including Contract completion dates within the allotted Contract Time. The accompanying

narrative shall describe the cause of the problems and the actions planned by the Contractor to recover lost time.

- B. The Contractor shall promptly undertake the appropriate action at no additional cost to Metro to recover lost time. Appropriate recovery actions may include, but not be limited to, assigning additional labor and/or equipment, shift or overtime work, expediting submittals or deliveries, overlapping activities or sequencing changes to increase activity concurrence.
- C. Lack of Action. The Contractor’s refusal, failure, or neglect to take appropriate recovery action or to submit a recovery schedule shall constitute reasonable evidence that the Contractor is not executing the Work or separable part with the diligence that will ensure its completion within the applicable Contract Time. Such lack of action shall constitute a sufficient basis for Metro to consider withholding some or all of any payment due and shall be considered grounds for termination by Metro.

3.05 SCHEDULE SUBMISSION AND REPORTING REQUIREMENTS TABLE

- A. The reports required by this Section are to be prepared and submitted by the Contractor in accordance with the following table.

Table 01 32 17-1 Table of Schedule Submittal Requirements									
No.	Schedule	Narrative	Electronic (Compatible with P6)	Look-ahead	Critical Path (In time scaled logic format)	-Cash flow (Early & Late) -Labor Histogram -Total Float Report -Other Reports as required in respective Sections or by the Construction Manager	Detailed Precedence Report	Out-of-Sequence Report with Explanation	Comparative with detailed explanation for changes using fragnets supporting narratives
1.	Mobilization		√		√	√			
2.	Baseline	√	√		√	√	√		
3.	Bi-Weekly Progress		√	1 week progress, 3 week look-ahead	√				
4.	Monthly Updates	As required	√	3 month	√	√ (Planned vs. Actual)		√	
5.	Revised Construction Progress Schedules/ Recovery Schedules	√	√		√	√	√		√
6.	Impact Analysis	√	√		√	CM discretion	Critical Path only		√

END OF SECTION

SECTION 01 32 23

PRE- AND POST-CONSTRUCTION SURVEYS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Description
- C. Contractor's Responsibilities
- D. Submittals
- E. Quality Assurance
- F. Sequencing and Scheduling
- G. Records
- H. Surveys and Layouts
- I. Pre- and Post-construction Survey Layouts

1.02 RELATED SECTIONS

- A. Section 01 11 00 - Summary of Work
- B. Section 01 33 00 - Submittals

1.03 DESCRIPTION

- A. Provide pre- and post-construction surveys as noted below.

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall have in their employment or retain services from a Tennessee-licensed Registered Land Surveyor to oversee, develop, and make all detailed property and control surveys and provide quality control for measurements needed for construction. Except where the Registered Land Surveyor must complete survey directly, the Registered Land Surveyor shall supervise and certify the survey.
- B. All survey work for construction control shall be made by the Contractor at its expense. Drawings prepared to show buried piping, structures, duct banks, etc., shall be sealed by a Tennessee-licensed Professional Engineer or Land Surveyor.
- C. The Contractor shall establish all applicable baselines for the locations of the principal component parts of the Work together with a suitable number of benchmarks, coordinates, centerlines, and structure lines adjacent to the Work. Based upon the information provided by the Contract Drawings, the Contractor shall develop and make all detail surveys necessary for construction, including the slope stakes, stakes for all working points, lines, and elevations.

1.05 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00,- Submittals.
 - 1. Submit surveys in electronic format using most recent AutoCAD version. AutoCAD drawings shall be projected in the coordinate system and datum as stated on the Contract Drawings.
 - 2. Provide coordinate values (X, Y, Z description) in the design datum (as stated on Contract Drawings) in ASCII format.
 - 3. Submit one hardcopy of surveys on 24-inch x 36-inch commercial quality media and a copy of the survey in Adobe PDF in a digital format acceptable to the Construction Manager.

1.06 QUALITY ASSURANCE

- A. All Work under this Contract shall be constructed in accordance with the lines and grades shown on the Contract Drawings or as directed by the Construction Manager. Elevations for the existing ground and appurtenances are believed to be reasonably correct but are not guaranteed to be absolute and, therefore, are presented only as an approximation. Any error or apparent discrepancy in the data shown or omitted data required for accurately accomplishing the stake out survey shall be referred immediately to the Construction Manager for interpretation or correction.
- B. The Contractor shall be solely responsible for all locations, dimensions, and horizontal and vertical positions. No information, other than written orders from Metro, shall justify departing from the dimensions and/or horizontal or vertical positions required by the Drawings.

1.07 SEQUENCING AND SCHEDULING

- A. Dates for the Pre- and Post-construction Surveys at the site shall be coordinated with the Construction Manager. The Contractor shall notify the Construction Manager a minimum of 48 hours prior to each survey.

1.08 RECORDS

- A. Maintain a complete, accurate log of all control and survey work as it progresses. When requested by Construction Manager, provide a written copy of all survey logs, survey raw data, and all field engineering notes, including, but not limited to, pipe layout schedules, sketches, cut sheets, and working notes. Records shall be available for inspection at all times.
- B. When pipe installations and other major site improvements have been completed, prepare a certified survey drawing showing the final layout of all existing benchmarks, including all construction, dimensions, locations, angles, and elevations. The drawing shall indicate all critical elevations and locations for buried new piping, existing piping, utilities where encountered during excavation, finish grades, etc., and other actual information.

PART 2 - PRODUCTS

2.01 SURVEYS AND LAYOUTS, PRE & POST-CONSTRUCTION

- A. Provide construction surveys for existing (pre-construction) and final (post-construction) conditions in accordance with the following:
1. Develop and make all detail surveys and measurements needed for construction, including slope stakes, batter boards, piling layouts, and all other working lines, elevations, and cut sheets. Provide first floor elevations, operating floor elevations, equipment elevations, the corners of buildings, and structures foundations both front and rear.
 2. Provide all materials required for benchmarks, control points, grade stakes, and other items.
 3. Provide elevations for sidewalks, driveways, edge of roadway, retaining walls, fences, garages, sheds, etc.
 4. Include structure limits, roadways, manhole rim and invert elevations, structures elevations, piping elevations, etc.
 5. The Professional Registered Land Surveyor shall complete and provide locations and elevations for stormwater control constructed under the Project to verify that the designed volumes were obtained and that they comply with the developed grading plans. Provide computations for cut/fill volumetric changes in site topography for compliance with the design grades and improvements.
 6. The location of each elevation shall be described in detail in words and located on the plan. The contour interval shall be 1-foot.
 7. Re-establish safeguard points, stakes, grade marks, monuments, and benchmarks made or established on the Work if disturbed and still needed. Rectify all Work improperly installed due to not maintaining, not protecting, or removing without authorization such established points, stakes, marks, and monuments.
 8. The Contractor shall have the responsibility to carefully preserve the benchmarks, reference points, and stakes. If any benchmarks, reference points, and/or stakes are destroyed by or as a result of the Contractor's negligence, the Contractor shall be responsible for any resulting damage. The Contractor shall also be responsible for any mistakes that may be caused by the unnecessary loss or disturbance of such benchmarks, reference points, and stakes.
 9. Existing or new control points, property markers, and monuments that shall be or are destroyed during normal construction shall be re-established by the Contractor, and all reference ties shall be recorded and furnished to the Construction Manager. All computations necessary to establish the Work's exact position shall be made and preserved by the Contractor and submitted to the Construction Manager.
 10. The Construction Manager may check all or any portion of the Work, and the Contractor shall afford all necessary assistance in carrying out such checks. Any necessary corrections to the Work to make it conform to the Contract Documents shall be immediately made by the Contractor at no additional cost to Metro. Such checking shall not relieve the Contractor from any responsibilities for his work's accuracy or completeness.

11. Where the dimensions and locations for existing structures are critically important for installing or connecting any part of the Work, verify such dimensions and locations in the field before having any material dependent on such information's correctness fabricated or installed.

PART 3 - EXECUTION

3.01 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00, Contract Closeout.

END OF SECTION

FOR INFORMATION ONLY

SECTION 01 32 33

CONSTRUCTION VIDEOS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Submittals
- D. Quality Assurance
- E. Photographic Media
- F. Pre-construction Video
- G. Supplemental Video Records

1.02 RELATED SECTIONS

- A. Section 01 11 00 - Summary of Work
- B. Section 01 33 00 - Submittals
- C. Section 01 43 00 - Quality Requirements

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Purpose of Video Recording. The purpose of the color audio-video recording of the project is to document surface features before the start and after completion of the Work.
- B. The Contractor shall provide audio videos to document the progress of the Work as well as the existing conditions and features of the work prior to Construction. The audio videos shall consist of color video recordings of the surface features taken along the entire length of the project and include all work and storage areas, all public roadways within 0.25 miles of the project site(s), and all intersecting roadways for facilities or new pipe projects. All video recordings shall be accompanied by a running audio narrative of the aspects being recorded. Prior to audio-video recording of the project, all areas to be inventoried shall be investigated visually with notations made of items not readily visible by recording methods.
- C. Videos shall be taken in the presence of the Construction Manager.
- D. Record the videos within 30 days of the construction activity for line segments or areas as directed by the Construction Manager.
- E. Provide progress and final photographs of the work for facility and new pipe projects or portions thereof.
- F.

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00, -Submittals:
 - 1. Preconstruction video recordings
 - 2. Periodic construction video recordings as requested by the construction manager or as desired by the Contractor for additional documentation
 - 3. Final Construction Video
- B. Pre-construction Video. Submit video record within fourteen (14) days of taking videos.
- C. Video Equipment
 - 1. Video camera. The video camera shall have a minimum sensor resolution of 12 megapixels (MP).
 - 2. Video record submittal. Provide in accordance with the Construction Manager's directions.
 - 3. Identification. Provide the following information with each video description in file metadata tag:
 - a. Name of Project, Program Project Number, and Metro project number
 - b. Name and contact information for the photographer
 - c. Name of the Construction Manager's representative
 - d. Name of the Contractor
 - e. Date that the video was taken
 - f. Description of vantage points, indicating location, direction (by compass point), and station or property address

1.05 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00,- Quality Requirements.
- B. The photographer is to use techniques, material, and equipment capable of producing videos of high quality and resolution.
- C. The dates for recording videos at the site are to be coordinated with the Construction Manager, who shall be present during the video recording at site unless otherwise approved.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHIC MEDIA

- A. Video. Provide images in MPG format produced by a digital camera with minimum sensor size of 12 megapixels and at an image resolution of not less than 3200 x 2400 pixels. Videos taken with mobile phones are not acceptable.

PART 3 - EXECUTION

3.01 PRE-CONSTRUCTION VIDEO

- A. Pre-construction Video. Before starting construction, take a video of the Project site, including the existing items to remain during construction and other critical features from different vantage points as directed by the Construction Manager.
 - 1. Flag the construction limits before recording the video.
 - 2. The video is to show the existing conditions adjacent to the property before starting the Work.
 - 3. The video is to show the existing buildings either on or adjoining the property to accurately record the physical conditions at the start of construction.
 - 4. Take additional videos, as required, to record settlement or cracking of adjacent structures, pavements, and improvement.
- B. The video coverage shall include, but not be limited to, all existing driveways, sidewalks, curbs, streets, signs, landscaping, trees, catch basins, fences, visible utilities, and all buildings located within the zone of influence. Of particular concern are any existing faults, fractures, defects, or other features. The audio description shall be made simultaneously with the recording of the video and support the video coverage.
- C. Streets. The streets shall be recorded by audio-video recording for the full width of the right-of-way except where specifically noted otherwise by the Construction Manager.
- D. Work Areas. Work areas shall be recorded by audio-video, including all adjacent areas lying within the zone of influence of construction as directed by the Construction Manager.
- E. Front and/or Side Yard Areas. Front and/or Side Yard Areas of residential homes within the zone of influence of construction shall be recorded.

3.02 SUPPLEMENTAL VIDEO RECORDS

- A. Take additional videos as required by the Construction Manager to document changes in conditions such as the completion of clearing.

3.03 CONSTRUCTION PHOTOGRAPHS < DELETE FOR REHAB PROJECTS >

- A. The Contractor shall provide monthly construction photographs by a professional photographer utilizing adequate light showing the progress of the Work. The photographs shall be taken of such subjects as may be directed by the Construction Manager and shall be taken with a digital camera. The photographs shall be provided in electronic format and on 8-inch by 10-inch glossy photograph paper. The electronic format pictures shall be labelled with name of view and date. The 8-inch by 10-inch glossy color photographs shall be labelled on the bottom and front of each print with the date (YYYYMMDD), job title, and brief description of the photograph, including the location where the photograph was taken. Starting one month after the date of the notice to proceed and continuing as long as the work is in progress, monthly photographs shall be taken.
- B. Every three months aerial photographs shall be taken from three angles and provided to the Construction Manager. The Contractor shall provide high resolution aerial photographs on

8-inch by 10-inch glossy color photograph paper as well as a digital set. Each flight shall provide views of the entire construction zone.

- C. Upon acceptance of the Work, a complete set of all pre-construction, construction, aerial, and final acceptance electronic photographs shall be provided on electronic digital storage devices acceptable to the Construction Manager and given to the Construction Manager. Color exposure photographs shall be made of the Work where directed by the Construction Manager. The photographer shall be equipped to take either interior or exterior exposures with a proper digital camera. Photographs taken with mobile phones are not acceptable.
- D. The 8-inch by 10-inch high resolution digital image of each exposure shall be delivered to the Construction Manager each month in PMIS with the Contractors Monthly Application for Payment.
- E. The Construction Manager shall have the right to request that monthly photographs be re-taken if the photographs are of poor quality due to lighting, distance, focus, sharpness, or other poor qualities. The Contractor shall not receive extra compensation for re-taking poor quality photographs. The Contractor shall meet with the Construction Manager and show the Construction Manager the monthly construction photographs 7 days prior to submitting the Monthly Application for Payment. This pre-review of the construction photographs shall allow time for the Contractor to re-shoot any poor views prior to the submitting the Application for Payment.
- F. **REQUIRED NUMBER OF PHOTOGRAPHS**
 - 1. For the work of this contract, photographs shall be provided as listed:
 - a. Pre-construction--1 time
 - b. Construction (interior/exterior)--monthly for the duration of the project
 - c. Aerial photographs--every 3 months
 - d. Final Acceptance--1 time

3.04 DRONE PHOTOGRAPHY

- A. The Contractor may provide aerial drone photographs of the site as a substitute for the aerial and surface photography if approved by the Construction Manager. The drone photographs may be taken by a licensed third-party service. Interior work such as in tunnels, galleries, and small buildings shall be traditional digital photography. Each drone flight shall provide views of the entire construction zone. Drone flights shall be coordinated with MWS complex security if on MWS property and with property owners if on improved private property.

END OF SECTION

SECTION 01 33 00

SUBMITTALS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Description
- B. Related Sections
- C. Contractor's Responsibilities
- D. Metro's/ Engineer's Duties
- E. Submittal Schedule
- F. Submittal Requirements
- G. Re-submittal of Submittals
- H. Initial Submittals
- I. Submittal Procedures
- J. Contractor's Review
- K. Submittal Review
- L. Distribution

1.02 DESCRIPTION

- A. This Section specifies the general methods and requirements of submissions applicable to work-related submittals.

1.03 RELATED SECTIONS

- A. Section 01 14 14 – Control of Work
- B. Section 01 25 00 – Substitution Procedures
- C. Section 01 29 73 – Schedule of Values
- D. Section 01 32 16/17 – Construction Progress Schedules <SELECT BASED ON PROJECT>
- E. Section 01 43 00 – Quality Requirements
- F. Section 01 61 16 - Web Based Information Management
- G. Section 01 77 00 – Contract Closeout

H. Section 01 78 23 – Operation and Maintenance Data

I. Division 02 – Division ## <PROJECT SPECIFIC>

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. The review and approval of shop drawings, samples, or product data by the Engineer or Construction Manager shall not relieve the Contractor from their responsibility with regard to the fulfillment of the terms of the Contract. All risks of review error and omission are assumed by the Contractor, and the Construction Manager and/or Metro's Engineer will not have responsibility, therefore.
- B. The following actions are required of the Contractor:
1. Review submittals prior to submittal
 2. Determine and verify the following for each submittal:
 - a. Field measurements
 - b. Field construction criteria
 - c. Catalog numbers and similar data
 - d. Conformance with Specifications
 3. Coordinate each submittal with the requirements of the Work and Contract Documents.
 4. Notify Metro in writing, at the time of submittal, of deviations in submittals from the requirements of the Contract Documents. No deviation will be allowed without the written permission of Metro. If the Contractor fails to notify Metro of deviations, it shall pay for all costs for equipment replacement or removal to correct the problem.
 5. Begin no fabrication or work requiring submittals until the return of submittals with Metro's approval as provided in Section 3.02.
 6. Deliver no products or equipment to the site requiring submittals until the return of submittals with Engineer's approval as provided in Section 3.02.
 7. Provide a Submittal Schedule in accordance with Paragraph 1.06.

1.05 METRO'S/ENGINEER'S DUTIES

- A. Review Submittals in accordance with schedule
- B. Return Submittals to the Contractor for distribution or for re-submittal in accordance with the Contract Documents
- C. See Paragraph 3.02 for submittals responses designations

1.06 SUBMITTAL SCHEDULE

- A. Submit a schedule of submittals, arranged in chronological order by dates, required by the construction progress schedule. Include the time required for review, ordering, manufacturing, fabrication, and delivery when establishing the dates. Include the additional

time required for making corrections or revisions to the submittals as noted by the Engineer and the additional time for handling and reviewing submittals required by those corrections.

B. The Contractor shall:

1. Coordinate the submittal schedule with the list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Submit an initial submittal schedule concurrently with the startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead-time for manufacture or fabrication.
3. Final Submittal Schedule. Submit concurrently with the first complete submittal of Contractor's construction schedule.
4. Format. Arrange the following information in a tabular format:
 - a. Scheduled date for first submittal
 - b. Specification Section number and title
 - c. Name of subcontractor
 - d. Description of the Work covered
 - e. Scheduled date for final release or acceptance
 - f. Scheduled date of fabrication
 - g. Scheduled dates for purchasing
 - h. Scheduled dates for installation
 - i. Applicable activity or event number from the progress schedule

1.07 SUBMITTAL REQUIREMENTS

- A. Provide and present submittals in accordance with Section 01 61 16 – Web-based Information Management.
- B. Coordination. Coordinate the preparation and processing of submittals with the Contractor's Submittal Schedule and the construction Progress Schedule.
 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on the accepted Submittal Schedule.
 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.

4. Coordinate the transmittal of different types of submittals for the related parts of the Work so processing will not be delayed because of the need to review the submittals concurrently for coordination.
- a. Metro reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Numbering Convention. ----- All submittals shall be assigned sequentially a unique 4-digit number by the Contractor beginning with 0001 and the referencing the applicable Contract Specification section or drawing sheet number. Re-submittals, if necessary, shall bear the number of the first submittal followed by a letter (A, B, etc.) suffix to indicate the sequence of the re-submittal.
- D. All shop drawings submitted by subcontractors for approval shall be sent directly to the Contractor for checking and submission. The Contractor shall be responsible for their submission at the proper time so as to prevent delays in the delivery of materials.
- E. Processing Time. The time for review shall commence upon the Engineer's receipt of the submittal in accordance with Section 01 61 16, Web-based Information Management. No extension of the Contract Time will be authorized because of a failure to transmit the submittals in sufficient advance of the Work to permit processing, including re-submittals. Allow time for submittal review, including time for re-submittals, as follows.
1. Initial Review. Allow 21 days for the initial review of each submittal. Allow additional time if coordination with the subsequent submittals is required. The Engineer will advise the Contractor when a submittal being processed must be delayed for coordination.
 2. Re-submittal Review. Allow 21 days for the review of each re-submittal.
 3. Sequential Review. Where a sequential review of submittals by Metro, Metro's Engineer, Engineer's consultants, or other parties is indicated, allow 30 days for the initial review of each submittal.
 4. If more than two reviews are required of Metro because of the failure of the Contractor to provide all previously requested corrected data or additional information, the Contractor shall reimburse Metro in periodic payment requests deductions in an amount of \$500.00 per re-submittal for the charges of Metro's review of the additional re-submissions.
- F. Deviations and Additional Information. On an attached separate sheet prepared on the Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by Metro on previous submittals, and deviations from the requirements in the Contract Documents, including minor variations and limitations. Include the same identification information as the related submittal.
- G. Re-submittals. Make the re-submittals in same form as the initial submittal.
1. Note the date and content of the previous submittal.
 2. Note the date and content of the revision in the label or title block and clearly indicate the extent of revision.
 3. Re-submit submittals until they are accepted as specified herein.
- H. Distribution. Furnish copies of final submittals to Manufacturers, subcontractors, suppliers, fabricators, installers, and others, as necessary, for the performance of construction activities.

- I. Use for Construction. Retain complete hard copies of the submittals at the Project site. Use only the final action submittals that are marked with an acceptance notation from the designated action in the submittal review response in the PMIS system.

1.08 RE-SUBMITTAL OF SUBMITTALS

- A. The Contractor shall accept full responsibility for the completeness of each re-submittal. The Contractor shall verify that all corrected data and additional information previously requested are provided on the re-submittal.
- B. When corrected copies are resubmitted, the Contractor shall, in writing, direct specific attention to all revisions and shall list separately any revisions made other than those called for on previous submissions.
- C. Requirements specified for the initial submittals shall also apply to re-submittals.

1.09 INITIAL SUBMITTALS

- A. Within 10 days after the Notice to Proceed, the Contractor shall provide the following Preliminary Schedules for review and acceptance:
 - 1. Schedules as defined in Section 01 32 16/17, Construction Progress Schedules<PROJECT SPECIFIC>
 - 2. A Preliminary Schedule of Submittals, including complete list of Equipment/Products proposed for use
 - 3. List of subcontractors, including name, email, phone number, and address of company representative
 - 4. A Preliminary Schedule of Values in accordance with Section 01 29 73, Schedule of Values
- B. Within 30 days after the Notice to Proceed Contractor shall provide:
 - 1. Stormwater Pollution Prevention Plan (SWPPP) (including the Erosion and Sediment Control Plan)
 - 2. Project Sign(s) submittal
 - 3. Independent Testing Laboratory name and certifications as defined in Section 01 45 23, - Testing and Laboratory Services Provided by Contractor

PART 2 - PRODUCTS

2.01 SUBMITTAL PROCEDURES

- A. General: Submittals fall into three categories:
 - 1. ACTION SUBMITTALS-
 - a. Action Submittals require review and response by the Engineer before proceeding with incorporating the equipment, materials, or procedures into the work.

- b. Review returned comments for Action Submittals and perform subsequent actions based on the REVIEW ACTION requirements specified.
2. INFORMATIONAL SUBMITTALS-
- a. Informational Submittals are reviewed but no REVIEW ACTION is taken.
3. CLOSEOUT SUBMITTALS-
- a. Closeout Submittals consist of documentation that is not available for review at the time Action Submittals are submitted for review or documentation that is typically generated or furnished following incorporation of the equipment, materials, or procedure into the work. Closeout Submittals include spare parts inventory listing, spare parts, extra stock materials, special tools and other materials or components that are furnished separate from the installed and completed work.
- b. Review comments for Closeout Submittals, and perform the subsequent actions based on the REVIEW ACTION requirements specified.
- B. General Submittal Procedure Requirements. Prepare and submit submittals required by individual Contract Specification sections. The types of submittals are indicated in individual Contract Specification sections.
1. Post the electronic submittals as PDF electronic files directly to the PMIS specifically established for Project.
- a. Metro or the Construction Manager or the Engineer will review the file, annotate and return the submittal via the PMIS.
- b. Provide a notarized statement on the original paper copy certificates and certifications where indicated.
- c. Provide one hard copy of the final reconciled submittal delivered to a location identified by Construction Manager.
- C. Product Data. Collect information into a single submittal for each element of construction and type of product or equipment.
1. If the information must be specially prepared for a submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:
- a. Manufacturer's catalog cuts
- b. Manufacturer's product specifications
- c. Manufacturer's equipment warranty
- d. Standard color charts
- e. Statement of compliance with specified referenced standards

- f. Testing by recognized testing agency
- g. Application of testing agency labels and seals
- h. Notation of coordination requirements
- i. Availability and delivery time information
4. For equipment, include the following in addition to the above, as applicable:
- a. Wiring diagrams showing factory-installed wiring
- b. Printed performance curves
- c. Operational range diagrams
- d. Clearances required to other construction, if not indicated on accompanying Shop Drawings
5. Submit Product Data before or concurrently with Samples.
6. Submit Product Data as follows:
- a. PDF electronic file via PMIS
- D. Shop Drawings. Prepare Project-specific information, drawn accurately to scale. Do not submit the base Shop Drawings on reproductions of the Contract Documents or standard printed data.
1. Certified shop and erection drawings. The Contractor shall submit electronic files of the proposed equipment in the capacity, size, and arrangement as indicated and specified. The electronic files shall conform to the following minimum requirements:
- a. Electronic Files. PDF and AutoCAD latest version, drawn to scale.
- b. Submit electronic files as part of the Shop Drawing submittal.
- c. Submit electronic PDF files into PMIS.
- d. Drawings shall include plan views, sectional views, title block, Tag Numbers, serial numbers, Parts List (identifying each component), dimensions, connection sizes and types, and all details of all related items. In cases where certain information is proprietary and is omitted, provide a statement to that effect.
- e. Drawings shall be in conformance with all other requirements as specified herein.
2. Preparation. Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
- a. Identification of products
- b. Schedules
- c. Compliance with specified standards

- d. Notation of coordination requirements
- e. Notation of dimensions established by field measurement
- f. Relationship and attachment to adjoining construction clearly indicated
- g. Seal and signature of Tennessee-licensed Professional Engineer if specified
3. Sheet Size. Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8 ½-inches x 11-inches but no larger than 24-inches x 36-inches.
4. Submit Shop Drawings as follows:
- a. PDF electronic file into PMIS
- E. Product Schedule. As required in individual Contract Specification sections, prepare a written summary indicating the types of products required for the Work and their intended locations. Include the following information in tabular form:
1. Type of product. Include a unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
 2. Manufacturer and product name, and model number, if applicable
 3. Number and name of room or space
 4. Location within room or space
 5. Submit product schedule as a PDF electronic file into PMIS.
- F. Coordination Drawing Submittals. Comply with the requirements specified in Section 01 14 14, Control of Work.
- G. Contractor's Construction Schedule. Comply with the requirements specified in Section 01 32 16/17, Construction Progress Schedules.
- H. Schedule of Values. Comply with the requirements specified in Section 01 29 73, Schedule of Values.
- I. Test and Inspection Reports and Schedule of Tests and Inspections Submittals. Comply with the requirements specified in Section 01 43 00, Quality Requirements.
- J. Closeout Submittals and Maintenance Material Submittals. Comply with the requirements specified in Section 01 77 00, Contract Closeout.
- K. Additional Specific Specification Transmittal Procedures
1. Follow additional transmittal procedures as indicated in specific specifications.
 2. Provide a Certificate of Unit Responsibility assigning unit responsibility in accordance with the requirements of the specific specification Section. No other submittal material will be reviewed until the certificate has been received and found to be in conformance with the Specifications.

PART 3 - EXECUTION

3.01 CONTRACTOR'S REVIEW

- A. Submittals. Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents.
- B. Conformity. Fabrication performed, materials purchased, or on-site construction accomplished that does not conform to accepted shop drawings and data shall be at the Contractor's risk. Metro will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.
- C. Project Closeout and Maintenance Material Submittals. See requirements in Section 01 77 00, Contract Closeout.
- D. Submittal Information. Include the Project name and location, submittal number, Specification Section title and number, name of the reviewer, date of the Contractor's approval, and a statement certifying that the submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

3.02 SUBMITTAL REVIEW

- A. The review of shop drawings, data, and samples will be general.
 - 1. They shall not be construed as permitting any departure from the Contract requirements.
 - 2. They shall not be construed as relieving the Contractor of responsibility for any errors, including details, dimensions, and materials.
 - 3. They shall not be construed as approving departures from the details except as otherwise provided herein.
- B. If the shop drawings, data, or samples, as submitted, describe variations and show a departure from the Contract requirements found to be in the interest of Metro and to be so minor as not to involve a change in Contract Price or time for performance, the reviewed documents may be returned without noting an exception.
- C. REVIEW ACTIONS: Submittals will be returned to the Contractor under one of the REVIEW ACTION codes indicated below and provided via PMIS.
 - 1. Action and Closeout Submittals: Returned submittals shall indicate on the following actions:
 - a. No Exception Taken. When submittals are marked as "No Exception Taken," the Work covered by the submittal may proceed if it complies with the Contract Documents. Acceptance of the Work depends on that compliance.
 - b. Make Corrections Noted. When submittals are marked as "Make Corrections Noted," the Work covered by the submittal may proceed provided it complies with the Engineer's notations or corrections on the submittal and with the Contract Documents. Acceptance of Work depends on that compliance. A re-submittal is not required.
 - c. Amend and Resubmit

- 1) When submittals are marked as "Amend and Resubmit," the Work covered by the submittal may not proceed. Do not permit the Work covered by submittals to be used at the Project site or elsewhere where the Work is in progress.
- 2) Revise the submittal or prepare a new submittal in accordance with Metro's or the Engineer's notations and in accordance with the re-submittal requirements of this Section. Re-submit without delay.
2. Rejected – See Remarks
- a. When submittals are marked as "Rejected - See Remarks," the Work covered by the submittal may not proceed. The Work covered by the submittal does not comply with the Contract Documents.
- b. Prepare a new submittal for a different material or equipment supplier or different product line or material of same supplier complying with the Contract Documents.
3. Closeout submittal requirements are not satisfied until each submittal is reviewed and returned marked "No Exceptions Taken or "Make Corrections Noted."
4. For Information Only
- a. When submittals are marked as "For Information Only," Metro will review the submittal but take no action.
- b. It will be recorded as "For Information Only." Work covered by this submittal may proceed if it complies with the Contract Documents.
- D. Re-submittals will be handled in the same manner as first submittals. On the re-submittals, the Contractor shall direct specific attention, in writing, on the letter of transmittal and on re-submitted shop drawings by use of revision triangles or other similar methods, to revisions other than the corrections requested on previous submissions. Any such revisions which are not clearly identified shall be made at the risk of the Contractor. The Contractor shall make corrections to any work done because of this type revision that is not in accordance to the Contract Documents as may be required.
- E. Partial submittals may not be reviewed. The degree of completeness of a submittal shall be determined solely by Metro or its assigns. Incomplete submittals will be returned to the Contractor and will be considered "Rejected" until re-submitted.
- F. If the Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Contractor shall give written notice to the Construction Manager least seven working days prior to the release for manufacture.
- G. When the shop drawings are satisfactorily completed, the Contractor shall carry out the construction with no further changes except upon written instructions from the Construction Manager.

3.03 DISTRIBUTION

- A. Distribute one hard copy reproduction of the final, accepted submittals, shop drawings, and copies of accepted product data and samples, where directed by the Construction Manager.

END OF SECTION

SECTION 01 35 23

SAFETY AND HEALTH

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Potential Exposures during Execution of the Work
- D. Safety and Health Regulations
- E. Safe Access to the Work
 - a. Construction Safety Program
- F. Safety Equipment
- G. *Emergency Response Plan*
- H. Accidents

1.02 RELATED SECTIONS

- A. Division 01 - Division ## <PROJECT SPECIFIC>

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall be solely responsible for initiating, maintaining, and supervising all safety precautions and programs in connection with the Work. Such responsibility does not relieve subcontractors of their responsibility for the safety of persons or property in the performance of their work, nor for compliance with applicable safety Laws and Regulations. Contractor shall take all necessary precautions for the safety of, and shall provide the necessary protection to prevent damage, injury, or loss to the following:
 - 1. All persons on the Site or who may be affected by the Work
 - 2. All the Work and materials and equipment to be incorporated therein, whether in storage on or off the Site
 - 3. Other property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction
- B. The Contractor shall comply with all applicable Laws and Regulations relating to the safety of persons or property, or to the protection of persons or property from damage, injury, or loss; and shall erect and maintain all necessary safeguards for such safety and protection. The Contractor shall notify owners of adjacent property and/or Underground Facilities prior to starting the Work.

- C. The Contractor shall designate a qualified, competent person who is not engaged full time on-site for daily work production supervision to lead the safety program, to audit compliance, and to perform reviews of the work.
- D. The Contractor shall develop and maintain a program for confined space entry during the construction work execution. This program shall comply with all state, federal, and local regulations.
- E. The Contractor shall develop and maintain a program for excavation and trench protection during the construction work execution. This program shall comply with all state, federal, and local regulations.

1.04 POTENTIAL EXPOSURES DURING EXECUTION OF WORK

- A. Portions of the Work involve gravity and pressure sewer pipes, manholes, and appurtenances that provide potential exposure to raw sewage and disease-producing organisms normally found in wastewater. The working environment is known to be associated with detrimental gases, oxygen deficiencies, flowing water velocity, excavation soils instability and confined space issues. The Contractor shall be experienced and qualified to anticipate and meet this project's safety and health requirements.
- B. Workers involved in removing, renovating, or installing sewage equipment and sewer collection system piping components may be exposed to disease-producing organisms in wastewater. The Contractor shall require their personnel to use personal protective equipment (PPE) and observe proper hygienic precautions in accordance with the Contractor's Safety Plan and OSHA requirements.
- C. Solvents, gasoline, and other hazardous materials and gases may enter the pumping stations, equalization tanks, and treatment plant with incoming sewage. Therefore, certain areas are hazardous to open flame, sparks, or unventilated occupancy. The Contractor shall take measures to ensure that their personnel observe proper safety precautions when working in these areas.
- D. The Contractor shall provide in its Safety Program a Plan indicating that it understands the project's safety and health dangers and is experienced and qualified to perform the Work indicated.

1.05 SAFETY AND HEALTH REGULATIONS

- A. The Contractor shall comply with all federal, state, city, and local Safety and Health Regulations for Construction.
- B. Safety provisions shall conform to the Federal and State Departments of Labor Occupational Safety and Health Act (OSHA) and all other applicable federal, state, county, and local laws, ordinances, codes, the requirements set forth herein, and any regulations that may be specified elsewhere in these Contract Documents. Where any provision conflicts with another, the more stringent requirement shall be followed. The Contractor's failure to become thoroughly familiar with the aforementioned safety provisions shall not relieve the Contractor from compliance with the obligations or penalties set forth therein.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 SAFE ACCESS TO THE WORK

- A. The Contractor shall at all times provide proper facilities for safe access to the work by Metro, the Construction Manager, the Engineer, and their authorized representatives, including all testing personnel and all authorized government officials.

3.02 CONSTRUCTION SAFETY PROGRAM

- A. Within 30 days after the Notice to Proceed, the Contractor shall develop and implement a project-specific safety program and submit the plan to the Construction Manager for information and not technical review. The Construction Manager will review the Contractor's safety program on behalf of Metro and may provide comments to Metro and the Contractor. The Construction Manager's review will not relieve the Contractor of their responsibility for safety, nor shall it relieve the Contractor from liability for any incompleteness or inadequacy of their safety program. The Contractor's plan shall include, but not be limited to, the following items:
 - 1. Safety organization and representatives
 - 2. Employee training and orientation
 - 3. Blood-borne pathogen exposure prevention
 - 4. PPE requirements
 - 5. Procedure for mandatory initial and refresher excavation and trench protection training for all Contractor and subcontractor onsite personnel
 - 6. Procedure for mandatory initial and refresher confined space training for all Contractor and subcontractor onsite personnel
 - 7. Procedures for electrical and mechanical Lock-Out/Tag-Out
 - 8. Procedures for Hot Works in hazardous areas
 - 9. General site safety regulations
 - 10. Record keeping and reporting requirements
 - 11. Safety promotion programs or incentive goals
 - 12. Documentation incorporated into the Contractor's safety manual whereby its personnel have been informed about and know what health precautions should be taken when working in a wastewater pumping station or equalization facility and in any parts of the wastewater system.
 - 13. The Contractor's plan shall include a list with emergency phone numbers that shall allow Metro to obtain responses to an emergency at any time day or night.
 - 14. The Contractor's onsite Work safety quality control and audit plan.

3.03 SAFETY EQUIPMENT

- A. The Contractor shall implement a hardhat and PPE system for all employees and subcontractors. Company logos must also be provided on all hard hats. All hardhats and PPE used on the project must comply with OSHA requirements and applicable standards and be in good working condition at all times.

3.04 EMERGENCY RESPONSE PLAN

- A. The Contractor shall develop and implement an *Emergency Response Plan*. The plan shall be submitted to the Construction Manager within 60 days after the Notice to Proceed for Metro's review and acceptance. The Contractor's plan shall include, but not be limited to, the following:
 1. Emergency evacuation procedures
 2. Emergency notification plan
 3. Emergency supplies
 4. Disaster supply kit

3.05 ACCIDENTS

- A. If the accident causes death, serious injuries, or serious damages, the accident shall be reported immediately by telephone, electronic text message or messenger to the Construction Manager and Metro.
- B. The Contractor shall promptly report all accidents that cause death, personal injury, or property damage no later than 24 hours after the occurrence of the accident. A written report shall be submitted to the Construction Manager providing full details and witness statements no later than 7 days after the accident. This procedure shall be followed for all accidents resulting from or in conjunction with performing the Work, whether on or adjacent to the site.
- C. If anyone makes any claim against the Contractor or a subcontractor due to an accident, the Contractor shall promptly report the facts in writing to the Construction Manager giving full details about the claim no later than 24 hours after receiving notice of the claim.

END OF SECTION

SECTION 01 35 24

BUILDING SEWER BACKUP CLEANUP

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Submittals
- D. *Construction Sewer Backup Mitigation and Cleanup Plan*
- E. Reporting Incidents and Claims

1.02 RELATED SECTIONS

- A. All Specification Sections

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Environmental and public health dangers can result from Sanitary Sewer Overflows (SSOs) from wastewater system operations. Metro has a policy to eliminate SSO incidents such as building sewer backups during and as caused by construction. SSO discharges violate TDEC/EPA regulations and may result in fines and imprisonment in addition to damages, delays, and costs from incidents.
- B. In performing the Work, the Contractor shall avoid and limit disruptions to public and private wastewater systems, including, but not limited to, gravity sanitary sewers, pressure sanitary sewers, combined sewers, and building plumbing systems. The Contractor and its subcontractors shall perform all construction and rehabilitation services in an environmentally responsible manner.
- C. The Contractor shall be responsible for all costs associated with SSO and building sewer backups caused by the Contractor's actions or inactions. Costs may include, but are not limited to, cleaning up, repairing, or replacing public and private property such as utilities, pipes, equipment, motor vehicles, structures, flooring, building finishes, furnishings, rental equipment, temporary accommodations, and any fines or penalties assessed.
- D. The Contractor shall conduct its operations and perform all work necessary to address a sewer backup's mitigation and cleanup in and around buildings or lands. These requirements shall be continuously applied and shall not be limited to normal working hours.
- E. The work for SSO building and sewer backup mitigation and cleanup may be on private property. The Contractor shall obtain a right-of-entry from the impacted property owner to accomplish the work involving building sewer backups and discharges on private property outside the Metro easement. Metro will not secure this permission.
- F. The Contractor shall respond immediately to SSO and building sewer backups to stop and contain the wastewater flow. The Contractor shall immediately stop the causative work on or

within their project without endangering the public or causing further detrimental environmental and property effects.

1.04 SUBMITTALS

- A. Within thirty (30) days after receiving the Notice to Proceed, A *Construction Sewer Backup Mitigation and Cleanup Plan*, also known as the “Plan,” shall be submitted in accordance with Section 01 33 00, Submittals, for review and acceptance.

1.05 CONSTRUCTION SEWER BACKUP MITIGATION AND CLEANUP PLAN

- A. The Contractor shall develop and implement a written *Construction Sewer Backup Mitigation and Cleanup Plan*. The Plan shall include:
1. Contractor’s Sewer Backup Mitigation and Preventive Measures
 2. Contractor’s Emergency Response Organization
 3. Contractor’s Emergency Response Procedures and Processes
- B. Sewer Backup Mitigation and Preventive Measures
1. The Contractor shall provide a list of the means and methods established by the Contractor to prevent and mitigate SSO and building sewer backups.
 2. The Contractor shall provide certification that the Contractor’s personnel and subcontractors have received training in the Contractor’ means and methods to prevent and mitigate SSO and sewer building backups.
 3. The Contractor shall provide a Procedure demonstrating and confirming refresher training for all new and continuing Contractor and subcontractor personnel employed onsite to prevent and mitigate SSO and sewer building cleanup.
- C. Contractor’s Emergency Response Organization
1. Contractor shall provide a list of personnel available 24 hours per day for response to SSO or sewer backups. The personnel list shall include the persons’ names, addresses, cell phone numbers, and job titles.
 2. The Contractor shall provide an on-call sewer spill or building backup cleanup organization. The Contractor shall retain a professional and experienced sewer cleanup services firm or firms specializing in sewer backup and emergency responses for building sewerage cleanup and resulting environmental issues. Approved professional sewer service cleanup and emergency response firms are:
 - a. Rainbow International, Inc.
 - b. ServiceMaster Clean, Inc.
 - c. Servpro Industries, Inc.
 - d. Or Equal
 3. The employment of an independent cleanup organization shall in no way alter or reduce the Contractor’s obligations in this Section or as otherwise required by the contract.

D. Contractor's Emergency Response Procedures and Processes

1. The Contractor shall include in the Plan its procedures and processes for responding to emergencies due to SSO and/or sewer backups. The procedures and processes shall include, but not be limited to, the following items:
 - a. Emergency notification and first response procedures
 - b. Emergency equipment
 - c. Emergency supplies
 - d. Sewer overflow first response supply kit
 - e. Sewer backup cleanup procedures, including:
 - 1) Water, fluid and solids removal
 - 2) Ventilation
 - 3) Disinfection of impacted surfaces
 - 4) Absorbent materials removal
 - 5) Contaminated materials disposal plan

1.06 REPORTING INCIDENTS AND CLAIMS

- A. The Contractor shall immediately notify the Construction Manager of any incident or backup.
- B. Within 24 hours of any sewer backup, claim, or incident whatsoever out of or in conjunction with performing the Work or whether on or adjacent to the site, the Contractor will provide a written notice to the Construction Manager. The Contractor's written report shall include the following items:
 - a. Address for incident or claim
 - b. Name of the party making the claim
 - c. Date and time of the incident or claim
 - d. Detailed description for incident or claim, including full extent of damages and estimated costs
 - e. List witnesses, names, addresses and phone numbers

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

FOR INFORMATION ONLY

SECTION 01 35 43

PROTECTION OF ENVIRONMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. References
- C. Contractor's Responsibilities
- D. Disposal of Excess Excavated and Other Waste Materials
- E. Protection of Air Quality
- F. Use of Chemicals
- G. Noise Control
- H. Dust Control
- I. Fuel and Lubricants
- J. Pile and Sheet piling Driving Noise
- K. Notifications
- L. Implementation

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 14 14 – Control of Work
- C. Section 01 33 00 – Submittals
- D. Section 01 43 00 – Quality Requirements
- E. Section 01 57 13 – Erosion and Sediment Control and Containment of Construction

1.03 REFERENCES

- A. United States Environmental Protection Agency (USEPA)
 - 1. USEPA 43019-73-007: Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall provide the methods, means, and facilities to prevent contamination of soil, water, and atmosphere from the discharge of noxious, toxic substances and pollutants produced by construction operations. The Contractor, in executing the Work, shall maintain work areas onsite and offsite free from environmental pollution that would violate any federal, state, or local codes or regulations.
- B. Controlling environmental pollution requires the consideration of air, water, and land and involves managing wastewater, stormwater, noise, dust, fumigants, processing chemical emissions, and solid waste as well as other pollutants.
- C. Ensure that construction is achieved with a minimum of disturbance to the existing ecological balance between a water resource and its surroundings. It is the Contractor's responsibility to determine the specific construction techniques to meet these guidelines.
- D. Schedule and conduct all Work in a manner that will minimize the level of noise escaping the site, especially at night and on weekends.
- E. Payment. Consider Work specified in this Section as incidental and include payment as part of the appropriate lump sum or unit prices specified in the Bid Form.

1.05 DISPOSAL OF EXCESS EXCAVATED AND OTHER WASTE MATERIALS

- A. Excess excavated material not required or not suitable for backfill and other waste material shall be disposed of in accordance with local regulatory requirements.
- B. Contractor shall control site wastes such as discarded building materials, concrete truck washout, chemicals, litter, and sanitary waste at the construction site that may cause adverse impacts to water quality. The term "control" as used in the prior sentence shall mean implementing and maintaining best management practices as required to prevent pollution from being lost from or leaving the site.
- C. Provide a watertight conveyance for liquid, semiliquid, or saturated solids that tend to bleed during transport. Liquid loss from transported materials is not permitted, whether being delivered to the construction site or hauled away for disposal. Fluid materials hauled for disposal must be specifically acceptable at the selected disposal site.

1.06 PROTECTION OF AIR QUALITY

- A. Minimize air pollution by requiring the use of properly operating combustion emission control devices on construction vehicles and equipment and encourage shutting down motorized equipment when not in use.
- B. Do not burn trash on the construction site.
- C. If temporary heating devices are necessary for protecting the Work, they shall not cause air pollution.
- D. Minimize air pollution from fumigate chemicals from processes used in rehabilitation by requiring the use of ventilation devices and equipment.

1.07 USE OF CHEMICALS

- A. Chemicals used during Project construction or furnished for Project operation, whether herbicide, pesticide, disinfectant, polymer, reactant, or of other classification, shall be approved by USEPA, U.S. Department of Agriculture, or any other applicable regulatory agency.
- B. The use and disposal of chemicals and residues shall comply with the Manufacturer's instructions and applicable federal and state laws, codes and regulations.

1.08 NOISE CONTROL

- A. Conduct operations to cause the least annoyance to residents in the vicinity of the Work and comply with applicable Metro Nashville ordinances.
- B. Equip compressors, hoists, and other apparatus with mechanical devices necessary to minimize noise and dust. Equip compressors with silencers on the intake lines.
- C. Equip gasoline or oil-operated equipment with silencers or mufflers on the intake and exhaust lines.
- D. Line storage bins and hoppers with material that will deaden sounds.
- E. Conduct the operation of dumping rock and of carrying rock away in trucks so as to cause a minimum of noise and dust.
- F. Route vehicles carrying rock, crushed stone, spoil, concrete, or other material over such streets that will cause the least annoyance to the public. Do not operate on public streets between the hours of 6:00 p.m. and 7:00 a.m., local time, or on Sundays or legal holidays unless approved in writing by the Construction Manager.

1.09 DUST CONTROL

- A. Due to the close geographic location of the Work to other off-site facilities and residential homes, the Contractor shall take special care to provide and maintain temporary site roadways, Metro's existing roads, and public roads used during construction operations in a clean, dust-free, debris-free, mud-free condition.
- B. Comply with the local environmental regulations for dust control. If the Contractor's dust control measures are considered inadequate, the Construction Manager may require the Contractor to take additional dust control measures.
- C. The Contractor shall execute the Work by methods that minimize raising dust from the construction operations. Prior to commencing any dust control, the Contractor shall notify the Construction Manager. Included in the notification will be the Contractor's means and methods of dust control for the Construction Manager's acceptance.
- D. All Metro and/or state/federal roads used during construction shall be cleaned at the end of each working day to pre-construction conditions.

1.10 FUELS AND LUBRICANTS

- A. Comply with local, state, and federal laws, codes, and regulations concerning transporting and storing fuels and lubricants.

- B. The fuel storage area and fuel equipment shall be approved by the Construction Manager prior to installation. Submit containment provisions to the Construction Manager for approval.
- C. Immediately report spills or leaks from fueling equipment or construction equipment to the Construction Manager and authorities. The Contractor shall clean up and mitigate spills or leaks from fueling equipment or construction equipment as required by local, state, or federal regulations.
- D. If grease, oil, solvent, or other residue from the Contractor's operations occurs, the Contractor shall conduct a remedial investigation and remediate as required by the Construction Manager.
- E. The Construction Manager will require the Contractor to remove damaged or leaking equipment from the Project site, permanently abate the leak, or repair said equipment.
- F. If the Project site is within a watershed protection and sensitive wetlands area, minimize the use of potentially hazardous materials, including fuels and lubricants.
- G. Keep motorized equipment in good working order with no fuel or lubricant leakage. Protect the ground's surface from leakage using tarps or other methods.
- H. Do not change the oil on equipment or store or dispose of fuels, solvents, lubricants, or other potentially hazardous materials on site.
- I. Do not store more than one-week's usage supply volume of fuels or dispose of fuels on site.

1.11 PILE AND SHEETING DRIVING NOISE

- A. Conduct operations to cause the least annoyance to residents in the vicinity of the Work and comply with applicable Metro Nashville ordinances.
- B. If piles or driven sheeting are required, use only pile driver hammers or placement equipment with mufflers able to significantly reduce noise and use barriers or shielding techniques to comply with applicable federal, state, and local ordinances.
- C. Do not operate pile or sheeting placement equipment or handling equipment with reverse movement alarms between the hours of 6:00 p.m. and 7:00 a.m., local time, or on Sundays or legal holidays unless approved in writing by the Construction Manager.

1.12 NOTIFICATIONS

- A. The Construction Manager will notify the Contractor in writing about any noncompliance with the foregoing provisions or any environmentally objectionable acts and corrective action to be taken.
- B. State or local agencies responsible for verifying certain aspects of the environmental protection requirements may notify the Contractor and/or Metro about any noncompliance with state or local requirements.
- C. The Contractor shall, after receiving such notice from the Construction Manager or from the regulatory agency, immediately take corrective action. Such notice, when delivered to the Contractor or their authorized representative at the Work site, shall be deemed sufficient notice for the purpose of requiring the Contractor to take correction action. If the Contractor fails or refuses to promptly comply, Metro may issue an order stopping all or part of the Work

until a satisfactory corrective action has been taken. No part of the time lost due to any such stop Work orders shall be made the subject of a claim for extending time or for excess costs or damages by the Contractor unless it is later determined the Contractor was in compliance.

1.13 IMPLEMENTATION

- A. Prior to commencing the Work, meet with the Construction Manager to develop mutual understandings relative to compliance with this provision.
- B. Remove temporary environmental control features when accepted by the Construction Manager and incorporate permanent control features into the Project at the earliest practicable time.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 42 00

REFERENCE STANDARDS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Schedule of References

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 33 00 – Submittals
- C. Section 01 43 00 – Quality Requirements
- D. Division 02 – Division ## <PROJECT SPECIFIC>

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. Conform to reference standards, which based on date of issue, are current on date for receiving bids.
- B. All materials, products, and procedures used or incorporated in the Work shall be in strict conformance with applicable codes, regulations, specifications, and standards.
- C. When required, furnish evidence satisfactory to Metro that materials and methods are in accordance with such standards where specified.
- D. A partial listing of codes includes the following:
 - 1. National Fire Codes
 - 2. Underwriters Laboratories, Inc.
 - 3. National Electrical Manufacturer's Association
 - 4. American National Standards Institute (ANSI)
 - 5. Regulations and Standards of the Occupational Safety and Health Act (OSHA)
 - 6. International Building Code (IBC)
 - 7. American Society for Testing Materials
 - 8. International Plumbing Code
 - 9. International Mechanical Code

10. Metropolitan Government of Nashville and Davidson County Code and Regulations
11. Tennessee Codes and Regulations

1.04 SCHEDULE OF REFERENCES

The specifications cited in these Contract Documents may be obtained from the associations or organizations listed below:

1. AA Aluminum Association Inc.
<http://www.aluminum.org>
2. AABC Associated Air Balance Council
<http://www.aabchg.com>
3. AAMA American Architectural Manufacturer's Association
<http://www.aamanet.org>
4. AAN American Nursery and Landscape Association
<http://www.anla.org>
5. AASHTO American Association of State Highway and Transportation Officials
<http://www.aashto.org>
6. AATCC American Association of Textile Chemists and Colorists
<http://www.aatcc.org>
7. ACGIH American Conference of Governmental Industrial Hygienists
<http://www.acgih.org>
8. ACI American Concrete Institute
<http://www.aci-int.net>
9. ACPA American Concrete Pipe Association
<http://www.concrete-pipe.org>
10. ACPPA American Concrete Pressure Pipe Association
<http://www.acppa.org>
11. ADC Air Diffusion Council
<http://flexibleduct.org>
12. AGA American Gas Association
<http://www.aga.org>
13. AGC Associated General Contractors of America
<http://www.agc.org>
14. AGMA American Gear Manufacturers Association, Inc.
<http://www.agma.org>
15. AHAM Association of Home Appliance Manufacturers
<http://www.aham.org>
16. AISC American Institute of Steel Construction
<http://www.aisc.org>

- FOR INFORMATION ONLY
17. AISI American Iron and Steel Institute
<http://www.steel.org>
 18. AITC American Institute of Timber Construction
<http://www.aitc-glulam.org>
 19. AMCA Air Movement and Control Association, Inc.
<http://www.amca.org>
 20. ANLA American Nursery & Landscape Association
<http://www.anla.org>
 21. ANSI American National Standards Institute, Inc.
<http://www.ansi.org>
 22. APA The Engineered Wood Association
<http://www.apawood.org>
 23. ARI Air-Conditioning and Refrigeration Institute
<http://www.ari.org>
 24. ASAE American Society of Agricultural Engineers
<http://www.asae.org>
 25. ASCE American Society of Civil Engineers
<http://www.asce.org>
 26. ASHRAE American Society of Heating, Refrigerating, and Air-Conditioning Engineers
<http://www.ashrae.org>
 27. ASME American Society of Mechanical Engineers
<http://www.asme.org>
 28. ASSE American Society of Sanitary Engineering
<http://www.asse-plumbing.org>
 29. ASTM American Society for Testing and Materials
<http://www.astm.org>
 30. AWI Architectural Woodwork Institute
<http://www.awinet.org>
 31. AWS American Welding Society
<http://www.aws.org>
 32. AWWA American Water Works Association
<http://www.awwa.org>
 33. BHMA Builders Hardware Manufacturers Association
<http://www.buildershardware.com>
 34. BIA Brick Institute of America
<http://www.bia.org>
 35. CAGI Compressed Air and Gas Institute
<http://www.cagi.org>

36. CGA Compressed Gas Association, Inc.
<http://www.cganet.com>
37. CI The Chlorine Institute, Inc.
<http://www.chlorineinstitute.org>
38. CISCA Ceilings and Interior Systems Construction Association
<http://www.cisca.org>
39. CISPI Cast Iron Soil Pipe Institute
<http://www.cispi.org>
40. CLFMI Chain Link Fence Manufacturers Institute
<http://www.chainlinkinfo.org>
41. CPMB Concrete Plant Manufacturers Bureau
<http://www.cpm.org>
42. CRA California Redwood Association
<http://www.calredwood.org>
43. CRSI Concrete Reinforcing Steel Institute
<http://www.crsi.org>
44. CTI Cooling Technology Institute
<http://www.cti.org>
45. DHI Door and Hardware Institute
<http://www.dhi.org>
46. EGSA Electrical Generating Systems Association
<http://www.egsa.org>
47. EEI Edison Electric Institute
<http://www.eei.org>
48. EPA Environmental Protection Agency
<http://www.epa.gov>
49. ETL ETL Testing Laboratories, Inc.
<http://www.etl.com>
50. FCC Federal Communications Commission
<http://www.fcc.gov>
51. FPS The Forest Products Society
<http://www.forestprod.org>
52. GANA Glass Association of North America
<http://www.cssinfo.com/info/gana.html/>
53. FM Factory Mutual Insurance
<http://www.fmglobal.com>
54. GA Gypsum Association
<http://www.gypsum.org>

55. HI Hydraulic Institute
<http://www.pumps.org>
56. HPVA Hardwood Plywood & Veneer Association
<http://www.hpva.org>
57. ICBO International Conference of Building Officials
<http://www.icbo.org>
58. ICC International Code Council
<http://www.iccsafe.org>
59. ICEA Insulated Cable Engineers Association Inc.
<http://www.icea.net>
60. ICAC Institute of Clean Air Companies
<http://www.icac.com>
61. IEEE Institute of Electrical and Electronics Engineers
<http://www.ieee.org>
62. IMSA International Municipal Signal Association
<http://www.imsasafety.org>
63. NBMA Metal Buildings Manufacturers Association
<http://www.mbma.com>
64. MSS Manufacturers Standardization Society of the Valve and Fittings Industry Inc.
<http://www.mss-hq.com>
65. NAAMM National Association of Architectural Metal Manufacturers
<http://www.naamm.org>
66. NAPHCC Plumbing-Heating-Cooling Contractors Association
<http://www.phccweb.org.org>
67. NBS National Bureau of Standards
See - NIST
68. NBBPVI National Board of Boiler and Pressure Vessel Inspectors
<http://www.nationboard.org>
69. NEC National Electric Code
See - NFPA National Fire Protection Association
70. NEMA National Electrical Manufacturers Association
<http://www.nema.org>
71. NFPA National Fire Protection Association
<http://www.nfpa.org>
72. NIH National Institute of Health
<http://www.nih.gov>
73. NIST National Institute of Standards and Technology
<http://www.nist.gov>

74. NLMA Northeastern Lumber Manufacturers Association, Inc.
<http://www.nelma.org>
75. NPA National Particleboard Association
www.pbmdf.com
76. NSF National Sanitation Foundation
<http://www.nsf.org>
77. NWWDA Window and Door Manufacturers Association
<http://www.nwwda.org>
78. OSHA Occupational Safety and Health Administration
Department of Labor
<http://www.osha.gov>
79. PCA Portland Cement Association
<http://www.portcement.org>
80. PCI Precast Prestressed Concrete Institute
<http://www.pci.org>
81. PPI The Plastic Pipe Institute
<http://www.plasticpipe.org>
82. PEI Porcelain Enamel Institute, Inc.
<http://www.porcelainenamel.com>
83. PTI Post-Tensioning Institute
<http://www.post-tensioning.org>
84. RFCI The Resilient Floor Covering Institute
<http://www.rfci.com>
85. RMA Rubber Manufacturers Association, Inc.
<http://www.rma.org>
86. SDI Steel Door Institute
<http://www.steeldoor.org>
87. IGMA Insulating Glass Manufacturers Alliance
<http://www.igmaonline.org>
88. SJI Steel Joist Institute
<http://www.steeljoist.org>
89. SMACNA Sheet Metal and Air-Conditioning Contractors
National Association, Inc.
<http://www.smacna.org>
90. SSPC The Society for Protective Coatings
<http://www.sspc.org>
91. STI Steel Tank Institute
<http://www.steeltank.com>

92. SWI Steel Window Institute
<http://www.steelwindows.com>
93. TCA Tile Council of America, Inc.
<http://www.tileusa.com>
94. TEMA Tubular Exchange Manufacturers Association
<http://www.tema.org>
95. TPI Truss Plate Institute, Inc.
www.tpinst.org
96. UBC The Uniform Building Code
See ICBO
97. UL Underwriters' Laboratories Incorporated
<http://www.ul.com>
98. ULC Underwriters' Laboratories of Canada
<http://www.ulc.ca>
99. WWPA Western Wood Products Association
<http://www.wwpa.org>

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 42 16

DEFINITIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. All Specification Sections

1.02 DEFINITIONS

- A. **General.** Basic Contract definitions are included in the Contract.
- B. **Accepted or Approved.** When used to convey the Construction Manager or Engineer's action on Contractor's submittals, applications, and requests, "approved" or "accepted" is limited to the Construction Manager or Engineer's duties and responsibilities as stated in the Contract Documents.
- C. **Authorized Consultants.** Metro has authorized the consultants identified below to act as representatives for specific purposes, to perform specified duties and responsibilities, and to have the rights and authorities, as assigned, in connection with completing the work in accordance with the Contract Documents until such time as the Contractor is notified otherwise.
 - 1. Metro's representative providing program management services is CDM Smith, 210 25th Avenue, North Suite 1104, Nashville, TN 37203 hereinafter referred to as the Program Manager and having specific duties and responsibilities for engineering management, Program management, project management, and finance reporting for the Program.
 - 2. Metro's representative providing Construction Management phase services is Gresham, Smith and Partners, 222 Second Avenue South, Suite 1400, Nashville, TN 37201 hereinafter referred to as the Construction Manager and having specific duties, including, but not limited to, progress monitoring, coordinating the Work with Metro system services and operations staff, and construction payment recommendations. All communication with the Contractor, Metro, and Engineer is facilitated through the Construction Manager.
 - 3. Metro's representative providing design services for the project is <INSERT NAME AND ADDRESS> hereinafter referred to as the Engineer and having specific rights and responsibilities for the Project's design and limited services during construction, including applicable submittal reviews, RFI responses, and on-call technical issue resolution services.
- D. **Bid Package:** Designers plans, specifications, and associated engineering documents combined with Contractor's procurement documents to form the document(s) that will be presented to bidders for the purpose of receiving bids or proposals for the work.
- E. **Clean Water Nashville Overflow Abatement Program also known as the "Program."** The "Program" abbreviation may also be shown as CWNOAP.
- F. **Commissioning (also known as "Project Commissioning").** A quality- focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that

the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet Metro's Contract requirements.

- G. **Construction Progress Schedule.** Also known as the "Progress Schedule." A schedule prepared and maintained by the Contractor describing the sequence and duration for the activities comprising the Contractor's plan to accomplish the Work within the Contract Times.
- H. **Contract Documents.** Metro has defined the Contract Documents in the Contract's Terms and Conditions. Included in the Contract Documents are the plans and specifications that may also be referred to as Drawings, Contract Drawings, or Specifications.
- I. **Defective.** The word "defective," when modifying the word "Work," refers to Work that is unsatisfactory, faulty, or deficient in that it
- a. Does not conform to the Contract Documents; or
 - b. Does not meet the requirements of any applicable inspection, reference standard, test, or approval referred to in the Contract Documents; or
 - c. Has been damaged prior to the Construction Manager's recommendation of final payment unless responsibility for the protection thereof has been assumed by Metro at Substantial Completion.
- J. **Directed.** "Directed" is a command or instruction by the Construction Manager. Other terms, including "requested," "ordered," "authorized," "selected," "required," and "permitted," have the same meaning as "directed."
- K. **Earth.** The word "earth," wherever used as the name for an excavated material or material to be excavated, shall mean all kinds of material other than rock as previously defined.
- L. **Elevation.** The figures given on the Drawings or in other Contract Documents after the word elevation or its abbreviation shall mean the distance in feet above the datum adopted by the Construction Manager or Engineer.
- M. **Furnish.** Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
- N. **Indicated.** Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms, including "shown," "noted," "scheduled," and "specified," have the same meaning as "indicated."
- O. **Install.** Operations at the Project site, including unloading, temporarily storing, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.
- P. **Metro.** Metropolitan Government of Nashville and Davidson County, Tennessee.
- Q. **MWS.** The Metro Water Services Department of the Metropolitan Government of Nashville and Davidson County, Tennessee.
- R. **NTP.** Notice to Proceed.
- S. **Owner:** Metropolitan Government of Nashville and Davidson County, Tennessee

- T. **Program Management Information System (PMIS).** The web- based information management system owned and operated by Metro is Oracle Primavera Unifier®. The intent of PMIS is to allow all data and documents required by the Contract Documents (unless specified otherwise by the Metro) to be submitted electronically.
- U. **Project Site.** The project site is space available for performing construction activities. The extent of Project site is shown on the Drawings and may or may not be identical to the description for the land on which Project is to be built.
- V. **Provide.** Furnish and install, complete and ready for the intended use.
- W. **Punchlist.** A survey list with incomplete or unsatisfactory Contractor and subcontractor work performed prior to Substantial Completion. This is also known as a “Deficiencies List.”
- X. **Regulations.** Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction and rules, conventions, and agreements within the construction industry that control Work performance.
- Y. **Request for Information (RFI).** The business process and resulting form used in the procedure for initiating, implementing, and documenting field requests for clarification to the Contract Documents. The process initiated by the Contractor shall be used by the Contractor and Construction Manager to request and respond to clarifications.
- Z. **Rock.** The word “rock,” wherever used as the name for an excavated material or material to be excavated, shall mean only boulders and pieces of concrete or masonry exceeding one cubic yard in volume or solid ledge rock which, in the Construction Manager’s opinion, requires for its removal the process of drilling and blasting, wedging, sledging, barring, or breaking up with a power-operated tool. No soft or disintegrated rock that can be removed with a hand pick or power-operated excavator or shovel, no loose, shaken or previously-blasted rock or broken stone in rock fillings or elsewhere, and no rock exterior to the maximum measurement limits allowed, that may fall into the excavation, shall be measured or allowed as “rock.” Contracts in the Program are unclassified excavation, and no separate payment is allowed for “rock.”
- AA. **Sanitary Sewer Overflow (SSO).** A condition whereby untreated sewage is discharged into the environment prior to reaching sewage treatment facilities. A backup of the sanitary sewer into plumbing fixtures and surfaces may include a discharge within and around buildings from fixtures and plumbing appurtenances which may be due to a rupture or blockage of a sewer line.
- BB. **Substantial Completion.** The time at which the Work (or a specified part thereof) has progressed to the point where, in the Construction Manager’s certified and written opinion, the Work (or a specified part thereof) is at a level of completion in strict compliance with this Contract such that the Metropolitan Government or its designee can enjoy beneficial use or occupancy and can use or operate it in all respects for its intended purpose. The terms “substantially complete” and “substantially completed,” as applied to all or part of the Work, refer to the Substantial Completion thereof. **Substantial Completion is not to be confused with operational completion for major processes and equipment, and will occur before Substantial Completion as all project work elements (or a specified part thereof) are required to be completed such as demolition, access for Metro, security, appurtenances, surface finishes, grading and landscaping, paving, etc., to be positioned for approval/review for Metro Codes in granting Use and Occupancy permits.** **<Designer will delete yellow highlighted sentence for rehab and pipe**

CC. **Substitutions.** Changes in products, materials, equipment, and construction methods from those required by the Contract Documents and proposed by Contractor.

1. Whenever a materials or equipment item is specified or described in the Contract Documents by using proprietary item names or particular Supplier names, the products from the named Suppliers shall be furnished by the Contractor, except as otherwise provided for herein, and the costs thereof shall be deemed included in the Bid price.
2. Unless identified as no substitute, substitute products may be proposed by the Contractor after the Contract award. However, the Construction Manager or Program Manager has no obligation to accept such products. The Contractor shall not be entitled to additional compensation if it is required to provide the listed products. Wherever the term “or equal” is used in the Contract Documents, it shall have the same meaning as the terms “substitute” or “substitution” as used herein. Substitutions shall be considered if sufficient information is submitted by Contractor to allow Metro to determine that the material or equipment is equivalent or equal to that named. The acceptability of a proposed substitution shall be solely at the judgment of Metro.

DD. **Underground Facilities.** All underground pipelines, conduits, ducts, cables, wires, manholes, vaults, tanks, tunnels, or other such facilities or attachments and any encasements containing such facilities, including those conveying electricity, gases, steam, liquid petroleum products, telephone or other communications, cable television, water, wastewater, stormwater, other liquids or chemicals, or traffic or other control systems, are considered underground utilities.

EE. **Unclassified Excavation.** An excavation priced with a single unit cost regardless of whether the excavator finds loose fill or embedded rock. On an unclassified excavation, the Contractor assumes the risk for whatever appears.

FF. **Under Roadway.** The words “Under Roadway,” whenever used in delineation of unit price payment for Work, shall be defined as where crushed stone or flowable fill trench backfill is used and required to provide generally non-compactable refill of excavated areas for limitation of settlement and stable foundations for improved travel surfaces. “Under Roadway” is not limited to public or private traveled improved “roads” but includes, and is not limited to, public roadways, private roadways, state highway pavements, driveways, improved hard surfaced parking lots, improved alleys, bikeways, greenways, roadway shoulders and recreational walking paths with asphalt or pavers surface or as directed or required by the Construction Manager. Additionally, excavations that could adversely impact surficial features or buildings where the Construction Manager directs stone backfill in trench excavations will be compensated under the “Under Roadway” unit pricing.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 43 00
QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Description
- B. Related Sections
- C. References
- D. Definitions
- E. Contractor's Responsibilities
- F. Conflicting Requirements
- G. Submittals
- H. Contractor's *Quality Control Plan*
- I. Reports and Documents
- J. Quality Assurance
- K. Offsite Inspection
- L. Materials and Equipment
- M. Part 1 - Quality Control
- N. Special Tests and Inspections
- O. Examination
- P. Preparation
- Q. Part 3 - Quality Control
- R. Test and Inspection Log
- S. Repair and Protection

1.02 DESCRIPTION

- A. This Section includes quality assurance and quality control (QA/QC) administrative and procedural requirements.

- B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve the Contractor from the responsibility for compliance with Contract Document requirements.
 - 1. Specific QA/QC requirements for individual construction activities are specified in the Sections that identify those activities. Requirements in those Sections may also cover producing standard products.
 - 2. Specified tests, inspections and related actions do not limit the Contractor's other QA/QC procedures which facilitate compliance with the Contract Document requirements.
 - 3. Requirements for Contractor to provide QA/QC services required by Construction Manager or authorities having jurisdiction are not limited by provisions in this Section.

1.03 RELATED SECTIONS

- A. Division 01 – Division ## <PROJECT SPECIFIC>

1.04 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. E329: Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspections

1.05 DEFINITIONS

- A. Quality Assurance Services. Activities, actions, and procedures performed before and while executing the Work to guard against defects and deficiencies and to substantiate the proposed construction shall comply with requirements.
- B. Quality Control Services. Tests, inspections, procedures, and related actions during and after executing the Work to evaluate the actual products incorporated into the Work and completed construction comply with requirements. Services do not include contract enforcement activities performed by Construction Manager.
- C. Pre-construction Testing. Tests and inspections performed specifically for Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria.
- D. Product Testing. Tests and inspections performed by a Nationally Recognized Testing Laboratory (NRTL), a National Voluntary Laboratory Accreditation Program (NVLAP), or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction to establish product performance and compliance with specified requirements
 - 1. NRTL. A nationally recognized testing laboratory according to 29 CFR 1910.7
 - 2. NVLAP. A testing agency accredited according to National Institute of Standards and Technology's National Voluntary Laboratory Accreditation Program
- E. Source Quality Control Testing. Tests and inspections performed at the source, e.g., plant, mill, factory, or shop
- F. Field Quality Control Testing. Tests and inspections performed onsite for installing the Work and for completed Work

- G. Testing Agency. A testing agency is an entity engaged to perform specific tests, inspections or both. Testing laboratory shall mean the same as testing agency.
- H. Installer/Applicator/Erector. Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor to perform a particular construction operation, including installation, erection, application and similar operations
 - 1. Using trade-specific terminology in referring to a trade or entity does not require that certain construction activities be performed by accredited or unionized individuals, nor do requirements specified apply exclusively to specific trade(s).
- I. Experienced. When used with an entity or individual, “experienced” means having successfully completed a minimum of five previous projects similar in nature, size, and extent of this Project; worked in this field of endeavor and task for a minimum of 2 years; being familiar with special requirements indicated; and having complied with the requirements from authorities having jurisdiction.

1.06 CONTRACTOR’S RESPONSIBILITIES

- A. The Contractor is responsible for controlling the Work’s quality, including work by its subcontractors and suppliers, and for ensuring that the quality specified in the Contract Documents is achieved.

1.07 CONFLICTING REQUIREMENTS

- A. Referenced Standards. If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements which are different but apparently equal to the Construction Manager for a decision before proceeding.
- B. Minimum Quantity or Quality Levels. The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, the indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Construction Manager for a decision before proceeding.

1.08 SUBMITTALS

- A. Shop Drawings
 - 1. Indicate the Manufacturer and model number for individual components.
 - 2. For QA/QC activities and responsibilities, provide the following:
 - a. Qualification Data. Supply this for the Contractor's quality control personnel.
 - b. Contractor's Statement of Responsibility. When required by authorities having jurisdiction, submit copy of a written statement of responsibility sent to authorities having jurisdiction before starting work on the systems listed below.
 - 1) Seismic force-resisting system, designated seismic system, or component listed in the designated seismic system quality assurance plan prepared by Contractor’s Engineer

- 2) Main wind force-resisting system or a wind-resisting component listed in the wind force-resisting system quality-assurance plan prepared by Contractor's Engineer
- B. Testing Agency Qualifications. For testing agencies specified in the Quality Assurance Section to demonstrate their capabilities and experience, include proof of qualifications by submitting a recent inspection report by a recognized authority that inspected the testing agency.
- C. Tests and Inspections Schedule. Prepare in tabular form and include the following items:
<PROJECT SPECIFIC>
1. Specification Section number and title
 2. Entity responsible for performing tests and inspections
 3. Description for test and inspection
 4. Identification for applicable standards
 5. Identification for test and inspection methods
 6. Number of tests and inspections required
 7. Time schedule or time span for tests and inspections
 8. Requirements for obtaining samples

1.09 CONTRACTOR'S *QUALITY CONTROL PLAN* <PROJECT SPECIFIC – WILL NOT BE REQUIRED FOR ALL PROJECTS>

- A. *Quality Control Plan, General.* Submit a *Quality Control Plan* within 10 days after receiving the Notice to Proceed. Submit it in format acceptable to the Construction Manager. Identify the personnel, procedures, controls, instructions, tests, records, and forms to be used to achieve the Contractor's QA/QC responsibilities. Coordinate with the Contractor's construction schedule.
- B. Quality Control Personnel Qualifications. Engage qualified full-time personnel trained and experienced in managing and executing QA/QC procedures similar in nature and extent to those required for Project.
1. The Project quality control manager may also serve as the Project superintendent.
 2. The Project surveyor may NOT serve as a quality control party for elevation and alignment verification. The Quality control surveyor shall be licensed in Tennessee and perform their review independently of the project surveyor's site controls and computations.
- C. Submittal Procedure. Describe procedures for ensuring compliance with requirements by reviewing and managing the submittal process. Indicate the qualifications for the personnel responsible for submittal review.
- D. Continuous Inspection for Workmanship. Describe the process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to the testing and inspection specified. Indicate the required corrective action types to bring the

Work into compliance with workmanship standards established by the Contract requirements and accepted mockups.

- E. Monitoring and Documentation. Maintain testing and inspection reports, including a log containing the accepted and rejected results. Include work that the Construction Manager has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with the requirements. Comply with the requirements of authorities having jurisdiction.

1.10 REPORTS AND DOCUMENTS <REVISE "TEST AND INSPECTION REPORTS" PARAGRAPH BELOW TO SUIT PROJECT>

- A. Test and Inspection Reports. Prepare and submit certified written reports specified in other Sections. Include the following items:

1. Issue date
2. Project title and number
3. Name, address and telephone number for testing agency
4. Dates and locations for samples and tests or inspections
5. Names for individuals making tests and inspections
6. Description for the Work and test and inspection method
7. Identification for product and Specification Section
8. Complete test or inspection data
9. Test and inspection results and an interpretation of test results
10. Record for temperature and weather conditions when the sample was taken, tested and inspected
11. Results from tested or inspected Work which confirms the Work complies or did not comply with the Contract Document requirements
12. Name and signature for laboratory inspector
13. Recommendations on retesting and re-inspecting

- B. Manufacturer's Technical Representative's Field Reports. Prepare written information documenting the Manufacturer's technical representative's tests and inspections specified in other Sections. Include the following items:

1. Name, address and telephone number for technical representative making report
2. A statement on substrates condition and their acceptability for installing product
3. A statement saying that the products at Project site comply with Contract requirements
4. A summary of the installation procedures being followed whether they comply with requirements and, if not, what corrective action was taken

5. Results from operational and other tests and a statement about whether observed performance complies with the requirements
 6. A statement about whether conditions, products, and installation shall affect the warranty
 7. Other required items indicated in individual Specification Sections
- C. Factory-authorized Service Representative's Reports. Prepare written information documenting the Manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following items:
1. Name, address, and telephone number of the factory-authorized service representative making report
 2. Statement saying that the equipment complies with requirements
 3. The results from operational and other tests and a statement about whether the observed performance complies with the requirements
 4. A statement about whether the conditions, products, and installation shall affect warranty
 5. Other required items indicated in the individual Specification Sections
- D. Permits, Licenses and Certificates. For Metro's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with the standards and regulations bearing on the Work's performance.

1.11 QUALITY ASSURANCE

- A. General. Qualification paragraphs in this Section shall establish the minimum qualification levels required; individual Specification Sections shall specify additional requirements.
- B. Manufacturer Qualifications. A firm experienced in manufacturing products or systems similar to those indicated for this Project with a successful in-service performance record and sufficient production capacity to produce required units
- C. Fabricator Qualifications. A firm experienced in producing products similar to those indicated for this Project with a successful in-service performance record and sufficient production capacity to produce required units
- D. Installer Qualifications. A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project whose work has resulted in construction with a successful in-service performance record
- E. Professional Engineer Qualifications. A professional engineer who is legally qualified to practice in Tennessee and who is experienced in providing engineering services of the kind indicated
- F. Specialists. Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists shall satisfy the qualification requirements indicated and shall be engaged for the activities indicated.
 1. Requirements by authorities having jurisdiction shall supersede requirements for specialists.

- G. Testing Agency Qualifications. An NRTL (Nationally Recognized Testing Laboratories), an NVLAP (National Voluntary Laboratory Accreditation Program), or an independent agency with the experience and capability to conduct the testing and inspecting indicated as documented according to ASTM E329 with additional qualifications specified in individual Sections and, where required by authorities having jurisdiction, that is acceptable to authorities.
- H. Factory authorized Service Representative's Qualifications. An authorized representative of the Manufacturer who is trained and approved by Manufacturer to inspect installation of Manufacturer's products that are similar in material, design, and extent to those indicated for this Project.
- I. Pre-construction Testing: Where a testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
1. Provide test specimens representative of proposed products and construction.
 2. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
 3. When testing is complete, remove test specimens and assemblies and do not reuse products on Project.
- J. Testing Agency Responsibilities. Submit a certified written report for each test, inspection, and similar quality-assurance service to the Construction Manager and copy the Contractor. Interpret tests and inspections and state in each report whether the tested and inspected work complies with or deviates from the Contract Documents.
- K. Codes and Standards. Copies of applicable referenced standards are not included in the Contract Documents. Where the Contractor needs copies of standards for superintendence and quality control of the Work, the Contractor shall obtain a copy or copies directly from the publication source and maintain them at the jobsite in a place that is available to the Contractor's personnel, subcontractors, and the Construction Manager.
- L. Quality of Materials. Unless otherwise specified, all materials and equipment furnished for permanent installation in the Work shall conform to applicable standards and specifications and shall be new, unused, and free from defects and imperfections when installed or otherwise incorporated in the Work. The Contractor shall not use material and equipment for any purpose other than that intended or specified unless the Construction Manager authorizes such use.
- M. Where so specified, products or workmanship shall also conform to the additional performance requirements included within the Contract Documents to establish a higher or more stringent standard or quality than that required by the referenced standard.

1.12 OFFSITE INSPECTION

- A. When the Specifications require inspecting materials or equipment during the production, manufacturing, or fabricating process or before shipment, such services shall be performed by the inspection organization acceptable to the Construction Manager in conjunction with the Engineer.
- B. The Contractor shall give appropriate written notice to the Construction Manager not less than 30 days before offsite inspection services are required. The Contractor shall ensure that the

producer, Manufacturer, or fabricator furnishes safe access and proper facilities and cooperates with inspecting personnel when performing their duties.

1.13 MATERIALS AND EQUIPMENT

- A. The Contractor shall maintain control over its procurement sources to ensure that materials and equipment conform to the specified requirements in the Contract Documents.
- B. The Contractor shall comply with the Manufacturer's printed instructions regarding all facets for materials and/or equipment movement, storage, installation, testing, startup, and operation. Should circumstances occur where the Contract Documents are more stringent than the Manufacturer's printed instructions, the Contractor shall comply with the Contract Documents. In cases where the Manufacturer's printed instructions are more stringent than the Contract Documents, the Contractor shall advise the Construction Manager about the disparity and shall conform to the Manufacturer's printed instructions. In either case, the Contractor is to apply the more stringent specification or recommendation unless accepted otherwise by the Construction Manager.

1.14 QUALITY CONTROL

- A. Contractor Responsibilities. Tests and inspections not explicitly assigned to Metro are the Contractor's responsibility. Perform additional quality control activities required to verify that the Work complies with the requirements, whether specified or not.
 - 1. Unless otherwise indicated, provide the quality control services specified and those required by authorities having jurisdiction. Perform quality control services required of a Contractor by authorities having jurisdiction, whether specified or not.
 - 2. Monitor quality control over suppliers, Manufacturers, products, services, site conditions, and workmanship to produce Work with the specified quality.
 - 3. Comply with the Manufacturer's instructions, including each step in the sequence.
 - 4. Where the Manufacturer's instructions conflict with the Contract Documents and prior to proceeding, the Contractor shall request clarification from the Construction Manager.
 - 5. Comply with the specified standards as a minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
 - 6. Perform Work by persons qualified to produce the required and specified quality.
 - 7. Verify that field measurements are as indicated on the Shop Drawings or as instructed by the Manufacturer.
 - 8. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
 - 9. Where services are indicated as the Contractor's responsibility, engage a qualified testing agency to perform these quality control services.
 - 10. Notify testing agencies at least 24 hours before the Work requiring testing or inspecting shall be performed.

11. Where quality control services are indicated as a Contractor's responsibility, submit a certified written report, in duplicate, for each quality control service.
12. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
13. When directed, submit additional copies of each written report directly to the authorities having jurisdiction.

B. Tolerances

1. Monitor product fabrication and installation tolerance control to produce acceptable Work. Do not permit tolerances to accumulate.
2. Comply with the Manufacturers' tolerances. When Manufacturers' tolerances conflict with the Contract Documents, request clarification from the Construction Manager before proceeding.
3. Adjust products to appropriate dimensions; position before securing products in place.

C. Manufacturer's Field Services. Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing in accordance with Section 01 33 00, Submittals.

D. Manufacturer's Technical Services. Where indicated, engage a Manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participating in pre-installation conferences, examining substrates and conditions, verifying materials, observing installer activities, inspecting completed Work portions, and submitting written reports. Report results in writing in accordance with Section 01 33 00, Submittals.

E. Re-testing/Re-inspecting: Regardless of whether the original tests or inspections were the Contractor's responsibility, provide quality control services, including re-testing and re-inspecting for construction that replaced Work which failed to comply with the Contract Documents.

F. Testing Agency Responsibilities. Cooperate with the Engineer, the Construction Manager, and the Contractor when performing duties. Provide qualified personnel to perform the required tests and inspections.

1. Notify the Construction Manager and Contractor promptly about irregularities or deficiencies observed in the Work when performing its services.
2. Determine the location from which test samples shall be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections and state in each report whether the tested and inspected work complies with or deviates from the requirements.
4. Submit a certified written report, in duplicate, for each test, inspection, and similar quality control service through the Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any Work portion.

6. Do not perform any Contractor duties.
- G. Contractor's Associated Services. Cooperate with agencies performing the required tests, inspections, and similar quality control services and provide reasonable auxiliary services as requested. Notify the agency sufficiently in advance of operations to permit assigning personnel. Provide the following items:
1. Safe access to the Work and safety equipment required for access
 2. Incidental labor and facilities necessary to facilitate tests and inspections
 3. Adequate quantities for representative material samples requiring testing and inspecting. Assist agency in obtaining samples.
 4. Facilities for storing and field curing test samples
 5. Delivering samples to testing agencies
 6. Security and protection for samples and for testing and inspecting equipment at Project site
- H. Coordination. Coordinate the activity sequence to accommodate required QA/QC services with minimum delay and to avoid the necessity to remove and replace construction to accommodate testing and inspecting.
1. Scheduling. Schedule times for tests, inspections, obtaining samples, and similar activities.
 2. Distribution. Distribute a schedule to Metro, the Construction Manager, the testing agencies, and each party involved in performing Work portions where tests and inspections are required.

1.15 SPECIAL TESTS AND INSPECTIONS

- A. Special Tests and Inspections. These shall be conducted by the Construction Manager or their qualified testing agency as required by the authorities having jurisdiction as indicated in Section 01 48 34 and individual Specification Sections. The Contractor is responsible for the following items:
1. Safe access to the Work and safety equipment required for access
 2. Incidental labor and facilities necessary to facilitate special tests and inspections
 3. Adequate quantities for representative material samples requiring testing and inspecting. Assist in obtaining samples when applicable.
 4. Providing adequate notice when the Work is ready for inspection in accordance with the Contract Documents
 5. Redoing Work that fails to pass any special tests and inspections until the Work passes the special tests and inspections

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that the existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning new Work means accepting the existing conditions.
- B. Verify that the existing substrate can provide structural support or attachment for the new Work being applied or attached.
- C. Examine and verify the specific conditions described in individual Specification Sections.
- D. Verify that utility services are available with the correct characteristics and in the correct locations.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying the next material or substance.
- B. Seal substrate cracks or openings prior to applying the next material or substance.
- C. Apply the Manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying the new material or substance in contact or bond.

3.03 QUALITY CONTROL

- A. Quality control is the Contractor's responsibility, and the Contractor shall maintain control over construction and the installation processes to ensure compliance with the specified requirements.
- B. Certifications for personnel, procedures, and equipment associated with special processes (e.g., welding, cable splicing, instrument calibration, surveying) shall be maintained in the Contractor's field office and be available for inspection by the Construction Manager. Copies shall be made available to the Construction Manager upon request.
- C. Construction and installation process means and methods are the Contractor's responsibility. At no time is it the Construction Manager's intent to supersede or void that responsibility.

3.04 TEST AND INSPECTION LOG

- A. Test and Inspection Log. Prepare a record for tests and inspections and include the following items:
 - 1. The date that the test or inspection was conducted
 - 2. Description of the Work tested or inspected
 - 3. The date that the test or inspection results were transmitted to Construction Manager
 - 4. Identification of the testing agency or special inspector conducting test or inspection

- B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to the test and inspection log for the Construction Manager's reference during normal working hours.

3.05 REPAIR AND PROTECTION

- A. General. After completing the testing, inspecting, sample taking, and similar services, repair the damaged construction and restore the substrates and finishes.
 - 1. Provide materials and comply with the installation requirements specified in other Specification Sections or matching existing substrates and finishes.
 - 2. Restore patched areas and extend restoration into adjoining areas with durable seams that are as invisible as possible.
 - 3. Comply with the Contract Document requirements for cutting and patching in Section 01 73 29, Cutting, Coring and Patching.
- B. Protect the construction that is exposed for quality-control service activities.
- C. Repair and protection are the Contractor's responsibility.

END OF SECTION

SECTION 01 45 23

TESTING AND LABORATORY SERVICES PROVIDED BY CONTRACTOR

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. References
- C. Contractor's Responsibilities
- D. Submittals
- E. Quality Assurance

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 33 00 – Submittals
- C. Section 01 43 00 – Quality Requirements
- D. Section 01 48 34 – Structural Tests and Inspections

1.03 REFERENCES

- A. ASTM E329 – 18: Standard Specification for Agencies Engaged in Construction Inspection, Testing or Special Inspection

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall provide all independent testing other than those tests specifically identified as being provided by Metro. Testing provided by the Contractor typically shall be, but is not limited to, concrete placement, concrete strengths, soils, compaction, specialty coatings thickness, crushed stone gradations, etc., as required by the Contract Documents.
- B. The Contractor shall employ and pay for an independent testing laboratory to perform the services required by the Contract Documents. The Contractor's selected laboratory shall be subject to the Construction Manager's approval.
- C. Metro, through its Construction Manager, will complete all Special Inspections as identified in Section 01 48 34 and in accordance with the Metropolitan Government of Nashville and Davidson County's codes and regulations.

1.05 SUBMITTALS

- A. Submit a copy of the Certificate of Calibration made by accredited calibration agency certifying that the laboratory's equipment has been calibrated within the last 12 months and every 12 months by devices of accuracy traceable either to the National Bureau of Standards or to accepted values of natural physical constants.

- B. The testing agency shall submit a proof of qualifications in the form of a recent report within the last 18 months of the inspection of the testing agency by a recognized authority.

1.06 QUALITY ASSURANCE

- A. Where applicable, meet *Recommended Requirements for Independent Laboratory Qualification*, latest edition published by the American Council of Independent Laboratories and the basic ASTM E 329 requirements, *Standard Specification for Agencies Engaged in Construction Inspection, Testing or Special Inspection*.
- B. The chosen laboratory shall be authorized to operate in Tennessee.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 45 33

PERFORMANCE TESTING AND INSPECTIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Submittals
- D. Sequence for Completing Testing
- E. Testing
- F. Test Schedule
- G. Test Coordination
- H. Test Methods
- I. Reports
- J. Completing Reports

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 33 00 – Submittals
- C. Section 01 43 00 – Quality Requirements
- D. Section 01 45 23 – Testing and Laboratory Services Provided by the Contractor
- E. Division 02 – Division ## <PROJECT SPECIFIC>

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. This Section specifies the performance testing work required as a basis for completing the Work. Performance testing is part of the overall completion-testing requirement. Responsibility for performance testing shall be with the Contractor. These assignments shall be detailed and assigned as part of the detailed *Performance Testing Plan* submitted in accordance with this Section. Contractor shall be responsible for obtaining manual logging for operations parameters.
- B. Performance testing shall not commence for equipment or unit process systems until all requirements for commissioning and start-up are completed. Additionally, no performance testing may commence until backup power, telemetry, control to instrumentation, alarms, etc., are functional if the equipment or system is to remain in operational service. The requirements for this Section shall be completed prior to beginning training.

- C. Performance testing shall be completed for equipment and unit process system items to confirm that the equipment or unit process systems meet the specified performance criteria. Performance testing shall include testing required by regulatory agencies or environmental regulations to the extent identified and quantified by the technical specifications and other contract documents.
- D. Performance testing shall be performed to demonstrate the specified capacity for the equipment and unit process systems while maintaining regulatory compliance with federal, state, and local government regulations and minimum compliance with the equipment or unit process systems' performance requirements and guarantees.
- E. The information collected shall be used as a basis for determining the equipment or unit process systems ability to acceptably meet performance requirements.
1. Testing Requirements: Testing requirements for performance testing shall include, but not be limited to, the following:
 - a. Requirements specified for the equipment and unit process systems
 - b. Where multiple units are provided, all units shall be tested unless otherwise specified or indicated. Multiple units may be tested individually where process solids or liquids are not available in sufficient quantities.
 2. If any equipment or unit process system fails to meet the specified requirements and guarantees, the Contractor and/or equipment supplier is responsible for making the necessary corrections or replacements and repeating the test. This procedure shall be followed until all of the equipment meets the guaranteed performance requirements and has been accepted by the Construction Manager.
 3. All modifications required to meet the performance criteria and all re-testing shall be performed at no additional cost to Metro. This includes paying all fees and expenses associated with observing the re-tests, including, but not limited to, those of the Construction Manager and/or the Engineer.
 4. Corrective work resulting from failed performance shall be immediately scheduled, and work shall commence within one week at no additional cost to Metro.

1.04 SUBMITTALS

- A. *Performance Testing Plan.* Provide a *Performance Testing Plan* in accordance with Section 01 33 00, Submittals, which includes the following:
1. List and type of performance testing to be completed, including:
 - a. Equipment
 - b. Systems
 2. Proposed schedule for performance tests
 3. Location for equipment or systems being performance tested

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 SEQUENCE FOR COMPLETING TESTING

- A. Performance testing shall be performed only after commissioning is completed.
- B. Equipment shall be operated until stable operating conditions are achieved before each test is initiated.

3.02 TESTING

- A. Provide 30 days written notice to the Construction Manager for any performance testing so that the Engineer and Construction Manager may witness the performance test.
- B. The cost for the labor to conduct the performance testing shall be included in the project's lump sum cost. The cost for test media, chemicals, electric power, and natural gas shall be included in the project's lump sum cost. The cost for test media, chemicals, electric power, and natural gas for any re-testing shall be accomplished at no additional cost to Metro.
- C. The tests shall be conducted in accordance with applicable industry standard techniques.
 - 1. Local and remote onsite instrumentation equipment may be used to record test data where it is determined to be sufficiently accurate to obtain the necessary data for the performance evaluation.
 - 2. Where special analysis and emissions testing are required or other resources are needed for testing, the Contractor shall be responsible for providing them.
 - 3. Where local instrumentation is available, data shall be manually logged in conjunction with the instrumentation readings to verify remote instrumentation readings.
 - 4. Any necessary adjustment to test results shall be made by using standard formulae and relationships.
- D. All data values shall be reported as measured and corrected as required by the performance or regulations. Data values shall be stated in the engineering units noted for guaranteed performance or regulatory compliance.
- E. Performance Testing shall be witnessed by the Engineer and Construction Manager.
- F. Equipment or unit process systems testing shall include complete testing for the duration listed herein and as modified in individual specifications for equipment or unit process systems. Testing time for emissions or other regulatory purposes shall be in accordance with the regulatory agency's test requirements and as required in the Contract Documents.

- G. Performance Testing shall be categorized into two types: Equipment and System.
1. Equipment Performance Testing
 - a. Performed on individual pieces of equipment to verify equipment meets design performance requirements
 - b. Provide performance verification documents such as pump curves, solids handling capacity verification, dewatering performance, etc., for individual pieces of equipment.
 - c. Test duration shall be as needed to obtain the required performance detail or as stated in individual equipment specifications.
 2. System Performance Testing
 - a. Performed on a complete unit process or facility with all equipment operating to meet the capacity needs of the influent flow stream
 - b. Provide operating data throughout test period at intervals of every 6-hours or as agreed to between Metro, Engineer, and Contractor.
 - c. Test duration shall be a minimum of consecutive 14 days.
- H. All test runs shall be continuous without Significant Interruption. A Significant Interruption shall cause the test period to start over after corrective measures have been taken to resolve the interruption. Significant Interruption shall be defined as follows and as further defined in individual equipment specifications:
1. Failure of critical equipment, component, or system which is not corrected within 4 hours
 2. Failure of ancillary equipment, component, or system which is not corrected within 8 hours
 3. Failure of equipment or system to consistently meet performance requirements within a rolling 2-hr period
 4. More than one (1) failure of the same type within a 24-hr period
- I. Further interruptions for more than one-tenth (1/10) of the established test time shall be reason for aborting the test run, and a new test run shall be made. The cause for the interruption or increase or decrease in feed rate or wastewater or solids characteristics shall be established. If corrective measures are necessary, the work shall be performed immediately.
- J. Where multiple test runs are required and if interruptions occur after several test runs have been completed, the Construction Manager shall determine whether a test run is valid or must be re-run. This shall be determined by the nature of the correction and its relation to the established normal operation criteria.
- K. Equipment or unit process systems' performance shall be judged on an averaged basis for the entire test period, not individual test runs, unless otherwise specified.

3.03 TEST SCHEDULE

- A. The tests shall be scheduled as soon as commissioning has been successfully completed in time for performance testing to commence in accordance with the schedule in the *Performance Testing Plan*. Commissioning includes the provision of documentation that all instruments have been properly calibrated and all controls are in satisfactory operating condition.
- B. Tests shall be performed on a schedule satisfactory to the Construction Manager. The tests shall follow the general order and timing outlined in the *Performance Testing Plan* developed by the Contractor.

3.04 TEST COORDINATION

- A. Where required, the Contractor shall furnish an authorized competent representative from the equipment or unit process systems suppliers to attend and coordinate the test program.
 - 1. Test coordinator's scope of services shall include disseminating preliminary instructions and providing an orientation for the Contractor's personnel prior to the actual test, providing instructions throughout the test period, recommending variations, if required, to assure the test's validity, and providing post-test instructions for a system shutdown or continued operation as required by the Construction Manager.
 - 2. Instrument readings and other test data shall be tabulated by the Contractor.
 - 3. Data sheet copies shall be submitted to the Construction Manager for review and analysis at the end of each testing day.
- B. The Contractor shall work closely with the equipment or unit process systems supplier to help coordinate the required plant functions involving systems not furnished by the supplier for the equipment or unit process systems being tested. This shall include, but is not limited to, support equipment, utilities, and support processes.

3.05 TEST METHODS

- A. Data collection and analysis methods used for performance testing to show compliance shall be as required by regulatory agencies and industry standards and as specified with the equipment or unit process systems.

3.06 REPORTS

- A. Reports are required for all tests specified in the individual specifications for equipment and unit process. Preliminary test results shall be supplied to the Construction Manager for review at the end of each testing day.
- B. Final tests reports shall be submitted no later than 21 calendar days after the equipment or system testing ends. The Contractor shall assist and furnish the required information, including operating data sheets in a timely manner.
- C. The reports shall include, but not be limited to, the following:
 - 1. Cover Sheet. This will include the project name and number, facility name and location, the equipment or unit process systems tested, the testing organization's name, and address and dates for the test.

- FOR INFORMATION ONLY
2. Certification. The certification section includes a certification by the report preparer stating that they are the person responsible for the test data, and a certification by the Contractor or equipment or unit process systems certifying the report's authenticity and accuracy.
 3. Table of Contents. The table of contents shall list all report sections, tables, figures, and appendices.
 4. Introduction. Pertinent background information shall be presented in this section. The information shall include, but not be limited to, the following.
 - a. Equipment or unit process systems tested
 - b. Test purpose
 - c. Name and address for supplier and testing organization
 - d. Test dates
 - e. Items or performance criteria tested
 - f. Names for persons present during test
 - g. Any other important background information
 5. Summary. A comprehensive test result summary shall have sufficient information and data necessary to evaluate the process with respect to the applicable performance Specifications. This information shall include, but not be limited to, the following.
 - a. Test results summary
 - b. Test results comparison with required performance criteria
 - c. Process and operation data or parameters that can be used to verify operation at performance criteria
 - d. A description and results for any collected samples analyzed during the test which supports the test results
 - e. Discussion about real and apparent errors in the test
 6. Methods. This section describes the sampling and analytical methods used.
 7. Operation. The section describing the facility's operation during testing shall contain the following:
 - a. A presentation of the process data for the test with calculations, where necessary, to show the solids throughput or production and demonstrate that the operating conditions sufficiently represent those required for testing. Calculations may be included in the Appendix.
 - b. Process and control equipment flow diagram

8. Appendix. The Appendix will include the following information:
- a. A summary of all data used in the calculations, including the source and formulas with all terms defined
 - b. Calculations for all data submitted, fully defined
 - c. Copies of all raw field data sheets, including those indicating sampling point locations and notes
 - d. Laboratory reports complete with analytical data sheets and chain-of-custody list
 - e. Production and/or operational data
 - f. Calibration procedures and work sheets for sampling equipment
 - g. Copies of calibration records for instrumentation
 - h. Pertinent correspondence concerning the test
 - i. Any other information necessary to comply with the Contract Documents

3.07 REPORTING COMPLETION PROCESS

- A. After the review of the performance testing reports, the Construction Manager will return the reports to the Contractor with any Engineer-noted exceptions.
- B. At the conclusion of performance testing, the Construction Manager shall provide a Letter of Completion to the Contractor for the equipment or unit process systems that have completed testing.

END OF SECTION

SECTION 01 48 34

STRUCTURAL TESTS AND INSPECTIONS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Description
- C. Contractor's Responsibilities
- D. Form 01 48 34 -1 Program of Structural Inspections
- E. Form 01 48 34 -2 Steel Construction – Category of Construction
- F. Form 01 48 34 -3 Cast-in-Place Concrete Construction – Category of Construction
- G. Form 01 48 34 -4 Precast Concrete Construction – Category of Construction
- H. Form 01 48 34 -5 Masonry Construction – Category of Construction
- I. Form 01 48 34 -6 In Situ Bearing Strata for Foundations – Category of Construction
- J. Form 01 48 34 -7 Controlled Structural Rill (Prepared Fill) – Category of Construction
- K. Form 01 48 34 -8 Pile Foundations – Category of Construction
- L. Form 01 48 34 -9 Drilled Pier Foundations – Category of Construction
- M. Form 01 48 34 -10 Aluminum Construction – Category of Construction
- N. Form 01 48 34 -11 Special Cases – Category of Construction

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Division 02 – Division ## <PROJECT SPECIFIC>

1.03 DESCRIPTION

- A. The Project Structural Engineer of Record (SER) is required to prepare a program describing the structural tests and inspections that will be performed for this project. The SER is the structural engineer (an individual) who is in responsible charge of the preparation of the Contract structural drawings and structural Specifications for this project and whose professional engineering seal appears on said structural drawings. The parties responsible for the performance of the structural tests and inspections are noted on the Program of Structural Tests and Inspections prepared by the SER.
- B. The SER has prepared a Program of Structural Tests and Inspections that can be submitted to the Metro building official who has jurisdiction over this project.

- C. The Program of Structural Tests and Inspections shall not relieve the Contractor or its subcontractors of their responsibilities and obligations for quality control of the Work, their other obligations for supervising the Work, for any design work which is included in their scope of services, and for full compliance with the requirements of the Contract Documents. The detection of, or failure to detect, deficiencies or defects in the Work during the testing and inspection conducted pursuant to the Program of Structural Tests and Inspections shall not relieve the Contractor or its subcontractors of their responsibility to correct all deficiencies or defects, whether detected or undetected, in all parts of the Work, and to otherwise comply with all requirements of the Contract Documents. Further, while the SER and the Construction Manager shall perform certain tasks in the Program of Structural Tests and Inspections requiring the review of certain construction activities, the SER and Construction Manager shall only perform such tasks to ensure compliance with the SER-approved submittals and the Specifications. Neither the SER nor the Construction Manager shall assume any responsibility or liability for the means, methods, procedures, or techniques used by any construction contractor. Any testing completed by the SER and/or the Construction Manager shall not change the Contract requirements.
- D. The Program of Structural Tests and Inspections does not apply to the Contractor's equipment; temporary structures used by the Contractor to construct the project; the Contractor's means, methods, and procedures; and job site safety.

1.04 CONTRACTOR'S RESPONSIBILITIES:

- A. Where the Program of Structural Tests and Inspections indicates that a structural component or system is subject to structural tests and inspections and that the SER for the project has not been retained to design said component or system or to prepare a performance Specification for said component of system, the Contractor shall retain, or require others under their aegis to retain, a qualified professional engineer registered in Tennessee to design said component or system and to provide the required Program of Structural Tests and Inspections for said component or system.
- B. The Contractor shall provide free and safe access to the Work for the Construction Manager, SER, and all other individuals who are observing the Work or performing structural tests or inspections. The Contractor shall provide all ladders, lifts, scaffolding, staging, and up-to-date safety equipment, all in good and safe working order, and qualified personnel to handle and erect them, as may be required for safe access.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

PART 4 - FORMS

1. Form 01 48 34 -1 Program of Structural Inspections
2. Form 01 48 34 -2 Steel Construction – Category of Construction
3. Form 01 48 34 -3 Cast-in-Place Concrete Construction – Category of Construction

4. Form 01 48 34 -4 Precast Concrete Construction – Category of Construction
5. Form 01 48 34 -5 Masonry Construction – Category of Construction
6. Form 01 48 34 -6 In Situ Bearing Strata for Foundations – Category of Construction
7. Form 01 48 34 -7 Controlled Structural Rill (Prepared Fill) – Category of Construction
8. Form 01 48 34 -8 Pile Foundations – Category of Construction
9. Form 01 48 34 -9 Drilled Pier Foundations – Category of Construction
10. Form 01 48 34 -10 Aluminum Construction – Category of Construction
11. Form 01 48 34 -11 Special Cases – Category of Construction

FOR INFORMATION ONLY

Form 01 48 34 – 1
PROGRAM OF STRUCTURAL INSPECTIONS

(NOTE: This Specification Section relates to structural elements and shall be edited only by the Structural Engineer of Record for the specific project.)

Provide all relevant project specific information. Select or insert the appropriate governing building code for the project.)

Project Title:
Project Number:
Location:
Owner: Metro Water Services
Engineer of Record:
Structural Engineer of Record (SER):

This Program of Structural Inspections is submitted as a condition for issuance of the Building Permit in accordance with the International Building Code 2006.

(NOTE: Each firm, agency, or individual, who is selected by the Structural Engineer of Record (SER) to perform tests and inspections should be listed as an agent, together with an appropriate abbreviation identifying said agent.)

<u>Abbreviation</u>	<u>Agent</u>
SER	Structural Engineer of Record Listed Above
RES	Resident Representative
ITA(C)	Independent Testing Agency Employed by Contractor
RPE(C)	Registered Professional Engineer Employed by Contractor
GEO	Project Geotechnical Engineer
IWI	Independent Welding Inspector

The above abbreviations will be used on the attached pages to identify which agent is performing the particular inspections.

The following categories of structural inspections, if checked, are included in the program for structural inspections for this project. The specific inspections required for each checked category are listed on the page noted opposite the category and further described in the various technical Specification Sections.

(NOTE: The following category listing encompasses all the construction categories subject to structural tests and inspections. Check all that apply to the specific program of structural tests and inspections. Do not check curtain walls unless they have been designed by the SER, or will be designed by other engineers in accordance with a performance specification prepared by the SER.)

<u>Category</u>	<u>Category</u>
<input type="checkbox"/> Steel Construction	<input type="checkbox"/> Controlled Structural Fill
<input type="checkbox"/> Cast-in-Place Concrete	<input type="checkbox"/> Pile Foundations
<input type="checkbox"/> Precast Concrete Construction	<input type="checkbox"/> Drilled Pier Foundations
<input type="checkbox"/> Masonry Construction	<input type="checkbox"/>
<input type="checkbox"/> In Situ Bearing Strata for Foundations	<input type="checkbox"/> Special Cases

Form 01 48 34 – 1
PROGRAM OF STRUCTURAL INSPECTIONS

The following items of construction, if checked, are specified in the structural plans or specifications on a performance basis. The structural design of these items will be performed by the RPEC and reviewed by the SER. The construction of these items is included in the program for inspections on the attached sheets.

(NOTE: The following category listing is a listing of all items which may be specified by the SER on a performance basis. Check all that apply. Add items to the listing, as applicable.)

- | <u>Category</u> | <u>Category</u> |
|--|---|
| <input type="checkbox"/> Precast Concrete Components | <input type="checkbox"/> Metal Stairs |
| <input type="checkbox"/> Post-tensioning Steel | <input type="checkbox"/> Metal Railings |
| <input type="checkbox"/> | <input type="checkbox"/> Metal and Composite Gratings |
| <input type="checkbox"/> | <input type="checkbox"/> Metal Plate Covers |
| <input type="checkbox"/> | <input type="checkbox"/> |

(NOTE: Include the next paragraph and list items or systems that are to be excluded from the Program of Structural Tests and Inspections required by the Code. The exclusions apply when the SER has not been retained to design an item or system or has not been retained to provide a performance specification for an item or system.)

The following items are excluded from this Program of Structural Inspections, since other structural engineers not under the aegis of the SER designed them and the SER has no duties or responsibilities with respect to such performance specifications or designs. Metro shall assign other engineers, or construction contractors, as applicable; to be special SERs for their respective designs and such engineers and/or contractors shall be responsible for all such structural tests and inspections for their respective designs.

- Seismic design of mechanical or electrical components, systems and their anchorage to the structure.
- Excavation support systems.
- Temporary bracing, temporary platforms, scaffolding, temporary guards, and railings.
- Anything related to jobsite safety or construction means and methods.

Structural Engineer of Record

Name:

Signature:

Firm:

Date:

Registration Seal

Form 01 48 34 – 2

STEEL CONSTRUCTION - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Fabricator Certification/ Quality Control Procedures	SER	Review to ensure that quality control procedures have been adopted for each Fabricator.	Start of project
2. Fabricator Inspection	SER	Review to ensure that an Independent Inspection Agency has approved each Fabricator.	Start of project
3. Material Certification	SER	Review for conformance to the specifications.	Each product
4. Bolting	ITA(C)	Test and inspect bolted connections in accordance with specifications. Verify bolt size and grade in accordance with AISC specifications A325/A490.	Periodic
5. Welding	IWI	Check welder qualifications. Verify filler material in accordance with AWS D1.1. Visually inspect fillet welds. Test complete and partial penetration groove welds full length by dye penetrant, ultrasonic, or radiographic testing in accordance with the contract documents.	Periodic
6. Shear Connectors	IWI	Inspect for size and placement. Test for proper weld attachment.	Periodic
7. Structural Framing, Details and Assemblies	RES	Review for conformance with specifications and shop drawings.	Continuous
8. Open Web Steel Joists	RES	Inspect for size, placement, bridging, bearing, and connection to structure.	Continuous
9. Open Web Steel Joists	IWI	Visually inspect all welds of a minimum of 5 percent of the joists, randomly selected.	Periodic
10. Steel Decking	RES/ IWI	Verify gage, width, and type. Inspect placement, laps, welds, side lap attachment and screws or other mechanical fasteners (IWI). Check welder qualifications (RES).	Periodic

Form 01 48 34 – 3

CAST-IN-PLACE CONCRETE CONSTRUCTION - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Mix Design	ITA(C)	Design concrete mixes	Each mix
	SER	Review mix designs.	Each mix
2. Materials Certification	SER	Review for conformance to specifications.	Each product
3. Batching Plant	ITA/	Review to ensure that Plant quality control procedures have been adopted.	Start of project
	SER		
4. Reinforcement Installation	RES	Inspect reinforcing for size, quantity, condition, and placement.	Prior to each placement
5. Formwork Geometry	RES	Inspect form sizes for compliance with specifications.	Prior to each placement
6. Concrete Placement	RES	Review for conformance with specifications.	Each placement
	ITA	Perform slump, density, and air content tests at point of discharge.	Each truck
7. Curing and Protection	ITA/ RES	Observe procedures for conformance to the specifications.	Each placement
8. Evaluation of Concrete Strength	ITA	Test and evaluate in accordance with the specifications.	Every 50 cubic yards or part thereof

NOTE: The Contractor may elect to have the Contractor's independent testing agency (ITA(C)) perform additional tests at no cost to METRO.

Form 01 48 34 – 4

PRECAST CONCRETE CONSTRUCTION - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Plant Certification/Quality Control Procedures	SER/ ITA	Review to ensure that Plant quality control procedures have been adopted (SER). Inspect plant storage and handling procedures (ITA). Confirm that approved submittals are being used for fabrication; review welder's certifications (SER). Monitor finished product for structural defects (cracks) (ITA).	Start of project
2. Material Certification	SER	Review for conformance to ACI 318.	Each product
3. Formwork Geometry	ITA	Inspect form sizes.	Selected placements
4. Reinforcement Installation	ITA RES	Inspect reinforcing and prestressing strands for size, quantity, condition, and placement for conformance with Contract Documents, SER approved submittals, and ACI 318. Inspect welding.	Selected placements
5. Mix Design	ITA(C) SER	Design concrete mixes Review for conformance with specifications (SER).	Each mix Each mix
6. Concrete Placement	RES/ ITA	Inspect concrete placement procedures for conformance to ACI 318, Sections 5.9 and 5.10 (ITA), and for conformance with specifications (RES).	Selected placements
7. Curing and Protection	RES/ ITA	Inspect for maintenance of specified curing temperatures and techniques per ACI 318 (ITA), and for conformance with specifications (RES).	Each placement
8. Evaluation of Concrete Strength	ITA(C)	Test for conformance to specifications in accordance with ACI 318.	Every 50 cubic yards or part thereof
9. Prestress Operation	ITA(C)	Inspect application of prestressing forces per ACI 318. Inspect grouting of bonded, post-tensioned, prestressing tendons.	Selected placements

Form 01 48 34 – 5

MASONRY CONSTRUCTION - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Material Certification	SER	Review for conformance to specifications.	Each product
2. Evaluation of Masonry Strength	ITA(C)	Verify strength in accordance with the specifications.	Periodic
3. Proportioning, Mixing and Consistency of Mortar and Grout	ITA/RES	Inspect field-mixing procedures for conformance to the specifications.	Continuous
4. Installation of Masonry	RES	Inspect placement for conformance to the specifications.	Continuous
5. Reinforcement Installation	RES/ IWI	Inspect reinforcing steel for conformance to SER approved submittals and specifications (RES) Inspect welding of reinforcement and review welder's certifications (IWI).	Periodic
6. Grouting Operations	RES	Review grouting procedures for conformance with the specifications.	Periodic
7. Weather Protection	RES	Review procedures for protection for cold and hot weather for conformance with the specifications.	Periodic
8. Anchorage	RES	Inspect anchorage of masonry to other construction for conformance with specifications.	Periodic

Form 01 48 34 – 6

IN SITU BEARING STRATA FOR FOUNDATIONS - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Bearing strata for foundations	GEO/ RES	Review strata for conformance to the structural drawings, specifications, and/or geotechnical report.	Prior to foundation placement
2. Bearing surfaces of foundations	GEO/R ES	Review for conformance to the requirements of the structural drawings, specifications, and/or geotechnical report.	Prior to foundation placement

CONTROLLED STRUCTURAL FILL (PREPARED FILL) - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Fill Material	ITA(C)	Test material for conformance to specifications or geotechnical report. Perform laboratory compaction tests in accordance with the specifications to determine optimum water content and maximum dry density.	Each material
2. Installation of Controlled Structural Fill	RES/ ITA	Provide review of the installation, in accordance with the specifications. Verify maximum lift placement thickness (ITA).	Each lift
3. Density of Fill	ITA(C)	Perform field density tests of the in-place fill in accordance with the specifications.	Each lift

NOTE: These tests are the testing required by the Contractor’s independent testing agency (ITA(C)).

FOR INFORMATION ONLY

Form 01 48 34 – 8

PILE FOUNDATIONS - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Pile Material	SER/ RES	Review for conformance with the specifications, and that the identification is maintained from the point of manufacture to the point of delivery to the site.	Each pile shipment
2. Pile Material Tests	ITA(C)	If Item 1 is unsatisfactory, test material for conformance to the Contract Documents.	As required
3. Precast Concrete Piles.	-	Perform structural tests and inspections as listed under Precast Concrete Construction.	See precast concrete requirements
4. Steel Piles	-	Perform structural test and inspections as listed under Steel Construction.	See steel construction requirements
5. Pile Installation	RES/GE O	Provide review for conformance with specifications. Maintain accurate records for each pile. Record final location of each pile in plan.	Continuous
6. Cast-in-Place Concrete Piles	-	Perform structural tests and inspections as listed under Cast-in-Place Concrete Construction.	See cast-in-place concrete construction

NOTE: Confirmatory observations and/or testing required by the Contractor's independent testing agency (ITA(C)) and the Contractor's registered professional engineer (RPE(C)).

DRILLED PIER FOUNDATIONS - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Load-bearing Steel Components	SER	Review documents identifying material and certifying grade of material for conformance to the specifications	Each component
2. Concrete and Reinforcing Steel Components	-	Perform structural tests and inspections as listed under Cast-in-Place Concrete Construction.	See concrete requirements
3. Pier installation	RES	Provide review of installation for conformance with specifications. Maintain accurate records for each pier, documenting observations.	Continuous

Form 01 48 34 – 10

ALUMINUM CONSTRUCTION - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Fabricator Certification/ Quality Control Procedures.	SER	Review to ensure that quality control procedures have been adopted for each Fabricator.	Start of project
2. Fabricator Inspection	SER	Review to ensure that an Independent Inspection Agency has approved each Fabricator.	Start of project
3. Material Certification	SER	Review for conformance to the specifications.	Each product
4. Bolting	ITA(C)	Test and inspect bolted connections in accordance with specifications. Verify bolt size and grade in accordance with AISC specifications A325/A490.	Periodic
5. Welding	IWI	Check welder qualifications. Verify filler material in accordance with AWS D1.1. Visually inspect fillet welds. Test complete and partial penetration groove welds full length by dye penetrant, ultrasonic, or radiographic testing in accordance with the contract documents.	Periodic
6. Structural Framing, Details and Assemblies	RES	Review for conformance with specifications and shop drawings.	Periodic

Form 01 48 34 – 11

SPECIAL CASES - CATEGORY OF CONSTRUCTION

(NOTE: The tests and inspections listed under each category of construction have been listed with as much detail as is feasible.

- The SER should add items, delete items that do not apply, and edit the listed items to suit the project.
- The abbreviation for the agent who will be performing the tests or inspections should be indicated for each item.
- There are three levels of structural tests and inspections. All three levels of structural tests and inspections should be included under each category of construction.
 1. Those specifically mandated by the governing Building Code
 2. Those which are required by standards referenced by the Building Code, and
 3. Those required by the professional judgment of the SER.)

Item	Agent	Scope	Frequency
1. Rock Anchors	RES	Witness testing in accordance with contract documents.	Each anchor
2. Pressure Relief Valves	RES	Verify that quantity, location and details conform to SER approved submittals and specifications.	Each valve
3. Tank Leakage Testing	RES	Witness testing in accordance with contract documents.	Each tank
4. Concrete Anchor Installation	RES	Verify diameters, depth and cleaning of holes conforms to manufacturer's instructions.	Each anchor

END OF SECTION

SECTION 01 50 00

TEMPORARY FACILITIES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. References
- D. Use Charges
- E. Submittals
- F. Quality Assurance
- G. Materials
- H. Temporary Facilities
- I. Trailer (Office) for Construction Manager
- J. Equipment
- K. Installation, General
- L. Temporary Utility Installation
- M. Support Facilities Installation
- N. Security and Protection Facilities Installation
- O. Moisture and Mold Control
- P. Operation, Termination and Removal

1.02 RELATED SECTIONS

- A. Section 01 11 00 - Summary of Work
- B. Section 01 29 73 – Schedule of Values
- C. Section 01 32 ## – Construction Progress Schedules <PROJECT SPECIFIC>

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. The Contractor shall provide all temporary facilities for the proper completion of the Work as required and specified herein.

1.04 REFERENCES

- A. American National Standards Institute (ANSI)
 - 1. A 117.1: Accessible and Usable Buildings and Facilities
- B. American Society for Testing and Materials (ASTM)
 - 1. E84: Standard Test Method for Surface Burning Characteristics of Building Materials
 - 2. E136: Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 °C
- C. National Fire Protection Association (NFPA):
 - 1. 70: National Electrical Code
 - 2. 241: Standard of Safeguarding Construction, Alteration, and Demolition Operations
 - 3. 701: Standard Methods of Fire Tests for Flame Propagation of Textiles and Films

1.05 USE CHARGES

- A. General. Installation, removal of, and use charges for temporary facilities shall be included in the Contract Lump Sum unless otherwise indicated. Allow other authorized entities to use temporary services and facilities without cost, including, but not limited to, the Construction Manager, Engineer, testing agencies, and authorities having jurisdiction.
- B. Sewer Service. Pay all sewer service use charges for sewer usage by all entities for construction operations.
 - 1. The Contractor shall provide adequate sanitary facilities for the use of those employed on the Work. Such facilities shall be made available when the first employees arrive on the site of the Work, shall be properly secluded from public observation, and shall be constructed and maintained during the progress of the Work in suitable numbers and at such points and in such manner as may be required.
 - 2. The Contractor shall maintain the sanitary facilities in a satisfactory and sanitary condition at all times and shall enforce their use. The Contractor shall rigorously prohibit the committing of nuisances on the site of the Work, on the lands of Metro, or on adjacent property.
 - 3. Metro's existing sewer system and facility tank drainage lines are available for use without metering and without payment for connection and use charges. Provide connections and extensions of services as required for construction operations coordinated with and inspected by the Construction Manager. Disconnecting any sewer connections and extensions shall be coordinated with and inspected by the Construction Manager.
 - 4. Metro's existing sanitary facilities and maintenance sinks in buildings for Metro employees are not available for use by the Contractor.

- C. Water Service. Pay all water service use charges for water used by all entities for construction operations.
1. For all necessary operations at the site of the Work in the Metro's water service area, (except as noted in the next paragraph below), Metro shall provide reasonable quantities of water at the then existing pressure from a mutually convenient hydrant of the Metro water distribution system. The Contractor shall furnish all necessary pipe or hose extensions to conduct the water to the points of use and shall exercise due care not to waste water. The Contractor shall not contaminate the water supply and shall comply with all applicable regulations and code requirements, including metering and backflow prevention. If outside of Metro's water service area, make arrangements with the servicing water utility.
 2. Metro reserves the right to limit, suspend, or terminate the supplying of water as set forth above should it consider such action necessary because of damage to the distribution system, the necessity of conserving water, or other emergency. In this event, the Contractor shall obtain water from some other approved source, at their own expense.
 3. Metro's existing facility metered potable lines are available for on-site use for trailers and construction offices without metering and without payment for connection and use charges. The Contractor shall provide connections and extensions of services as required for construction operations and shall coordinate installing the connections and extensions with the Construction Manager and have them inspected by the Construction Manager. Disconnecting any water connections and extensions shall be coordinated with the Construction Manager, and the Construction Manager will inspect the disconnections. The Contractor shall not contaminate the metered plant potable water supply and shall comply with all applicable regulations and code requirements, including backflow prevention.
- D. Electric Power Service. Pay electric power service use charges for electricity used by all entities for construction operations.
1. The Contractor shall make all necessary applications and arrangements and pay all fees and charges for electrical energy for power and light necessary for the proper completion of the Work and during its entire progress. The Contractor shall provide and pay for all temporary wiring, switches, connections, distribution panels, and meters.
 2. The Contractor shall provide sufficient electric lighting so that all Work may be done in a workmanlike manner when there is not sufficient daylight.
 3. The Contractor will be allowed to use existing facility electrical outlets when these receptacles are within the immediate proximity of the work area and when their use does not interfere with existing operations or create a safety hazard.
 4. For temporary Contractor power distribution panels, the Contractor will be allowed to make connections to and use existing plant local power distribution panels constrained to 50 percent of the available spares in the panel. This may be terminated if loads or use is detrimental to the MWS facility electrical system or process equipment. The Contractor will provide connections and extensions of services as required for construction operations and coordinate the installation with the Construction Manager and MWS facility electrical personnel. Disconnecting any power connections and extensions shall be coordinated with the Construction Manager and MWS facility electrical personnel.

1.06 SUBMITTALS

- A. Site Plan. Show temporary facilities, utility hookups, staging areas, and parking areas for construction personnel.
- B. Fire Safety Program. Show compliance with requirements of NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire prevention program.
- C. Dust and HVAC Control Plan. Submit coordination drawing and narrative that indicates the dust and HVAC control measures proposed for use, proposed locations, and proposed time frame for their operation. Identify further options if proposed measures are later determined to be inadequate. Include the following:
 - 1. Locations of dust control partitions at each phase of Work
 - 2. HVAC system isolation schematic drawing
 - 3. Location of proposed air filtration system discharge
 - 4. Waste handling procedures
 - 5. Other dust control measures

1.07 QUALITY ASSURANCE

- A. Electric Service. Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.
- B. Tests and Inspections. Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.
- C. Temporary Use of Permanent Facilities. Engage an installer of each permanent service to assume responsibility for the operation, maintenance, and protection of each permanent service during its use as a construction facility before Metro acceptance regardless of previously assigned responsibilities.
- D. During adverse weather and against the possibility thereof, the Contractor shall take all necessary precautions so that the Work may be properly completed and is satisfactory in all respects. When required, protection shall be provided by use of tarpaulins, wood, and building-paper shelters, or other suitable means.
- E. During cold weather, materials shall be preheated, if required, and the materials and adjacent structure into which they are to be incorporated shall be made and kept sufficiently warm so that a proper bond will take place and a proper curing, aging, or drying will result. Protected spaces shall be artificially heated by suitable means that will result in a moist or a dry atmosphere according to the particular requirements of the Work being protected. Ingredients for concrete and mortar shall be sufficiently heated so that the mixture will be warm throughout when used.

PART 2 - PRODUCTS

2.01 MATERIALS <PROJECT SPECIFIC>

- A. Chain Link Fencing. Minimum 2-inch, 0.148-inch thick, galvanized steel, chain link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top rails with galvanized barbed wire top strand
- B. Portable Chain Link Fencing. Minimum 2-inch, 0.148-inch thick, galvanized steel, chain link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8-inch- OD line posts and 2-7/8-inch- OD corner and pull posts, with 1-5/8-inch- OD top and bottom rails. Provide concrete or galvanized steel bases for supporting posts.
- C. Polyethylene Sheet. Reinforced, fire resistive sheet, 10-mil minimum thickness, with flame-spread rating of 15 or less per ASTM E84 and passing NFPA 701 Test Method 2
- D. Dust Control Adhesive Surface Walk-off Mats. Provide mats - minimum 36 by 60 inches
- E. Insulation. Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively

2.02 TEMPORARY FACILITIES

- A. Field Offices, General. Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading
- B. The Contractor shall maintain a temporary field office near the Work for their own use during the period of construction at which readily accessible copies of all contract documents shall be kept. The office shall be located where it will not interfere with the progress of the Work. In charge of this office, there shall be a competent Superintendent of the Contractor.
- C. Available land inside the fenced area of the XXXXX Wastewater Pumping Station may be used for the Contractor and Construction Manager's job site trailer and the Contractor's equipment/materials storage. The Contractor must maintain full access to the MWS facilities at all times and maintain the security of the site when not occupied with a double padlocking system. NO excavated spoils material storage will be allowed. The use of the site is subject to revocation within 30 days of a written notice if there are unforeseen risk, nuisance, or issues from use. <PROJECT SPECIFIC, VERIFY USE WITH CWNOAP FOR FACILITIES /PIPE /REHAB PROJECT>

2.03 TRAILER (OFFICE) FOR CONSTRUCTION MANAGER <PROJECT SPECIFIC>

- A. Promptly after starting Work at the site, the Contractor shall provide and equip a suitable trailer (office) for the exclusive use of the Construction Manager, and the Contractor shall maintain this trailer/office thereafter until the completion of the Work to be done under this contract.
 1. The Construction Manger's office trailer is required for each project, even if the Contractor is involved in other projects for CWNOAP or others in the area.
 2. The trailer shall have a minimum width of 12 feet and a length, as required, to obtain the square footage specified below and an insulated floor.
 3. The office and furniture shall be relatively new and in good condition.

4. The equipment, supplies, and services furnished shall be acceptable to the Construction Manager.
- B. The Contractor shall furnish insurance coverage of adequate amount to replace not only the Contractor's equipment but also all property belonging to the Construction Manager and staff at replacement cost.
- C. The office shall be of suitable height and of ample size to accommodate the furniture and equipment listed below without crowding (at least 480 sq. ft. of floor area) ~~<PROJECT SPECIFIC>~~. It shall be weathertight, acceptably insulated, and suitably ventilated; the floor shall be tight and of sufficient construction to withstand the loads imposed upon it.
1. The office shall be partitioned to provide a minimum of 3 separate rooms.
 2. Each room will have a door, with lock and key, and a minimum of two screened windows which can be both opened and locked shut.
 3. The office shall have two exterior doors with cylinder locks and keys.
 4. The office shall contain acceptable toilet facilities, including a toilet, a sink with hot and cold water, an exhaust fan, and a mirror.
 5. The Contractor shall make arrangements and pay all costs associated with tying the office's sanitary system into an approved disposal system or alternative means of sanitary service.
- D. The Contractor shall furnish a parking area large enough to accommodate a minimum of four cars adjacent to the office for the exclusive use of the Construction Manager.
- E. The Contractor shall furnish the following furniture, equipment, supplies, and services:
1. One plan table or sloping plan shelf about 3 feet by 6 feet with a reasonably smooth top and one suitable swivel stool
 2. Eight additional folding chairs
 3. Shelves, tables, and bookcases as required by the Construction Manager
 4. Electric lights, desk lamps, and outlets. The Contractor shall pay for the installation and all charges for the energy used.
 5. Broom and dustpan
 6. Two desks for general office use--each about 3 feet by 5 feet, all with a desk chair of the armchair swivel type
 7. A plan rack acceptable to the Construction Manager
 8. A plan storage cabinet acceptable to the Construction Manager
 9. Two four-drawer, legal size, metal filing cabinets each with locks
 10. Class ABC type fire extinguisher of at least 4-pound capacity
 11. Supply of drinking water in a suitable dispenser with hot and cold supply

12. A 10 cubic feet (minimum) refrigerator
13. Paper cups, paper towels, liquid soap, and toilet paper each with a suitable dispenser or holder
14. A wastebasket for each desk and a supply of appropriately-sized plastic trash bags
15. Thermostatically controlled heating unit or system of adequate capacity to maintain a minimum temperature of not less than 68 °F under all cold weather conditions. The Contractor shall provide all energy used and service necessary.
16. Thermostatically controlled, refrigerant type, air conditioner of adequate capacity to maintain a maximum temperature of not more than 72 °F under all hot weather conditions. The Contractor shall provide all service necessary and provide all power used.
17. Metal storage cabinet 36-inches wide by 18-inches deep by 72-inches high with a minimum of five adjustable shelves and a door lock
18. Outdoor minimum-maximum thermometer with a range of -40 °F to +120 °F and reset provisions
19. Rain gauge
20. Printer. Wireless "All-in-one" unit equipped with a printer server, color printing, photocopying, scanning, and faxing capabilities or separate units for each of these three functions. Device(s) shall support 8 ½" x 11" and 11" x 17" paper sizes in separate trays. Toner/Ink and paper shall be provided by the Contractor for the duration (final completion) of the project.
21. Internet Service. Broadband modem, router, and ISP equipped with hardware firewall and providing a minimum of 1 Gbps download and 1 Gbps upload speeds at each computer. Contractor shall have the option of providing wireless service that maintains referenced bandwidth. Network Maintenance shall be the responsibility of the Contractor for the full duration (final completion) of the project.
22. Provide a minimum 55-inch wall mounted monitor or projector /screen and appurtenances for connections to present presentations, plans and screen images from a computer of others for group viewing.
23. Construction-grade 25-person First Aid Kit. The First Aid Kit shall be checked and resupplied on a monthly basis.

F. The Contractor shall provide trailer space and facilities until the office, furnishings, and equipment described above are ready for use, but by so doing, the Contractor shall not be relieved of their obligation to provide and equip the specified Construction Manager's office as promptly as possible.

G. Unless otherwise directed by the Construction Manager, after the date of completion of the Work as stated in the final estimate, the Contractor shall remove the office and all such temporary facilities from the site, the same to become their property, and leave the premises in a condition acceptable to the Construction Manager.

H. Provide janitorial service with two cleanings per week.

2.04 EQUIPMENT

- A. Fire Extinguishers. Portable, UL rated with class and extinguishing agent as required by locations and classes of fire exposures
- B. HVAC Equipment. Provide vented, self-contained, electric, liquid propane gas or fuel oil heaters with individual space thermostatic control.
 - 1. The use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
 - 2. Heating Units. Listed and labeled for the type of fuel being consumed by a qualified testing agency acceptable to authorities having jurisdiction and marked for the intended location and application
- C. Air Filtration Units. Primary and secondary HEPA filter equipped portable units with four-stage filtration. Provide a single switch for emergency shutoff. Configure to run continuously.
- D. Utility Task Vehicle. For exclusive use of the Construction Manager, provide, maintain, and fuel one (1) four person side by side fully enclosed cab, UTV with utility bed person of current model year at the NTP as manufactured by Kubota (RTV-X1140 & RTV-X1120), Polaris, John Deere, or equal. < Designer to Delete if rehab or not a large site Facility Project.>

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

- A. If the site location is not located on the Contract Drawings, locate the facilities where they will serve the Project adequately and result in minimum interference with the performance of the Work in coordination with the Construction Manager. Relocate and modify facilities as required by the progress of the Work and as accepted by the Construction Manager in accordance with Paragraph 1.06.A.
- B. Provide each temporary facility ready for use when needed to avoid delay. Do not remove until the facilities are no longer needed or are replaced by the authorized use of completed permanent facilities.

3.02 TEMPORARY UTILITY INSTALLATION

- A. General. Install temporary service or connect to existing service. Arrange with utility company, Metro, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
- B. Sewers and Drainage. Provide temporary utilities to remove effluent lawfully. Connect temporary sewers to the municipal system as directed by authorities having jurisdiction.
- C. Water Service. Install water service and distribution piping in sizes and pressures adequate for construction.
- D. Sanitary Facilities. Provide temporary toilets, wash facilities, and drinking water for the use of construction personnel. Comply with the requirements of authorities having jurisdiction for the type, number, location, operation, and maintenance of fixtures and facilities.

- E. Heating. Provide temporary heating required by construction activities for the curing or drying of completed installations or for protecting the installed construction from the adverse effects of low temperatures or high humidity. Select equipment that will not have a harmful effect on the completed installations or elements being installed.
- F. Isolation of Work Areas in Occupied Facilities. Prevent dust, fumes, and odors from entering the occupied areas.
1. Prior to commencing Work, isolate the HVAC system in an area where Work is to be performed according to the coordination drawings required by paragraph 1.06.D above.
 - a. Disconnect the supply and return ductwork in the Work area from the HVAC systems servicing occupied areas.
 - b. Maintain negative air pressure within the Work area using HEPA-equipped air filtration units, starting with the commencement of temporary partition construction and continuing until the removal of temporary partitions is complete.
 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited Work within occupied areas using portable dust-containment devices.
 3. Perform daily construction cleanup and final cleanup using approved, HEPA filter-equipped vacuum equipment.
- G. Ventilation and Humidity Control. Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from the adverse effects of high humidity. Select equipment that will not have a harmful effect on the completed installations or elements being installed. Coordinate ventilation requirements to produce the required ambient condition and minimize energy consumption. Provide dehumidification systems when required to reduce substrate moisture levels to the level required to allow installation or the application of finishes.
- H. Electric Power Service. Provide electric power service and a distribution system of sufficient size, capacity, and power characteristics required for the construction operations.
- I. Lighting. Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
 2. At each telephone and Emergency Response station, post a list of important telephone numbers, including, but not limited to, those listed below and the site's address.
 - a. Police and fire departments
 - b. Ambulance service
 - c. Contractor's home office
 - d. Contractor's emergency after hours telephone number
 - e. Construction Manager's offices

- f. Metro Water Services' Public Information Officer
 - g. Principal subcontractors' field and home offices
 - h. Map of the nearest clinic and nearest emergency room
3. Provide the superintendent with cellular telephone or portable two-way radio for use when away from field office.

3.03 SUPPORT FACILITIES INSTALLATION

A. General. Comply with the following:

- 1. Provide construction for temporary offices, shops, and sheds located within construction area or within 30 feet of building lines that is noncombustible according to ASTM E136. Comply with NFPA 241.
- 2. Maintain support facilities until Construction Manager schedules Substantial Completion inspection. Remove before Final Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Metro.

B. Temporary Roads and Paved Areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated on Drawings. Provide dust control treatment that is nonpolluting and non-tracking. Reapply treatment as required to minimize dust.

C. Temporary Use of Permanent Roads and Paved Areas. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

- 1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
- 2. Prepare subgrade and install subbase and base for temporary roads and paved areas.
- 3. Recondition the base after temporary use, including removing contaminated material, regrading, proof rolling, compacting, and testing.
- 4. Delay installation of final course of permanent hot mix asphalt pavement until immediately before Substantial Completion. Repair hot mix asphalt base course pavement before installation of final course.

D. Traffic Controls. Comply with the requirements of authorities having jurisdiction.

- 1. Protect existing site improvements to remain, including curbs, pavement, and utilities.
- 2. Maintain access for firefighting equipment and access to fire hydrants.

E. Parking. Provide temporary parking areas for construction personnel. Provide designated parking for the Construction Manager's onsite staff.

- F. Dewatering Facilities and Drains. Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.
 - 1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
 - 2. Remove snow and ice as required to minimize accumulations.
- G. Waste Disposal Facilities. Provide waste collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of authorities having jurisdiction.
- H. Lifts and Hoists. Provide facilities necessary for hoisting materials and personnel. Truck cranes and similar devices used for hoisting materials are considered "tools and equipment" and not temporary facilities.
- I. Temporary Stairs. Until permanent stairs are available, provide temporary stairs where ladders are not adequate.
- J. Existing Stair Usage. Use of Metro's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Metro. At Substantial Completion, restore stairs to condition existing before initial use. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of corrective Work.
- K. Temporary Use of Permanent Stairs. Use of new stairs for construction traffic will be permitted. However, the stairs must be protected, and the finishes must be restored to a new condition at the time of Substantial Completion.

3.04 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Protection of Existing Facilities. Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties except those indicated to be removed or altered. Repair damage to existing facilities.
- B. Pest Control. Engage pest control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Final Completion. Perform control operations lawfully, using environmentally safe materials.
- C. Site Enclosure Fence. Before construction operations begin, furnish and install a site enclosure fence in a manner that will prevent people and animals from easily entering site except by the entrance gates. <PROJECT SPECIFIC>
- D. Extent of Fence. Install the fence as required to enclose entire Project site or portion determined sufficient to accommodate construction operations or as indicated on Drawings.
- E. Security Enclosure and Lockup. Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.
- F. Barricades, Warning Signs, and Lights. Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

- G. Temporary Egress. Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.
- H. Temporary Enclosures. Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weather tight enclosure for building exterior. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.
- I. Temporary Partitions. Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Metro from fumes and noise.
1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire retardant treated plywood on construction operations side.
 2. Construct dustproof partitions with two layers of 6-mil polyethylene sheet on each side. Cover floor with two layers of 6-mil polyethylene sheet, extending sheets 18 inches up the sidewalls. Overlap and tape full length of joints. Cover floor with fire retardant treated plywood. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches between doors. Maintain water-dampened foot mats in vestibule.
 3. Where fire resistance rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
 4. Insulate partitions to control noise transmission to occupied areas.
 5. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
 6. Protect air handling equipment.
 7. Provide walk-off mats at each entrance through temporary partition.
- J. Temporary Fire Protection. Install and maintain temporary fire protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage a fire prevention program.
1. Prohibit smoking in construction areas.
 2. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of authorities having jurisdiction.
 3. Develop and supervise an overall fire prevention and protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
 4. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign stating that hoses are for fire protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.05 MOISTURE AND MOLD CONTROL

- A. Contractor's Moisture Protection Plan. Avoid trapping water in finished Work. Document visible signs of mold that may appear during construction.

- B. Exposed Construction Phase. Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:
1. Protect porous materials from water damage
 2. Protect stored and installed material from flowing or standing water
 3. Keep porous and organic materials from coming into prolonged contact with concrete
 4. Remove standing water from decks
 5. Keep deck openings covered or dammed
- C. Partially Enclosed Construction Phase. After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 2. Keep interior spaces reasonably clean and protected from water damage.
 3. Periodically collect and remove waste containing cellulose or other organic matter.
 4. Discard or replace water damaged material.
 5. Do not install material that is wet.
 6. Discard, replace, or clean stored or installed material that begins to grow mold.
 7. Perform Work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- D. Controlled Construction Phase of Construction. After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 2. Use a permanent HVAC system to control humidity.
 3. Comply with Manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
 - a. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for 48 hours are considered defective.
 - b. Measure the moisture content of materials that have been exposed to moisture during the construction operations or after installation. Record readings beginning at the time of exposure and continuing daily for 48 hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to the Construction Manager.
 - c. Remove materials that cannot be completely restored to their manufactured moisture level within 48 hours.

3.06 OPERATION, TERMINATION, AND REMOVAL

- A. Supervision. Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance. Maintain facilities in good operating condition until removal. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.
- C. Temporary Facility Changeover. Do not change over from using temporary security and protection facilities to permanent facilities until Final Completion.
- D. Termination and Removal. Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
 - 1. Materials and facilities that constitute temporary facilities are property of Contractor. Metro reserves right to take possession of the Project identification signs.
 - 2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.
 - 3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Complete final cleaning requirements in accordance with the requirements stated herein.

END OF SECTION

SECTION 01 55 26

TRAFFIC CONTROL

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Scope
- B. Submittals
- C. Measurement and Payment
- D. General
- E. Traffic Control

1.02 SCOPE

- A. Traffic Control

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 - Submittals.
- B. Submit vehicular and pedestrian traffic control plan(s) for review to the appropriate agencies, including, but not limited to, Nashville Department of Transportation and Multimodal Infrastructure (NDOT), formerly the Metro Public Works (MPW), the Americans with Disabilities Act (ADA), and/or the Tennessee Department of Transportation (TDOT). The Construction Manager will not issue an approval of traffic control plan(s).

1.04 MEASUREMENT AND PAYMENT

- A. Consider expenses for traffic control to be incidental to the Work with no separate payment allowed unless a traffic control bid item is specifically indicated on the Bid Schedule.

1.05 GENERAL

- A. Assume sole responsibility of traffic control operations and associated vehicular and pedestrian safety.
- B. Provide traffic control processes needed to create a safe work zone and maintain the safety of vehicular and pedestrian traffic.
- C. Provide traffic control for Work within local roads in accordance with NDOT's most recent standards and local road permit provisions.
- D. Provide traffic control for Work within state route and interstate rights-of-way in accordance with TDOT's most recent standards and the permit provisions.
- E. Provide off-duty officers, certified flaggers, temporary signage, traffic control devices, and other incidentals necessary for the traffic control operations.

- F. Ensure that roadways are fully accessible to traffic during non-working hours.
- G. Provide temporary ingress and egress to properties during working hours.
- H. Maintain access for emergency vehicles at all times and access to fire hydrants.
- I. Maintain access for US Postal Service mail delivery, package delivery services, and scheduled trash services to impacted parcels.
- J. Coordinate and receive permit approval from NDOT prior to roadway or lane closures for local roadways.
- K. Coordinate and conform to the stipulations of TDOT's permit requirements for Work within state routes and/or interstate rights-of-way and coordinate with NDOT.
- L. Utilize traffic control in accordance with the most recent revision of the Metropolitan Code of Laws, -, but not limited, to Sections 13.20.030 and 13.20.090.

PART 2 - PRODUCTS

2.01 TRAFFIC CONTROL

- A. Provide traffic control devices in conformance with the most recent revision of the *Manual on Uniform Traffic Control Devices (MUTCD)*.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 57 13

EROSION AND SEDIMENT CONTROL AND CONTAINMENT OF CONSTRUCTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. References
- C. Contractor's Responsibilities
- D. Submittals
- E. *Stormwater Pollution Prevention Plan*
- F. Metro Grading Permits
- G. Erosion and Sediment Control Construction Measures
- H. Corrections
- I. Products, General
- J. Erosion and Sediment Control Inspections and Reporting
- K. Project Review
- L. Pre-construction Conference
- M. Construction of Structures
- N. Maintenance
- O. Erosion Control Outside Project Area

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 33 00 – Submittals
- C. Section 01 43 00 – Quality Requirements
- D. Division 31

1.03 REFERENCES

- A. United States Environmental Protection Agency (USEPA)
 - 1. USEPA- 72-015: Guidelines for Erosion and Sedimentation Control Planning and Implementation

2. USEPA 43019-73-007: Processes, Procedures, and Methods to Control Pollution Resulting from All Construction Activity
- B. Tennessee Department of Environment & Conservation (TDEC)
1. TDEC General NPDES permit for Storm Water Discharge Associated with Construction Activities
 2. *TDEC Erosion & Sediment Control Handbook*
 3. Metropolitan Government of Nashville and Davidson County, Department of Water and Sewerage Services (Metro) - *Stormwater Management Manual*

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. All activities performed under this Contract shall be conducted in full compliance with Metro Code of Law §§ 15.6 et al (Stormwater Management) including §§ 15.64.205 (<http://www.nashville.gov/Water-Services/Pollution-Prevention/Illicit-Discharge-Ordinance.aspx>).
- B. The Contractor shall revise, sign, and submit the final *Stormwater Pollution Prevention Plan* (SWPPP). CWNOAP or the Engineer may have prepared a draft SWPPP for facility projects, and the Contractor may use that as a plan basis. The SWPPP shall be submitted to TDEC for approval. Copies shall be provided to the Construction Manager.
- C. The Contractor is responsible for obtaining the Grading Permits from Metro. All supporting documentation for the Grading Permit is the Contractor's responsibility.
- D. The Contractor, in executing the Work, shall schedule and conduct all Work in a manner that will comply with the Reference Documents listed in Paragraph 1.03, all state and local, laws, codes, and regulations. Where the Reference Documents have similar standards and requirements, the Contractor shall comply with the more stringent standards and requirements.
- E. All erosion control measures shall be in place in a work area prior to the commencement of any construction activity in that area. Ensure that the construction is achieved with a minimum of disturbance to the water resource and its surroundings.
- F. Prior to commencing the Work, the Contractor shall meet with the Construction Manager to review how the Contractor will comply with the requirements of this Section.
- G. Limit total land disturbance to less than one acre at all times for the duration of the Work. Any land previously disturbed that has not been fully restored, will be included in the total calculation of disturbed land. **<PROJECT SPECIFIC – REHAB PROJECTS ONLY>**

1.05 SUBMITTALS

- A. *Stormwater Pollution Prevention Plan*
- B. TDEC Construction Stormwater Inspection Certifications
- C. Metro Grading Permits

1.06 STORMWATER POLLUTION PREVENTION PLAN

- A. The Contractor shall be provided with a draft *Stormwater Pollution Prevention Plan* for review and use on facility and linear pipe projects as a basis for its submittal to TDEC and Metro. This draft will be attached in bid documents appendices for information. The Contractor shall revise the SWPPP to meet all TDEC and Metro requirements for its Work. The provision of the draft SWPPP to the Contractor shall in no way change the duties or responsibilities of Metro, Contractor, Construction Manager, Engineer, or any of their subcontractors, consultants, agents, or employees from those set forth in the Contract Documents

1.07 METRO GRADING PERMITS

- A. The Contractor shall provide to Metro all required documentation needed to obtain all Grading Permits. The documentation that must be provided includes:
 - 1. Copies of all State and Federal Permits
 - 2. Grading and Drainage Plans
 - 3. Erosion Prevention and Sediment Control Plans
 - 4. Post-construction Stormwater Management Plan
- B. The Contractor is required to coordinate its Grading Permit submissions with the requirements in the Metro *Stormwater Management Manual*.

1.08 EROSION AND SEDIMENT CONTROL CONSTRUCTION MEASURES

- A. The Contractor shall comply with the provisions of Metro Water Services' Stormwater Management guidance documents and Best Management Practices and TDEC regulations. Specifically, apply the appropriate soil conservation measures to protect the Project area and adjacent lands as required by TDEC and Metro.
- B. These measures may include, but not be limited to, mulching, rapid growth vegetation, fabric mat, hay bales, filter barriers, sediment traps, and basins.

1.09 CORRECTIONS

- A. The state or local agencies responsible for verifying certain aspects of the environmental protection requirements may notify the Contractor and/or Metro about any noncompliance with state or local requirements. The Contractor shall, after receiving such notice from the Construction Manager or from the regulatory agency, immediately take corrective action.
- B. If the Contractor fails or refuses to promptly correct the defective Work, Metro may issue an order stopping all or part of the Work until satisfactory corrective actions have been taken.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Materials. All erosion and sediment control materials used by the Contractor shall comply with TDEC and Metro standards.

PART 3 - EXECUTION

3.01 EROSION AND SEDIMENT CONTROL INSPECTIONS AND REPORTING

- A. The Contractor will meet with the Construction Manager prior to, will complete and submit to TDEC, as required, the Construction Stormwater Inspection Certification form.
- B. The Construction Manager will perform and forward the erosion and sediment control inspections to Metro and TDEC, as required.
- C. Corrections shall be made in accordance with Paragraph 1.09

3.01 PROJECT REVIEW

- A. Prior to the Pre-construction Conference, the Contractor shall meet with the Engineer and go over in detail the expected problem areas in regard to the erosion control work. Different solutions should be discussed so that the best method might be determined. It is the basic responsibility of the Contractor to develop an *Erosion and Siltation Control Plan* acceptable to the Construction Manager.
- B. The project drawings show the minimum erosion and siltation control measures required for this job. If the Contractor desires to stockpile construction materials, stone, earth, etc., the location of same and protection thereof shall be outlined in the *Erosion and Siltation Control Plan* to be submitted to the Construction Manager for review.
- C. The Contractor shall submit a *Spill Prevention Plan* to the Construction Manager for review. The contents of this *Spill Prevention Plan* shall depend on what types of chemicals, lubricants, and fuels will be used and if these will be stored on site. As a minimum, if fuel or lubricants or other chemicals are stored on site, either temporarily in vehicular tanks with containment or in skid or trailer mounted tanks with containment, a plan shall be supplied which directs all employees of the Contractor in the proper procedures to be followed should a spill occur. For more complex chemical storage requirements, a more complex plan will be required.

3.02 PRE-CONSTRUCTION CONFERENCE

- A. The Construction Manager has the authority to limit the surface area of erodible earth material exposed by clearing and grubbing, the surface of erodible earth material exposed by excavation, and borrow and fill operations, and to direct the Contractor to provide immediate permanent or temporary pollution control measures to prevent contamination of adjacent streams or other watercourses, lakes, ponds, or other water impoundment. Such work may involve the construction of temporary berms, dikes, dams, sediment basins, slope drains, and use of temporary mulches, mats seeding, or other control devices or methods as necessary to control erosion. Cut and fill shall be seeded and mulched as the excavation proceeds to the extent directed by the Construction Manager.
- B. The Contractor shall be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the accepted schedule. Temporary pollution control measures shall be used to correct conditions that develop during construction that were not foreseen during the pre-construction stage, that are needed prior to installation of permanent pollution control features, or that are needed temporarily to control erosion that develops during normal construction practices but are not associated with permanent control features on the project.
- C. Where erosion is likely to be a problem, clearing and grubbing operations should be so scheduled and performed that grading operations and permanent erosion control features can

follow immediately thereafter if the project conditions permit; otherwise erosion control measures may be required between successive construction stages. Under no conditions shall the surface area of erodible earth material exposed at one time by clearing and grubbing exceed 435,600 square feet (10 acres) without approval of the Construction Manager.

- D. The Construction Manager will limit the area of excavation, borrow, and embankment operations in progress commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent pollution control measures in accordance with the accepted schedule. Should seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified.
- E. In the event of conflict between these requirements and pollution control laws, rules, or regulations or other federal, State, or local agencies, the more restrictive laws, rules, or regulations shall apply.

3.03 CONSTRUCTION OF STRUCTURES

- A. Inlet Protection. Install inlet protection around stormwater inlets to help prevent sediment from entering the inlet.
- B. Sediment Tubes. Stake down sediment tubes in place near specific areas of low flow to help prevent the movement of sediment.
- C. Temporary Seeding and Mulching. Seeding and mulching shall be performed in accordance with Section 32 92 00, Turf and Grasses.
- D. Temporary Silt Fences
 - 1. Temporary silt fences shall be placed on the natural ground, at the bottom of fill slopes, in ditches, or other areas where siltation is a problem. Silt fences are constructed of wire mesh fence with a covering of burlap or some other suitable material on the upper grade side of the fence and anchored into the soil.
 - 2. The Contractor shall be required to maintain the silt fences in a satisfactory condition for the duration of the project or until its removal is requested by the Construction Manager. The silt accumulation at the fence may be left in place and seeded or removed, as directed by the Construction Manager. The silt fence remains the property of the Contractor whenever the fence is removed.
- E. Erosion Control Blanket. Install erosion control blanket over final graded and seeded disturbed soil. Secure blanket to soil using manufacturer's recommended staple pattern.
- F. Under no circumstances shall spent oil wastes be discharged on the site.

3.04 MAINTENANCE

- A. The temporary erosion control features installed by the Contractor shall be acceptably maintained by the Contractor until no longer needed or permanent erosion control methods are installed. Any materials removed shall become the property of the Contractor.

3.05 EROSION CONTROL OUTSIDE PROJECT AREA

- A. Temporary pollution control shall include construction work outside the project area where such work is necessary as a result of construction such as off-site Contractor employee parking, borrow pit operations, haul roads, and equipment storage sites.

END OF SECTION

FOR INFORMATION ONLY

SECTION 01 61 00

CONTROL OF MATERIALS AND SPARE PARTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Description
- B. Related Sections
- C. References
- D. Definitions
- E. Spare parts
- F. Maintenance Materials Data
- G. Quality Assurance
- H. Delivery, Storage and Handling of Spare Parts
- I. Warranty
- J. Products
- K. Substitution and/or Equal Items for Spare Parts
- L. Products, Materials and Equipment
- M. Field Quality Control; Installation, Instructional and Post-startup Services
- N. Form 01 61 11 -- 1, Equipment Manufacturer's Certification of Installation Services

1.02 DESCRIPTION

- A. This Section delineates the administrative and procedural requirements for selecting products for use on the Project; product delivery, storage and handling; the Manufacturers' standard warranties on products; special warranties; and comparable products.
- B. This Section also delineates the general procedures and requirements for submitting spare parts, special tools, and maintenance material. Requirements for spare parts, special tools, and maintenance material are included in applicable sections of the Technical Specifications (Divisions 2 through xx).
- C. All spare parts and maintenance material required by the Contract Documents must be submitted to and receive an acceptable written disposition from the Construction Manager prior to issuance of the Certificate of Substantial Completion.

1.03 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 25 00 – Substitution Procedures
- C. Section 01 33 00 – Submittals
- D. Section 01 66 10 – Delivery, Storage and Handling
- E. Section 01 77 00 – Contract Closeout
- F. Section 01 78 23 – Operation and Maintenance Data
- G. Division 02 – Division ## <PROJECT SPECIFIC>

1.04 REFERENCES

- A. American Society of Mechanical Engineers (ASME)
 - 1. B1.1: Unified Inch Screw Threads (UN and UNR Thread Form)
- B. American Society for Testing and Materials (ASTM)
 - 1. A123/A123M: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 2. A325/A325M: Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

1.05 DEFINITIONS

- A. **Products.** Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term “product” also refers to the terms material, equipment, system, and terms with similar intent.
 - 1. **Named Products.** Items identified by the Manufacturer's product name, including the make or model number or other designation shown or listed in Manufacturer's published product literature that is current as of the Contract Documents date.
 - 2. **New Products.** Items not previously incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
 - 3. **Comparable Product.** Product demonstrated and accepted through the submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance and other characteristics that equal or exceed the specified product.
 - 4. **Spare Parts.** Replacement parts identified by the Contract Documents to be furnished as spare parts or to be furnished by the product Manufacturer based on knowledge of the product service history and recommended to be stored on site or specified to be provided with equipment.
 - 5. **Maintenance Material.** Materials used to maintain the product in appearance or function which are not replacement parts. These include items such as servicing tools and

equipment, paints, and lubricants or other items as identified in applicable sections of the technical Specifications (Divisions 2 through xx).

1.06 SPARE PARTS

- A. Provide and submit a complete list with required spare parts for all equipment and systems as specified in the various individual Contract Specification Sections.
- B. The Spare Parts List shall be organized in accordance with the Contract Specification Sections by Section Number and Title.
 - 1. The Spare Parts List shall include the part's generic name or description, its trade name, part number, Manufacturer's name, Manufacturer's part number, retail price, quantity and correlation with Contract Drawings and Maintenance Manuals Specified in Section 01 78 23, Operation and Maintenance Data.
 - 2. Spare Parts shall be grouped by equipment category. Replacement parts common to more than one category shall be cross-referenced and indexed. Such common parts shall only have one part number.
- C. Provide spare parts for products as specified in the individual technical Specification Sections.
- D. Spare parts shall be identical to the parts installed in the Work.
- E. Pack spare parts to protect them during storage and in accordance with Section 01 66 10, Delivery, Storage and Handling. Tag spare parts and containers to clearly identify them in accordance with Contractor's parts numbering system as reviewed by the Construction Manager. All parts shall be cross-referenced to their applicable Specification Section.
- F. Spare parts shall be coated or packaged to prevent corrosion or deterioration during long-term indoor unheated storage. Any special storage environment required within this constraint shall be clearly marked on the packaging.
- G. All packaging shall be clearly labeled with the product Manufacturer's name and part number. This shall conform to the identification data provided on the list of spare parts, special tools, and maintenance materials required herein.
- H. Metal parts shall be packaged in sealed plastic wrappers with dispersion-type corrosion inhibitors included in the packaging.
- I. Electric and electronic parts shall be packed in sealed plastic wrappers or hermetically-sealed containers. Desiccant cartridges shall be included in the packaging.
- J. Plastic wrapping shall be sealed and shall not be less than 4 mils thick.
- K. Electronic spare parts shall be installed in the requisite equipment and
 - 1. Brought to operating temperature
 - 2. Calibrated as required
 - 3. Tested
 - 4. Removed and repacked according to herein for storage prior to acceptance

1.07 MAINTENANCE MATERIALS DATA

- A. Maintenance materials shall be provided in sealed, original Manufacturer's packaging or containers. Packaging shall be suitable for long-term indoor unheated storage. Any special storage environment required within this constraint shall be clearly marked on the packaging.
- B. All packaging shall be clearly labeled with the product Manufacturer's name and part number. This shall conform to the identification data provided on the list of special tools and maintenance materials required by Subparagraph 1.06.C of this Section.
- C. All special tools and equipment shall be in new, unused condition. If any tools or equipment are used during construction, they shall be returned to the Manufacturer for rebuilding and inspection and shall be certified and warranted by the Manufacturer to conform to all requirements for new material or replaced with new tools or equipment.
- D. QUALITY ASSURANCE
- E. Comply with the requirements specified in this Section 01 61 00, Delivery, Storage and Handling, and in Section 01 43 00, Quality Requirements.
- F. Compatibility for Options. If the Contractor is given the option to select between two or more products for use on a Project, select the product compatible with products previously selected, even if the previously selected products were also options.

1.08 DELIVERY, STORAGE AND HANDLING OF SPARE PARTS

- A. The Contractor shall arrange material and equipment deliveries in accordance with the Construction Progress Schedule and coordinate the deliveries to avoid conflicts with the Work and site conditions.
- B. Deliver spare parts, special tools, and lubrication to locations specified by the Construction Manager. Provide unloading service at the designated storage location for all delivered products.
- C. Prepare formal receipts for all such deliveries and have them signed by the authorized Metro representative at the drop-off location.
- D. Provide equipment and personnel to handle the materials and equipment by methods recommended by the Manufacturer to prevent soiling or damage to materials, equipment, or their packaging and in accordance with Section 01 66 10, Delivery, Storage and Handling.
- E. Metro assumes no responsibility for damage or loss due to storing materials and equipment.
- F. The Contractor shall assume the responsibility for protecting the completed construction, and repair and restore damage to completed Work equal to original condition.
- G. Wheeling loads over finished floors, with or without floor protection, is not permitted in anything except rubber-tired wheelbarrows, buggies, trucks, or dollies. This applies to finished floors, exposed concrete floors and those covered with composition tile or other applied surfacing.
- H. Where structural concrete is also a finished surface, avoid marking or damaging the surface.

1.09 WARRANTY

- A. Warranties specified in other Sections shall be in addition to other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor's obligations under the Contract Document requirements.
 - 1. **Manufacturer's Warranty.** A written warranty furnished by individual Manufacturer for a particular product and specifically endorsed by Manufacturer to Metro
 - 2. **Special Warranty.** A written warranty required by the Contract Documents to provide specific rights for Metro.
- B. **Special Warranties.** Prepare a written document containing appropriate terms and identification, ready for execution.
 - 1. **Manufacturer's Standard Form.** Modified to include Project-specific information and properly executed
 - 2. **Specified Form.** When specified forms are included with the Specifications, prepare a written document using the indicated form properly executed.
 - 3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

1.10 PRODUCTS

- A. Furnish products from qualified Manufacturers suitable for intended use. Furnish products for each type from a single Manufacturer unless specified otherwise.
- B. Do not use materials and equipment removed from existing premises except as specifically permitted by the Contract Documents.
- C. Furnish interchangeable components from the same Manufacturer for components being replaced.

1.11 SUBSTITUTION AND / OR EQUAL ITEMS FOR SPARE PARTS

- A. Requests for spare part substitutions shall be in accordance with Section 01 25 00, Substitution Procedures.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT

- A. Material and Equipment incorporated into the Work shall
 - 1. Conform to the applicable specifications and standards.
 - 2. Comply with the size, make, type, and quality specified or as accepted by the Submittal.

2.02 FIELD QUALITY CONTROL, INSTALLATION, INSTRUCTIONAL, AND POST-STARTUP SERVICES

A. General

1. For the equipment furnished by the Contractor, provide Supplier representatives' onsite services during construction, installation, equipment startup, and the training of Metro's personnel for equipment or plant operation as specifically required in the Specification Section for the particular equipment or system.
2. Include and pay the costs for the Supplier's services.
3. The Workday for this Section's purpose does not include travel to or from the Site.
4. Specifications include minimum man-days to provide as a basis for bidding. If additional time is required to perform the services, the Contractor shall include that time in the Contract Price.

B. Installation Services

1. Where Specifications call for installation services, provide the material or equipment and the system Manufacturer's competent and experienced technical representative(s) to resolve assembly or installation procedures attributable to, or associated with, the equipment furnished.
2. After the equipment is installed, representatives shall perform the initial equipment and system adjustment and calibration to conform to the Specifications and Manufacturer's requirements and instructions.
3. Provide a Certificate of Installation Services stating that the proper adjustments have been made to the equipment or system, and that the equipment or system is ready for startup and system demonstration. Use Form 01 61 00-1 and furnish two copies to the Construction Manager.

C. Training

1. Do not start training until the Installation Services have been completed and accepted.
2. Review the data contents with personnel in full detail to explain aspects of operations and maintenance.

PART 3 - EXECUTION

NOT USED

PART 4 - FORMS

1. Form 01 61 00 - 1 Equipment Manufacturer's Certification of Installation Services

FORM 01 61 00 - 1

EQUIPMENT MANUFACTURER'S CERTIFICATION OF INSTALLATION SERVICES

Owner: Metro Water Services <FILL IN OWNERS NAME>

Project Name: <FILL IN DESCRIPTION>

Contract No.: <FILL IN CONTRACT NO.>

Project Nos.: <FILL IN PROJECT NO.>

Equipment Specification Section: _____

Equipment Description: _____

I, _____, Authorized representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____
(Print equipment name, model, and serial number.)

conforms to Contract requirements and is ready for permanent operation; and nothing in the installation shall render the Manufacturer's warranty null and void.

on

Date: _____ Time: _____

CERTIFIED BY: _____ Date: _____
(Signature of Manufacturer's Representative)

END OF SECTION

SECTION 01 61 16

WEB-BASED INFORMATION MANAGEMENT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. User Access Limitations
- D. Data ownership
- E. Computer Requirements
- F. System Use Requirements
- G. Internet Connectivity
- H. Program Management Information System (PMIS) Downtime
- I. Request for Information (RFI)
- J. Oracle Primavera Unifier®
- K. PMIS Use and Rollout
- L. Communications

1.02 RELATED SECTIONS

- A. Section 01 32 16/17 – Construction Progress Schedule <PROJECT SPECIFIC>
- B. Section 01 33 00 – Submittals

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. The Clean Water Nashville Overflow Abatement Program (Program or CWNOAP) has implemented a Program Management Information System (PMIS) for the electronic transmittal and storage for all construction documents. The system is owned and operated by Metro and is Oracle Primavera Unifier®. The Contractor shall use PMIS to electronically submit all of the data and documents required by the Contract Documents (unless specified otherwise by the Metro) to achieve the following:
 - 1. Facilitate exchanging information electronically
 - 2. Expedite the review process for submitted documents
 - 3. Centralize Project information

- B. Project communications shall be submitted and processed using PMIS and shall be the primary communication tool for all document transfers between the Construction Manager, the Engineer, and the Contractor.
- C. All documents that are required in a hard copy format shall be provided in accordance with the Contract Documents.
 - 1. PMIS shall be used to track and expedite the processing of these items.
 - 2. The submitted documents accepted via PMIS shall not relieve the Contractor from their responsibility for any variation from the Contract Document's requirements.
 - 3. If a discrepancy exists between the electronic version and the paper documents, the electronic documents shall govern.

1.04 USER ACCESS LIMITATIONS

- A. Metro shall establish, assign, and manage user access and access rights to the PMIS site. The Contractor shall be provided access rights for two people.
- B. Access to PMIS shall be provided to allow for submitting and processing documents, including, but not limited to, letters, shop drawings, submittals, meeting minutes, daily reports, drawings, specifications, memoranda, payment requisitions, change order requests, testing reports, warranties, guarantees, and correspondence. Requests for Information (RFIs) shall be directly entered into PMIS and generated by the application unless specified otherwise.
- C. Subcontractors and suppliers shall not have direct access to PMIS unless specified or approved otherwise by Metro. Entering information to be exchanged and transferred between the Contractor and subcontractors and suppliers shall be the Contractor's responsibility.

1.05 DATA OWNERSHIP

- A. All data entered into PMIS shall be Metro's sole property.

1.06 COMPUTER REQUIREMENTS

- A. PMIS is accessed via the internet through a web browser using Java run-time plug-in technologies. Provide computer hardware and software that meets the PMIS system requirements. The Program staff shall not operate, install, or troubleshoot any of the Contractor's hardware or software. The Contractor is solely responsible for their system's functionality.
- B. Should the PMIS version be upgraded during the Contract time, the Contractor shall not be required to upgrade their system(s) to meet the upgraded application's requirements unless the Contractor cannot access PMIS. Upgrading the Contractor's computer systems shall not be justification for a time and/or cost modification to the Contract.
- C. Metro shall accept no liabilities arising from the Contractor using PMIS.

1.07 SYSTEM USE REQUIREMENTS

- A. The Contractor shall be responsible for the validity of the information placed in PMIS and their personnel's ability to use the application.

- B. An overview of the setup and submittal processes associated with PMIS shall be presented to the Contractor. The Contractor is responsible for training their personnel in the use of PMIS.
- C. All costs associated with using the PMIS system shall be evenly distributed in the Project overheads; a separate added cost shall not be allowed.
- D. The Contractor shall notify the Construction Manager immediately about any users who no longer require PMIS access. Their user account shall be deactivated.
- E. The Contractor shall protect the PMIS system's security by limiting access to authorized users only and not allowing them to share usernames and passwords.
- F. The Contractor shall comply with the applicable laws and regulations regarding the electronic transmission of documents requiring the stamps or signatures of professional architects, professional engineers, geologists, and surveyors, including any provisions to provide of hard copies of such documents as appropriate.
- G. The Contractor, their representatives, users, sub-consultants, and subcontractors shall not enter, attach, or store sensitive personal information such as Social Security numbers in PMIS.
- H. Project Communications requiring an authorized person's signature shall use either of the following:
 - 1. An approved image of the official signature to be affixed to the document with the original signed hard copy/paper document to be provided as well
 - 2. An electronic copy or electronic image of a fully executed document containing the required signatures with the original signed hard copy/paper document to be provided as well

1.08 INTERNET CONNECTIVITY

- A. PMIS is a web-based environment subject to the Contractor's internet service provider's speed and connectivity issues. The Contractor is responsible for their own connectivity to the internet. PMIS' response time depends on the user's equipment, including processor speed, network interface equipment, internet service provider access speed, etc., and current traffic on the internet.
- B. Metro shall not be liable for any delays associated with the usage of PMIS, including, but not limited to, slow response time, down time periods, connectivity problems, or information loss on the Contractor's equipment.
- C. Under no circumstances shall using PMIS be grounds for a time extension or cost adjustment to the Contract.
- D. The Contractor shall have access to PMIS, and PMIS shall be operational on the Notice to Proceed date.

1.09 PMIS DOWN TIME

- A. If the PMIS system is temporarily unavailable, continue with Project Communications using an alternate secure electronic means (e-mail) or hard copies to transmit and receive Project communications.

- B. Maintain records for all Project communications during the PMIS down time and upload the records to PMIS when it is operational.
- C. Notify the Construction Manager by telephone and/or e-mail when PMIS is not functional.

1.10 REQUESTS FOR INFORMATION (RFI)

- A. Questions, including those for the Engineer during construction, shall be submitted to the Construction Manager via PMIS.
- B. RFIs shall be uploaded directly into PMIS. All attachments to RFIs shall be submitted in Portable Document Format (PDF) form.
- C. The minimum information to be provided within the RFI shall include, but not necessarily be limited to, the following:
 - 1. Contractor's name, address, telephone number, and contact name
 - 2. Project number and name
 - 3. Date
 - 4. Sequential RFI number as assigned by PMIS
 - 5. RFI subject
 - 6. Detailed description for request
 - 7. Applicable Specification Sections and/or Contract Drawings
- D. Responses to RFIs shall be provided within 14 days via PMIS.

PART 2 - PRODUCTS

2.01 ORACLE PRIMAVERA UNIFIER®

- A. Web-based electronic information management application as operated by CWNOAP for Metro

PART 3 - EXECUTION

3.01 PMIS USE AND ROLLOUT

- A. The Contractor shall meet with the Construction Manager within 10 days after the Contract is awarded to discuss the Contractor's use of PMIS.
- B. Prior to providing access to PMIS, a system overview shall be held. The overview shall include:
 - 1. User access requirements, information (name, position, e-mail address, and phone number)
 - 2. PMIS site location (URL) and log-on process

3. Navigation through PMIS
4. Uploading documents instructions
5. Submittal review process
6. RFI review process
7. Correspondence requirements

3.02 COMMUNICATIONS

- A. All official documents attached to PMIS shall be in one complete PDF electronic file. These official PDF document files shall include duly executed signatures as required by the Contract. Supporting source document files may also be attached when so required.
- B. The date that the Contractor enters a document into PMIS shall be recorded as the date received with the following exceptions:
 1. All Project communications submitted through PMIS after 3:30 p.m., local time, Monday through Friday, shall be acknowledged no earlier than the following regular business day.
 2. For Project communications purposes, business days and hours are defined as Monday through Friday, 8:00 a.m. to 3:30 p.m., local time, excluding Metro government holidays.

END OF SECTION

SECTION 01 66 10

DELIVERY, STORAGE AND HANDLING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Transportation and Delivery
- D. Hazardous Products
- E. Storage and Protection
- F. Records

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 14 14 – Control of Work
- C. Section 01 32 17/16 Construction Progress Schedule <PROJECT SPECIFIC >
- D. Section 01 33 00 – Submittals
- E. Division 02 – Division ## <PROJECT SPECIFIC>

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. This Section specifies the Contractor's general requirements for delivering, handling, storing, and protecting all items required to construct the Work. Specific requirements, if any, are specified with the related item.
- B. Contractor shall make all arrangements and provisions necessary for storing products. All excavated materials and construction equipment and materials and equipment to be incorporated into the Work shall be placed in such a way as to prevent injuring any part of the Work or existing facilities such that there shall be free access to all Work parts and all public utility installations in the Work's vicinity. Products shall be kept neatly and compactly stored in locations that cause minimum inconvenience to other contractors, public travel, adjoining owners, tenants, and occupants. Arrange storage in a manner to provide easy access for inspection.
- C. The Contractor will establish the minimum level of storage required by the individual equipment specifications, including, but not limited to, weather tight enclosures, heating, cooling, and humidity control. Facilities shall be equipped with suitable electric power supply, lighting, and security to meet the storage requirements.
- D. The Contractor shall be fully responsible for the loss or damage, including theft, of stored products.

1.04 TRANSPORTATION AND DELIVERY

- A. Transport and handle items in accordance with Manufacturer's printed instructions.
- B. Schedule delivery to reduce long-term onsite storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than two months prior to installation without a written authorization from the Construction Manager.
- C. Ship equipment, material, and spare parts complete except where partial disassembly is required by transportation regulations or to protect components.
- D. Pack spare parts in containers bearing labels clearly designating the contents and the equipment pieces for which intended.
- E. Deliver spare parts at same time as the pertaining equipment. Deliver spare parts to Metro after completing the Work.
- F. Coordinate the delivery with the installation to ensure a minimum holding time for items that are hazardous, flammable, easily damaged, or sensitive to deterioration.
- G. Deliver products to the site in the Manufacturer's original sealed containers or other packing systems, complete with the instructions for handling, storing, unpacking, protecting, and installing.
- H. Bearing housings, vents, ends of blower/pump/fan inlet and outlet pipes, and other types of openings shall be wrapped or otherwise sealed to prevent contamination by grit and dirt.
- I. All items delivered to the site shall be unloaded and placed in such a manner so as to not hamper the Contractor's normal construction operations or those of the subcontractors and other contractors and in such a manner so as to not interfere with the necessary traffic flow.
- J. Provide equipment and personnel to unload all items delivered to the site.
- K. Promptly inspect the shipment to ensure that the products comply with requirements; the quantities are correct; and the items are undamaged. For items furnished by others (i.e., Metro, other contractors), inspect them in the Construction Manager's presence. Notify the Construction Manager verbally and in writing about any problems.
- L. The Contractor shall pay all demurrage charges if items were not unloaded promptly.

1.05 HAZARDOUS PRODUCTS

- A. Prevent personnel, storage area, and Site contamination. Comply with the requirements in the Contract Documents, codes, and Manufacturer's instructions.

1.06 STORAGE AND PROTECTION

- A. Store and protect products and equipment in accordance with the Manufacturer's instructions and with seals and labels intact and legible. Storage instructions shall be studied by the Contractor and reviewed with the Construction Manager. Instructions shall be carefully followed, and a written record shall be kept by the Contractor for each product and piece of equipment.

- B. Arrange the product and equipment storage to permit access for inspection. Periodically inspect to ensure that the products and equipment are undamaged and properly maintained under specified conditions.
- C. Lawns, grass plots, parking lots, or other private property outside of the easements shall not be used for storage purposes without the written permission from the premise's owner.
- D. Provide protective maintenance during storage, including manually exercising the equipment, inspecting the mechanical surfaces for signs of corrosion or other damage, lubricating, applying any coatings as recommended by the equipment Manufacturer necessary for its protection, and utilizing all other precautions to ensure the proper protection for all of the equipment stored and for compliance with Manufacturers' requirements related to warranties. Log all protective maintenance for each equipment piece in the written record noted above.
1. Perform maintenance on stored material and equipment in accordance with Manufacturer's written instructions.
 - a. Submit a report for completed maintenance and covering conditions to the Construction Manager with each Application for Payment.
 - b. Failure to perform maintenance or to submit the maintenance report may result in the rejection of the material or equipment.
- E. Store loose granular materials on a solid flat surface in a well-drained area. Prevent mixing it with foreign matter.
- F. Store pipe materials and fittings to prevent foreign materials, excavation spoils and bedding materials, and dirty water in the inner spaces. Cover plastic pipe materials such as PVC to protect from UV deterioration if they will be stored longer than 30 days. Potable water pipe and fittings shall be kept free from environmental containments, including dirty water from runoff and animal entry. The Contractor shall comply with the CIPP liner Manufacturer's printed recommendations for delivery, storage, and handling of all liner products.
- G. Store CIPP liners and related materials out of direct sunlight and maintain at proper temperature to prevent freezing or reaction of catalyst.
- H. Receiving, storage and handling of resins shall conform to the Guideline for the Use and Handling of Styrenated Resins in Cured-in-Place Pipe by the National Association of Sewer Service Companies (NASSCO).
- I. Cement and lime shall be stored under a roof and off the ground and shall be kept completely dry at all times. All structural, miscellaneous, and reinforcing steel shall be stored off the ground or otherwise to prevent dirt or grease from accumulating and in a position to prevent standing water to accumulate and to minimize rusting. Beams shall be stored with the webs vertical. Precast concrete shall be handled and stored in a manner to prevent dirt, standing water, staining, chipping, or cracking to accumulate. Brick, block, and similar masonry products shall be handled and stored in manner to reduce breakage and keep cracking and spalling to a minimum.

- J. All mechanical and electrical equipment and instruments shall be covered with protective fabrics and stored in a weathertight building to prevent damage. The building may be a temporary structure on the Site or elsewhere, but it shall be satisfactory to the Construction Manager. The Building shall have adequate ventilation to prevent condensation. Maintain temperature and humidity within the Manufacturer's required range and in such a way as to prevent condensation on the stored equipment.
1. Keep equipment in the Manufacturer's original packaging crates to protect and preserve the equipment.
 2. All equipment shall be stored fully lubricated with oil, grease, and other lubricants unless otherwise instructed by the Manufacturer.
 3. Moving parts shall be rotated in accordance with Manufacturer's recommendations to ensure proper lubrication and to avoid metal-to-metal welding. Log all rotation maintenance for each piece of equipment in the written record noted above.
 4. Upon installing the equipment, the Contractor shall start the equipment in accordance with Manufacturer's recommendations to ensure that the equipment did not deteriorate from lack of use. Log all startups for each piece of equipment in the written record noted above.
 5. Lubricants shall be changed in accordance with Manufacturer's recommendations when installation has been completed, and thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.
 6. Prior to accepting the equipment, the Contractor shall have the Manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the storage period if it exceeded 3 months. Such certifications by the Manufacturer shall be deemed to mean that the equipment is judged by the Manufacturer to be in a condition equal to the equipment shipped, installed, tested, and accepted in a minimum time period. As such, the Manufacturer shall warrant the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. The equipment shall be removed and replaced at the Contractor's expense.

1.07 RECORDS

- A. Keep a running account for products in storage and maintenance to facilitate preparing the progress payments if the Contract provides payment for the products delivered but not yet installed (stored materials) in the Work.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 73 29

CUTTING, CORING AND PATCHING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. Quality Assurance
- D. Submittals
- E. Products, General
- F. Materials
- G. Execution, General
- H. Inspection
- I. Preparation
- J. Coring
- K. Cutting
- L. Patching
- M. Cleaning

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 14 14 – Control of Work
- C. Section 01 33 00 – Submittals
- D. Section 01 43 00 – Quality Requirements
- E. Section 01 50 00 – Temporary Site Facilities
- F. Section 01 92 00 – Maintenance of Facility Operations during Construction
- G. Division **02** - Division## <PROJECT SPECIFIC>

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. This Section provides the Contractor's responsibilities for cutting, coring, and patching all Work under construction, completed Work, and existing facilities to accommodate

coordinating the Work, installing other Work, uncovering Work for access, inspection or testing, or for similar purposes.

- B. Demolition Work is specified elsewhere.
- C. Execute all cutting and patching, including excavation, backfill and fitting, required to complete the following:
 - 1. Remove all existing constructions required to provide for specified alteration to existing or future Work.
 - 2. Uncover Work to allow the Construction Manager to observe the covered Work or to provide an opportunity for observation by any regulatory agencies having jurisdiction.
 - 3. Remove or relocate existing utilities and pipes obstructing the Work in locations where connections must be made.
 - 4. Make connections or alterations to existing or new facilities.

1.04 QUALITY ASSURANCE

- A. Comply with Section 01 43 00, Quality Requirements.
- B. Structural Work. Do not cut or patch the structural elements in a manner that could change their load-carrying capacity or load deflection ratio.
- C. Operating Elements. Do not cut or patch operating elements in a manner that would result in reducing their capacity to perform as intended. Do not cut or patch operating elements in such a manner that would result in increased maintenance or decreased operation life or safety.
- D. Restore all existing Work to a state equal to what exists prior to cutting and restore new Work to the standards of the Contract Documents.

1.05 SUBMITTALS

- A. Prior to cutting, submit written notice to the Construction Manager requesting approval. Include the following information:
 - 1. Project identification
 - 2. Description for the Contractor's affected Work and the Work of others
 - 3. Necessity for cutting
 - 4. Effect on other Work and on structural integrity
 - 5. A description for proposed Work designating the following:
 - a. Scope for cutting and patching
 - b. Contractor, subcontractor, or trade to execute the Work
 - c. Proposed products to be used
 - d. Extent for refinishing

- e. Operations schedule
- 6. Alternatives to cutting and patching, if any
- 7. Designated party responsible for cutting and patching
- B. Should the Work conditions or schedule indicate changing materials or methods, submit written recommendation to Metro, including:
 - 1. Conditions indicating change
 - 2. Recommendations for alternative materials or methods
 - 3. Submittals, as required, for substitutions
- C. Submit a written notice to the Construction Manager designating a time that the Work will be uncovered to provide for observation. Do not begin cutting or patching operations until authorized by the Construction Manager.
- D. Where cutting and patching involves adding reinforcement to structural elements, submit details and engineering calculations to show how reinforcement is integrated with the original structure.
- E. Provide shoring, bracing, and support as required to maintain the Project's structural integrity and protect adjacent areas from damage during cutting and patching.
- F. Conform to all applicable Specifications for applying and installing materials used for patching.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Use materials identical to existing materials.
- B. For exposed surfaces, use materials that visually match the existing adjacent surfaces to the fullest extent possible.
- C. If identical materials are unavailable or cannot be used, use materials whose installed performance shall equal or surpass that of the existing materials.

2.02 MATERIALS

- A. Concrete repair mortar shall be a non-shrink, commercial formula requiring only adding water that will allow the concrete mortar to have a 5,000 psi minimum 28-day compressive strength.
- B. Provide a non-shrink cementitious repair mortar material as manufactured by the following:
 - 1. Sika Repair 224 manufactured by Sika Corp.
 - 2. EMACO S88CI manufactured by Master Builder, Inc.
 - 3. Underlayment F-120 by Sauereisen, Inc.

4. Or acceptable equivalent product

PART 3 - EXECUTION

3.01 GENERAL

- A. Perform all cutting and coring in such a manner as to limit the extent of patching.
- B. Core drill all holes to be cut through concrete and masonry walls, slabs, or arches unless otherwise approved.

3.02 INSPECTION

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed before cutting.
- B. Report, in writing, unsatisfactory or questionable conditions to the Construction Manager. Do not proceed with the Work until the Construction Manager has provided instructions.
- C. Before proceeding, the Contractor shall meet at the site with all subcontractors involved in cutting and patching, including the Construction Manager and any affected subcontractors. The potential interferences and conflict areas shall be reviewed prior to proceeding with the Work.

3.03 PREPARATION

- A. Provide shoring, bracing, and temporary support, as required, to maintain the Project's structural integrity to protect adjacent areas from damage during cutting and to support the Work to be cut.
- B. Protect the existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for the portions of the Project that will be exposed during the cutting and patching operations.
 1. Avoid interference with adjoining area use or interrupting free passage to adjoining areas.
 2. Do not cut existing pipe, conduit, or ductwork that are scheduled to be removed or relocated and are serving facilities, until provisions have been made to bypass these existing pipe, conduit, or ductwork.

3.04 CORING

- A. Perform coring with a non-impact rotary tool using diamond core drills. Size holes for pipe, conduit, sleeves, equipment, or mechanical seals, as required.
- B. Protect the existing equipment, utilities, and adjacent areas from water and other damage caused by drilling operations.
- C. Vacuum or otherwise remove slurry or tailings from the Work area following drilling.

3.05 CUTTING

- A. Cut existing construction using methods that are the least likely to damage the retained elements or adjoining construction and provide proper surfaces to receive the installation or repair.
 - 1. In general, use hand or small power tools designed for sawing or grinding and not hammering and chopping.
 - 2. Cut through concrete and masonry using a concrete wall saw with diamond saw blades.
 - 3. Provide for controlling slurry generated by sawing on both sides of walls.
- B. Cut holes and slots neatly and as small as possible to the required size causing minimum disturbance to adjacent surfaces. Provide temporary covering over openings when not in use.
- C. To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into the concealed side.
- D. Provide adequate bracing for the area to be cut prior to beginning cutting.
- E. Provide adequately sized equipment to remove the cut panel.

3.06 PATCHING

- A. Patch construction by filling, repairing, refinishing, closing-up, and similar operations following other Work performance. Patch with durable seams that are as invisible as possible. Provide materials and comply with the installation requirements as specified in other Specification Sections.
- B. Where feasible, test patched areas to demonstrate the installation's integrity.
- C. Fit Work airtight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces. Maintain the existing fire rating of wall penetrations by use of appropriately rated sealants.
- D. Restore exposed finishes for patched areas and extend finish restoration into retained adjoining construction in a manner that shall eliminate evidence of patching and refinishing.
 - 1. For continuous surfaces, refinish to the nearest intersection.
 - 2. For an assembly, refinish the entire unit.

3.07 CLEANING

- A. Clean the areas and spaces where cutting, coring and patching are performed.
- B. Clean the piping, conduit, or similar constructions before applying paint or other finishing materials.
- C. Restore any damaged pipe covering to its original condition.

END OF SECTION

SECTION 01 77 00
CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Definitions
- C. Contractor's Responsibilities
- D. Contract Closeout Sequence of Events

1.02 RELATED SECTIONS

- A. Division 01 – Division ## <PROJECT SPECIFIC>

1.03 DEFINITIONS

- A. Contract closeout is the process that commences as the work nears Substantial Completion. It continues through Substantial Completion and Final Completion of the Work.
- B. This Specification Section defines the overall change over process from construction (by the Contractor) to the Correction Period.

1.04 CONTRACTOR'S RESPONSIBILITIES

- A. As construction of the project enters the final stages of completion, the Contractor shall, in accordance with accomplishing the requirements set forth in the Contract Documents, attend to or have already completed the following items as they apply to the Contract:
 - 1. Scheduling equipment manufacturers' visits to site
 - 2. Required testing of project components
 - 3. Scheduling training sessions for plant personnel by equipment manufacturers
 - 4. Scheduling startup and initial operation
 - 5. Scheduling and furnishing Metro approved personnel during initial operation
 - 6. Correcting or replacing defective work, including completion of items previously overlooked or work which remains incomplete, all as evidenced by Metro's "Punch Lists"
 - 7. Attend to any other items listed herein or brought to the Contractor's attention by the Construction Manager and Metro

1.05 CONTRACT CLOSEOUT SEQUENCE OF EVENTS <PROJECT SPECIFIC>

- A. The sequence of events and their description listed below represent the suggested order of activities as the contract proceeds from “Work Required Prior To Requesting Substantial Completion” through “Substantial Completion,” “Warranty Period,” “Correction Period,” and “Final Completion.” Adjustments may be made, after approval by Metro for the mutual benefit of the Contractor and Metro, if the situation so warrants. Any adjustment made in the sequence of events, to accommodate the Contractor, shall be at no additional cost to Metro.
- B. Work Required Prior To Requesting Substantial Completion. The Contractor shall perform the following prior to requesting issuance of a Certificate of Substantial Completion. Requirements include, but are not limited to, the following:
1. Complete all Work for each Contract Milestone in accordance with the Contract Documents.
 2. Submit acceptable *Operations and Maintenance Manual* information as required by Section 01 78 23 - Operation and Maintenance Data (Manual) and in Divisions 02- ##.
 3. Complete training in accordance with Section 01 78 24, Training and in Divisions 02- ##.
 4. Complete start-up and performance testing in accordance with the approved plans for individual items of equipment and systems for which turnover is intended. Submit acceptable test reports and other test documentation as required by the Contract Documents.
 5. Turn over all spare parts.
 6. Provide specified startup material and operating supplies as specified in Divisions ## – ##.
 7. Provide copies of all Certificates or approvals, including the Fire Marshall approvals required by jurisdictions having authority for Occupancy, Use, or Operation as appropriate or required by the Contract Documents and as required in the Contract Purchase Agreement (Contract Terms and Conditions). <PROJECT SPECIFIC>
 8. Submit proof of warranties required in Divisions 02-##. <PROJECT SPECIFIC>
 9. Submit proof of maintenance according to the manufacturer’s and industry standard requirements for all stored and installed materials.
 10. Perform cleanup as required below. <SAMPLE - PROJECT SPECIFIC>
 - a. Clean interior and exterior glass and surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
 - b. Clean equipment and fixtures by removing temporary labels, stains, dirt, and other foreign substances.
 - c. Clean permanent filters or replace, disposable filters of operating equipment.
 - d. Clean debris from galleries, pipes, roofs, gutters, basins, pump wet wells, down spouts, tanks, drainage systems, and HVAC ducting.

- e. Clean site; sweep paved areas, rake clean unpaved surfaces.
 - f. Remove waste and surplus materials, rubbish, construction fencing, equipment, temporary utilities, and construction facilities from the site.
11. Return all temporary water meters and backflow preventer assemblies checked out from Metro Water Services for rehabilitation and conveyance projects for usage readings and subsequent return to inventory. Submit documentation of the return of these items to the Construction Manager.

C. Substantial Completion

1. Substantial Completion is defined in Article 9(B) of the Contract Purchase Agreement (Contract Terms and Conditions).
2. Refer to Article 9(B) of the Contract Purchase Agreement (Contract Terms and Conditions) for minimum requirements and other stated milestones and specific requirements in the Contract Documents to obtain Certificate of Substantial Completion.
3. The Construction Manager will provide a punch list of items to be completed or corrected prior to final payment.

D. One Year Correction Period

1. If, within one year after the date of Substantial Completion (or such longer period of time as may be prescribed by Laws or Regulations or by the terms of any applicable special guarantee required by the Contract Documents) or by any specific provision of the Contract Documents, any Work is found to be defective, or if the repair of any damages to the land or areas made available for Contractor's use by Metro or permitted by Laws and Regulations is found to be defective, Contractor shall within fifteen (15) days after notice from and without cost to Metro, and in accordance with Metro's written instructions:
 - a. Repair such defective land or areas, or
 - b. Correct such defective Work, or
 - c. If the defective Work has been rejected by Metro, remove it from the Project and replace it with Work that is not defective, and
 - d. Satisfactorily correct or repair or remove and replace any damage to other Work, to the work of others or other land or areas resulting therefrom.
2. If the Contractor does not promptly comply with the terms of the Metro's written instructions, or in an emergency where delay would cause serious risk of loss or damage, Metro may have the defective Work corrected or repaired or may have the rejected Work removed and replaced. All claims costs, losses, and damages (including, but not limited to, fees and charges of engineers, architects, attorneys and other professionals and all court or other dispute resolution costs) arising out of or relating to such correction or repair or such removal and replacement (including, but not limited to, all costs of repair or replacement of work of others) will be paid by Contractor.
3. In special circumstances where a particular item of equipment is placed in continuous service before Substantial Completion of all the Work, the correction period for that item may start to run from an earlier date if so provided in the Specifications.

4. Where defective Work (and damage to other Work resulting therefrom) has been corrected or removed and replaced under this Paragraph, the correction period hereunder with respect to such Work will be extended for an additional period of one year after such correction or removal and replacement has been satisfactorily completed.
5. The Contractor's obligations under this Section are in addition to other obligations or warranties. The provisions of this Section shall not be construed as a substitute for or a waiver of the provisions of any applicable statute of limitation or repose.
6. The Construction Manager with Metro and the Engineer may conduct a review of the project site approximately 1 month prior to the expiration of the 1-year correction period to ascertain if issues, restoration, work, or installed equipment and instrumentation provided under the Contract need corrective action by the Contractor. The Contractor may be given notice of the review, and the Contractor's participation is non-mandatory.

E. Final Completion

1. Final Completion is defined in Article 9(B) of the Contract Purchase Agreement (Contract Terms and Conditions).
2. The contract time for Final Completion shall commence on the date of Substantial Completion as determined by the Construction Manager.
3. For rehabilitation projects, up to twenty-one (21) days of the contract time is allocated for use by MWS and the Construction Manager to conduct onsite project inspections and reviews, to process post-rehabilitation CCTV data, and to compile and issue the project punch lists for Contractor completion or correction. The Contractor shall incorporate and schedule this allocated time accordingly.
4. The Contractor shall submit the Final Contractor's Payment Request in accordance with Article 9(B) of the Contract Purchase Agreement (Contract Terms and Conditions).

F. Warranties

1. The equipment and appurtenances furnished under this Contract shall be guaranteed to be free from defects in workmanship, design, and/or materials for a period of one (1) year unless otherwise specified in the individual equipment Specifications. The period of such warranties shall start on the date of Substantial Completion or partial utilization where allowed by the Construction Manager provided that the equipment demonstrates satisfactory performance during the thirty-day operational period after the equipment startup. If the equipment does not perform satisfactorily during the thirty-day operational period, the start of the warranty period shall be delayed until the equipment demonstrates proper operation. The Equipment Supplier shall repair or replace without charge to Metro any part of equipment which is defective or showing undue wear within the guarantee period or replace the equipment with new equipment if the mechanical performance is unsatisfactory by furnishing all parts, materials, labor, etc., necessary to return the equipment to its specified performance level.
2. The Contractor shall provide an equipment warranty log book prepared specifically for this project and submit two (2) copies of the document to the Construction Manager prior to final payment as specified herein. The equipment warranty log book shall include a summary listing of all equipment warranties provided, date received, and start date and end date of warranty period. A copy of each equipment warranty and equipment start-up certification shall also be provided in the document.

3. The Equipment Supplier shall guarantee to Metro that all equipment offered under these Specifications or that any process resulting from the use of such equipment in the manner stated is not the subject of patent litigation and that they have not knowingly offered equipment, the installation or use of which is likely to result in a patent controversy, in which Metro, as user, is likely to be made the defendant.
4. Where patent infringements are likely to occur, each Equipment Supplier shall submit, as a part of their bid, license arrangements between themselves or the Manufacturer of the equipment offered and the patent owner or the controller of the patent which will permit the use in the specified manner of such mechanical equipment as they may be bidding.
5. Each Equipment Supplier, by submitting their bid, agrees to hold and save Metro, the Construction Manager, and Engineer or its officers, agents, servants, and employees harmless from liability of any nature or kind, including cost and expenses for or on account of, any patented or unpatented invention, process, article, or appliance manufactured or used in the performance of the work under this contract, including the use of the same by Metro.
6. Provide an electronic and one hard copy of the warranties and bonds required in the Contract Documents. Execute and assemble documents from subcontractors, suppliers, and manufacturers.
7. Execute and assemble documents from subcontractors, suppliers, and Manufacturers.
8. Bind the warranties and bonds in commercial quality 8 ½ x 11-inch three-ring side binders with hardback cleanable plastic covers.
 - a. Label the cover of each binder with a typed or printed title "Warranties and Bonds" with title of the Project; the name, address, and telephone numbers of Contractor; and the name of responsible principal.
 - b. Table of Contents. Each binder should contain a Table of Contents that is neatly typed in the sequence of the Table of Contents of the Project Specifications with each item identified with the number and title of the Specification Section in which it is specified and the name of the product or work item.
9. Separate each warranty or bond with index tab sheets keyed to the Table of Contents listing.
10. List the subcontractor, supplier, and Manufacturer with the appropriate names, addresses, and telephone numbers of the responsible principal.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01 78 23

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Description
- C. Definitions
- D. Submittals
- E. Format - Hardcopy
- F. Format - Electronic Documentation
- G. Quality Assurance
- H. General Content of Data
- I. Specific Data for Each Item of Equipment and/or System
- J. Manual for Materials and Finishes
- K. Assembly
- L. Form 01 78 23 - 1, Equipment Table for Operation and Maintenance Data

1.02 RELATED SECTIONS

- A. Section 01 11 00 - Summary of Work
- B. Section 01 33 00 - Submittals
- C. Section 01 43 00 - Quality Requirements
- D. Section 01 61 16 - Web Based Information Management
- E. **Division ## - Division ## <APPLICABLE TECHNICAL SECTIONS - PROJECT SPECIFIC>**

1.03 DESCRIPTION

- A. This Section includes the procedural requirements for providing, compiling, and submitting the operation and maintenance data required for this project.
- B. The Section also includes the administrative and procedural requirements for preparing *Operation and Maintenance Manuals*, including the following:
 - 1. General contents of data

2. Specific data for each equipment and system
3. Manual for materials and finishes
4. Assembly

1.04 DEFINITIONS

- A. **System.** An organized collection of parts, equipment, or subsystems united by regular interaction
- B. **Subsystem.** A portion of a system with characteristics similar to a system

1.05 SUBMITTALS

- A. *Initial O&M Manual.* The Contractor will submit a draft copy of each manual as required in the Specification Sections. The Construction Manager will comment regarding whether or not the general scope and content of the manual are acceptable.
- B. *O&M Manual Contents.* *Operations and Maintenance Manual* submittal requirements are specified in individual Specification Sections for the Products for which they must be supplied. The Contractor will submit a manual that includes the required content that has been formatted and organized in accordance with this Section.
 1. The Construction Manager will comment regarding whether or not the content of the operations and maintenance submittals are acceptable.
 2. Where applicable, the Contractor will clarify and update the reviewed initial manual content to correspond to revisions and field conditions.
- C. *Pre-final O&M Manual Submittal*
 1. The Contractor will submit 2 copies of each manual in final form prior to requesting inspection for Substantial Completion
 2. The Construction Manager will return one copy with comments.
 3. The Contractor will correct or revise each pre-final manual to comply with the Construction Manager's comments.
- D. *Final O&M Manual.* The Contractor will submit four (4) copies of each corrected manual as a final manual within 15 days of the receipt of the Construction Manager's comments and prior to commencing startup, commissioning, and/or training.
- E. After acceptance, the Contractor will deliver one electronic copy to the Construction Manager.

1.06 FORMAT - HARDCOPY

- A. The Contractor will prepare data in the form of an instructional *O&M Manual*.
- B. **Binders.** The Contractor will bind the hardcopy in commercial quality, 8 ½ x 11-inch three-hole post type binders with hardback, 3-inch maximum binder size. When multiple binders are used, the data will be correlated into related consistent groupings. Three ring binders are not acceptable.

- C. The Contractor will arrange the Table of Contents and manual in sequential order by Specification Section numbers.
- D. The Contractor will provide a tabbed flyleaf for each separate product and system that contains a printed description of the product and the major component parts of the equipment. Insert type tab labels must be secured or bonded to prevent the labels from falling out.
- E. Text. The text must be the Manufacturer's printed data or typewritten on 20-pound paper.
- F. Drawings. The Drawings will be bound in a reinforced punched binder tab. The drawings will be bound in with text with the larger folded drawings to the size of text pages and inserted into clear plastic envelopes that are secured into the three-hole post binders.

1.07 FORMAT - ELECTRONIC DOCUMENTATION

- A. The Contractor must provide *Operation and Maintenance Manual* information specific to the configuration of the project in electronic form. Documents should be formatted like a web site complete with index page and Table of Contents. The electronic format must be such that Metro is able to load the files onto a server to provide online access via any standard web browser. The Contractor shall use PDF file formats. The complete document shall be provided to the Construction Manager on an electronic storage device (flash drive) and in PMIS.
- B. The electronic O&M data must be organized in a logical manner to aid operation in troubleshooting and information retrieval.

1.08 QUALITY ASSURANCE

- A. Preparation of data shall be performed by personnel who have the following qualifications:
 - 1. Trained and experienced in the O&M of described equipment
 - 2. Familiar with requirements of this Section
 - 3. Skilled as technical writers to the extent required to communicate the essential data to the Reader
 - 4. Skilled as drafters competent to prepare any required drawings

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 GENERAL CONTENTS OF DATA

- A. Each individual manual shall contain equipment data pertaining to not more than one Specification Section number as indicated in the Contract Documents.

- B. Title Sheet. The title sheet is the first page in the manual and contains the following information:
1. Title. The title shall be listed as “OPERATION AND MAINTENANCE INSTRUCTIONS.”
 2. Title and Metro Project Number as shown on the Contract Documents
 3. Name(s) of applicable building(s) or structure(s) in which equipment is located
 4. Name of equipment as described in the Contract Documents
 5. Contractor’s name, address, and telephone number
 6. Subcontractor’s name, address, and telephone number if the equipment is provided by Subcontractor
 7. Contractors or Subcontractor’s purchase order number, Manufacturer’s shop order number or other such numbers required for parts and service ordering
 8. Manufacturer’s name, address, and telephone number
 9. Name, address, and telephone number for the local source of supply for parts and service
- C. Equipment List. The Equipment List is placed after the Title Sheet. The sections following the Equipment List are:
1. Table of Contents. Arrange in logical, systematic order, each page shall be numbered and shall include as minimum:
 2. Tabbed Dividers. Insert tabbed section dividers between each major section.
 - a. Provide the title of the section on each tab.
 - b. Provide a Table of Contents for each tabbed section, arranged in systematic order.
 3. Equipment Data Sheets. Provide catalog sheets showing the configuration, Manufacturer’s specifications, models, options, styles of equipment, and major components being provided. Product data sheets will show project- specific information with the inapplicable information deleted by crossing out or removal.
 4. Text
 - a. Include only those sheets applicable to the Project.
 - b. Each sheet shall
 - 1) Identify the specific equipment or part installed
 - 2) Identify the text applicable to the equipment or part installed
 - 3) Do not include inapplicable information or neatly strike it out

5. Drawings

a. Supplement text with drawings to clearly illustrate the following

- 1) Equipment and components
- 2) Relationships of component parts of equipment and systems
- 3) Control and flow diagrams

b. Actual drawings of equipment from Manufacturer. "Typical" drawings are not acceptable unless they accurately illustrate actual installation for this contract.

6. Specially written information, as required to supplement text for particular installation

- a. Provide an explanation of the interrelationships of the equipment and components and the effects that one component has on another or entire system
- b. Provide overall instructions and procedures for tying in equipment components into a unified system.
- c. Provide a glossary of any special terms used by the Manufacturer when applicable
- d. Organize the information in a consistent format under separate headings for different O&M procedures
- e. Provide a logical sequence of instructions in order of O&M action required for each procedure

3.02 SPECIFIC DATA FOR EACH ITEM OF EQUIPMENT AND/OR SYSTEM

A. For each item of equipment and system include

1. A description of equipment and component parts

- a. Function
- b. Normal operating characteristics
- c. Limiting conditions
- d. Performance curves
- e. Engineering data
- f. Applicable Tests for the equipment and/or system information provided
- g. The complete nomenclature and model number of replaceable parts, including a keyed, labeled, exploded diagram
- h. The complete nameplate data
- i. Metro's tag (or asset) numbers for equipment as indicated on the Contract Drawings

2. The Operating Procedures
 - a. Startup and break-in
 - b. Normal operating instructions
 - c. Regulation and control
 - d. Stopping and shutdown
 - e. Emergency instructions
 - f. Summer and winter operating instructions, as applicable
 - g. Special operating instructions
3. The Maintenance Procedures
 - a. Routine maintenance operations
 - b. Guide to troubleshooting
 - c. Disassembly, repair, and reassembly instructions
 - d. Alignment, adjusting, and checking instructions
4. Servicing and Lubrication Schedule
 - a. List of lubricants required and quantity to be applied
 - b. Schedule of lubrication
 - c. Schedule for other routine maintenance
5. Manufacturer's printed instructions regarding safety precautions for both (a) protection of personnel operating equipment and systems and (b) prevention of damage to equipment and systems
6. Description of sequence of operation of controls
7. Assembly drawings and diagrams required for maintenance
8. Manufacturer's parts list and illustrations
 - a. Predicted life of parts subject to wear
 - b. Quantities of items recommended to be stocked by Metro as spare parts
9. Accepted control diagrams such as ladder diagrams, instrumentation loop diagrams, and electrical schematics
10. Bill of material
11. Other data as required under applicable Specification Sections

B. Each electric and electronic system as applicable to equipment such as switchgear, motor control centers, panel boards, switchboards, starters, breakers, and relays shall include the following:

1. Description of System and Component Parts
 - a. Function
 - b. Normal operating characteristics
 - c. Limiting conditions
 - d. Performance curves
 - e. Engineering data
 - f. Rating tables
 - g. Tests, as applicable
 - h. Complete nomenclature and model number of replaceable parts
 - i. Complete nameplate data
 - j. Metro's Tag (asset) numbers for equipment as indicated on the Contract Drawings
2. Circuit Directories of Panel Boards
 - a. Electrical service
 - b. Controls
 - c. Communications
3. Complete instrumentation
 - a. Loop diagrams
 - b. Tabulated listing of components in each control circuit or loop
4. Operating Procedures
 - a. Routine and normal operating instructions
 - b. Sequences required
 - c. Special operating instructions
5. Maintenance Procedures
 - a. Routine maintenance operations
 - b. Guide to troubleshooting
 - c. Disassembly, repair, and reassembly instructions

- d. Adjustment and checking instructions
 6. Manufacturer's printed instructions regarding safety precautions for both of the following:
 - a. Protection of personnel operating equipment and systems
 - b. Prevention of damage to equipment and systems
 7. List of original Manufacturer's components, spare parts with diagram, and recommended quantities to be maintained in storage by Metro
 8. Other data as required under pertinent Sections of the Specifications
- C. Prepare and include additional data when the need for such data becomes apparent or per the request of Metro personnel. Differences between the equipment *O&M Manual* and the Manufacturer's training session shall result in the training and/or *O&M Manual* being corrected.

3.03 MANUAL FOR MATERIALS AND FINISHES

- A. Building Products, Applied Materials, and Finishes. Include product data, with catalog number, size, composition, and color and texture designations. Provide information for re-ordering custom manufactured products.
- B. Instructions for Care and Maintenance. Include Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.
- C. Moisture Protection and Weather Exposed Products. Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- D. Additional Requirements as specified in the individual product specification Sections.
- E. Provide a listing in the Table of Contents for design data behind a tabbed fly sheet and leave space for insertion of data

3.04 ASSEMBLY

- A. Assemble in sets
- B. Remove the bindings of individual manuals
- C. Insert index tabs labeled with the respective pieces of equipment to separate individual manuals
- D. Provide a Table of Contents at the front of each volume showing the equipment items in the order in which they appear in the volume. Each equipment item shall include the functional name, applicable Specifications Section, and the plan listing, if any.
- E. The preventive maintenance schedule shall be bound in the front of each section immediately following the index tab sheet. The schedule shall be identified with respect to the piece of equipment to which it refers.

- F. Sheet Size. 8-1/2 x 11-inch sheets
- G. Drawings may be on 11 x 17-inch sheets folded to 8 ½ x 11 inches.
- H. Engrave the following on the covers and the end of the binder:
 - 1. Title – “OPERATIONS AND MAINTENANCE INSTRUCTIONS”
 - 2. Name of Project
 - 3. Metro’s project number and OAP project number
 - 4. Date of Contract
 - 5. Volume number
 - 6. Design Engineer’s name

PART 4 - FORMS

- 1. Form 01 78 23 -1 Equipment Table for Operation and Maintenance Data

FOR INFORMATION ONLY

FORM 01 78 23 -1		
EQUIPMENT TABLE FOR OPERATION AND MAINTENANCE DATA		
NAME OF EQUIPMENT	PERTINENT TECHNICAL SPECIFICATION DIVISION & SECTION NO.	O&M DATA REQUIREMENTS

END OF SECTION

FOR INFORMATION ONLY

SECTION 01 78 24

TRAINING

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Description
- C. Submittals
- D. Pre-instruction Conference
- E. Coordination
- F. *Instructor Manual*
- G. Facilities for Training
- H. Schedule
- I. Preparation
- J. Instruction
- K. Training Content
- L. Field Quality Control
- M. Training Documentation
- N. Form 01 78 24 – 1, Equipment Manufacturer’s Certificate of Instruction
- O. Form 01 78 24 – 2, Metro's Acknowledgment of Manufacturer's Instruction

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 33 00 – Submittals
- C. Section 01 61 16 – Web Based Information Management
- D. Section 01 78 23 – Operation and Maintenance Data
- E. Division 02 – Division ## <PROJECT SPECIFIC INSERT APPLICABLE SECTIONS>

1.02 DESCRIPTION

- A. This Section includes the administrative and procedural requirements for instructing Metro’s personnel about the operational and maintenance procedures for new equipment and systems.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00, Submittals:

1. Working jointly with the Engineer, the Contractor will lead the development of the outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module. Submit two copies (one electronic copy and one hard copy) of the outline.
 - a. Indicate proposed training modules using Manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of the live instructional module.
 - b. Submit a draft training outline for review. Outline will be reviewed and comments returned to the Contractor.
 - c. Submit final training course outline incorporating review comments for review. After the final course outline is accepted, submit student notes and instructor guides for review.
2. Qualification Data for Instructor. It is Metro's intent to have a live instructor to present all training. Submit resumes of a factory-authorized service representative experienced in the operation and maintenance procedures and in providing training for the products and systems installed under this Contract. Metro shall have right of refusal of any instructor that is not factory-authorized service representative.
3. Within 7 days after the completion of each training module, submit a list of participants and the length of instruction time.
4. Submit electronic copies of each training module within seven calendar days following the delivery of each training module.
 - a. On each copy, provide an applied label with the following information:
 - 1) Name and Number of Project
 - 2) Training Session Name
 - 3) Name and address of videographer
 - 4) Name of Engineer
 - 5) Name of Construction Manager
 - 6) Name of Contractor
 - 7) Date of video recording
 - b. The modules must be prepared in format matching the *Operation and Maintenance Manuals*. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include the name of the Project and the date of the video recording on each page.

- c. The modules must be prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include the name of the Project and the date of video recording on each page.
- d. Provide hard copies of the training materials and handouts for all participants in the training session.
- e. At the completion of training, submit the complete training manual(s) for Metro's use in both hardcopy and electronic format. Hard copies should be in a format matching the *Operation and Maintenance Manuals* and in PDF electronic file format on compact disc or electronic storage media (flash drive).

1.04 PRE-INSTRUCTION CONFERENCE

- A. Conduct the conference at the Project site to review methods and procedures related to the demonstration and training. The participants in this Pre-instruction Conference shall include the Contractor, Construction Manager, Engineer, and the Contractor's Training Coordinator.
- B. The topics at the conference will include, but not be limited to, the following:
 - 1. Inspect and discuss classroom locations and other facilities required for instruction.
 - 2. Review and finalize the instruction schedule and verify the availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed in order to deliver the scheduled training in a timely manner.
 - 3. Review required content of instruction.
 - 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.05 COORDINATION

- A. Working together with the Engineer, the Contractor will coordinate instruction schedule with Metro's operations through the Construction Manager. Adjust the schedule as required to minimize disrupting Metro's operations and to ensure the availability of the Metro's personnel.
- B. The Contractor will coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Working together with the Engineer, the Contractor will coordinate the content of the training modules with the content of the accepted emergency and *Operation and Maintenance Manuals*. Do not submit instruction program(s) for review until the operation and maintenance data required under Section 01 78 23, Operation and Maintenance Data has been reviewed and accepted by the Construction Manager.

PART 2 - PRODUCTS

2.01 INSTRUCTOR MANUAL

- A. The Contractor shall prepare an *Instructor Manual* that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanical

specialists and instrument technicians, or other disciplines, depending upon the target audience.

- B. The *Instructor Manual* shall be consistent with the nomenclature and contents of the accepted Contractor's *O&M Manuals* required in Specification Section 01 78 23, Operation and Maintenance Data. The *O&M Manuals* cannot be substituted for the *Instructor Manual*.
- C. The purpose of the *Instructor Manual* is to define the concepts and information that will be taught to each target audience and to describe the methods and materials to be used during the training. The *Instructor Manual* is designed to provide specific guidance to the Instructor regarding all aspects of the training program.
- D. The *Instructor Manual* shall include:
 - 1. Description of the equipment
 - 2. Parts and equipment graphics
 - 3. Safety procedures
 - 4. Startup checks and procedures
 - 5. Overview of routine operation, including startup and shutdown and operating parameters
 - 6. Routine, preventive, and corrective maintenance procedures
 - 7. Lubrication (schedule and type)
 - 8. Assembly and disassembly procedures
 - 9. Troubleshooting procedures
 - 10. Parts list
 - 11. Special maintenance practices
 - 12. Emergency shutdown
- E. All manuals shall be presented in electronic format per the requirements of Specification Section 01 33 00. Submittals.
- F. Each *Instructor Manual* shall contain:
 - 1. *Instructor Manual* cover page
 - 2. *Instructor Manual* table of contents
 - 3. Lesson Plan which shall include:
 - a. Lesson Plan cover page
 - b. Lesson Plan summary

- c. Lesson Plan text, including:
- 1) Identity of the target audience (a separate Lesson Plan is required for each target audience, such as mechanical O&M personnel, electronic/electrical O&M personnel, etc.)
 - 2) Length of the training program and each topic to be covered
 - 3) Performance and/or training objectives
 - 4) Outline of the material to be covered
 - 5) Training strategies to be used and interaction with the trainees
 - 6) Audio visual and/or support materials required and when used or referred to during instruction
 - 7) A list of resource and/or reference materials
4. A copy of all training aids, including electronic files
5. A copy of trainee materials (handouts, reference materials, etc.) in electronic format
- G. Co-ordinating with the Engineer, the Contractor shall submit the equipment Manufacturer's lesson plans for acceptance by the Engineer no less than ninety (90) days prior to the date that the training is to take place and in accordance with Paragraph 2.01.B.
- H. With the exception of cutaway models or other items expressly exempted by the Engineer, all training aids and trainee materials contained in the *Instructor Manual* or used in the delivery of training shall become the property of Metro and may be duplicated by Metro for its own use.
- I. The Contractor shall provide required acceptance and/or copyright releases obtained from those who own proprietary and/or copyrighted materials provided by the Contractor so that the materials can be reproduced by Metro.
- J. The Contractor shall provide *Instructor Manuals* bound in 3-hole D-ring binders.
- K. Training Modules
1. Develop a learning objective and teaching outline for each module. Include a description of the specific skills and knowledge that each participant is expected to master.
 2. For each module, include instructions for the following as applicable to the system, equipment, or component.
 - a. Basis of System Design, Operational Requirements, and Criteria. Include the following items:
 - 1) System, subsystem, and equipment descriptions
 - 2) Performance and design criteria if the training provider is delegated design responsibility
 - 3) Operating standards

- 4) Regulatory requirements
- 5) Equipment function
- 6) Operating characteristics
- 7) Limiting conditions
- 8) Performance curves

b. Documentation. Review the following items in detail:

- 1) Emergency manuals
- 2) Operations manuals
- 3) Maintenance manuals
- 4) Project record documents
- 5) Identification systems
- 6) Warranties and bonds
- 7) Maintenance service agreements and similar continuing commitments

c. Emergencies. Include the following, as applicable:

- 1) Instructions on meaning of warnings, trouble indications, and error messages
- 2) Instructions on shutdown
- 3) Shutdown instructions for each type of emergency
- 4) Operating instructions for conditions outside of normal operating limits
- 5) Sequences for electric or electronic systems
- 6) Special operating instructions and procedures

d. Operations. Include the following, as applicable:

- 1) Start-up procedures
- 2) Equipment or system break-in procedures
- 3) Routine and normal operating instructions
- 4) Regulation and control procedures
- 5) Control sequences
- 6) Safety procedures
- 7) Instructions on stopping

- 8) Normal shutdown instructions
 - 9) Operating procedures for emergencies
 - 10) Operating procedures for system, subsystem, or equipment failure
 - 11) Seasonal and unattended operating instructions
 - 12) Required sequences for electric or electronic systems
 - 13) Special operating instructions and procedures
- e. Adjustments. Include the following:
- 1) Alignments
 - 2) Checking adjustments
 - 3) Noise and vibration adjustments
 - 4) Economy and efficiency adjustments
- f. Troubleshooting. Include the following:
- 1) Diagnostic instructions
 - 2) Test and inspection procedures
- g. Maintenance. Include the following:
- 1) Inspection procedures
 - 2) Types of cleaning agents to be used and methods of cleaning
 - 3) List of cleaning agents and methods of cleaning detrimental to product
 - 4) List of lubrication products, procedures, and intervals
 - 5) Procedures for routine cleaning
 - 6) Procedures for preventive maintenance
 - 7) Procedures for routine maintenance
 - 8) Instruction on use of special tools
- h. Repairs. Include the following:
- 1) Diagnosis instructions
 - 2) Repair instructions
 - 3) Disassembly; component removal, repair, and replacement; and reassembly instructions
 - 4) Instructions for identifying parts and components

- 5) Review of spare parts needed for operation and maintenance

PART 3 - EXECUTION

3.01 FACILITIES FOR TRAINING

- A. Use Metro's designated training facilities for specified field training programs.
- B. Facilities include installation sites that shall be used for hands-on training programs.
- C. Coordinate the use of Metro's facilities with Metro and the Construction Manager.

3.02 SCHEDULE

- A. Coordinate training periods with the Construction Manager and the Supplier's representatives.
 1. Training shall be limited to no more than three days per week. No training shall be conducted on Mondays or Fridays.
 2. The Contractor shall coordinate the manufacturer's training services with Metro and the Construction Manager, providing a minimum of fourteen (14) days prior notice of training, subject to the acceptance of the Construction Manager, Engineer, and Metro.
 3. In order to provide training for an adequate number of Metro operation and maintenance personnel, a minimum of two 8-hour training days shall be provided for each item of equipment at the site, unless otherwise specified in the specifications.
 4. The Contractor shall deliver all training material to the Construction Manager, and Metro a minimum of fourteen (14) days prior to the scheduled training.
 5. The Contractor shall maintain a calendar of training events which defines each submission for each vendor's training curriculum. The calendar shall be updated as required.
 6. Reschedule canceled training sessions 7 calendar days in advance.
- B. Training Procedures
 1. The instructor shall arrive at the training site at least one-half hour before training is scheduled to be delivered in order to review the *Instructor Manual* with the Construction Manager, and complete final preparations for presentation of the training session. The instructor shall comply with all site safety requirements, including wearing a hard hat, safety shoes, and other safety and/or personal protective equipment.
 - a. Information presented in the training program shall be based on the instructor and trainee manuals.
 - b. The Construction Manager will monitor and evaluate the performance of the instructor and the quality of the training session. Unacceptable sessions are those where the accepted lesson plan was not presented, where inadequate time was taken to present lesson plan or the training was not understood by the trainees. The adequacy of the training shall be determined solely by Metro. Contractor shall repeat any training sessions deemed unacceptable, at no additional cost to Metro.

- c. A safety briefing shall be conducted by the instructor prior to use of any equipment.
- C. Factory training programs, if required, shall be completed prior to start-up of Metro's system and shall use equipment similar to Metro's equipment.
- D. Training shall be completed minimum of 14 days before performance testing or Metro's operational acceptance on each piece of equipment or unit process begins.
- E. Metro's personnel will require training, both for operating and maintenance functions. These individuals shall be trained in small groups at times and dates agreed upon by Metro.

3.03 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training modules. Assemble training modules into a training manual organized in coordination with requirements of this Section and in Section 01 78 23, Operations and Maintenance Data.
- B. Set up instructional equipment at the instruction location.

3.04 INSTRUCTION

- A. Prepare instruction program and training modules to coordinate instructors and to coordinate between Contractor and Metro for number of participants, instruction times, and location.
- B. Engage qualified instructors to instruct Metro's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1. Metro will furnish the Contractor with names and positions of the proposed participants after the final course outline is accepted.
- C. Manufacturer's Training Location and Reference Material
 - 1. Conduct training on-site in the completed and fully operational facility using the actual equipment in-place.
 - 2. Conduct training using final operation and maintenance data submittals as training aides.
- D. At the conclusion of each training module, assess and document each participant's mastery of module by use of a demonstration performance-based test.
- E. Cleanup
 - 1. Collect used and leftover educational materials and remove from the Project site if unwanted by Metro.
 - 2. Remove instructional equipment.
 - 3. Restore systems and equipment to condition existing before initial training use.

3.05 TRAINING CONTENT

A. Maintenance of Instrumentation

1. Training requirements
 - a. Describe overall function of each instrument and control loop installed under this Contract
 - b. Locating probable source of malfunction in instrumentation equipment, determining symptoms of trouble, establishing probable cause and effecting solution
 - c. Taking appropriate preventive and corrective maintenance procedures necessary to keep instrumentation system in proper operating condition, including calibration and testing
2. Course Materials
 - a. Pertinent portions of submittals specified in Specifications such as calibration data and maintenance instructions
 - b. Detailed course outlines and troubleshooting guides for field use. Troubleshooting guides shall include symptoms, probable causes and solutions for all cases of trouble described during training program
3. Training program shall not include any time specified for system start-up instruction or acceptance testing

B. Maintenance of Process Equipment

1. Training requirements
 - a. Describe functions of process equipment.
 - b. Component preventive and corrective maintenance activities required to keep unit equipment in good operating conditions
 - c. Instruct trainees in locating probable source of equipment malfunctions, determining symptoms of trouble, establishing probable cause, and effecting solution
2. Course materials
 - a. Pertinent portions of the *Operation and Maintenance Manuals* as well as alignment tolerances, lubrication schedules, vibration analysis instructions and parameters, and special calibration test and procedures
 - b. Detailed course outlines and trouble-shooting guides for each piece of equipment. Trouble-shooting guides shall include symptoms, probable causes, and solutions for trouble described during training program.
3. Method of training maintenance personnel shall include the Contractor using Metro's equipment to demonstrate trouble-shooting, preventive and corrective maintenance procedures.

C. Operation of Process Equipment

1. Training requirements

- a. Being able to implement start-up and shutdown procedures for each piece of equipment individually as well as start-up and shutdown of systems comprising equipment. This instruction shall include normal operation, alternative operations, and emergency operations.
- b. Understand functions of instrumentation, describing individual components and how each component is used in monitoring and controlling equipment and processes for the instrumentation supplied by the manufacturer
- c. Understand operating modes possible as result of modifications and installations
- d. Locating probable source of system inefficiency, determining symptoms, establishing probable cause, and re-stabilizing system efficiency for systems
- e. Precautions for safe operation of equipment, instrumentation, and control system
- f. Emergency procedures for equipment and systems during any malfunction, chemical spills, and other extreme conditions

2. Course materials

- a. Pertinent portions of *Operations and Maintenance Manuals*, including start-up and shutdown procedures, descriptions of equipment and instrumentation functions and modes of operations, control, monitoring, troubleshooting instructions, and process control instructions
- b. Detailed course outlines and operations guides for equipment and processes for field use. Operations guides shall include general operating procedures, start-up and shutdown procedures, optimization procedures, and emergency operating procedures.

3. Methods of training Metro's operations personnel shall include field training program at Metro's site consisting of classrooms and hands-on training using Metro's equipment and systems

3.06 FIELD QUALITY CONTROL

A. Manufacturer's Training Effectiveness

1. Instructor audio and class participant questions/answers shall be clear and audible on the electronic media or the sessions will need to be redone at no additional cost to Metro.
2. Effectiveness of training operations personnel shall be assessed through written and in-the-field skills evaluation of trainees. Evaluations shall be provided and designed to determine trainees' ability to control processes, as well as their ability to operate or maintain equipment.
3. Unsatisfactory evaluations shall include recommendations for corrective action and the training session must be given again at no cost to Metro.

3.07 TRAINING DOCUMENTATION

- A. On completion of their training, the manufacturer's or supplier's representative shall submit to the Construction Manager a complete signed Form 01 78 24 - 1, Equipment Manufacturer's Certificate of Instruction, that provides demonstration that the training is complete.
- B. If Metro approves the training, the acceptance will be documented in a completed Form 01 78 24 - 2, Metro's Acknowledgment of Manufacturer's Instruction.
- C. Differences between the equipment *O&M Manual* and the manufacturers training session shall result in the training and/or *O&M Manual* being corrected.

PART 4 - FORMS

- 1. FORM 01 78 24 – 1 EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTRUCTION
- 2. FORM 01 78 24 – 2 METRO'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

FORM 01 78 24 - 1

EQUIPMENT MANUFACTURER'S CERTIFICATE OF INSTRUCTION

Owner: Metro Water Services

Project Name: _____

Contract No.: _____

Metro Project No.: _____

CWNOAP Project No.: _____

Equipment Specification Section: _____

Equipment Description: _____

I, _____, Authorized Representative of
(Print Name)

(Print Manufacturer's Name)

hereby CERTIFY that _____,

(Print Equipment Name and Model with Serial No.)

installed for the subject project (has) (have) been installed in a satisfactory manner, (has) (has) been satisfactorily tested, (is) (are) ready for operation, and that the Metro-assigned operating personnel have been suitably instructed in the operation, lubrication, and care of the unit(s) on

Date: _____ Time: _____

Certified By: _____ Date: _____
(Signature of Manufacturer's Representative)

FORM 01 78 24 - 2

METRO'S ACKNOWLEDGMENT OF MANUFACTURER'S INSTRUCTION

Metro Project No.: _____

CWNOAP Project No.: _____

(I) (We), the undersigned, authorized representatives of the

_____ Metro Water Services (or other entity, as appropriate)

and/or facility Operating Personnel, have received classroom and hands-on instruction on the operation, lubrication, and maintenance of the subject equipment and (am) (are) prepared to assume normal operational responsibility for the equipment:

_____ (Print Manufacturer's Name)

_____ (Print Equipment Name and Model with Serial No.)

Date: _____

_____ (Print Name Here)

_____ (Signature)

END OF SECTION

SECTION 01 81 10

SUSTAINABILITY

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Sustainability Intent
- C. Management of Excess Construction Materials
- D. Use of Materials with Recycled Content
- E. Use of Regional Materials
- F. Use of Alternative Fuels and Clean-idle
- G. Submittals
- H. Form 01 81 10 – 1 EXCESS MATERIAL MANAGEMENT PLAN
- I. Form 01 81 10 – 2 MATERIAL DATA
Form 01 81 10 – 3 RESOURCE CONSERVATION

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 14 14 – Control of Work
- C. Section 01 33 00 – Submittals
- D. Section 01 35 43 – Protection of Environment
- E. Section 01 43 00 – Quality Requirements

1.03 SUSTAINABILITY INTENT

- A. Metro and Metro Water Services seek to encourage the use of sustainable design and construction practices in the execution of its projects. This Section is intended to identify potential opportunities to implement sustainable practices during construction and to gather data on how sustainable practices are being used on the Clean Water Nashville Overflow Abatement Program. This Section does not alter the requirements of the technical sections nor require options that would increase project costs.
- B. This project is required to meet *Metro Water Services Construction and Demolition Debris Diversion Guidelines* (included in this specification) to reduce, reuse, and recycle construction and demolition debris. The goal of these guidelines is for all projects to
 - 1. Generate as little waste as possible

2. Reclaim and reuse as much material as possible
3. Recycle as much remaining debris as possible

These guidelines must be incorporated into all design, construction, demolition, and site management considerations for this project. Metro Water Services Zero Waste staff are available to provide technical support as needed.

1.04 COSTS INCLUSION

- A. Cost proposals should include any and all costs associated with meeting the *Metro Water Services Construction and Demolition Debris Diversion Guidelines*. Costs associated with meeting these guidelines could include but are not limited to the following:
 1. Collection and hauling of source separated recyclables to a recycling processor
 2. Costs for environmentally preferred construction materials
 3. Collection and hauling of crew members' personal waste
 4. Deconstruction services
 5. Material salvage

1.05 MANAGEMENT OF EXCESS CONSTRUCTION MATERIALS

- A. Where practical and as allowed in the technical specifications, the Contractor shall re-use excavated material with required preparation to meet the applicable technical material specification as fill, base, cover, or aggregate.
- B. Before commencement of Work, the Contractor shall identify permitted sites for material re-use and disposal, onsite stockpiles, recycling facilities, borrow sites, construction and demolition disposal facilities, and landfills.
- C. Preference for material disposal is given in the following order:
 1. Recycling Facilities, reuse or salvage
 2. Drop-off and borrow sites
 3. Construction and demolition disposal facilities
 4. Landfills
- D. Any unused materials should be returned to the manufacturer, if possible.
- E. See Section herein for submittal information about Form 01 81 10 -1.

1.06 USE OF MATERIALS WITH RECYCLED CONTENT

- A. All products containing recycled content shall comply with applicable standards found in these specifications.
- B. Preference shall be given to products that contain recycled content when procuring supplies and materials.

- C. When possible, include recycled content in materials such as concrete (fly-ash) and asphalt.
- D. See Section herein for submittal information about Form 01 81 10 -2.

1.07 USE OF REGIONAL MATERIALS

- A. All products and materials selected shall comply with applicable standards found in these specifications.
- B. The Contractor shall consider use of products and materials that can be procured within the shortest distance from the project site.
- C. See Section herein for submittal information about Form 01 81 10 -2.

1.08 USE OF ALTERNATIVE FUELS AND CLEAN-IDLE

- A. The Contractor shall consider the use of alternative fuels in all vehicles and equipment.
- B. Alternative fuels include but are not limited to: biodiesel, hybrid powertrains, natural gas, propane, bio-gas, electric motors, etc.
- C. Contractor shall consider Clean-idle certification on vehicles and equipment that must remain in operation for long periods of time.
- D. See Section herein for submittal information about Form 01 81 10 -3.

1.09 SUBMITTALS

- A. Provide in accordance with Section 01 33 00, Submittals.
- B. Within 30 days of the Notice-to-Proceed, provide a plan that details how the Contractor will meet the *Metro Water Services Construction and Demolition Debris Diversion Guidelines*.
- C. Along with the plan to meet the *Metro Water Services Construction and Demolition Debris Diversion Guidelines*, submit the following Forms 01 81 10 -1, 01 81 10 -2, and 01 81 10 -3 before commencing site Work:
 - 1. FORM 01 81 10 -1 – EXCESS MATERIAL MANAGEMENT PLAN: Submit an *Excess Materials Management Plan* that identifies excess materials, amount generated and proposed amount to be disposed of (recycled/reused or landfilled).
 - 2. FORM 01 81 10 -2 – MATERIAL DATA: Submit a list of sustainability data for project materials that includes: amounts, percentage of recycled content, percent of material sourced regionally, and the amount of low volatile organic compound materials used.
 - 3. FORM 01 81 10 -3 – RESOURCE CONSERVATION: Submit a list of any sustainability rating system practices incorporated into project, including any water or energy saving techniques and other sustainability practices to be used on the project.
- D. FORMS 01 81 10 -1, 01 81 10 -2, and 01 81 10 -3 shall be presented for review by and for discussion with the Construction Management Consultant team at early project biweekly Construction Progress Meetings before commencing any site Work activity that generates waste or spoil.

- E. FORMS 01 81 10 -1, 01 81 10 -2, and 01 81 10 -3 for facility and conveyance projects shall be updated each quarter with the total amount to date for the project and submitted with contractor's monthly application for payment coinciding with the end of that quarter.
- F. FORMS 01 81 10 -1, 01 81 10 -2, and 01 81 10 -3 shall be updated at the conclusion of the project with the total amount to date for the project and submitted with the final acceptance and closing documents.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

FOR INFORMATION ONLY

Metro Water Services Construction and Demolition Debris Diversion Guidelines

These guidelines serve to assist Metro Water Services in reducing the amount of construction and demolition waste from infrastructure, construction, and demolition projects. This includes both capital and maintenance projects. Overall, all projects should aim to generate as little waste as possible, reclaim and reuse as much material as possible, and recycle as much remaining debris as possible.

Rationale

1. That there are established end markets for recovered debris such as unpainted and unpainted wood, metals (ferrous and non-ferrous), land clearing debris, and concrete.
2. Per Metro Code § 10.20.095, cardboard is banned from disposal in solid waste containers going to landfill.
3. Per state and federal (40 CFR § 258.2) regulations, construction and demolition (C&D) landfills can accept only inert, non-putrescible wastes that degrade very slowly or do not degrade. These landfills are not permitted for the disposal of municipal solid waste or hazardous waste. For a typical jobsite, this includes crew members' personal waste, such as food waste and plastic bottles.
4. Per Metro Code § 10.24.070-080, the owner or person in control of any private property shall at all times maintain the premises free of litter and no person shall throw or deposit litter on any occupied private property within the area of metropolitan government.

All MWS Projects

1. Request for proposals (RFP) and invitations to bid (ITB) for construction and demolition projects should include provisions in the scope of services for the following:
 - a. Collect recycling material separate from garbage and other non-recyclable debris
 - b. Make contractors responsible for the following provisions, not to be limited to: monitoring contamination of recycling containers for non-recyclable material, monitoring garbage containers for misplaced recyclables, and maintaining recycling and landfilling receipts from the dumpster provider.
2. Request for proposals (RFP) and invitations to bid (ITB) for the procurement of construction and demolition materials, such as those stocked with Stores, should include provisions in the scope of services for the following:
 - a. Make vendors responsible for taking back and recycling or reusing any large quantities of shipping or packaging material that is not readily recyclable or reusable by Metro Water Services.
 - b. Procurement of construction materials should always give preference to purchasing products and materials that support a circular economy. This includes, but is not limited to, products and materials that are reused, products and materials made from

reclaimed or recycled material, and products and materials that at their end of life can be reclaimed, reused, or recycled for further use.

3. Crew members' personal waste is banned from disposal in C&D dumpsters or waste containers going to a C&D landfill. Crew members' personal waste can be managed in one or more of the following ways, but is not limited to:
 - a. MWS can provide access to any MWS contracted trash, recycling, or food waste collection that is readily available at the site.
 - b. MWS can require by contract that crew members dispose of all personal waste off site.
 - c. MWS can require by contract that contractors and subcontractors provide proper disposal containers and collection for trash, recycling, or food waste.
4. Any debris generated in large quantities that does not have a currently understood market for reuse or recycling should be shared with the Waste Services Zero Waste team to assist in identifying any potential markets or uses for reuse or recycling.
5. Material that is considered hazardous or deemed unsuitable for reuse or recycling is not subject to these guidelines.
6. All materials salvaged for reuse should be stored, organized, and labelled alongside new items and equipment. Materials should be evaluated for obsolescence at the initial time of salvage and on an annual basis. If material is obsolete at any time, it should be properly recycled, if possible, or disposed.
7. All efforts should be made to achieve the waste reduction and recycling goals set in this policy unless they pose a significant and unreasonable cost barrier.

Water Line, Sewer Line, and Stormwater Infrastructure

1. All scrap metal debris generated from the removal or installation of new pipe or other infrastructure that can be recycled should be collected separately from other debris for recycling.
2. Soil, rock, and other land debris that can be used as fill material removed during a construction project should be collected separately from other debris and, if it meets the appropriate specifications, be reused on site or reused on another Metro Water Services project; or, if it does not meet MWS specifications, reused on other fill site as available.
3. Meters, valves, fire hydrants, and other infrastructure components that have the potential for reuse should be reclaimed and collected for reuse. Components that have parts that could be used in repairing other pieces of infrastructure should also be reclaimed and disassembled for that use.

Construction, Renovation, or Rehabilitation of Buildings and Facilities

This includes, but is not limited to, all office, administration, or operations buildings; pumping stations, reservoirs, and other field facilities; and treatment plant facilities and infrastructure.

1. Preference should be given where appropriate to the reuse of existing facilities through rehabilitation before considering demolition or new construction.
2. Considerations for reducing waste should be incorporated into the design phase of every project to identify and incorporate opportunities to reduce the amount of waste generated on a

project. This includes incorporating prefabrication of building and facilities components and other ways to design for less waste.

3. Any debris generated on a construction site that has a readily available market for reuse or recycling should each be collected separately by material type and sent for reuse or recycling with the goal of diverting a minimum of 50% of generated debris from landfill. This includes at minimum all cardboard, ferrous and non-ferrous metals, unpainted and untreated wood, and concrete. Reuse options on MWS sites or projects should be considered first.

Building and Facility Demolitions

1. Preference should be given for all demolition projects to use a method of deconstruction and salvage where markets are available for the building material that would be generated.
2. Furniture, fixtures, millwork, cabinetry, and any other finish goods that can be reclaimed for reuse should be removed for that purpose through e-bid or other reuse program if available.
3. Infrastructure components that can be reused by other regional water or sewer facilities outside of Metro Water Services or other uses should be reclaimed and marketed for reuse.
4. Reservoirs and other large pieces of infrastructure that can be reused by other regional water or sewer facilities outside of Metro Water Services or other uses should be reclaimed and marketed for reuse.
5. Any debris generated on a demolition site that has a readily available market for reuse or recycling should each be collected separately by material type and sent for reuse or recycling with the goal of diverting a minimum of 95% of generated debris from landfill. This includes at minimum all land clearing debris, ferrous and non-ferrous metals, unpainted and untreated wood, and concrete. Reuse options on MWS sites or projects should be considered first.

SECTION 01 92 00

MAINTENANCE OF FACILITY <SUBSTITUTE SPECIFIC FACILITY NAME HERE>
OPERATIONS
DURING CONSTRUCTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Related Sections
- B. Contractor's Responsibilities
- C. General Constraints
- D. Vehicular and Personnel Access
- E. Maintaining Existing Building and Utilities
- F. Coordination
- G. Submittals
- H. Products, General
- I. Shutdowns <DELETE THIS LINE IF NOT USED>

1.02 RELATED SECTIONS

- A. Section 01 11 00 – Summary of Work
- B. Section 01 14 14 – Control of Work
- C. Section 01 32 16/17 – Construction Progress Schedule <Designer Verify No>
- D. Section 01 33 00 – Submittals
- E. Section 01 29 73 – Schedule of Values
- F. Section 01 50 00 – Temporary Facilities
- G. Section 01 77 00 – Contract Closeout
- H. Division 02 through Division ## <PROJECT SPECIFIC - ADD AS NEEDED>

1.03 CONTRACTOR'S RESPONSIBILITIES

- A. This Section includes the general requirements and constraints for maintaining facility operations during construction. Prior to commencing Work, the Contractor shall submit to the Construction Manager for written approval, a detailed overall Work plan detailing the Contractor's plan for performing the Work in conjunction with maintaining the <INSERT FACILITY'S NAME> operation. The Contractor's plan shall include, but not be limited to, all criteria stated in this Section. The Contractor shall note that the shutdowns listed in Part 3

<PROJECT SPECIFIC> are not necessarily listed in sequential order. <DELETE THE PREVIOUS SENTENCE IF NO SHUTDOWNS WILL BE LISTED IN PART 3.> The Contractor shall review the information provided and incorporate the requirements into the Project schedule.

- B. The Contractor shall be responsible for ensuring that the Work is performed in a manner and an order that prevents interrupting the conveyance or degrading the treatment processes occurring at the facility. In performing the Work indicated and specified, the Contractor shall plan and schedule their Work to meet the facility operating requirements and to comply with the constraints and construction requirements as outlined in this Section.
- C. Work under this Contract shall be scheduled and conducted by the Contractor to prevent impeding any conveyance, pumping, wet weather storage or treatment process, reducing the facility's effluent quality, or causing odor or other nuisance. No raw or inadequately treated wastewater discharge shall be allowed. The Contractor shall pay all civil penalties, costs, assessments, etc., associated with any raw or inadequately treated wastewater discharge resulting from the Contractor's Work.
- D. The Contractor shall be responsible for coordinating the general construction and piping, electrical, mechanical, HVAC, instrumentation, and plumbing construction schedules to ensure that temporary requirements are met for maintaining all facility operations required to be on line at any given time.
- E. The Contractor has the option to provide additional temporary facilities that can eliminate a constraint, provided all of the Specification's requirements are fulfilled. Work not specifically covered in the following paragraphs may, in general, be performed at any time during the contract period, subject to the operating requirements and constraints and construction requirements outlined hereinafter. All references to days in this Section shall be construed as consecutive calendar days.
- F. The Contractor shall install and complete all Work without a full facility shutdown.
- G. Prior to restoring all facility operations after a shutdown, the Contractor shall test all of the piping and equipment in accordance with the testing criteria specific to the materials installed.

1.04 GENERAL CONSTRAINTS

- A. The Contractor shall schedule and execute all Work so that the facility's processes and all facility systems are maintained in continuous operation. All system shutdowns, complete or partial, temporary or extended, shall be approved in advance and in writing by the Construction Manager. If, in the Construction Manager's judgment, a requested shutdown is not required for the Contractor to perform the Work, the Contractor shall use the approved alternative methods to accomplish the Work. All shutdowns shall be coordinated with and scheduled at times approved and suitable to the Construction Manager. The scheduling and duration for tie-ins and connections requiring pumping or process interruptions or removing tanks from service or, depending upon process operations, the performance requirements, wastewater flow, or weather as related to flow rate shall be coordinated with and approved by the Construction Manager based on field conditions and consideration for the above-listed factors. Piping and process interruptions may be scheduled during low flow periods defined as 12:00 a.m. to 5:00 a.m., local time, or as otherwise approved by Metro. All night Work premiums, overtime, security costs, and other costs related to scheduling for pumping and process interruptions shall be borne by the Contractor. Shutdowns shall not begin until all required materials are on hand and ready for installation.

- B. Each shutdown period shall commence at a time approved by the Construction Manager. The Contractor shall perform the Work continuously, start-to-finish, until the Work is completed, and the normal facility operation has been restored. If the Contractor completes all required Work before the specified shutdown period has ended, Metro may immediately place the existing system back into service.
- C. The Contractor shall submit requests for short-term and extended shutdowns in advance and shall show all shutdowns in the updated schedules presented at the bi-weekly progress meetings. Shutdown requests shall be submitted, approved, and fully coordinated with the Construction Manager at least seven days before the scheduled shutdown unless otherwise indicated. Metro's personnel shall operate all existing facilities involved in the short-term and extended shutdowns and diversions.
- D. Prior to any approval of a shutdown, the Contractor shall submit a written Shutdown Plan listing all of the contingency procedures the Contractor will employ if the equipment fails or other foreseeable events occur. All Work not indicated in the Contractor's detailed shutdown plan shall remain the Contractor's responsibility to complete within the stated allowable shutdown period. Prior to any shutdown the Contractor shall conduct an inventory with the Construction Manager and verify that all planned and required resources are available and onsite.
- E. Short-term shutdowns in the facility's flow or systems will be allowed for tie-ins to existing facilities, installing temporary bulkheads, shoring, etc. All such shutdowns shall be scheduled seven days in advance unless otherwise indicated and for low-flow periods or low demand periods, as applicable, if critical to the facility's operation. Shutdowns shall generally be limited to less than four hours.
- F. Any temporary Work, facilities, roads, walks, protection for existing structures, piping, blind flanges, valves, equipment, etc., that may be required within the Contractor's Work limits to maintain continuous and dependable facility operation shall be furnished by the Contractor at no cost to Metro.
- G. Metro shall have the authority to order Work to be stopped or to prohibit Work that would, in its opinion, unreasonably result in interrupting functions necessary to maintaining the facility's operations.
- H. If the Contractor impairs the facility's performance or operation because they did not comply with specified provisions for maintaining the facility's operations, the Contractor shall immediately make all repairs or replacements and perform all Work necessary to restore the facility's operation to Metro's satisfaction. Such Work shall progress continuously to completion on a 24-hour per day, seven-day per week basis.
- I. The Contractor shall provide services from emergency repair crews that are on call 24 hours per day.

1.05 VEHICULAR AND PERSONNEL ACCESS

- A. An unobstructed traffic route through all access gates shall be maintained at all times for Metro's operations personnel and maintenance equipment. Limited parking for Construction Manager, contractor, sub-contractor, vendor, and personnel vehicles may be available in designated onsite areas. However, the Contractor may be required to arrange for all personnel vehicle parking be offsite due to the limited onsite space available. Any areas disturbed along the access road and interior road shoulders and elsewhere inside and outside the facility shall be repaired, graded, seeded, etc., as necessary to equal pre-construction conditions. If the

Contractor fails to identify existing damaged or disturbed areas, the Contractor shall be responsible for repairs to these areas.

- B. Metro's facility operating personnel shall have access to all areas remaining in operation throughout the construction period. The Contractor shall locate stored material, dispose of construction debris and trash, provide temporary walkways, provide temporary lighting, and perform other such Work as directed by the Construction Manager to maintain personnel access to areas in operation. Access and adequate parking areas for Metro's facility operating personnel must be maintained throughout construction.
- C. Where portions of the facility's roads, driveways, parking areas, or other paved areas must be disturbed to install piping, conduits, or other buried utilities, the Contractor shall include provisions for maintaining vehicle access, including, but not limited to, facility vehicles, hauling operations, and chemical deliveries. Steel plates or other protective device shall be provided when required.

1.06 MAINTAINING EXISTING BUILDING AND FACILITY UTILITIES

- A. Heating and ventilating for the existing facility structures shall be maintained in service for the entire construction period. Temporary heating and ventilation shall be provided to maintain adequate facility heating and/or ventilation where Work is being performed. Temperatures to be maintained in any areas occupied by facility operating personnel shall be at least 65°F and no higher than 85°F. The temperature in all other interior facility areas, whether new, existing, or temporary, shall be maintained at a minimum of 45°F.
- B. Electric power, lighting service, process control, fire alarm, and communications systems shall be maintained in uninterrupted operation in all areas. Individual units may be disconnected as required for replacement, but service shall be available at all times, including periods when certain facility utilities are out of service. The Contractor shall coordinate the required shutdowns to minimize the total number of shutdowns necessary to complete the construction. SCADA and phone service to the facility shall be maintained in continuous operation during construction.
- C. Public, potable water service adjacent to and on the site shall be maintained in continuous service at all times during construction except for short-term shutdowns required for tie-ins and connecting temporary bypass piping as permitted by the water utility. Site potable water system shutdowns shall be fully planned and coordinated through the Construction Manager and shall be limited to not more than 4 hours except where otherwise indicated. Existing fire hydrants within the facility's site shall be operational at all times unless otherwise approved by the Construction Manager.
- D. All existing sumps and sump pumps shall be maintained in an operable condition with either existing pumps or temporary pumps. Interim piping, power, and controls shall be provided as necessary to comply with this requirement.
- E. The supply for service and seal water and the necessary connections to existing equipment shall be maintained during construction. Interim piping and seal water supply shall be provided as necessary to comply with this requirement.

1.07 COORDINATION

- A. The Contractor shall coordinate this Section's requirements with those in Section 01 14 14, Control of Work.

1.08 SUBMITTALS

- A. Provide the following:
 - 1. Detailed Work Plan prior to commencing the Work in accordance with herein.
 - 2. Shutdown Plan submitted with each shutdown request in accordance with Paragraph
- B. The Contractor shall incorporate into the CPM (Critical Path Method) schedule all constraints and milestones identified in this Section. Any proposed deviations or modifications to the constraints shall be submitted for approval prior to implementation
- C. The Contractor is free to propose such modifications to the existing or proposed structures to accommodate the construction or to facilitate with equipment installation. Where structural modification to an existing or proposed facility is requested, the request shall be accompanied by calculations, Contract Drawings, etc., and be sealed by a Tennessee-registered Professional Engineer specializing in structural design. Metro must approve all such proposals in writing.

PART 2 - PRODUCTS

2.01 GENERAL

- A. The Contractor shall provide all labor, materials, equipment, and incidentals to perform the Work required and specified in this Section.
- B. If required, bypass pumping shall be arranged and performed by a subcontractor who is fully qualified and equipped to provide temporary pumping services. Bypass pumping shall be provided in accordance with the accepted diversion pumping plan. Standby/redundant pumps shall be provided wherever bypass pumping is used or required. Repair crews shall be available on a 24 hours per day, seven days per week basis during bypass pumping events.

PART 3 - EXECUTION

NOT USED OR <PROJECT SPECIFIC ADD IF NEEDED>

END OF SECTION

SECTION 02 01 20

PROTECTING EXISTING UNDERGROUND UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Protecting existing underground utilities
 - 1. Removing and plugging abandoned lines
 - 2. Compaction
 - 3. Alternative support methods
 - 4. Protecting thrust blocks

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)

1.03 DEFINITIONS

- A. Controlled Low Strength Fill: Refer to Section 03 30 00.
- B. Class C Concrete: Refer to Section 03 30 00.

1.04 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01 33 00.
 - 1. Record drawings to include record survey coordinates and elevations
 - 2. Proposed locations for test pits

1.05 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.

1.06 PROJECT/SITE CONDITIONS

- A. Pipelines will be indicated on the drawings, but Metro reserves the right, acting through the Construction Manager, to make such modifications in location as may be found desirable to avoid interference with existing utilities.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Except as indicated or as specifically authorized by the Construction Manager where existing utilities to remain must be removed, reconstruct utilities with new material of the same size, type, and quality as that removed.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Comply with the requirements in Section 01 14 14.
- B. Notify utility owner at least 72 hours before digging operations are scheduled to begin.
- C. Test Pits: Excavate test pits to field verify the locations, depth of bury, diameter, and pipe material of existing underground utilities at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Construction Manager if conflicts are encountered.

3.02 PREPARATION

- A. Where utilities are parallel to or cross work, but do not conflict with work, notify the utility owner at least 48 hours in advance of construction at the crossing. Coordinate the construction schedule with the utility owner.

3.03 PROCEDURES

- A. Protect in Place: Protect utilities in place, unless abandoned, and maintain the utility in service, unless otherwise indicated or specified.
- B. Damage to Utilities to Remain: If existing utilities to remain are damaged, immediately notify utility owner and repair to utility owner's satisfaction.

3.04 COMPACTION

- A. Protecting Existing Utilities
 1. Backfill and compact under and around utilities. Compaction shall conform to Section 31 23 00.
 2. Where compaction cannot adequately be performed around utility due to the presence of encroaching existing utilities, utilize controlled low strength fill.

3.05 ALTERNATIVE METHODS

- A. Structural Steel Beam: Support utilities by a structural steel beam(s) to prevent the utility line from settling during and after construction and to protect existing utilities.

3.06 PROTECTION OF THRUST BLOCKS

- A. Protect thrust blocks on existing waterlines or sewer force mains in place, or shore to resist the thrust by a means accepted by the Construction Manager. If the thrust blocks are exposed or rendered to be ineffective, reconstruct them to bear against firm unexcavated or backfill material.
 1. Provide firm support by backfilling affected portion of the trench for a distance of 2 feet on each side of the thrust block to be reconstructed from the pipe bedding to the pavement subgrade with either of the following:
 - a. Controlled low strength concrete fill, or

- b. Crushed stone material compacted to a relative compaction of 98 percent. See Section 31 23 33 for compaction requirements.
2. Excavate the backfill material to construct the thrust block.
3. Test backfill material compaction before pouring any concrete thrust block. Concrete shall conform to Section 03 30 00.

3.07 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 02 01 30

CONNECTIONS TO EXISTING BURIED PIPELINES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Connecting to Existing Buried Pipelines

1. Tapping existing buried cast/ductile iron and PVC pipelines
2. Line stopping

1.02 REFERENCES

A. American Society of Mechanical Engineers (ASME)

1. B16.1: AN Standard for Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800

B. American Society for Testing and Materials (ASTM)

1. A36: Standard Specification for Carbon Structural Steel
2. A325: Standard Specification for Structural Bolts, Steel, Heat-Treated 120/105 ksi Minimum Tensile Strength
3. A325M: Standard Specification for Structural Bolts, Steel, Heat-Treated 830 MPa Minimum Tensile Strength (Metric)
4. A536: Standard Specification for Ductile Iron Castings

C. American Water Works Association (AWWA)

1. C110: Ductile Iron and Gray Iron Fittings
2. C213: Fusion Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
3. C223: Fabricated Steel and Stainless Steel Tapping Sleeves
4. C509: Resilient Seated Gate Valves for Water Service
5. C550: Protective Interior Coatings for Valves and Hydrants
6. C800: Underground Service Line Valves and Fittings

D. Manufacturer's Standardization Society (MSS)

1. SP-60: Connecting Flange Joint between Tapping Sleeves and Tapping Valves
2. SP-111: Gray Iron and Ductile Iron Tapping Sleeves

3. SP-113: Connection Joint between Tapping Machine and Tapping Valve

E. NSF International (NSF)

1. 61: Drinking Water System Components Health Effects

1.03 SUBMITTALS

A. Submit the following shop drawings in accordance with Section 01 33 00:

1. Manufacturer's catalog data for products to be used

1.04 QUALITY ASSURANCE

A. Comply with the requirements specified in Section 01 43 00.

1.05 DELIVERY STORAGE AND HANDLING

A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Tapping Sleeves (for tapping outlets 4-inch to 12-inch diameter) for Cast/Ductile Iron and PVC Pipe

1. Manufacturers

a. Smith-Blair

b. Mueller

2. Products

a. Complies with AWWA C223

b. Carbon Steel, ASTM A36

c. Ductile Iron

d. Bolts, Nuts, and Washers: Type 304 Stainless Steel, coated to protect from galvanic corrosion

e. Outlet: Recessed for tapping valve per MSS-SP 60

f. Pressure Rating: To match or exceed rating of existing piping

B. Tapping Valves 4-inch to 12-inch diameter

1. Manufacturers

a. Mueller

b. US Pipe

- c. American Pipe
2. Products
- a. Conforms to AWWA C509
 - b. Ends: Conform to ANSI B16.1, Class 125, and MSS SP-60 and MSS SP-113.
 - c. Wedge: Iron, fully encapsulated in rubber
 - d. Stem: Non-rising
 - e. Bonnet and Stuffing Box: 304 stainless steel
 - f. Nuts and Bolts: 304 stainless steel
3. Coating
- a. Fusion bonded epoxy, conforming to AWWA C550
 - b. Certified to meet NSF 61 standard
- C. Tapping Saddles 4 inch diameter and smaller for Ductile Iron and PVC Pipe
1. Manufacturers
- a. Smith-Blair
2. Products
- a. Conforms to AWWA C800 and NSF 61
 - b. Body: Ductile Iron, ASTM A536
 - c. Outlet: Threaded NPT
 - d. Gasket: Buna-N, conforming to NSF 61
 - e. Straps: Single at least 2 inches wide, or multiple each 1.5 inches wide
 - f. Studs, Nuts, and Washers: Type 304 Stainless Steel, coated to protect from galvanic corrosion
 - g. Pressure Rating: To match or exceed rating of existing piping
3. Coating
- a. Fusion-bonded epoxy coating
- D. Line Stop Fittings
1. Manufacturers
- a. ADS, Hydra-Stop
 - b. Furmanite, IPSCO Flo-Stop

2. Products
 - a. Type 304 Stainless Steel split sleeve
 - b. Seals: Rubber gasket constructed of Buna-N
 - c. Bolts and Nuts: Steel, ASTM A325
3. Rubber Stopper
 - a. Fully expandable rubber, minimum 100 psi pressure rating, or
 - b. Carbon steel pivoting head with Buna-N sealing element, minimum 100 psi pressure rating.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Line Stopping: Expose the existing pipeline and determine the pipe wall thickness prior to ordering the line stop materials. If wall thickness cannot be visually ascertained, utilize pipe thickness testing using ultrasonic technology.
- B. Tapping: Expose the existing pipeline to be tapped. Verify material of construction and outside diameter prior to ordering tapping materials.

3.02 PREPARATION

- A. Coordinate work to be performed with pipeline owner.

3.03 INSTALLATION

- A. Line Stopping
 1. Install concrete and support thrust blocking before installing the temporary pressure tapping machinery and valve.
 2. After tapping and line stopping operations have been completed, seal the tee fitting with an ASTM A36 steel pin-locked completion plug with Buna-N O-ring seal.
 3. Close the fitting with a blind flange meeting AWWA C110 requirements.
 4. Repair any damage that occurs to line stop fitting, accessories, or existing pipeline.
 5. Dispose of existing pipeline at no additional cost to Metro.
- B. Tapping
 1. Prepare the excavation and shore or protect per OSHA requirements.
 2. Assist Metro perform the tap on the Metro water and sewer utility.

3.04 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 0.

END OF SECTION

FOR INFORMATION ONLY

SECTION 02 41 00

DEMOLITION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide demolition and alterations of existing conditions as indicated and specified. Before demolition begins, inspect existing structures, equipment and paving that will remain in place within and adjacent to the demolition area for existing defects and damage. Record and notify the Construction Manager of defects and damage found during this inspection.
- B. Meet with the Construction Manager prior to beginning the salvage operation to verify the materials and equipment to be salvaged for Metro. Items to be salvaged shall be inspected by the Contractor and the Construction Manager for existing defects and damage at this time.
- C. Related Section – Temporary Facilities 01 50 00.

1.02 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00.
 - 1. Demolition procedures and schedules
 - 2. Shop Drawings
 - a. Indicate demolition and removal sequence.
 - b. Indicate location of items designated for reuse and Metro's retention.
 - c. Indicate location and construction of temporary work.
 - d. Provide method and details for sealing pipes to be removed and/or abandoned, with calculations for seals under pressure as requested.

1.03 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.
- B. Demolition Plan: Provide description of sequence, methods, and equipment used for demolition (including disposal).
- C. Conform to applicable code for demolition work, dust control, products requiring electrical disconnection and reconnection.
- D. Obtain required permits from authorities.
- E. Do not close or obstruct egress width to exits.
- F. Do not disable or disrupt building fire or life safety systems without 3-day prior written notice to Metro.
- G. Conform to procedures applicable when discovering hazardous or contaminated materials.

1.04 DELIVERY STORAGE AND HANDLING

- A. Comply with the requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 PREPARATION

- A. Survey Markers and Monuments.
- B. Provide three reference points, established by a licensed land surveyor, for each survey marker or monument temporarily removed. Record locations and designations of survey markers and monuments prior to removal.
- C. Store removed markers and monuments during demolition work and replace upon completion of work. Reestablish survey markers and monuments in conformance with recorded reference points. Forward letter to the Construction Manager, signed by a licensed land surveyor, verifying reestablishment of survey markers and monuments.
- D. Burning demolition debris is prohibited.
- E. Notify affected utility companies and Metro before starting work and comply with their requirements. Contact One-call location services for buried utility marking.
- F. Mark location and termination of utilities.
- G. Erect and maintain temporary barriers and security devices including warning signs and lights and similar measures for protecting the public, Metro, and existing improvements indicated to remain.
- H. Erect and maintain weatherproof closures for exterior openings.
- I. Erect and maintain temporary partitions to prevent spread of dust, odors, and noise to permit continued Metro occupancy.
- J. Prevent movement of structure. Provide temporary bracing and shoring required to ensure safety of existing structure.
- K. Provide appropriate temporary signage including signage for exit or building egress.
- L. Protect existing materials and landscape items which are not to be demolished.
- M. Do not close or obstruct building egress path.
- N. Do not disable or disrupt building fire or life safety systems without 3 days prior written notice to Metro.
- O. Document condition of adjacent structure and buildings indicated to remain.

3.02 EXISTING BUILDING AND STRUCTURE DOCUMENTATION

- A. Provide the following graphic documentation:
 - 1. Photographically and videographically document existing building exterior before beginning demolition and after completing demolition.
 - 2. Take one overall digital photograph of each exterior wall. Take high resolution photographs to show full height of building facade at maximum size.
 - 3. Deliver a CD-ROM with all photographs to the Construction Manager with project record documents. Catalog and index photographs; provide typed table of contents.
 - 4. Video Recording. Submit two copies of video record. Use DVD video format. Identify video disk on face and edge with date, time, and project identification.

3.03 EXAMINATION

- A. Examine existing buildings and structures indicated to be demolished before demolition.
- B. Determine where removals may result in structural deficiency or unplanned building collapse during demolition. Coordinate demolition sequence and procedures to prevent structures from becoming unstable.
- C. Determine where demolition may affect structural integrity or weather resistance of adjacent buildings indicated to remain.
- D. Identify measures required to protect buildings from damage.
- E. Identify remedial work including patching, repairing, bracing, and other work required to leave buildings indicated to remain in structurally sound and watertight condition.
- F. Verify hazardous material abatement is complete before beginning demolition.

3.04 DEMOLITION

- A. Conduct demolition to minimize interference with adjacent and occupied building areas.
- B. Cease operations immediately when structure appears to be in danger and notify the Construction Manager.
- C. Disconnect, remove, cap, and identify designated utilities within demolition areas.
- D. Demolish in orderly and careful manner. Protect existing supporting structural members and adjacent structures and utilities.
- E. Carefully remove building components indicated to be reused. Disassemble components as required to permit removal. Package small and loose parts to avoid loss. Mark components and packaged parts to permit reinstallation. Store components, protected from construction operations, until reinstalled.
- F. Remove demolished materials from site except where noted otherwise. Do not burn or bury materials on site.

- G. Continuously clean up and remove materials as Work progresses. Do not allow materials to accumulate in building or on the site. Upon completion of work, leave areas in clean condition.
- H. Remove temporary Work.
- I. Do not close or obstruct roadways, sidewalks, and hydrants without prior permission from Metro.
- J. Protect existing landscaping materials, trees, appurtenances, structures, and other items that are not to be demolished.
- K. Use of explosives is not permitted.
- L. Sprinkle Work with water to minimize dust. Provide hoses and water connections for this purpose.
- M. Where existing structures are to be demolished, remove structures to a minimum of two feet below finished grade or a minimum of two feet below bottom of new structures, pipes or electrical duct banks where these pass through existing structures to be demolished. Backfill in accordance with the requirements of Section 31 23 00, unless otherwise shown or noted.
- N. Remove concrete slabs on grade.
- O. Remove materials to be re-installed or retained in manner to prevent damage.
- P. Backfill areas of excavated open pits and holes caused as a result of demolitions.
- Q. Rough grade and compact areas affected by demolition to maintain required site grades and contours.
- R. Remove all demolished materials from the site unless otherwise noted to be salvaged. Do not burn or bury materials on site. Leave site in clean conditions.
- S. Provide dumpster type containers located in convenient locations approved by the Construction Manager for removing waste, litter, and debris offsite. Empty containers offsite to remove waste, litter, and debris. Empty containers as soon as they are full or at regular intervals of at least once a week. Keep area around containers clean. During filling and emptying of containers, spillage shall be immediately picked up and area cleaned.
- T. Protect existing structures, equipment, and appurtenances to remain.
- U. Obtain permission from the Construction Manager before abandoning or removing existing structures, materials, equipment, and appurtenances.
- V. Provide fire extinguishers in areas where demolition work is performed by use of an open flame. Exercise necessary precautions for fire prevention.
- W. Confine apparatus, material storage, demolition work, new construction, and operations of workers to areas that will not interfere with continued use and operation of entire facility. Provide and maintain lights, barriers, and temporary passageways for free and safe access.
- X. Provide shoring or bracing where necessary to prevent settlement or displacement of existing or new structures. Do not overload floors.

3.05 DEMOLITION OF PIPING AND EQUIPMENT

- A. Demolish all piping and equipment as shown on the drawings and as required for installation and of operation of new systems.
- B. To keep the existing facility in operation, demolition may require staging. In some areas, it may not be possible to remove items entirely in a single operation. Include demolition as part on the overall construction schedule. Staging of demolition shall be included in the lump sum costs, and no additional payment will be made.
- C. Where piping and equipment are shown to be removed, all items associated with the piping and equipment shall also be removed including valves, power and control conduit and wiring, pneumatic and hydraulic systems, pipe supports and hangers, concrete equipment pads, curbs, pressure gauges and switches, and all other related appurtenances for complete removal of the system. Anchor bolts shall be removed to 2-inches below finished surface and patched with a non-shrink, non-metallic grout.
- D. Remove concrete pads to approximately ¼" (+/-) below the existing floor level. Fill with approved leveling material, in accordance with the Contract Drawings, to match existing adjacent structural floor level and provide new floor finish to match existing adjacent floor finish.
- E. Where removed piping terminates at a floor or wall, seal watertight as follows or as approved:
 - 1. At concrete floors and walls, remove sleeve or casting and seal in accordance with detail shown on the standard structural detail sheet drawings.
 - 2. At walls below grade, seal with blind flange, or, if casting does not include a flange, seal with stainless steel plate, reinforced as required, and by use of stainless steel expansion anchors, grout, gasket, or sealant material, watertight as approved.
 - 3. At masonry walls above grade, seal with non-shrink grout cap with sealant on both sides.
- F. For demolition of electrical conduit, wiring, panels, and appurtenances, remove all accessible conduit and all wiring from the equipment to the control panel, motor control panel, or other power source. Plug and seal all conduit that terminates at walls or floors, airtight or watertight as required. Remove all motor starters and other control devices associated with the equipment. Anchor bolts shall be removed to 2-inches below finished surface and patched with a non-shrink, non-metallic grout.
- G. Remove buried piping as shown. Piping shown to be abandoned shall be sealed by use of concrete, reinforced as required for watertight seal placed in the final 12 inches of ends of the pipelines that are to remain in place.

3.06 CUTTING OF NEW OPENINGS

- A. Prior to cutting new openings in existing masonry walls and until new steel lintels are fully in place, the Contractor shall provide temporary supports to protect the existing structure above and adjacent to the new openings. Temporary supports shall include, but are not limited to, shoring and/or needling the existing masonry wall above the new opening.
- B. After the new steel lintels are fully in place, the Contractor shall remove all temporary supports and patch all existing structures disturbed or damaged by the Contractor to match the existing adjacent surfaces at no additional cost to Metro.

- C. Means and methods for providing the temporary supports, shoring, or needling shall be the Contractor's responsibility.

3.07 REMOVAL AND DISPOSAL OF SOLIDS

- A. The Contractor shall be responsible for cleaning all tanks where modifications or demolition are required and for off-site disposal of all residual solids that remain.
- B. The tanks shall be cleaned with various pumping procedures or vac-trucks with all temporary pumps, piping, and appurtenances furnished by the Contractor. The material removed including water, sludges, and all other residues hereinafter to be called wastes shall be transferred by the Contractor to a disposal site at Metro' Central WWTP.
- C. No separate payment will be made for solids volume removal and disposal.
- D. Metro will provide electrical power and nonpotable water for the cleaning operation if at an existing WWTP or pump station site.
- E. The Contractor shall work in a safe manner at all times and shall provide, erect, and maintain all necessary barricades and signs and take all necessary precautions to protect the work and the safety of Metro' employees. The wastes can be in the stage of active decomposition and producing carbon monoxide, methane gas, hydrogen sulfide, and other deleterious and/or harmful gases or produce an atmosphere that may lack oxygen.
- F. The Contractor shall be responsible for disposal of the wastes at his own cost at an approved site. The wastes shall be disposed of in accordance with all applicable laws and regulations of the United States, the state of Tennessee, USEPA, or any other agency having control of this disposal operation. The Contractor shall file a certificate with Metro, stating the location and manner of the waste disposal and documenting regulatory approval of the disposal site if necessary.
- G. All trucks used for disposing the wastes shall be constructed and operated in a manner to prevent spilling solids or dripping liquids onto streets and pavement.
- H. After removing the wastes, the Contractor shall pressure hose clean all floors, ceiling plates, landings, piping, steel work, supports, sumps, and other exposed items. The Contractor is responsible for preventing any damage to any adjacent structures and systems that are to remain such as valves, piping, electrical installations, and any other plant facilities in the work area. Any damage shall be promptly repaired or replaced as required.

3.08 SALVAGE

- A. Store equipment to be salvaged or relocated as directed by the Construction Manager.
- B. Protect salvaged items from damage during work.

3.09 REPAIR/RESTORATION

- A. Repair or remove items that are damaged. Repair and install damaged items to a condition at least equal to that which existed prior to start of work.

3.10 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 03 05 10

LEAKAGE TESTING OF CONCRETE CONTAINMENT STRUCTURES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section describes the method to test concrete containment structures for leakage. All containment structures shall be leak tested unless specifically exempted by the Engineer.

1.02 REFERENCES

- A. American Concrete Institute (ACI)
 - 1. 350.1: Tightness Testing of Environmental Engineering Concrete Containment Structures and Commentary.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01 33 00.
- B. Test Results
 - 1. Provide records on tank testing indicating test date, the amount of leakage, evaporation, precipitation, water temperature, corrective action, if any, and retest results.
 - 2. Contractor shall record test results in Table 03 05 10-2 and submit to the Construction Manager for review.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide piping and equipment required to bring water to point of use and dispose of it after leak testing the structure.

PART 3 - EXECUTION

3.01 GENERAL

- A. Hydrostatically test reinforced concrete structures which will contain fluids to determine they conform to leakage criteria specified herein and are free from detectable leaks
- B. Prior to testing, clean exposed surfaces by thoroughly hosing and removing surface laitance and loose matter from walls and slabs. Remove wash water and debris from the structures by means other than washing through plant piping. All potential leakage points shall be identified and repaired prior to filling the tank with water for the tightness test. Methods for repairing concrete shall be as described in Section 03 01 30.

- C. No backfilling, floor finish, concrete or mortar fill, wall insulation, gas-proofing or protective coatings shall be applied to or installed in any new containment structures until they have been tested for leakage.
- D. Tanks laterally restrained or supported by cross-walls, beams, or slabs shall not be tested until such restraining or supporting construction is in place.
- E. Testing shall not be done until concrete has reached its specified design strength.

3.02 LEAK TEST PROCEDURE

- A. Leak testing shall meet the provisions of ACI 350.1 – Tightness Testing of Environmental Engineering Concrete Containment Structures. Test criterion shall be fluid loss of no more than 0.050% volume per day. Test period shall be as noted in Table 03 05 10-1.
- B. During the test period, the excavation around the structure shall be kept dewatered by the Contractor. Dewatering shall maintain the groundwater level to below the top of the base slab. The Contractor shall temporarily seal all bottom openings and wall openings below maximum water level in the structures and furnish and fill the structures to the design maximum water level with clean water.
- C. Filling rate shall not exceed 8-feet/24 hours of water depth with continuous monitoring. Filling shall be at a uniform rate.
- D. Water shall be kept at test level or operational average fluid level if not noted of structure for at least 3 days prior to actual test. This waiting period will be considered sufficient for the concrete to absorb moisture and the test water's temperature to stabilize.
- E. Each cell of multi-cell tanks shall be considered single tank and tested individually unless otherwise directed by the Construction Manager.
- F. During the test period, the Construction Manager will inspect the structure daily for damp spots, seepage, and leakage.
- G. During the course of the test, if in the Construction Manager's opinion weather conditions are such that it becomes difficult to accurately conduct the leakage test, the test shall be stopped and started over again when weather permits, at no additional cost to Metro.
- H. On concluding the test, the Contractor shall pump or drain the water from the structure and dispose of it without damage to structures or surrounding facilities.
- I. Structure shall be considered to have failed the test if any of the following occurs.
 - 1. Water loss exceeds required criterion.
 - 2. Water is observed flowing or seeping from structure.
 - 3. Moisture can be transferred from exterior surface to dry hand.
- J. Repairs and additional tests shall be made by Contractor in acceptable manner at no additional cost to Metro.

3.03 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

PART 4 - FORMS

1. Form 03 05 10-1 Liquid Level Test Elevation
2. EXAMPLE Form 03 05 10-2 Test Results
3. Form 03 05 10-2 Test Results

FOR INFORMATION ONLY

Form 03 05 10-1 LIQUID LEVEL TEST ELEVATION			
Structure No. and Name	Liquid Level		Test Period In Days
	Tank Designation	Test Elevation	
[]	[]	[727.00]	[5]

FOR INFORMATION ONLY

EXAMPLE Form 03 05 10-2 Test Results

Test period shall be the least theoretical time required to lower the water surface 3/8", assuming loss of water at maximum allowable rate. Example: flat bottom tank with 20 ft water depth, maximum permissible loss is 0.05% \times 20 \times 12 or 0.12 in/day. It takes 3.13 days to lose 3/8". Use a test period of 4 days. Test period shall not exceed 5 days.

Tank Description =
 HWL Elevation in Tank for leakage testing =
 Number of days tank stayed filled before first water level reading was taken =
 Number of days tested = 5 days

Day	Date	Tester	Time	Test Pt #1			Test Pt #2			Test Pt #3			Test Pt #4			Ave. loss or gain at all test pts	Control Container for Evaporation/Precipitation		
				Water		Loss or gain	Water		Loss or gain	Water		Loss or gain	Water		Loss or gain		Water		Loss or gain
				Temp	Elev		Temp	Elev		Temp	Elev		Temp	Elev			Temp	Elev	
0	12/01			75	66.875	0.00	75	66.813	0.00	75	67.375	0.00	75	67.063	0.00	0.00	76	64.500	0.00
1	12/02			78	66.750	0.13	78	66.938	0.13	78	67.625	-0.25	78	67.313	-0.25	-0.13	74	64.625	-0.13
2	12/03			72	67.063	0.31	72	67.313	0.38	72	67.688	-0.06	72	67.563	-0.25	-0.25	72	64.813	-0.19
3	12/04			70	67.438	0.38	70	67.750	0.44	70	67.813	-0.13	70	67.750	-0.19	-0.28	70	65.125	-0.31
4	12/05			74	67.750	0.31	74	68.000	0.25	74	68.250	-0.44	74	67.938	-0.19	-0.30	74	65.500	-0.38
5	12/06			73	68.063	0.31	73	68.375	0.38	73	68.500	-0.25	73	68.188	-0.25	-0.30	73	65.688	-0.19
Total loss or gain					-1.19	1.19		-1.56	1.56		-1.13	-1.13		-1.13	-1.13	-1.25		-1.19	-1.19
Average daily loss or gain =															-0.25		-0.24		

Weather description when water level readings were taken:

12/01	
12/02	
12/03	
12/04	
12/05	
12/06	

Remarks:

Damp spot : _____
 Leakage : _____
 Seepage : _____

FORM 03 05 10-2 TEST RESULTS

Tank Description = _____

HWL Elevation in Tank for leakage testing = _____

Number of days tank stayed filled before first water level reading was taken = _____

Number of days tested = _____ days

Day	Date	Tester	Time	Test Pt #1			Test Pt #2			Test Pt #3			Test Pt #4			Avg loss or gain at all test pts	Control Container for Evaporation/Precipitation			
				Water		Loss or gain	Water		Loss or gain	Water		Loss or gain	Water		Loss or gain		Water		Loss or gain	
				Temp	Elev		Temp	Elev		Temp	Elev		Temp	Elev			Temp	Elev		
0																				
1																				
2																				
3																				
4																				
5																				
Total loss or gain																				
															Average daily loss or gain =					

Weather description when water level readings were taken:

Remarks

Damp spot : _____

Leakage : _____

Seepage : _____

END OF SECTION

SECTION 03 10 00

CONCRETE FORMWORK

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide design and furnish materials for fabricating, erecting, and removing formwork, falsework, and shoring for cast-in-place concrete as shown on the Drawings and specified herein.
- B. Use formwork to cast all cast-in-place concrete structures.

1.02 REFERENCES

- A. American Concrete Institute (ACI)
 - 1. 117/117R: Standard Tolerances for Concrete Construction and Materials
 - 2. 309.2R: Identification and Control of Visible Effects of Consolidation on Formed Concrete Surfaces
 - 3. 318/318R: Building Code Requirements for Structural Concrete and Commentary
 - 4. 347: Guide to Formwork for Concrete
- B. Engineered Wood Association (APA)
- C. National Institute of Product Standards and Technology
 - 1. Voluntary Product Standard PS 1 Structural Plywood

1.03 DESIGN REQUIREMENTS

- A. Design formwork in conformance with ACI 347R methodology for anticipated loads, lateral pressures, depth of concrete placement, and rate of concrete placement. Design shall consider any special requirements due to the use of self-consolidating, plasticized, and/or retarded set concrete. All forms and shoring shall be designed at the Contractor's expense.

1.04 QUALIFICATIONS

- A. Formwork Designer: Formwork, falsework, and shoring design shall be by an engineer licensed in Tennessee.

1.05 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01 33 00:
 - 1. Product data for form ties, spreaders, chamfer strips, form coatings, and bond breakers
 - 2. Layout of panel joints and tie hole pattern for architectural formwork
 - 3. Form Ties Tapered through Bolts. Proposed method for sealing form tie holes

1.06 QUALITY ASSURANCE

- A. Comply with requirements in Section 01 43 00 and as specified.
- B. Formwork Design
 - 1. Formwork design, detailing, and installation shall be the Contractor's responsibility, and shall conform to ACI 347R requirements.
 - 2. When high range water reducer (superplasticizer) is used in concrete mix or when self-consolidated concrete is specified, forms shall be designed for full hydrostatic pressure per ACI 347.
 - 3. The formwork shall be designed for the loads and lateral pressures in accordance with ACI 347 and wind loads as specified by the local building code.
 - 4. Construction and contraction joints, openings, offsets, keyways, recesses, moldings, chamfers, blocking, screeds, bulkheads, waterstops, anchorages, inserts, and other features shall be provided.
 - 5. Formwork shall be designed to be readily removable without impact, shock, or damage to 'green' concrete surfaces and adjacent materials.
 - 6. The maximum panel deflection shall be $1/360$ of the span between structural members.
- C. Unless otherwise specified herein, formwork shall be constructed so the concrete surfaces will conform to the tolerance limits per ACI 117.
- D. Materials, fabrications, and workmanship found defective shall be promptly removed and replaced, and new acceptable work shall be provided in accordance with Contract requirements at no additional cost to Metro.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the requirements in Section 01 66 10.
- B. Materials shall be delivered to the site in an undamaged condition.
- C. Material shall be stored and protected in a clean, properly drained location. Material shall be kept off the ground under a weathertight covering permitting good air circulation. Formwork materials shall be stored on dry wood sleepers, pallets, platforms, or other appropriate supports which have slope for positive drainage. Materials shall be protected from distortion, excessive stresses, corrosion, and other damage. Materials shall not be stored on the structure in a manner that might cause distortion or damage to the supporting structure.

PART 2 - PRODUCTS

2.01 LUMBER

- A. Lumber used in form construction shall be Southern Yellow Pine, No. 2, S4S, Standard Grade Rules Southern Pine Inspection Bureau. Boards shall be 6 inches or more in width.

2.02 PLYWOOD

- A. Only grade-marked plywood conforming to APA shall be provided.
- B. Plywood used in form construction shall be Grade B-B, Class 1 plyform, mill-oiled, and sanded on both sides in conformance with U.S. Product Standard PS 1 Structural Plywood.
- C. Thickness shall be sized to maintain alignment and surface smoothness but not less than 5/8-inch thick.

2.03 STEEL FORMS

- A. Provide commercial grade sheets not less than 16-gauge.
- B. Provide stock material free from warps, bends, kinks, cracks, and rust or other matter that could stain the concrete.

2.04 FORM MATERIAL LOCATIONS

- A. Wall Forms and Underside of Slabs and Beams
 - 1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particleboard, or steel in new and undamaged condition, of sufficient strength and surface smoothness to produce specified finish
- B. Column Forms
 - 1. Rectangular Columns: As specified for walls
 - 2. Circular Columns: Fabricated steel or fiber reinforced plastic with bolted together sections or spirally wound laminated fiber form internally treated with release agent for column height
- C. All Other Forms: Materials as specified for wall forms
- D. Rustication Grooves and Chamfer Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces

2.05 FORM TIES

- A. Locate form ties on exposed surfaces in a uniform pattern. Place form ties so they remain embedded in the concrete except for a removable portion at each end. Form ties shall have conical or spherical type inserts with a maximum 1-inch diameter. Construct form ties so no metal is within 1-1/2 inches of the concrete surface when the forms, inserts, and tie ends are removed. Ties shall withstand all pressures and maintain forms within acceptable deflection limits.
- B. Flat bar ties for panel forms shall have plastic or rubber inserts having a 1-1/2-inch minimum depth and sufficient dimensions to patch the tie hole.
- C. Tapered form ties shall be tapered through-bolts or through-bolts that utilize a removable tapered sleeve.
- D. Wire ties are not permitted.

- E. Water Stop Ties. For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
 - 1. Integral steel water stop 0.103 inch thick and 0.625 inch in diameter tightly and continuously welded to tie
 - 2. Neoprene water stop 3/16-inch thick and 15/16-inch diameter whose center hole is one-half diameter of tie, or molded plastic water stop of comparable size
- F. Mechanical EPDM Rubber Plug
 - 1. Mechanical plug for taper tie
 - 2. Manufacturers
 - a. Greenstreak Group Inc.
 - b. Or acceptable equivalent product
 - 3. Friction fit plugs will not be allowed.

2.06 BOND BREAKER

- A. Bond breaker shall be a V.O.C. compliant, nonstaining type that will provide a positive bond prevention.
- B. Manufacturers
 - 1. Edoco Burke, Clean Lift 90 W.B.
 - 2. Nox-Crete, Inc., Silco seal 97EC
 - 3. Or acceptable equivalent product

2.07 FORM LINERS

- A. Form liners shall be provided as shown on documents.
- B. Products
 - 1. Dura-Tex, Symons Corporation, Des Plaines, IL
 - 2. Or acceptable equivalent product

2.08 RUSTICATIONS

- A. Rustications shall be provided as shown on documents.
- B. Products
 - 1. Rustications, Symons Corporation, Des Plaines, IL
 - 2. Or acceptable equivalent product

2.09 FORM CAULKING

- A. Form caulking shall be a one-component, gun-grade silicone sealant capable of producing flush, watertight, and nonabsorbent surfaces and joints. Sealant shall be compatible with the type of forming material and concrete ingredients used.
- B. Products
 - 1. Series 1200 Construction Caulking, GE Silicones, Waterford, NY
 - 2. Dow Corning 999-A, Dow Corning Co., Midland, MI
 - 3. Or acceptable equivalent product

2.10 CHAMFER STRIPS

- A. Provide 3/4-inch by 3/4-inch chamfer strips milled from clear, straight-grain pine, surfaced each side, or having extruded vinyl type with or without nailing flange unless otherwise shown on the Contract Documents.

2.11 INSERTS

- A. Provide galvanized cast steel or galvanized welded steel inserts, complete with anchors to concrete and fittings such as bolts, wedges, and straps.

2.12 DOVETAIL ANCHOR SLOTS

- A. Provide dovetail anchor slots manufactured from 22-gauge, galvanized steel with removable felt or polyurethane filler where specified or shown on the Contract Documents.

2.13 FORM RELEASE AGENT

- A. Form release agent shall not bond with, stain, or adversely affect concrete surfaces, and shall not impair subsequent concrete surface treatments when applied to forms. Use a ready-to-use water-based material formulated to reduce or eliminate surface imperfections and containing no mineral oil or organic solvents.
- B. Manufacturers and Products
 - 1. BASF, Shakopee, MN, MBT, Rheofinish 211
 - 2. Cresset Chemical Company, Crete-Lease 20-VOC
 - 3. Unitex Chemicals, Farm Fresh
 - 4. Magic Kote: Symons Corporation, Des Plaines, IL
 - 5. Or acceptable equivalent product

PART 3 - EXECUTION

3.01 FORM TOLERANCES

- A. Comply with ACI 117 tolerance requirements for formed surfaces except as specified in Table 03 10 00-1.

Table 03 10 00-1	
Vertical alignment (plumbness)	1/4-inch in any 10 feet and 1-inch maximum for entire length
Variation in the lines and surfaces of foundation mats, base slabs and walls	1/4-inch in any 10 feet and 1-inch max. for entire length
Variation from the level or from the grades indicated on the Drawings	1/4-inch in any 10 feet
Variation of the linear building lines from established position in plan	1/2-inch in any 20 feet and 1-inch maximum for entire length
Variation of distance between walls	1/4-inch in any 10 feet and 1-inch maximum for entire length and height
Variation in the sizes and locations of sleeves, floor openings and wall openings	Minus 1/4-inch. Plus 1/2-inch.
Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus 1/4-inch. Plus 1/2-inch.
Offset between adjacent panels of formwork facing material	1/2-inch (ACI 117 Class C finish).
Offset between adjacent panels of formwork facing material for exposed surfaces where appearance is of importance	1/8-inch (ACI 117 Class A finish).

- B. Tolerances are not cumulative.
- C. Where equipment is to be installed, comply with manufacturer's tolerances if more restrictive than above.
- D. Failure of the forms to produce the specified concrete surface and surface tolerance shall be grounds for rejecting the concrete work. Rejected work shall be repaired or replaced at no additional cost to Metro.

3.02 PREPARATION

- A. Clean the form surfaces to be in contact with concrete or foreign material prior to installation. Tape, gasket, plug, and/or caulk joints, gaps, and apertures in forms so the joint will remain watertight and withstand placing pressures without bulging outward or creating surface irregularities.
- B. Coat form surfaces in contact with concrete with a form release agent prior to form installation.
- C. Keep form coatings off steel reinforcement, items to be embedded, and previously placed concrete.

- D. Steel Forms. Apply form release agent to steel forms as soon as they are cleaned to prevent discoloration of concrete from rust.
- E. Form liners to be installed for architectural concrete finish shall be in accordance to the manufacturer's recommendations.

3.03 ERECTION AND INSTALLATION

- A. Forms shall be constructed in accordance with ACI 347 to required dimensions, plumb, and straight. All joints and seams shall be made mortar-tight. Forms shall be substantial, properly braced, and tied together to maintain position and shape and to resist all pressures to which they may be subject. Unless otherwise indicated on the Contract Documents, formwork shall be constructed so the concrete surfaces will conform to the tolerance limits in ACI 117 and herein specified.
- B. Provide means for holding adjacent edges and ends of form panels tight and in accurate alignment to prevent formation of ridges, fins, offsets, or similar surface defects in the finished concrete. Forms shall be tight and prevent the loss of mortar and fines during placing and vibration of concrete.
- C. Provide openings at the base of each vertical form lift as access for cleaning and inspecting forms and reinforcing prior to depositing concrete.
- D. Provide exterior corners in concrete members with chamfers as specified.
- E. Provide means for removing forms without injury to the finished concrete surface.
- F. Do not embed any form-tying device or part thereof other than metal in the concrete.
- G. Locate large end of taper tie on the "wet" side of the wall.
- H. Use only form or form-tying methods that do not cause concrete spalling upon form stripping or tie removal.
- I. Form concrete member surfaces except where concrete placement against the ground is shown on the Drawings or as indicated below. The concrete member dimensions shown on the Drawings apply to formed surfaces, except where otherwise indicated. Add 2 inches of concrete where concrete is placed against trimmed undisturbed ground in lieu of forms. Placing concrete against the ground shall be limited to footings only, where the ground character is such that it can be trimmed to the required lines and will stand securely without caving or sloughing.
- J. Openings shall be a sufficient size to permit final alignment of pipes or other items without deflection or offsets of any kind. Allow space for packing where items pass through the wall to ensure watertightness. Provide openings with continuous water stops. Provide a slight flare to facilitate grouting and the escape of entrained air during grouting. Provide formed openings with additional reinforcement as shown in the typical structural details. Reinforcing shall be at least 2 inches clear from the opening surfaces and encased items.
- K. Set anchor bolts and other embedded items accurately before placing concrete, and hold securely in position until the concrete is placed and set. Check special castings, channels, or other metal parts to be embedded in the concrete prior to and again after placing concrete. Check nailing blocks, plugs, and strips necessary for attaching trim, finish, and similar work prior to placing concrete.

3.04 PROTECTION

- A. During installation, the forms shall not be used as a storage platform nor as a working platform until the forms have been permanently fastened in position.

3.05 PIPES AND WALL CASTINGS CAST IN CONCRETE

- A. Install wall spools, wall flanges, and wall anchors before placing concrete. Do not weld, tie, or otherwise connect the wall castings or anchors to the reinforcing steel.
- B. Support pipe and fabricated fittings to be encased in concrete on concrete piers or pedestals. Carry concrete supports to firm foundations so no settlement will occur during construction.
- C. Pipes or wall castings located below operating water level shall have waterstop ring collars, and shall be cast in place. Do not block out such piping and grout after the concrete section is cast unless approved by the Construction Manager. Pipes fitted with thrust rings shall be cast in place.

3.06 REMOVAL OF FORMS

- A. Forms shall be removed in accordance with ACI 347 recommendations without damage to concrete and in a manner to ensure complete safety to the structure. Forms, form ties, and bracing shall not be removed without specific permission from the Contractor's Tennessee Registered Professional Engineer.
- B. The following table indicates the minimum allowable time after the last cast concrete is placed before forms, shoring, or wall bracing may be removed during which the air surrounding the concrete is above 50 degrees F.

Table 03 10 00-2	
Sides of footings and encasements	24 hours
Walls, vertical sides of beams, girders, columns, and similar members not supporting loads	48 hours
Slabs, beams, and girders	10 days (forms only)
Shoring for slabs, beams, and girders	Until concrete strength reaches 70 percent specified 28-day strength or 14 days minimum
Wall bracing	Until top or roof slab concrete reaches 70 percent specified 28-day strength or 14 days minimum

- C. Removal times will be increased if the concrete temperature following placement is permitted to drop below 50 degrees F.
- D. Do not remove supports and reshore.

3.07 PATCHING OF TAPERED TIE HOLES

- A. Clear the tie hole of all loose debris with a taper tie void brush, and flush debris from tie hole with air or water.
- B. Install mechanical plug in accordance with manufacturer's instructions.

- C. Coat the hole's entire annular surface with epoxy bonding compound prior to filling with nonshrink, nonmetallic patching mortar. Apply epoxy in accordance with manufacturer's instructions.
- D. Fill each side of hole with mortar. Apply mortar to the "wet" side of the wall first. Consolidate mortar solidly into the hole.

3.08 ALUMINUM SURFACES IN CONTACT WITH CONCRETE

- A. Coat the aluminum surfaces that will be in contact with concrete.

3.09 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 03 15 00

CONCRETE JOINTS AND ACCESSORIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section describes materials, testing, and installation of concrete joints and accessories as specified and as shown on Drawings.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)
1. A276: Standard Specification for Stainless Steel Bars and Shapes
 2. C920: Specification for Elastomeric Joint Sealants
 3. C1193: Guide for Use of Joint Sealants
 4. D412: Standard Test Methods of Vulcanized Rubber and Thermoplastic Elastomers – Tension
 5. D570: Standard Test Method for Water Absorption of Plastics
 6. D624: Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
 7. D638: Standard Test Method for Tensile Properties of Plastics
 8. D746: Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
 9. D747: Standard Test Method for Apparent Bending Modulus of Plastics by Means of a Cantilever Beam
 10. D792: Standard Test Methods for Density and Specific Gravity of Plastics by Displacement
 11. D994: Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)
 12. D1171: Standard Test Method for Rubber Deterioration – Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
 13. D1259: Standard Test Methods for Nonvolatile Content of Resin Solutions
 14. D1752: Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
 15. D2240: Standard Test Method for Rubber Property – Durometer Hardness

- B. Environmental Protection Agency (EPA)
 - 1. 40 CFR 59: National Volatile Organic Compound Emission Standards for Consumer and Commercial Products
- C. U.S. Army Corps of Engineers
 - 1. CRD-C 572: Specifications for Polyvinylchloride Waterstop
- D. Federal Specifications
 - 1. TT-S-00230C: Sealing Compound: Elastomeric Type, Single Component

1.03 SUBMITTALS

- A. Submit following shop drawings in accordance with Section 01 33 00:
 - 1. Manufacturer's printed data and application instructions for specified materials and locations where materials are to be used.
 - 2. One sample of each type of waterstop – minimum length 6 inches
 - 3. Layouts for joints
- B. Certify that the materials used within the joint system are compatible with each other.

1.04 QUALITY ASSURANCE

- A. Comply with requirements in Section 01 43 00 and as specified.
- B. Do not add, relocate, or omit joints without written permission from the Engineer.
- C. Reject material exceeding expiration date for use.
- D. Clean concrete surfaces to receive expansion joint compound in accordance with the printed instructions of the joint compound manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the requirements in Section 01 66 10.
- B. Transport, handle, and deliver materials to the jobsite in the manufacturer's sealed bags, unopened containers, or banded pallets.
- C. Store materials off the ground on a platform or skids and protect with covers from snow, rain, and ground splatter.
- D. Store expansion joint compounds in a dry location where they cannot freeze.
- E. Store plastic products under cover in a dry location and out of direct sunlight.

1.06 MANUFACTURER'S SERVICES

- A. Prior to preparing joint for receiving sealant materials, require joint manufacturer's technical representative to demonstrate, on site, joint preparation, priming, and sealant materials application for the Contractor's personnel performing joint work.

PART 2 - PRODUCTS

2.01 PVC WATERSTOP

- A. Waterstops shall be extruded from a PVC compound and shall be lock-rib, center-bulb, retrofit or flat-strip type. Water stop shall comply with U.S. Army Corps of Engineers Specification CRD-C-572.
- B. PVC waterstops for construction joints shall be flat ribbed type, 6 inches wide unless otherwise noted on the Contract Drawings and with a minimum 3/8-inch thickness.
 1. Products
 - a. Greenstreak; Model 679
 - b. BoMetals, Inc.; Model FR-638
 - c. Vinylex; Model R638
 - d. Or accepted equivalent product
- C. PVC waterstop for contraction joints shall be ribbed with a center bulb, 6 inches wide with a minimum 3/8-inch thickness. The center bulb shall have an outside diameter (OD) not less than 7/8-inches.
 1. Products
 - a. Greenstreak; Model 732
 - b. BoMetals, Inc.; Model RCB-638LB
 - c. Vinylex; Model RB638H
 - d. Or accepted equivalent product
- D. PVC waterstop for expansion joints shall be ribbed with a center bulb, 9 inches wide with a minimum 3/8-inch thickness. The center bulb shall have an OD not less than 1-3/8 inches.
 1. Products
 - a. Greenstreak; Model 738
 - b. BoMetals, Inc.; Model RCB-938VLB
 - c. Vinylex; Model RB938H
 - d. Or accepted equivalent product

E. PVC waterstops for sealing existing concrete structures and new concrete placement shall be retro-fit type, 6 inches wide and 3-3/16 inches height, with a minimum 3/8-inch thickness. Attach waterstop to existing concrete using 1/4-inch by 2-1/4-inch stainless steel sleeve expansion bolt with stainless steel batten bars.

1. Products

- a. Greenstreak; Model 609
- b. BoMetals, Inc.; Model RF-638
- c. Or accepted equivalent product

F. Provide waterstops that are resistant to chemical action with Portland cement, alkalis, acids, and that are not affected by mildew or fungi. They shall show no effect when immersed for 10 days in a 10 percent solution of sulfuric or hydrochloric acid, saturated lime solution, or salt water. Water stops shall be such that any cross section will be dense, homogeneous, and free from porosity and other imperfections. They shall be symmetrical in shape. When tested in accordance with Federal Standard No. 601, the material shall meet the requirements in Table 03 15 10-1.

TABLE 03 15 10-1	
Requirement	ASTM Spec.
Tensile strength, 2,000 psi	D638
Hardness, Shore Durometer, 60-70	D2240
Elongation, ultimate, 280	D638
Water absorption, dry weight, maximum (48 hours) 0.32 percent	D570
Specific gravity, 1.3	D792
Stiffness in flexure, 920 psi	D747
Cold brittleness, -35 degrees F	D746
Tear resistance, 290 lbs/inch	D624

2.02 HYDROPHILIC RUBBER WATERSTOP

A. Provide a bentonite-free rubber waterstop. Waterstop shall expand by a minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast. Provide minimum concrete cover as recommended by the waterstop manufacturer.

1. Products

- a. Adeka; Ultraseal MC-2010MN
- b. Greenstreak; Hydrotite
- c. Or accepted equivalent product

2.03 ELASTOMERIC JOINT SEALANT

A. Federal Specification TT-S-00230C Type 1, Class A, single component, cold applied, pourable, polyurethane

1. Products
 - a. Euclid Chemical Corp; Eucolastic 1
 - b. Mameco; Vulkem 45
 - c. Or accepted equivalent product

2.04 JOINT SEALANT FOR CONCRETE STRUCTURES

A. Joint sealant shall be a multipart, gray, nonstaining, nonsagging, gun grade polyurethane sealant, which cures at ambient temperature to a firm, flexible, resilient, tear-resistant rubber. Sealant shall comply with ASTM C920, Type M, Grade P, Class 25 for horizontal joints and Grade NS, Class 25 for vertical joints, and be recommended by the manufacturer for continuous immersion in water. Troweling sealants into joints will not be permitted. Sealant shall meet requirements in Table 03 15 10-3.

TABLE 03 15 10-3	
Characteristic or Parameter	Technical Requirements
Pot life	1 to 3 hours
Hardness	35 Shore A, +/- 5
Elongation	650 percent, ASTM D412
Tensile strength	200 psi, ASTM D412
Peel strength on concrete	No adhesion loss at 25 pounds
Temperature service range	40 to 167 degrees F
Immersion in water	Continuous

B. Products

1. Tremco; Vulkem 227 or Vulkem 245 (for Type M, Grade P, Class 25)
2. Sika Corporation; Sikaflex-2CNS (for Grade NS, Class 25), Sikaflex-2CSL
3. Or accepted equivalent product

2.05 EPOXY JOINT SEALANT

A. 100 percent solids per ASTM D1259, two-part epoxy with an instantaneous Shore D hardness of 50 to 65 per ASTM D2240

1. Metzger-McGuire Co.; MM80 or Edge Pro50
2. Euclid Chemical Corp.; Euco700
3. Or accepted equivalent product

2.06 BACKING ROD FOR EXPANSION JOINTS

- A. Provide an extruded closed-cell polyethylene foam rod. The rod shall be 1/4-inch larger in diameter than the joint width. Where possible, provide full-length sections for the joint; minimize splices.
 - 1. Industrial Systems Department; Minicel backer rod
 - 2. Hercules, Inc.; Plastic Products Group
 - 3. Or accepted equivalent product

2.07 BOND BREAKER TAPE

- A. Provide an adhesive-backed glazed butyl or polyethylene tape that will adhere to the premolded joint material or concrete surface. The tape shall be the same width as the joint. The tape shall be compatible with the sealant.

2.08 PREFORMED CONTROL JOINT

- A. One-piece, flexible, PVC joint former
 - 1. Vinylex Corp.; Kold-Seal Zip-Per Strip KSF-150-50-50
 - 2. Or accepted equivalent product
- B. One-piece steel strip with preformed groove
 - 1. Burke Concrete Accessories, Inc.; Keyed Kold Retained Kap
 - 2. Or accepted equivalent product
- C. Provide the preformed control joint material in full-length unspliced pieces.

2.09 PREMOLDED JOINT FILLER FOR PAVEMENTS AND SLABS

- A. Joint filler shall be preformed, nonextruded type, constructed of closed-cell neoprene conforming to ASTM D1752, Type I.
- B. Bituminous-type preformed expansion joint filler conforming to ASTM D994

2.10 PREMOLDED JOINT FILLER FOR LIQUID CONTAINMENT STRUCTURES

- A. Self-expanding cork per ASTM D1752, Type III
- B. Sponge Rubber per ASTM D1752, Type I. Preformed, nonextruded type constructed of closed-cell neoprene

2.11 EXPANSION JOINT DOWELS

- A. Stainless steel smooth bar dowels conforming to ASTM A276, Type 316, 1 inch dia. x 2 feet long unless noted otherwise
- B. Grease and cap one end.

2.12 STYROFOAM FILLER BLOCK

A. Styrofoam filler blocks for future construction and expansion joints

1. Products

- a. Dow Chemical Company; Styrofoam SM brand
- b. Or accepted equivalent product

2.13 VOC LIMITS FOR SEALANTS AND SEALANT PRIMERS

A. VOC limits for sealants and sealant primers to comply with content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24), or applicable state and local codes containing more stringent requirements.

2.14 BOND BREAKER FOR JOINT COMPOUNDS

A. Provide polyethylene tape.

PART 3 - EXECUTION

3.01 PVC WATERSTOPS

- A. Heat splice at ends and intersections. Provide waterstops that provide a continuous, uninterrupted, watertight diaphragm throughout the entire joint system below the high water level and below grade.
- B. Construct forms for construction joints to prevent injury to water stops. Hold water stops securely in position in the construction joints by wire ties, continuous bars, and rings as shown on Drawings. Install water stops in construction, contraction, and expansion joints in liquid containment structures and as shown on Drawings.
- C. Use factory-made crosses, tees, and ells. Make field splices with a thermostatically controlled heating iron in conformance with the manufacturer's current recommendations. Allow at least 10 minutes before pulling or straining the new splice in any way. The finished splices shall provide a cross section that is dense and free of porosity, with tensile strength of not less than 80 percent of the unspliced materials.
- D. Provide waterstops with an integral fastening system consisting of grommets or pre-punched holes.

3.02 JOINTS

- A. Make joints only at locations shown on the Drawings or as permitted by the Engineer. Addition or relocation for any construction joints proposed by the Contractor must be submitted to the Construction Manager for written permission.
- B. Relocate additional joints where they least impair member's strength. In general, locate joints within the middle third of spans of slabs, beams, and girders. If a beam intersects a girder at the joint, offset the joint a distance equal to twice the width of the member being connected. Locate joints in walls and columns at the underside of floors, slabs, beams, or girders and at tops of footing or floor slabs.

- C. Cast slabs and beams monolithically without horizontal joints unless specifically indicated on the drawings.
- D. Do not use horizontal joints within foundation mats, base slabs, footings, pile caps, slabs on grade, or elevated beams and slabs.
- E. Provide joints in concrete fills and toppings at the same location as the joints in the supporting concrete.
- F. Provide waterstops in all wall and slab joints in liquid containment structures and at locations shown on the Contract Drawings. Do not provide metal waterstops unless permitted by Engineer.
- G. Construction Joints
1. Provide 6-inch wide, flat ribbed waterstops at construction joints where shown on Contract Drawings and specified herein, unless otherwise noted.
 2. Allow 48 hours between pours of adjacent slabs.
 3. Provide keyways at all construction joints. Form the keyways with beveled strips or boards placed at right angles to the formed face. Except where otherwise shown on Contract Drawings or specified, keyways shall be at least 1-1/2 inches in depth over at least 25 percent of the section width.
 4. After the pour has been completed to the construction joint and the concrete has hardened, thoroughly clean the entire joint surface of surface laitance, loose concrete and foreign material. Expose clean aggregate by sandblasting or waterblasting the surface of construction joints before placing the new concrete.
 5. In case of emergency, place additional construction joints. (A 45-minute interval between two consecutive concrete batches shall constitute cause for an emergency construction joint.)
- H. Contraction Joints
1. Provide 6-inch wide waterstop with center-bulb at contraction joints where shown on Contract Drawings and specified herein, unless otherwise noted.
 2. Where specifically noted on the Contract Drawings, coat the concrete surface with a bond breaker prior to placing new concrete against it. Avoid coating reinforcement or waterstops with bond breaker at these locations.
 3. Full contraction joints
 - a. Do not continuously extend reinforcement or other embedded items bonded to the concrete (except dowels bonded on only one side of joint) through any full contraction joint.
 - b. Where shown on Contract Drawings, provide steel expansion joint dowels. Use rigid ties to tightly secure steel the expansion joint dowels in the forms. Orient the dowels to permit joint movement.

4. Partial contraction joints
 - a. Extend every other reinforcement steel bar through partial contraction joints or as indicated on the drawings.

I. Control joints

1. Do not provide control joints in liquid containment structures.
2. Locate control joints as shown on the Contract Drawings.
3. Form control joints with control joint inserts or saw-cuts.
4. For saw-cutting
 - a. Using early entry saws, saw joints in slabs before uncontrolled cracking forms (i.e., cracking that occurs at locations other than construction, control, or contraction joints) and as soon as the concrete has sufficiently hardened to permit cutting without chipping, spalling, or tearing.
 - b. Fill saw-cut to full depth with elastomeric joint sealant for joints not exposed to vehicular traffic. Fill joints to full depth with epoxy joint sealant for joints exposed to vehicular traffic.
5. Unless noted otherwise on the Contract Drawings, total reduction in concrete member thickness shall be at least 1/4 the member thickness.

J. Expansion joints

1. The size and location for expansion joints shall be as shown on the Drawings.
2. Provide center-bulb waterstop at expansion joints where shown on Contract Drawings and specified herein. Waterstop shall be PVC or rubber, dumbbell or serrated 9-inch wide by 3/8-inch thick at center with 3/4-inch inside diameter hollow center bulb unless otherwise noted.
3. Do not continuously extend reinforcement or other embedded items bonded to the concrete through any expansion joint, except dowels bonded on only one side of joint.
4. Install stainless steel expansion joint dowels parallel to wall or slab face, perpendicular to the joint face, and in true horizontal position. Align stainless steel expansion joint dowels as indicated in Contract Drawings. Use rigid ties to tightly secure stainless steel expansion joint in forms. Orient dowels to permit joint movement.

3.03 INSTALLATION OF JOINT SEALANTS

- A. Immediately before installing the joint sealant, clean the joint cavity by sandblasting or power wire brushing. Install bond breaker tape per manufacturer's instructions.
- B. Apply masking tape along exposed joint surface edges.
- C. Application criteria for the sealant materials, such as temperature and moisture requirements and primer cure time, shall be in accordance with the sealant manufacturer's recommendations.

- D. After the joints have been prepared as described above, apply the joint sealant. Apply the primer, if required, and joint sealant only using the equipment and methods recommended by the joint sealant manufacturer.
- E. Trowel the joints smooth with a tuck pointing tool wiped with a solvent recommended by the sealant manufacturer.
- F. After the sealant has been applied, remove the masking tape and any sealant spillage.
- G. Sealants used in water retaining structures shall achieve final cure at least seven days before the structure is filled with water.

3.04 LEAKAGE TESTING

- A. Test hydraulic structures in accordance with Section 03 05 10.

3.05 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 03 21 00

REINFORCEMENT BARS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide concrete reinforcement as indicated and specified.

1. Section includes
 - a. Reinforcement bars
 - b. Welded wire reinforcement
 - c. Reinforcement accessories

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. A82: Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
2. A184: Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
3. A185/A185M: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
4. A496: Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement
5. A497: Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete Reinforcement
6. A555: Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods
7. A615: Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
8. A616: Standard Specification for Rail-Steel Deformed and Plain Bars for Concrete Reinforcement
9. A617: Standard Specification for Axle-Steel Deformed and Plain Bars for Concrete Reinforcement.
10. A706: Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
11. A767: Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement

- B. American Concrete Institute (ACI)
1. 301: Standard Specification for Structural Concrete
 2. 315: Details and Detailing of Concrete Reinforcement
 3. 318: Building Code Requirements for Structural Concrete
 4. 350: Building Code Requirements for Environmental Engineering Concrete Structures
 5. SP-66: ACI Detailing Manual
- C. Concrete Reinforcing Steel Institute (CRSI)
1. Manual of Standard Practice
 2. Placing Reinforcing Bars
- D. American Welding Society (AWS)
1. D1.4: Structural Welding Code, Reinforcement Steel
- E. Where reference is made to one of the above standards, the version in effect at the time of bid opening shall apply.

1.03 SUBMITTALS

- A. Unless otherwise acceptable to the Engineer, each submittal shall include reinforcement only for the individual structure to which it pertains.
- B. Shop Drawings
1. Submit bar lists and placing drawings for all reinforced concrete and masonry structures in accordance with Section 01 33 00.
 2. Detail reinforcement in conformance with ACI SP-66.
 3. Clearly indicate bar sizes, spacings, locations, and quantities for reinforcement steel and wire reinforcement, bending schedules, and supporting and spacing devices. Show joints with applicable joint reinforcement.
 4. Coordinate bar splicing and placement with Contractor's concrete placing schedule and joint locations. Do not add or delete joints without permission from the Engineer.
 5. Show wall reinforcement in elevation.
 6. Show slab reinforcement in plan view.
 7. Show location and size for all penetrations greater than 12-inch diameter or least dimension of the opening with the corresponding added reinforcement around the penetrations.
 8. Clearly show marking for each reinforcement item.
 9. Indicate locations for reinforcement bar cut-offs, splices, and development lengths.

- C. Submit Certificates. Submit AWS qualification certificates for welders employed on the work for the appropriate electrode and class of material. Testing shall be conducted and witnessed by an independent testing laboratory prior to welding reinforcement in work. Maintain qualification and certification records at the job site where they are readily available for examining test results.
- D. Submit certified copies of mill test reports of reinforcement analysis dated within the last three months for each reinforcement shipment. Identify specific lots in shipments.
- E. Submit the chemical composition of reinforcement steel via ladle analysis indicating the percentage of carbon, phosphorous, manganese, and sulfur present in steel.
- F. Where mechanical couplers are required or permitted to be used to splice reinforcement steel, submit manufacturer's literature that contains instructions and recommendations for:
 - 1. Installing each coupler type used
 - 2. Certified test reports verifying the load capacity for each type and size of coupler used
 - 3. Shop drawings showing the location for each coupler with details on how they are to be installed in the formwork

1.04 QUALITY ASSURANCE

- A. Comply with requirements in Section 01 43 00 and as specified.
- B. Do not fabricate reinforcement until shop and placement drawings have been reviewed and accepted by the Engineer.
- C. Perform concrete reinforcement work in accordance with CRSI Manual of Practice and ACI SP-66.
- D. An independent testing agency shall be retained by the Contractor and accepted by Metro to perform the following:
 - 1. Inspect each mechanical coupler and verify that each component is installed in accordance with the manufacturer's instructions and ICC Evaluation Services Report or equivalent code agency report.

1.05 QUALIFICATIONS

- A. Welders: AWS qualified within previous 12 months

1.06 INSPECTION AND TESTING

- A. Do not cover any reinforcement steel with concrete until the reinforcement installation has been observed by the Construction Manager and the Construction Manager's authorization to proceed with the concreting has been obtained. The Construction Manager shall be given 48 hours minimum prior notice about the readiness of placed reinforcement for observation. The forms shall be kept open until the Construction Manager has finished observing the reinforcement steel.

1.07 DELIVERY STORAGE AND HANDLING

- A. Comply with the requirements in Section 01 66 10.

- B. Keep reinforcement steel free from mill scale, rust, dirt, grease, or other foreign matter.
- C. Ship and store reinforcement steel with bars of the same size and shape fastened in bundles with durable tags, marked in a legible manner with waterproof markings showing the same "mark" designations as those shown on the submitted placing drawings.
- D. Store reinforcement steel off the ground, protected from moisture, and kept free from dirt, oil or other injurious contaminants.

PART 2 - PRODUCTS

2.01 REINFORCEMENT STEEL

- A. Reinforcement Steel: ASTM A615/A615M, 60 ksi yield grade; deformed billet steel bars
- B. Spiral reinforcement shall be cold-drawn steel wire conforming to ASTM A82 requirements.
- C. Welded Wire Reinforcement
 - 1. Provide welded wire reinforcement conforming to ASTM A185 in flat sheets.
 - 2. Provide support bars and reinforcement bar supports as specified herein to obtain the concrete cover indicated.
 - 3. Provide welded wire reinforcement heavier than W2.9 in flat sheets.

2.02 ACCESSORY MATERIALS

- A. Tie Wire: Minimum 16-gauge annealed type
- B. Chairs, Bolsters, Bar Supports, and Spacers: Sized and shaped for strength and support of reinforcement during concrete placement including load-bearing pad on bottom of base slabs and slabs on grade to prevent puncturing the vapor retarder
- C. Special Chairs, Bolsters, Bar Supports, and Spacers Adjacent to Weather Exposed Concrete Surfaces: Plastic-coated steel type; size and shape
- D. Provide 3-inch-by-3-inch plain precast concrete blocks, precast concrete doweled blocks, or concrete brick to support bottom reinforcement in foundation mats, base slabs, footings, pile caps, grade beams, and slabs on grade. Provide block thickness to produce concrete cover of reinforcement as indicated.
- E. Mechanical Couplers
 - 1. Reinforcement Tension Bar Splicers
 - a. Manufacturers: Cadweld or Lenton rebar splicers by Erico Products, Inc., and Dayton Barsplice, Inc.
 - b. Manufacturers: DB-SAE splicer system by Richmond Screw Anchor Company, Inc.; C2D rebar flange coupler by Williams Form Engineering Corporation; and Lenton Form Saver by Erico Products, Inc.

- c. Develop minimum 125 percent of yield capacity of bars spliced in tension when tested as assembly in accordance with ASTM A370 and A615.

F. Reinforcement Compression Bar Splicers

1. Manufacturers: G-Loc splicers by Gateway Building Products Division and Speed-Sleeve by Erico Products, Inc.

2.03 FABRICATION

- A. Fabricate concrete reinforcement in accordance with CRSI Manual of Standard Practice and ACI SP-66.
- B. Weld reinforcement in accordance with AWS D1.4 only when permitted by the Engineer.
- C. Locate reinforcement splices not indicated on drawings, at point of minimum stress.
- D. Cold bend bars. Do not straighten or rebend bars.
- E. Do not heat reinforcement steel to bend or straighten.
- F. Bend bars around a revolving collar having a diameter of not less than that recommended by ACI 318.
- G. Cut bar ends that are to be butt spliced or threaded by saw cutting. Terminate such ends in flat surfaces within 1-1/2 degrees of a right angle to the bar's axis.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Place, support, and secure reinforcement against displacement. Do not deviate from required position. Place reinforcement with a minimum of 2" of clearance from any metal pipe or fittings.
- B. Do not displace or damage vapor retarder.
- C. Accurately position dowels. Rigidly support, align, and securely tie dowels normal to the concrete surface before concrete placement. Setting dowels into wet concrete is prohibited.
- D. Bars additional to those indicated that may be found necessary or desirable by the Contractor to secure reinforcement in position shall be provided by the Contractor at no additional cost to Metro.
- E. Do not extend continuous reinforcement or other fixed metal items through expansion joints. Provide 2" of clearance from each expansion joint face.
- F. Provide additional reinforcement bars to support top reinforcement in slabs. Do not shift reinforcement bars from positions in upper layers to positions in lower layers as a substitute for additional support bars.
- G. Support reinforcement steel in accordance with CRSI "Placing Reinforcement Bars" with maximum spacing of 4' 0".

- H. Tie reinforcement steel at intersections in accordance with CRSI “Placing Reinforcement Bars.”
1. Maximum tie spacing for footings, walls, and columns shall be every third intersection or 3’ 0”.
 2. Maximum spacing for slabs and other work shall be every fourth intersection or 3’ 0”.
 3. Tie a minimum of 25 percent of all intersecting bars in foundation mats, base slabs, footings, pile caps, slabs on grade, and elevated slabs.
 4. Secure all dowels in place before placing concrete.
 5. Tie wires shall be bent away from the forms and from finished concrete surfaces to provide the required concrete coverage.
- I. Locate reinforcement to avoid interference with items drilled in later, such as concrete anchors.
- J. Extend welded wire reinforcement to within 2” of the slab or section edges. Lap sheets at least 12” or two wire spaces, whichever is greater, and at ends and edges and wire tightly together. Stagger end laps.
- K. Unless shown otherwise on Drawings, place welded wire reinforcement in slabs on grade between the slab’s upper third point and mid-point. Placing welded wire reinforcement on the subgrade and pulling it up during concrete placement is not permitted.
- L. Support welded wire reinforcement placed over the ground on wired concrete blocks spaced not more than 3’ on center in any direction.
- M. Support welded wire reinforcement placed over horizontal forms on slab bolsters spaced not more than 30” on center.
- N. Mechanical coupler systems may be substituted for dowels at Contractor’s option when permitted by Engineer.
- O. Provide additional reinforcement bars to support ties and stirrups in beams where top reinforcement is not continuous.
- P. Securely support and tie reinforcement steel to prevent movement during concrete placement.
- Q. Ship, handle, and place stainless steel reinforcement bars so they do not come into direct contact with carbon steel. Use stainless steel or non-metallic tie wires and bar chairs. Use nylon, PVC, or polyethylene spacers where stainless steel bar must be attached to carbon steel, to maintain a minimum 1-inch clearance.
- R. Unless otherwise shown on the Drawings or permitted by the Engineer, do not bend reinforcement bars that project from in-place concrete.
- S. Do not weld reinforcement steel bars (including tack welded) during either fabrication or erection unless specifically shown on the Drawings or specified herein or unless prior written permission has been obtained from the Engineer. Immediately remove from the work any bars that have been welded, including tack welds, without such permission. Comply with AWS D1.4 when welding of reinforcement is necessary.

- T. Reinforcement steel interfering with the location of other reinforcement steel, conduits, or embedded items may be moved up to 2". Make greater bar displacements to avoid interference only with the Engineer's permission. Do not cut reinforcement to install inserts, conduits, mechanical openings, or other items without the Engineer's prior permission.
- U. Reinforcement shall be clean and free from loose mill scale, dirt, grease, oil, form release agent, dried concrete, or any material-reducing bond with concrete.
- V. Setting bars and welded wire reinforcement on layers of fresh concrete as the work progresses or adjusting reinforcement during concrete placement is prohibited.
- W. Provide and place safety caps on all exposed vertical reinforcement ends that pose a danger to injury or life safety.

3.02 CONCRETE COVER OVER REINFORCEMENT BARS

- A. Conform to ACI 318 and ACI 350 for concrete cover over reinforcement.

3.03 REINFORCEMENT AROUND OPENINGS AND PENETRATIONS

- A. Accommodate placement of formed openings and penetrations.
- B. Unless specific additional reinforcement around openings and penetrations is shown on the Drawings, provide additional reinforcement steel on each side of opening or penetration equivalent to one half of the cross-sectional area of the reinforcement steel interrupted by an opening or penetration. The bars shall have sufficient length to be fully developed at each end beyond the opening or penetration.
- C. Refer to Drawing details for additional diagonal bars around openings or penetrations and bar extension length on each side of openings or penetrations.
- D. Where welded wire reinforcement is used, provide extra reinforcement using welded wire reinforcement or deformed bars around openings or penetrations.

3.04 SPLICING REINFORCEMENT

- A. Splices may be used to provide continuity due to bar length limitations. Do not splice reinforcement the Drawings detail to be continuous.
- B. Provide tension lap splices at all laps in compliance with ACI 318. Use Class B splices at all locations.
- C. Except as otherwise indicated on the Drawings, stagger splices in circumferential reinforcement in circular walls using Class B tension splices. Do not splice adjacent bars within the required lap length.
- D. Make splices for reinforcement in tension tie members, with a full mechanical or full welded splice and staggered at least 30".
- E. Make splices in column spiral reinforcement, when necessary, by a lap of 1-1/2 turns.
- F. Make reinforcement continuous through construction joints.
- G. Reinforcement may be spliced at construction joints provided the entire lap is placed within only one concrete placement.

3.05 ACCESSORIES

- A. Provide accessories such as chairs, chair bars, and the like in sufficient quantities and strength to adequately support the reinforcement and to prevent its displacement while erecting the reinforcement and placing concrete.
- B. Use precast concrete blocks where the reinforcement steel is to be supported over soil.
- C. Provide stainless steel bar supports or steel chairs with plastic tips where the chairs are set on forms for a concrete surface that will be exposed to weather, high humidity or liquid (including bottom of slabs over liquid containing areas) unless otherwise noted on contract documents.
- D. Do not use metal chairs, ferrous clips, nails, etc., that extend to the concrete surface. Do not use stones, brick, or wood block supports.
- E. Do not use alternate methods to support top steel in slabs, such as steel channels supported on the bottom steel or vertical reinforcement steel fastened to the bottom and top mats, unless permitted by the Engineer.
- F. Mechanical Couplers
 - 1. Couplers located at a joint face can be a type that is set either flush or recessed from the face as indicated on the Drawings.
 - 2. Seal couplers during concrete placement to completely eliminate concrete or cement paste from entering.
 - 3. Recess couplers intended for future connections a minimum of 1/2 inch from the concrete surface. After the concrete is placed, plug the coupler with plastic plugs that have an O-ring seal and the recess filled with sealant to prevent any contact with water or other corrosive materials.
 - 4. Unless indicated otherwise, provide mechanical coupler spacing and size to match the spacing and size of the reinforcement indicated for the adjacent section.

3.06 FIELD QUALITY CONTROL

- A. Remove reinforcement with kinks or bends not shown on shop or placement drawings. Remove such reinforcement from job site and replace with new fabricated steel. Do not field bend reinforcement, unless reinforcement is indicated or specified to be field bent.
- B. Protect reinforcement from rusting, deforming, bending, kinking, and other injury. Clean in-place reinforcement that has rusted or been splattered with concrete using sand or water blasting prior to incorporating into the work.

3.07 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 03 30 00

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment, and incidentals necessary to furnish and install cast-in-place concrete as specified and as shown on Drawings or as required to replace curbs, gutters, sidewalks, driveway ramps, driveways, and other concrete improvements disturbed in the course of the Work.

1.02 REFERENCES

A. American Concrete Institute (ACI)

1. 211.1: Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
2. 214R: Recommended Practice for Evaluation of Strength Test Results of Concrete
3. 301: Standard Specifications for Structural Concrete
4. 304R: Guide for Measuring, Mixing, Transporting and Placing Concrete
5. 304.2R: Placing Concrete by Pumping Methods
6. 305R: Hot Weather Concreting
7. 306R: Cold Weather Concreting
8. 308: Standard Practice for Curing Concrete
9. 309R: Guide for Consolidation of Concrete
10. 311.4R: Guide for Concrete Inspection
11. 318: Building Code Requirements for Structural Concrete
12. 350: Code Requirements for Environmental Engineering Concrete Structures

B. American Society for Testing and Materials (ASTM)

1. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
2. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
3. C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field
4. C33: Standard Specification for Concrete Aggregates

5. C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
6. C40: Standard Test Method for Organic Impurities in Fine Aggregates for Concrete
7. C42: Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
8. C87: Standard Test Method for Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
9. C88: Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
10. C94: Standard Specification for Ready-Mixed Concrete
11. C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch Cube Specimens)
12. C123: Standard Test Method for Lightweight Particles in Aggregate
13. C136: Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
14. C138: Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
15. C143: Standard Test Method for Slump of Hydraulic Cement Concrete
16. C150: Standard Specification for Portland Cement
17. C157: Standard Test Method for Length Change of Hardened Hydraulic Cement, Mortar and Concrete
18. C171: Standard Specification for Sheet Materials for Curing Concrete
19. C172: Standard Practice for Sampling Freshly Mixed Concrete
20. C192: Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory
21. C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
22. C260: Standard Specification for Air-Entraining Admixtures for Concrete
23. C289: Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
24. C295: Standard Guide for Petrographic Examination of Aggregates for Concrete
25. C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
26. C311: Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete

27. C494: Standard Specification for Chemical Admixtures for Concrete
28. C595: Standard Specification for Blended Hydraulic Cements
29. C618: Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
30. C881: Standard Test Method for Epoxy Resin Base Bonding Systems for Concrete
31. C882: Standard Test Method for Bond Strength of Epoxy Resin Systems Used with Concrete by Slant Shear
32. C1017: Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
33. C1064: Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete
34. C1107: Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
35. C1116: Standard Specification for Fiber Reinforced Concrete
36. D75: Standard Practice for Sampling Aggregates
37. E154: Test Methods for Water Vapor Retarders Used in Contact with Earth under Concrete Slabs, on Walls, or as Ground Cover
38. E1745: Standard Specification for Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
39. E329: Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials used in Construction

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

1. M182: Standard Specification for Burlap Cloth Made from Jute or Kenaf and Cotton Mats

1.03 SUBMITTALS

A. Submit shop drawings in accordance with Section 01 33 00.

B. Plant Certification

1. Submit certification that the plant or concrete supplier shall comply with the requirements of the National Ready Mixed Concrete Association (NRCMA) certification plan as regards to material storage and handling, batching equipment, central mixer, truck mixers with counters, agitators, non-agitating units, and the ticketing system.

C. Product Data

1. Provide manufacturer's specifications and instructions including Material Safety Data Sheets (MSDS) for admixtures and curing materials. Also, supply the manufacturer's compatibility certification for all admixtures.

D. Shop Drawings

1. Provide certification stating the cement used complies with ASTM C150.
2. Provide certification stating the aggregates comply with ASTM C33. Submit gradation analysis with concrete mix designs.
3. Provide manufacturer's certification stating the concrete admixtures comply with these specifications.
4. Prepare mix designs in accordance with ACI 318, Chapters 4 and 5, except as modified herein.
 - a. Submit concrete mix designs, laboratory 7-day and 28-day compressive tests results, and laboratory shrinkage test results for review and acceptance by the Engineer.
 - b. Alternatively, submit test reports from 7-day and 28-day compressive tests results and shrinkage test results for the proposed mix, where that same mix has been used on two previous projects in the past 12 months.
5. Submit proposed special procedures for protecting concrete under wet weather placement conditions.
6. Submit proposed special procedures for protecting and curing concrete under hot and cold weather conditions and procedures that will prevent plastic shrinkage cracking.

E. Test and Evaluation Reports

1. Provide drying shrinkage test results from trial concrete mixes by the Contractor's testing laboratory firm.

F. Manufacturers' Instructions

1. Provide epoxy bonding compound manufacturer's specific instructions for use.
2. Provide manufacturer's data sheets for product's suitability to meet job requirements with regard to surface, pot life, set time, vertical or horizontal application, and forming restrictions.

G. Field Quality Control Submittals

1. Provide delivery tickets for ready-mix concrete or weighmasters certificate per ASTM C94, including weights for cement and each size aggregate, water amount added at the plant, and placement records.
2. Record the water amount added on the job on the delivery ticket. Water added at the plant shall account for moisture in coarse and fine aggregate and liquid admixtures.

1.04 SHRINKAGE TESTS

- A. The testing laboratory shall perform drying shrinkage tests for the trial batches as specified herein. Shrinkage limitations apply only to structural concrete used in containment structures.

- B. Fabricate, cure, dry, and measure specimens in accordance with ASTM C157 modified as follows.
1. Remove specimens from molds at an age of 23 hours \pm 1 hour after trial batching.
 2. Place specimens immediately in water at 70 °F \pm 3 °F for at least 30 minutes.
 3. Measure within 30 minutes thereafter to determine original length, then submerge in saturated lime water at 73 °F \pm 3 °F.
 4. At age seven days, measure to determine expansion, expressed as a percentage of original length. This length at age seven days shall be the base length for drying shrinkage calculations (zero days' drying age).
 5. Store specimens immediately in a humidity-controlled room maintained at 73 °F \pm 3 °F and 50 percent \pm 4 percent relative humidity for the remainder of the test.
 6. Make and report separately measurements to determine shrinkage expressed as base length percentage for 7, 14, 21, and 28 days of drying after 7 days of moist curing.
- C. Compute the drying shrinkage deformation for each specimen as the difference between the base length (at zero days' drying age) and the length after drying at each test age. Compute the average drying shrinkage deformation for the specimens to the nearest 0.0001 inch at each test age. If the drying shrinkage for any specimen departs from the average test age for that test by more than 0.0004 inch, disregard the results obtained from that specimen. Report results from the shrinkage test to the nearest 0.001 percent of shrinkage. Take compression test specimens in each case from the same concrete used for preparing drying shrinkage specimens. These tests shall be considered part of the normal compression tests for the project.
- D. The maximum concrete shrinkage for specimens cast in the laboratory from the trial batch, as measured at 21-day drying age or at 28-day drying age, shall be 0.036 or 0.042 percent, respectively. Use a mix design for construction that has first met the trial batch shrinkage requirements.
- E. If the trial batch specimens do not meet both the strength and shrinkage requirements, revise the mix designs and/or materials and retest.

1.05 QUALITY ASSURANCE

- A. Provide in accordance with Section 01 43 00.
- B. Unless otherwise indicated, materials, workmanship, and practices shall conform to the following standards:
1. Local building codes
 2. ACI 301: Structural Concrete for Buildings
 3. ACI 318: Building Code Requirements for Reinforced Concrete
 4. ACI 350: Code Requirements for Environmental Engineering Concrete Structures
- C. Where provisions for pertinent codes and standards conflict with this specification, the more stringent provisions shall govern.

- D. Concrete not meeting the minimum specified 28-day design strength shall be cause for rejection and removal from the work.
- E. Perform concrete work in conformance with ACI 301 unless otherwise specified.
- F. Do not use admixtures including calcium chloride, which will cause accelerated cement setting in concrete.
- G. Do not place concrete until the Engineer has accepted the design mix, material tests, and trial concrete batch mix compression and shrinkage test results.
- H. Employ an independent testing laboratory, acceptable to Metro, to develop concrete mix designs and testing. Concrete testing shall be performed by an ACI certified Concrete Field Technician, Grade I, or equivalent.
- I. Contractor shall employ an independent testing laboratory to test material conformity to specifications. Concrete testing shall be performed by an ACI certified Concrete Field Technician, Grade I, or equivalent. Allow free access to obtain test samples.
- J. Methods for Sampling and Testing
 1. Fresh Concrete Sampling: ASTM C172
 2. Specimen Preparation: ASTM C31
 3. Compressive Strength: ASTM C39
 4. Air Content: ASTM C231
 5. Slump: ASTM C143
 6. Temperature: ASTM C1064
 7. Unit Weight: ASTM C138
 8. Obtaining Drilled Cores: ASTM C42
 9. Drying Shrinkage: ASTM C157
- K. Structure Acceptance: Acceptance for completed concrete work requires conformance with dimensional tolerances, appearance, and strength as indicated or specified.
- L. Hot weather concrete shall conform to ACI 305R and as specified herein.
- M. Cold weather concrete shall conform to ACI 306R and as specified herein.
- N. Reject concrete delivered to job site that exceeds the time limit or temperature limitations specified.
- O. Do not place concrete in water or on frozen or uncompacted ground.

P. Workability

1. Concrete shall be of such consistency and composition that it can be worked readily into the forms and around the reinforcement without excessive vibrating and without permitting the materials to segregate or free water to collect on the surface.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide in conformance with Section 01 66 10 and as specified herein.
- B. Deliver concrete to discharge locations in watertight agitator or mixer trucks without altering the specified properties of water-cement ratio, slump, air entrainment, temperature, and homogeneity.
- C. Reject concrete not conforming to specification, unsuitable for placement, exceeding the time or temperature limitations, or not having a complete delivery batch ticket.

1.07 SITE CONDITIONS

- A. Do not place concrete until conditions and facilities for making and curing control test specimens are in compliance with ASTM C 31 and as specified herein.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Cement

1. Portland Cement, ASTM C150, Type II
2. Use only one cement brand in any individual structure. Use no cement that has become damaged, partially set, lumpy, or caked. Reject the entire contents of the sack or container that contains such cement. Use no salvaged or reclaimed cement.
3. Maximum tricalcium aluminate shall not exceed 8 percent. The maximum percent alkalis shall not exceed 0.6 percent.

B. Fly Ash

1. Provide fly ash conforming to the following requirements:
 - a. Class F fly ash conforming to ASTM C 618 for chemical and physical properties
 - b. Supplemental requirements in percent
 - 1) Maximum carbon content: 3 percent
 - 2) Maximum sulfur trioxide (SO₃) content: 4 percent
 - 3) Maximum loss on ignition: 3 percent
 - 4) Maximum water requirement (as a percent of control): 100 percent
 - 5) Fineness, maximum retained on No. 325 sieve: 25 percent

2. Fly ash used in concrete that contacts potable water shall be certified as meeting ANSI/NSF 61 requirements.

C. Fine Aggregates

1. Clean, sharp, natural sand conforming to ASTM C33 requirements with a fineness modulus between 2.50 and 3.0

D. Coarse Aggregate

1. Well graded crushed stone, natural rock conforming to ASTM C33 requirements
2. Limit deleterious substances in accordance with ASTM C33, Table 3, Severe Weathering Regions. Limit clay lumps not to exceed 1.0 percent by weight. Limit loss when tested for soundness using magnesium sulfate to 12 percent.
3. Test aggregate conformity and confirm that the aggregates intended for use in concrete are potentially non-reactive when tested in conformance with ASTM C289.

E. Water and Ice

1. Use water and ice free from injurious amounts of oil, acid, alkali, salt, organic matter, or other deleterious substances and conforms to ASTM C94 requirements.
2. Water shall not contain more than 500 mg/L of chlorides or more than 500 mg/L of sulfate.
3. Heat or cool water to obtain specified concrete temperatures conforming to ACI 305R and ACI 306R.

F. Color Additive for Exterior Electrical Duct Encasement

1. For exterior electrical duct concrete encasements, use a red color additive for identification purposes.

G. Concrete Admixtures

1. Maintain compressive strength and maximum water-cement ratios specified in Table 03 30 00-1 when using admixtures. Include admixtures in solution form in the water-cement ratio calculations.
2. Do not use any admixture that contains chlorides or other corrosive elements.
3. Use admixtures in compliance with the manufacturer's printed instructions. The manufacturer shall certify the compatibility of multiple admixtures used in the same mix. Do not use admixtures in greater dosages than recommended by manufacturer.
4. Air Entrainment
 - a. Air-entraining admixture shall conform to ASTM C260.
 - b. Products
 - 1) BASF Corporation, MB-AE 90

- 2) Sika Corporation, AER
- 3) WR Grace & Co., Darex II-AEA
- 4) Or accepted equivalent product
- c. To obtain the specified air content, adjust the admixture content to accommodate fly ash or pozzolan requirements and other admixtures when used.
5. Water Reducing
- a. Water-reducing admixture shall conform to ASTM C494, Type A and be compatible with the air-entraining admixture. The admixture amount added to the concrete shall be in accordance with the manufacturer's recommendations.
- b. Products
- 1) BASF Corporation, Polyheed Series
- 2) Sika Corporation, Plastocrete 161
- 3) Euclid Chemical Company, Eucon NW
- 4) Or accepted equivalent product
6. Water Reducing and Retarding
- a. Water-reducing and retarding admixture shall conform to ASTM C494, Type D and be compatible with the air-entraining admixtures. The admixture amount added to the concrete shall be in accordance with the manufacturer's recommendations. Admixture use requires specific Engineer approval and only for extreme hot temperatures for placement consideration.
- b. Products
- 1) BASF Corporation, Pozzolith Series
- 2) Sika Corporation, Plastiment
- 3) Euclid Chemical Company, Eucon WR-91
- 4) Or accepted equivalent product
7. High-Range Water-Reducing Admixture (Superplasticizer)
- a. High-range water-reducing admixture shall conform to ASTM C494, Type F, or ASTM C1017, Type I.
- b. Products
- 1) BASF Corporation, Glenium Series
- 2) WR Grace & Co., Daracem 100
- 3) Euclid Chemical Company, Eucon SPC

- 4) Or accepted equivalent product

8. Shrinkage Reducing Admixture

- a. Shrinkage-reducing admixture is permitted to be used in the mix to meet shrinkage limitations provided that the specified strengths are met and there is no reduction in sulfate resistance and no increase in permeability. Quantity for shrinkage-reducing admixture used in the mix shall be added to the water quantity for determining the water/cementitious materials ratio.
- b. Products
 - 1) BASF Corporation, Tetragrad AS20
 - 2) WR Grace & Co., Eclipse
 - 3) Euclid Chemical Company, Eucon SRA
 - 4) Or accepted equivalent product

H. Fiber Reinforcement

1. Fiber reinforcing shall conform to ASTM C 1116, Type III.
2. Fibers shall be macro fibers. Micro fibers are prohibited.
3. Fibers shall be 100 percent virgin polypropylene fibrillated fibers containing no reprocessed olefin materials and specifically manufactured to an optimum gradation for use as concrete secondary reinforcement.
4. The fiber volume shall be a minimum of 1.5 pounds per cubic yard.
5. Physical Characteristics
 - a. Specific gravity: 0.91
 - b. Tensile strength: 40,000 to 110,000 psi
 - c. Fiber length: 1/2-inch to 3/4-inch
6. Fibrous concrete reinforcement materials provided in this Section shall produce concrete conforming to the strength requirements for specified concrete.
7. Provide fiber reinforced concrete where noted.

I. Epoxy Bonding Agent

1. Epoxy bonding agent shall conform to ASTM C881 Type I, II, IV or V, Grade 2 for epoxy resin adhesives. The class of epoxy bonding agent shall be suitable for ambient and substrate temperatures.
2. Products
 - a. Sika Corp., Sikadur 32

- b. Euclid Chemical Company, Duralcrete
 - c. BASF Corporation, Concessive Liquid LPL
 - d. Or accepted equivalent product
3. Vapor Retarder: 10 mil polyethylene sheet conforming to ASTM E1745

J. Curing Compound

1. Using a spray, apply liquid form which will form an impervious membrane over exposed concrete surface when applied to fresh concrete. Compound shall not inhibit future bond of floor covering or concrete floor treatment. Use Type I-D compound with red fugitive dye, Class B, having 18 percent minimum solids conforming to ASTM C309.
2. Products
 - a. BASF Building Systems, Kure 1315
 - b. Euclid Chemical Company, Super Diamond Clear VOX
 - c. W. R. Meadows, Inc., VOCOMP-30
 - d. Dayton Superior Corp, Safe Cure and Seal 30 percent
 - e. Or accepted equivalent product

K. Burlap Mats

1. Conform to AASHTO M182.

L. Sisal-Kraft Paper and Polyethylene Sheets for Curing

1. Conform to ASTM C171.

2.02 MIXES

- A. Conform to ASTM C94, except as modified by these specifications.
- B. Air content as determined by ASTM C231
 1. $5 \pm 1\text{-}1/2$ percent for concrete using 1-1/2 inch maximum aggregate size
 2. $6 \pm 1\text{-}1/2$ percent for concrete using 3/4-inch maximum aggregate size
 3. Concrete exposed to freeze/thaw cycle shall be air entrained.

- C. Provide concrete with the following compressive strengths at 28 days and proportion it for strength and quality requirements in accordance with ACI 318. The resulting mix shall not conflict with limiting values specified in Table 03 30 00-1.

Table 03 30 00-1				
Class	Type of Work	28-Day Minimum Compressive Strength (psi)	Minimum Cementitious Content (lbs per CY)	Maximum Water/Cement Ratio
A	Concrete for all structures and concrete not otherwise specified. Cradle supports across pipe trenches and reinforced pipe encasement.	4,500	600	0.42
B	Pavement, concrete topping	3,000	500	0.54
C	Concrete fill below structure foundations, miscellaneous unreinforced concrete.	2,000	376	0.60
D	Prestressed concrete	5,000	630	0.40
E	Precast concrete	5,000	630	0.40

- D. Measure slump in accordance with ASTM C143.

- Proportion and produce the concrete to have a maximum slump of 4 inches. A tolerance of up to 1 inch above the indicated maximum is allowed for individual batches, provided the average for all batches or the most recent 10 batches tested, whichever is fewer, does not exceed the maximum limit. Concrete with lower than usual slump may be used, provided it is properly placed and consolidated.
- Mixes containing water reducers shall have a maximum 6-inch slump after adding a mid-range water reducer and a maximum 9-inch slump after adding a high range water reducer.

- E. Pozzolan Content

- Fly ash: Use is optional. Combine fly ash with cement at rate of 1.0 lb fly ash/lb reduction in cement. Fly ash shall not exceed 20 percent of the total cementitious content. Water to cementitious ratio shall not exceed water to cement ratio given in Table 03 30 00-1.

- F. Aggregate Size

- Aggregate size shall be 3/4-inch maximum for slabs and sections 8 inches thick and less. Aggregate size shall be 1 inch maximum for sections greater than 8 inches and less than 17 inches. Aggregate size shall be 1-1/2 inches maximum for all larger slabs and sections. Aggregate size for floor topping shall be maximum 3/8-inch.
- Combined aggregate grading shall be as shown in the Table 03 30 00-2.

Table 03 30 00-2				
Maximum Aggregate Size	1-1/2-inch	1-inch	3/4-inch	3/8-inch
Aggregate Grade per ASTM C33	467	57	67	8

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine the subgrade and the conditions under which work is to be performed and notify the Construction Manager in writing about unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected to comply with specified subgrade conditions in a manner acceptable to the Construction Manager.

3.02 MIXING AND TRANSPORTING CONCRETE

- A. General: Conform to concreting procedures set forth in ASTM C94, ACI 304R, and as specified herein.
 1. Transport concrete to discharge locations without altering the specified properties of water-cement ratio, slump, air entrainment, temperature, and homogeneity.
 2. Discharge concrete into forms within 1-1/2 hours after cement has entered mixing drum or before the drum has revolved 300 revolutions after adding water, whichever occurs first.
 3. Do not add water at the job site unless permitted by the Engineer. If it is necessary to add water to obtain the specified slump, add water per ASTM C 94, but do not exceed the maximum water content in the reviewed and accepted concrete design mix. Added water shall be incorporated by additional mixing of at least 35 revolutions.
 4. Do not add water to concrete containing high range water reducing admixture. Do not add water to concrete in delivery equipment not acceptable for mixing.
 5. Keep a record showing time and place for each pour of concrete together with transit-mix delivery slips certifying the contents of the pour.
 6. Discharging concrete shall be completed within the limits set out in Table 03 30 00-3.

Table 03 30 00-3	
Maximum Time to Concrete Discharge	
Concrete Temperature	Limit
Over 90 Degree F	Remove concrete from jobsite and discard concrete
86 to 90 Degree F	45 minutes
81 to 85 Degree F	60 minutes
70 to 80 Degree F	75 minutes
Below 70 Degree F	90 minutes

- B. Conveying: Convey concrete from agitator or mixer truck to place for final deposit in forms by one of the following methods.
 1. Use buckets or hoppers with discharge gates having a clear opening equal to not less than one-third the maximum interior horizontal area or five times the maximum aggregate size being used, whichever is greater, and side slopes of not less than 60 degrees to horizontal.
 2. Use buggies or wheelbarrows equipped with pneumatic tires.

3. Use round bottom, metal or metal-lined chutes with inclined slope between 2 to 3 feet horizontally to 1 foot vertically and with sufficient capacity to avoid overflow.
4. Use circular drop pipes with a top diameter of at least eight times the maximum aggregate size, but not less than 6 inches, or tapered to not less than six times maximum aggregate size.

3.03 CONCRETE ACCEPTANCE

- A. Accept or reject each concrete batch delivered to the point of agitator or mixer truck discharge. Sign delivery batch tickets to indicate concrete acceptance.
- B. Reject concrete delivered without a complete concrete delivery batch ticket as specified herein. The concrete supplier will furnish copies of the signed batch ticket to the Contractor and Construction Manager.
- C. Accept or reject concrete on the basis of conformity with slump, air content, and temperature specified.
- D. The testing agency shall inspect concrete transit truck's barrel revolution counter and gauge for measuring water added to the concrete. Reject concrete that exceeds the maximum 300 barrel revolutions, the limits in Table 03 30 00-3 or concrete with water content exceeding the specified water-cement ratio.
- E. Reject concrete not conforming to specification before discharging into the forms.

3.04 PREPARATION AND COORDINATION

- A. Contractor shall notify the Construction Manager about the readiness to place concrete in any portion of the work a minimum of 3 working days prior to concrete placement. Failure to provide this notification will be cause for delay in placing until observations can be completed.
- B. Reinforcement, waterstop installation, positioning embedded items, and formwork condition will be observed by the Construction Manager prior to concrete placement.
- C. Coordinate the placement sequence so the construction joints will occur only where indicated on Drawings.
- D. Schedule sufficient equipment for continuous concrete placement. Provide for backup equipment and procedures to be implemented in case of an interruption in placement. Provide backup concrete vibrators at the project site. Test concrete vibrators the day before placing concrete.
- E. Compact the subgrade and/or bedding. Saturate the subgrade approximately 8 hours before placement and sprinkle water ahead of the concrete placement in areas where vapor barrier is not used. Remove standing water, mud, and foreign matter before concrete is deposited.
- F. Where shown on Drawings, intentionally roughen set concrete surfaces in a manner to expose bonded aggregate uniformly at joints.
- G. Provide concrete mud slabs when constructing below-grade slabs on earthen soils to obtain a dry and stable working platform for slab placement.

- H. When shown on Drawings, install a granular base beneath slabs on ground. Place granular material on a compacted subgrade and compact granular base.
- I. Place vapor retarder under structural slabs and buildings and where shown on Drawings. Install material with 6-inch lap at joints and tape joints. Tape material cut for slab penetrations to the pipe, conduit, or other items passing through the slab. Use tape recommended by the vapor retarder manufacturer.
- J. Install vapor retarder without punctures or tears and protect against punctures and breaks.
- K. Where concrete is required to be placed and bonded to existing concrete, coat the contact surfaces with epoxy bonding agent. The method for preparing and applying the bonding agent shall conform to the manufacturer's recommendations.

3.05 CONCRETE PLACEMENT

- A. Placement shall conform to ACI 304R as modified by these specifications.
- B. Alternate concrete wall and slab sections may be simultaneously cast. Do not place adjacent wall and slab sections until 7 days after placing the previously placed concrete.
- C. Do not place concrete until free water has been removed or has been diverted by pipes or other means and carried out of the forms, clear of the work. Do not deposit concrete underwater and do not allow free water to rise on any concrete until the concrete has attained its initial set. Do not permit free or storm water to flow over concrete surfaces so as to injure the quality or surface finish.
- D. Do not place concrete during inclement weather. Protect placed concrete from inclement weather. Keep sufficient protective covering ready at all times for this purpose.
- E. Deposit concrete at or near its final position to avoid segregation caused by rehandling or flowing. Do not deposit concrete in large quantities in one place to be worked along the forms with a vibrator.
- F. Deposit concrete continuously and in level layers 1 to 2 feet thick. Avoid inclined layers and cold joints. Place concrete at a slope's lower portion first on sloping surfaces.
- G. Do not deposit partially hardened concrete in forms. Retempering partially hardened concrete is not permitted. Remove partially hardened concrete from site at no additional compensation.
- H. Do not allow concrete to fall freely in forms and cause segregation (separation of coarse aggregate from mortar). Limit maximum concrete free fall to 4 feet. Do not move concrete horizontally more than 4 feet from discharge point. Space deposit points not more than 8 feet apart.
- I. At least 2 hours shall elapse after depositing concrete in the columns or walls before depositing in beams, girders, or slabs supported thereon. Place beams, girders, brackets, column capitals, and haunches monolithically as part of the floor or roof system, unless otherwise shown on Drawings.
- J. Consolidate concrete using mechanical vibrators operated within the concrete mass and/or on the forms conforming to procedures set forth in ACI 309R and as specified herein.
- K. Conduct vibration to produce a uniform texture and appearance concrete, free from honeycombing, streaking, cold joints, or visible lift lines.

- L. Conduct vibration in a systematic manner with regularly maintained vibrators. Furnish sufficient backup units at job site. Use vibrators having minimum frequency of 8,000 vibrations per minute and of sufficient amplitude to consolidate concrete. Use not less than one vibrator with crew for each 35 to 40 cubic yards of concrete placed per hour.
- M. Insert and withdraw vibrator vertically at a uniform spacing over the entire placement area. Space distances between insertions so the spheres of influence for each insertion overlap.
- N. Use additional vibration with pencil vibrators on vertical surfaces and on exposed concrete to bring full mortar surface against the forms to eliminate air voids, bug holes, and other surface defects. Employ the following additional procedures for vibrating concrete as necessary to maintain proper concrete consolidation.
1. Reduce distance between internal vibration insertions and increase time for each insertion.
 2. Insert vibrator as close to form face as possible without contacting form or reinforcement.
 3. Thoroughly vibrate area immediately adjacent to waterstops without damaging the waterstop.
 4. Use spading as a supplement to vibration where particularly difficult conditions exist.
- O. Pumping Concrete
1. Conform to ACI 304.2R recommendations except as modified herein.
 2. Base the pump size on concrete placement rate, delivery pipe or hose length, aggregate size, mix proportions, vertical lift, and concrete slump.
 3. Use pipe with inside diameter of at least three times the maximum coarse aggregate size, but not less than 2 inches.
 4. Do not use aluminum pipes for delivering concrete to the forms.
- P. Waterstops
1. Prevent waterstop displacement during concrete placement.

3.06 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defective areas repaired and patched. Remove fins and other projections exceeding ACI 347R limits for class of surface specified.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defective areas. Remove fins and other projections exceeding 1/8 inch in height.
1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete such as waterproofing, dampproofing, veneer plaster, or painting.
 2. Do not apply rubbed finish to smooth-formed finish.

- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.07 FINISHING FLOORS AND SLABS

- A. General: Comply with recommendations in ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
 - 1. Apply scratch finish to surfaces indicated and to surfaces to receive concrete floor topping or mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
 - 1. Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, or built-up or membrane roofing.
- D. Trowel Finish: After applying float finish, apply first trowel finish and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
 - 1. Apply a trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, or another thin film-finish coating system
 - 2. Finish surfaces to the following tolerances, measured within 24 hours according to ASTM E 1155/E 1155M for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 35, and levelness, F(L) 25, with minimum local values of flatness, F(F) 24, and levelness, F(L) 17, for slabs-on-grade
- E. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - 1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with the Construction Manager before application.

3.08 CURING AND PROTECTION

- A. General
 - 1. Protect concrete from premature drying, hot or cold temperatures, and mechanical injury beginning immediately after placement and maintain concrete with minimal moisture loss at relatively constant temperature.

2. Comply with curing procedures set forth in ACI 301, ACI 308, and as specified herein.
3. Perform hot weather concreting in conformance with ACI 305R and as specified herein when the ambient atmospheric temperature is 80 °F or above.
4. Perform cold weather concreting in conformance with ACI 306R.
5. Concrete required to be moist-cured shall remain moist for the entire cure duration. Repeated wetting and drying cycles in the curing process will not be allowed.

B. Curing Duration

1. Start initial curing after placing and finishing concrete as soon as free moisture has disappeared from unformed concrete surfaces. Initial curing starts as soon as concrete achieves final set. Forms left tightly in place are considered part of the curing system, provided the wooden forms are kept continuously moist. Keep continuously moist for not less than 72 hours.
2. Begin final curing procedures immediately following initial curing and before the concrete has dried. Continue final curing for at least 7 days and in accordance with ACI 301 procedures for a total curing period, initial plus final, of at least 10 days.
3. Avoid rapid drying at the end of the final curing period.

C. Curing Requirements

1. Unformed Surfaces: Cover and cure entire surface of newly placed concrete immediately after completing finishing operations and water film has evaporated from surface or as soon as concrete marring will not occur. Protect finished slabs from direct sun rays to prevent checking, crazing, and plastic shrinkage.
2. Formed Surfaces: Minimize moisture loss for formed surfaces exposed to heating by the sun by keeping forms wet until safely removed. Keep surface continuously wet using warm water spray or warm water saturated fabric immediately following form removal.
3. Liquid Containment and below Grade Structures: Moist cure by applying water to maintain the surface in a continually wet condition. Use water free from impurities that could etch or discolor exposed concrete surfaces.
4. Other Concrete: Moist cure by moisture-retaining cover curing or by using curing compound.

D. Curing Methods

1. Water Curing: Use water curing for unformed surfaces. Continuously water cure all exposed concrete for the entire curing period. Provide moisture curing using any of the following methods.
 - a. Keep the concrete surface continuously wet by ponding or immersion.
 - b. Use continuous water-fog spray or sprinkling.
 - c. Cover the concrete surface with curing mats. Thoroughly saturate the mats with water and keep the mats continuously wet with sprinklers or porous hoses. Place curing mats so they provide coverage for the concrete surfaces and edges, with a 4-

inch lap over adjacent mats. Weight down the curing cover to maintain contact with the concrete surface.

2. Sealing Materials

- a. Use common sealing materials such as plastic film or waterproofing (Kraft) paper.
- b. Lap adjacent sheets a minimum of 12 inches. Seal edges with waterproof tape or adhesive. Use sufficiently long sheets to cover sides of concrete member.
- c. Place sheet materials only on moist concrete surfaces. Wet the concrete surface with fine water spray before placing sheet material, if the surface appears dry.
- d. Moisture presence on concrete surfaces at all times during the prescribed curing period proves it is acceptable curing using sheet material.

3. Membrane Curing Compound

- a. Apply membrane curing compound uniformly over concrete surface by using a roller or spray at a rate recommended by the curing compound manufacturer, but not less than 1 gallon per 150 sq. ft. of surface area. Agitate curing material in supply container immediately before transferring to distributor and thoroughly agitate it during application for uniform consistency and pigment dispersion.
- b. Do not use curing compounds on construction and expansion joints or on surfaces to receive liquid hardener, dustproofer/sealer, concrete paint, tile, concrete fills and toppings, or other applications requiring positive bond.
- c. Reapply membrane curing compound to concrete surfaces subjected to wetting within 3 hours after curing compound has been applied by initial application method.

E. Protection from Environmental Conditions: Continuously maintain the concrete temperature above 50 °F throughout the curing period. Make arrangements before placing concrete for heating, covering, insulation, or housing to continuously maintain the specified temperature and moisture conditions for the curing period.

1. When the atmospheric temperature is 80 °F and above or during other climatic conditions which will cause the concrete to dry too rapidly, make arrangements before starting concrete placement for installing wind breaks or shading and for fog spraying, wet sprinkling, or moisture retaining covering.
2. Continuously protect the concrete for the entire curing period.
3. Maintain concrete temperature as uniformly as possible and protect from rapid atmospheric temperature changes.
4. Avoid temperature changes in concrete that exceed 5 °F in any one hour and 50 °F in any 24-hour period.

F. Protection from Physical Injury: Protect concrete from physical disturbances such as shock and vibration during curing period. Protect finished concrete surfaces from damage by construction equipment, materials, curing procedures, and rain or running water. Do not load concrete in such a manner as to overstress concrete.

G. Protection from Deicing Agents: Do not apply deicing chemicals to concrete.

3.09 FIELD QUALITY CONTROL

A. Hot Weather Requirements

1. During hot weather, give proper attention to ingredients, production methods, handling, placing, protection, and curing to prevent excessive concrete temperatures or water evaporation in accordance with ACI 305R and the following.
2. When the weather is such that the concrete's temperature as placed would exceed 90 °F, use ice or other means to cool the concrete during mixing and transportation so the concrete's temperature as placed will not exceed 90 °F.
3. Take precautions when placing concrete during hot, dry weather to eliminate early concrete setting. Precautions include
 - a. Protecting reinforcing from direct sunlight to prevent reinforcing from heating
 - b. Placing concrete during cooler hours of the day
 - c. Properly and timely applying specified curing methods
4. There will be no additional reimbursement to the Contractor for costs incurred for placing concrete in hot weather.

B. Cold Weather Requirements

1. Provide adequate equipment for heating concrete materials and protecting concrete during freezing or near-freezing weather in accordance with ACI 306R and the following.
2. When the surrounding atmosphere is 40 °F or is likely to fall below this temperature, use heated mixing water not to exceed 140 °F. Do not allow the heated water to come in contact with the cement before the cement is added to the batch.
3. When placed in the forms during cold weather, maintain concrete temperature at not less than 55 °F. Materials shall be free from ice, snow, and frozen lumps before entering the mixer.
4. Maintain the air and the forms in contact with the concrete at temperatures above 40 °F for the first 5 days after placing and above 35 °F for the remaining curing period. Provide thermometers to indicate the ambient temperature and the temperature 2 inches inside the concrete surface.
5. There will be no additional reimbursement made to the Contractor for costs incurred for placing concrete during cold weather.

C. Backfill Against Walls

1. Do not place backfill against walls until the concrete has obtained a compressive strength equal to the specified 28-day compressive strength. Where backfill is to be placed on both sides of the wall, place the backfill uniformly on both sides.

2. Do not backfill structure walls that will be laterally restrained or supported by suspended slabs or slabs on grade until the slab is placed and the concrete has reached the specified compressive strength.

D. Concrete Testing

1. Concrete quality testing shall be performed on the concrete by an independent testing agency retained by the Contractor.
2. The testing agency will use Contractor-provided concrete samples from the point of agitator or mixer truck discharge to perform slump (per ASTM C143), air content (per ASTM C231), and temperature tests (per ASTM C1064) and for field control test specimens. If concrete is pumped, concrete samples shall be taken at the point of pump discharge.
3. The testing agency will submit test reports for concrete field measurements specified above to the Contractor and to the Construction Manager.
4. Provide and maintain facilities on the project site for safe storage and proper curing of concrete test specimens as required by ASTM C31.
5. Concrete Quality Test Specimen
 - a. Perform test specimen sampling and curing in accordance with ASTM C31.
 - b. Testing agency personnel will record truck and load number from the delivery batch ticket, the concrete placement location of each specimen, the date, concrete strength, slump, air content, and temperature.
 - c. The testing agency will cast a minimum of one set of 5 test specimens, each 4-inch diameter by 8-inch long cylinders, for each 50 cubic yards of each concrete mix design but not less than once a day nor less than once for each 5,000 sq. ft. of surface area for foundation mats, base slabs, footings, pile caps, slabs on grade, grade beams, walls, or elevated slabs.
 - d. Test cylinders in accordance with ASTM C39. Test 1 cylinder at 7 days for information; test 3 cylinders at 28 days for acceptance; and hold 1 reserve cylinder for verification. Strength acceptance will be based on averaging the strengths for the three cylinders tested at 28 days. If one 28-day cylinder test manifests evidence of improper sampling, molding, or testing, other than low strength, discard it and use a reserve cylinder for the test result.
6. Concrete acceptance shall be based on ACI 318 and ACI 350 requirements.
7. Field cured cylinders conforming to ASTM C31 will be required to determine concrete field compressive strength. Laboratory cured cylinders for concrete quality testing shall not be used for determining field compressive strength.
8. Concrete Coring
 - a. When the concrete quality test specimen compression tests fail to comply with the Contract Documents or when the Construction Manager detects deficiencies in the concrete, the Contractor will take concrete cores at least 2 inches in diameter from the structure in conformance with ASTM C42 at locations determined by the Construction Manager.

- b. Obtain at least three representative cores from each concrete member or area considered potentially deficient.
- c. Obtain additional cores to replace cores that show evidence of damage subsequent to or during removal from the structure.
- d. The testing agency shall compression test the cores taken from the structure in conformance with ASTM C39 and submit core test strength test results specified above to the Contractor and to the Construction Manager.
- e. All costs associated with coring and testing of cores will be borne by the Contractor at no additional cost to Metro.

3.10 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 13 16 24

PRESTRESSED CONCRETE TANKS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Design, construct, and test a Type II wire-wound, circular prestressed concrete tank, including the following:
 - 1. Shotcrete walls
 - 2. Steel diaphragm between the water and the prestressing wires
 - 3. Sloped cast-in-place concrete floor
 - 4. Dome roof constructed with reinforced concrete which is circumferentially prestressed
 - 5. All accessories and testing related to the work in accordance with AWWA D110 and as specified
- B. Excavate, backfill, grade, prepare subgrade, and install micropiles or driven H-piles for tank foundations in accordance with the geotechnical investigation report referenced in Division 1, which includes recommendations and is included as part of the Contract Documents herein.

1.02 REFERENCES

- A. American Concrete Institute (ACI)
 - 1. 301: Specifications for Structural Concrete
 - 2. 304: Guide for Measuring, Mixing, Transporting, and Placing Concrete
 - 3. 305R: Guide to Hot Weather Concreting
 - 4. 306R: Guide to Cold Weather Concreting
 - 5. 318: Building Code Requirements for Structural Concrete
 - 6. 350: Environmental Engineering Concrete Containment and Commentary
 - 7. 350.1/350.1R: Tightness Testing of Environmental Engineering Concrete Containment and Commentary
 - 8. 350.3: Seismic Design of Liquid-Containing Concrete Structures and Commentary
 - 9. 372R: Design and Construction of Circular Wire- and Strand-Wrapped Prestressed Concrete Structures
 - 10. 506.2: Specification for Shotcrete

11. 506R: Guide to Shotcrete
 12. CP-60: Shotcrete Nozzleman Craftsman Workbook
- B. American National Standards Institute (ANSI)
1. A21.10: Ductile-Iron and Gray-Iron Fittings for Water
 2. A21.15: Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
 3. A21.50: Thickness Design of Ductile-Iron Pipe
 4. A21.51: Ductile-Iron Pipe, Centrifugally Cast
- C. American Society of Civil Engineers (ASCE)
1. MOP 7: Minimum Design Loads for Buildings and Other Structures - Includes Supplement No. 1
- D. American Society for Testing and Materials (ASTM)
1. A185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
 2. A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
 3. A276: Standard Specification for Stainless Steel Bars and Shapes
 4. A416: Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete
 5. A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
 6. A821: Standard Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks
 7. A882: Standard Specification for Filled Epoxy Coated Seven Wire Prestressing Steel Strand
 8. A1008: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
 9. C31: Test Methods for Making and Curing Concrete Test Specimens in the Field
 10. C33: Standard Specifications for Concrete Aggregates
 11. C39: Test Method for Compressive Strength of Cylindrical Concrete Specimens
 12. C94: Standard Specification for Ready-Mixed Concrete
 13. C143: Standard Test Method for Slump of Hydraulic Cement Concrete
 14. C172: Standard Practice for Sampling Freshly Mixed Concrete

15. C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
 16. C881: Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
 17. D1557: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft³)
 18. E1745: Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs
 19. F593: Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
- E. American Water Works Association (AWWA)
1. C110: Standard for Ductile-Iron and Gray-Iron Fittings
 2. C111: Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
 3. D110: Wire- and Strand-Wound, Circular, Prestressed Concrete Water Tanks
- F. Concrete Reinforcing Steel Institute (CRSI)
1. CRSI: Code of Standard Practice
- G. U.S. Army Corps of Engineers (COE)
1. CRD C572: Handbook for Concrete and Cement Corps of Engineers Specifications for Polyvinylchloride Waterstop
- H. International Code Council
1. IBC: International Building Code
- I. Occupational Safety and Health Administration (OSHA)
1. 1910.23: Guarding Floor and Wall Openings and Holes
 2. 1910.24: Fixed Industrial Stairs

1.03 DESIGN REQUIREMENTS

- A. The design shall conform to applicable portions of ACI 372R, AWWA D110, and currently accepted engineering principles and practices for designing such structures. Conform to latest applicable recommendations, codes, and standards cited in Paragraph 1.02 and their latest amendments unless otherwise specified herein or shown on the Drawings and consider the fluid contained is wastewater.
- B. Minimum Loads: Use the following loads for tank design:
1. Dead load: Weight for all permanent construction and fittings
 2. Internal fluid load: Weight for all water when tank is filled to overflowing, 62.4 pounds per cubic foot.

3. Snow load: Minimum design load for snow shall conform to ASCE-7, 10 pounds per square foot. The snow load need not be considered as acting concurrent with the live loads.
4. Live load: 20 pounds per square foot over entire tank roof in addition to the weight of any soil or other overlying material.
5. Backfill pressure: Earth loads determined by rational soil mechanic methods. Use 65 pounds per cubic foot for compacted and tested materials and for non-saturated compacted gravel. Use 90 pounds per cubic foot for moist weight. Backfill pressure shall not be used to reduce the amount of required prestressing.
6. Wind loads: Minimum design loads for wind shall conform to ASCE-7-05, 90 miles per hour.
7. Seismic loads: Minimum design loads for earthquake shall conform to ASCE 7-05 and to ACI 350.3. Seismic Design Category is . Occupancy Category III, Site Class C, Importance Factor = 1.25, $S_{DS} = 0.272g$, $S_{D1} = 0.147g$. Lateral deflection of foundation under seismic load shall be limited to 1" under service level loads. Pile deflection shall be analyzed using "L-Pile" software (or equivalent). If load tests are used to determine lateral capacity, a safety factor of 2 shall be applied. Estimated service level base shear = 5500 kips. If micropiles are used, battered piles shall be used to resist lateral loads.
8. Thermal differential loads: Provide for a minimum 50 °F thermal differential in designing tank elements.
9. Loads on platforms and walkways: 60 pounds per square foot
10. Flood condition: Design tank for a flood elevation of at the site, with the tank completely empty of liquid. If flotation is an issue, include a floatation restraint or rock anchor system designed in accordance with the geotechnical investigation report's recommendations.
11. Groundwater condition: Design partially buried tank for groundwater at the site to the lowest finished surface grade elevation with the tank completely empty of liquid. Design a groundwater subsurface collector and discharge piping system if required. If flotation is an issue, include a floatation restraint or rock anchor system designed in accordance with the geotechnical investigation report's recommendations.
12. The higher elevation of Flood condition or Groundwater condition from the above paragraphs shall prevail for tank design.

C. Design Parameters:

Design Parameters

Tank Volume: __ MG (\pm __,000 gallons)
Maximum Water Level: Elev. _____
Floor Level at Perimeter: Elev. _____
Finish Grade: Elev. _____
Inlet Pipe: _____" diameter
Overflow Pipe: _____" diameter
Drain Pipe: _____" diameter
Maximum Inlet Flow: _____ mgd
Tank Inside Diameter: _____ feet
Sidewall Depth: _____ feet
Roof: Reinforced Concrete Dome
Floor: Reinforced Concrete
Floor Slope: Perimeter Fillet, then 3 % to center of tank
Special Requirements: Wastewater containment Foundation system

D. Design Performance: Performed by a Tennessee registered Professional Structural Engineer

E. Structural Floor: The reinforced concrete structural floor design shall conform to the following:

1. The floor slab's minimum thickness is indicated on the Drawings. Concrete structural floors shall contain a minimum reinforcing steel amount equal to 0.50 percent of the gross cross sectional area. Reinforcing steel shall be placed orthogonally and distributed with at least 2/3 of the total minimum area required in the top face and 1/3 of the total minimum area in the bottom face.
2. Concrete sections that are 24 inches thick or greater may have the minimum percentage of reinforcing based on a 12-inch concrete layer at each face.
3. Minimum reinforcing size shall be #4 bar.
4. Maximum spacing for the structural floor's reinforcing steel shall be 12 inches.
5. Concrete structural floors shall be designed to resist bending moments and shears induced by loadings required in Paragraph 1.03.B and 1.03.C. Moments and shears shall be calculated based on rational analysis using an influence area derived from the pile spacing plus 2 times the pile spacing tolerance specified in Paragraph 1.03.E.10. In no case shall the dimensions for the concrete structural floor be less than the following:
 - a. Minimum floor thickness for unimproved foundation bearing with no floatation restraint system: 6 inches for tanks with water depth 40 feet or less and 8 inches for tanks with water depth 40.01 feet or more

- b. Minimum floor thickness for improved foundation bearing such as structural fill or overcut and improved structural backfill with no floatation restraint system: 12 inches
 - c. Minimum floor thickness for improved foundation bearing system such as pile supported and/or a floatation restraint system: 24 inches.
6. Circumferential steel shall be added to the outside edge of the structural floor as required to resist calculated bending moments in spans between perimeter piles, if required. Circumferential steel required for bending moments shall be calculated by any rational one-way analysis with a minimum required amount of 0.75 percent placed in a minimum width of 2'-6". Minimum circumferential steel shall be distributed with 2/3 of the total area required in the top face and 1/3 in the bottom face.
 7. Radial steel shall be added to the top and bottom reinforcing steel mats at the edge of the structural floor to account for edge effects in the circular plate. Edge effects shall include moments at the mid-span of the outer most span and the outside face of the first interior support of a two-way slab and shall be calculated by any rational analysis which considers these effects.
 8. Minimum pile embedment into the concrete structural floor shall be 6 inches.
 9. Minimum rock anchor embedment into the concrete structural floor shall be 8 inches.
 10. Minimum spacing tolerance shall be 6 inches for all rock anchors and individual and driven piles: 3 inches for all individual micropiles and drilled piers or as defined by the geotechnical design professional.
 11. Provide reinforcement to meet shrinkage and temperature steel requirements of ACI 350.

F. Core Wall

1. The wire-wound, prestressed concrete tank core wall shall be designed as a thin shell cylindrical element using shotcrete and an embedded, mechanically bonded, steel shell diaphragm.
2. The core wall's design shall take into account appropriate edge restraint. To compensate for bending moments, shrinkage, differential drying, and temperature stresses, the following minimum reinforcing steel shall be incorporated into the design.
 - a. The top 2 feet of core wall shall have not less than 1 percent circumferential reinforcing.
 - b. The bottom 3 feet of core wall shall have not less than 1 percent circumferential reinforcing.
 - c. Inside Face
 - 1) The core wall inside face may use the 26-gauge steel shell diaphragm as effective reinforcing.
 - 2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.

d. Outside Face

- 1) Vertical reinforcing steel in the core wall outside face shall be a minimum of #4 bars at 12 inches center to center.
- 2) Additional vertical and horizontal reinforcing steel bars shall be used as required by design computations.
3. The minimum core wall thickness shall be 3-1/2 inches.
4. Reinforcing steel used in the core wall shall be designed using a maximum allowable 18,000 psi design tensile stress, f_s .
5. Allowable compressive stress in the core wall due to initial prestressing force, f_{gi} , shall be:
 - a. 1,250 psi + 75t psi/in. with 0.5 f_{gi} maximum or less (where f_{gi} is defined as compressive strength at time initial prestressing force is applied and t is the core wall thickness in inches)
 - b. Maximum 2,250 psi
6. Allowable compressive stress in the core wall due to final prestressing force, f_g , shall be:
 - a. 1,250 psi + 75t psi/in. with 0.45 f_g maximum (where f_g is defined as compressive strength required for final prestressing force and t is the core wall thickness in inches)
 - b. Maximum 2,000 psi

G. Dome Roof

1. The dome roof shall be constructed with reinforced concrete and shall be circumferentially prestressed. The roof shall include a 4-foot wide walkway around the roof perimeter.
2. Dome shell reinforcement shall consist of reinforcing bars or welded wire fabric meeting ASTM A185, not galvanized. Bolsters for wire fabric and reinforcing bars shall be plastic. Wire ties shall be galvanized.
3. The dome ring girder shall be prestressed with sufficient wire to withstand the dome dead load and design live loads. The ring girder shall have cross section suitable to accept the applied prestressing forces.
4. The high water level in the tank shall be permitted to encroach on the dome shell no higher than the upper horizontal plane of the dome ring girder.
5. Overflow outlets shall be able to provide an overflow open area three times the area of the largest influent pipe. See Paragraph 2.04.C.4. for additional requirements.

6. The dome shall be designed as a free-span, spherical thin shell with one-tenth rise in accordance with the following.
- a. Typical dome design: The typical dome thickness and steel reinforcement shall meet AWWA D110 requirements.
 - b. In all cases, the dome thickness shall be no less than 4 inches.
 - c. Dome edge design: The dome edge and upper wall shall be designed to resist the moments, thrusts, and shears that occur in this region due to dome and wall prestressing and loading conditions. The edge region design shall conform to the following.

1) Dome Edge Thickness

- a) The buckle diameter determination shall be made, as defined by:

$$d_b = 2.5 \cdot \sqrt{r_d \cdot t_d} \text{ rounded up to the next foot}$$

Where: d_b = buckle diameter in feet

r_d = dome radius in feet

t_d = typical dome thickness in feet

- b) Dome edge thickening shall begin at a radial location on the dome, defined as s_2 which is at least one buckle diameter away from the tank wall.
- c) A springline haunch shall be provided, which extends radially from the inside tank wall face to radial location s_1 which is defined as:

$$s_1 = 0.6 \cdot \sqrt{1.5 \cdot r_d \cdot t_d} \text{ rounded up to the next foot}$$

Where: s_1 = distance from inside the wall face to haunch in feet

s_2 = distance from inside the wall face to typical dome thickness in feet.

This springline haunch shall begin at the inside tank wall face with a springline thickness as required by paragraph f) below and shall end at radial location s_1 with the following thickness:

$$t_{d1} = 1.33 \cdot t_d$$

Where: t_{d1} = minimum thickness at s_1 in feet

t_d = typical dome thickness in feet at one buckle diameter from tank wall

- d) Beginning at s_1 and continuing to s_2 the dome shell shall have a uniform straight line taper.

- e) Parameters b), c), and d) above are not required for domes where the calculated typical dome thickness is less than 75 percent of the actual typical dome thickness.
 - f) Sufficient concrete thickness at the dome springline shall be provided so no more than 2 feet of the springline haunch is considered in calculating the effective dome edge ring cross sectional area. Compressive stress in this area shall not exceed 1,000 psi when subjected to initial prestressing, offset by dead load only.
- 2) Dome Edge Steel Reinforcement
- a) Throughout the dome edge, the radial and circumferential percentage of steel reinforcement shall be no less than 0.25 percent of the concrete's gross cross sectional area.
 - b) Along the dome edge, steel reinforcement shall be distributed between the upper and lower layers unless finite element analysis calculations indicate tensile stress does not exist in the concrete along the dome edge's bottom face. In that case, only top bars are required radially and circumferentially. In addition, radial and circumferential reinforcing bars will not be required along the dome edge's bottom face where the calculated typical dome thickness is less than 75 percent of the actual typical dome thickness.
 - c) Where reinforcing bars are required in the bottom layer, they shall be placed near the tank wall to insure adequate development at the intersection between dome and wall.
 - d) In all cases, the percentage of circumferential steel reinforcement in the first 2 feet of the dome edge shall be no less than one percent of the concrete's gross cross sectional area.
 - e) Where bottom dome edge steel reinforcement is required, vertical steel reinforcement along the tank wall's inside face shall be no less than 0.5 percent of the cross sectional area of wall shotcrete.

H. Prestressing

1. Circumferential prestressing of the tank shall be achieved by applying cold-drawn, high-carbon steel wire complying with ASTM A821 Type B, placed under high tension.
2. A substantial allowance shall be made for prestressing losses due to shrinkage and plastic flow in the shotcrete and due to relaxation in the prestressing steel.
3. The prestressing design shall conform to the following minimum requirements.
 - a. Working stress for the tank wall, f_s , shall be 115,000 psi maximum.
 - b. Working stress for the dome ring, f_{sd} , shall be 120,000 psi maximum.
 - c. The allowable design tensile stress in the prestressing wire before losses, f_{si} shall be 145,600 psi or no greater than $0.63 f_u$, where f_u is defined as the ultimate wire strength.

- d. Areas to be prestressed shall contain no fewer than 10 wires per foot of wall for 8-gauge and 8 wires per foot of wall for 6-gauge.
- e. A maximum of 24 wires per layer per foot for 8-gauge and 20 wires per layer per foot for 6-gauge will be allowed.

I. Wall Openings

1. When it is necessary for a pipe or manway to pass through the tank wall, the pipe or sleeve invert shall be no less than 18 inches above the floor slab, and the prestressing wires required at the pipe elevation shall be distributed above and below the opening leaving an unbanded strip around the entire tank.
2. Unbanded strips shall have a vertical dimension of no more than 36 inches unless an axi-symmetric shell analysis is performed to account for compressive forces plus shear and moments caused by displacing the prestressing wires into adjacent bands.

1.04 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01 33 00.
- B. Shop Drawings and Product Data: Signed and sealed by a Tennessee registered Professional Structural Engineer
 1. Include details of reinforcing steel, prestressed tendons, joint design, deep foundation design, and concrete mix design.
 2. Include thickness for all tank structure parts, including floor, core wall, dome, and cover coat.
 3. Include reinforcing steel identification marks for each bar.
 4. Prestressing Schedule: Number and placement for prestressing wires on the tank and total applied force per foot of wall height
 5. Accessories: Location and details, including dome openings, stairways, hatches, railings, overflows and vents, inlet pipes, roof vent walkways, level sensors, utility stations for hose washdown, and other required appurtenances
- C. Product Data: Submit manufacturer's product literature, including catalog information, dimensions, materials, instructions for installation and use, and application rates for the following:
 1. Waterstop
 2. Joint Filler
 3. Bond Breaker
 4. Curing Compound
 5. Vibration Equipment
 6. Bearing Pads

7. Joint Sealant
 8. Roof Hatches
 9. Roof Ventilators
 10. Railings
 11. Wall Manholes
 12. Stairs
 13. Piping
 14. Couplings
- D. Design Submittal Data: Submit structural calculations and drawings signed and sealed by a Tennessee registered Professional Structural Engineer for the following items:
1. Tank
 2. Tank and tank foundation, including foundation improvements, rock anchors, and piling system
 3. Integrated 304 stainless steel influent box
 4. Brackets for supporting pipe and influent box
 5. All necessary curbs and bosses for supporting and installing equipment
- E. Test Reports
1. Submit reports for concrete slump tests, air content tests, and strength tests.
- F. Manufacturer's Certificate: Certify Products meet or exceed specified requirements for the following:
1. Non-prestressed reinforcing steel
 2. Non-prestressed welded steel wire fabric
 3. Concrete mix design
 4. Concrete mix ingredients, including admixtures
- G. Concrete batch tickets in accordance with ASTM C94 with the following additional information:
1. Admixtures type, name, and quantity
 2. Cement type, brand, and quantity
 3. Total water content by producer
 4. Maximum aggregate size

5. Fine and coarse aggregate weights
 6. Indicate ingredients are as previously certified.
- H. Pipe, pipe fittings, joints, joint gaskets, lubricants, and coatings
1. Submit horizontal and vertical loadings, overflow pipe connection details, anchor bolt sizes and locations, erection and settlement tolerances, maximum loads imparted to the foundation and estimated tank weight.
 2. Submit certification signed and sealed by a Tennessee registered Professional Structural Engineer stating the design conforms to the conditions specified and all applicable codes and standards.
- I. Shop Drawings: Show details for the following:
1. Foundation
 2. Base and roof joint
 3. Wall construction and prestressing
 4. Overflow vents
 5. Overflow piping
 6. Piping connections
 7. Stairs,
 8. Roof hatches
 9. Walkways and railings
 10. Instrumentation flange
 11. Other information as required by this and related specifications and as requested by the Construction Manager, including certified reports on the manufacture and testing of prestressing wire and steel diaphragm
- J. Starting fabrication or construction prior to the Engineer's review and acceptance of drawings is prohibited.
- K. Shop drawing review by Metro or any of its representatives will not in any way relieve the tank contractor of full responsibility for the accuracy and completeness of their design and their drawings.
- L. Exterior Finish: Furnish color charts for finish waterproofing coat for Metro selection.
- M. Reports on wire stress readings and final report on total stresses applied to the tank walls and dome ringwall shall conform to AWWA D110.

1.05 QUALITY ASSURANCE

- A. Provide in accordance with Section 01 43 00 and the applicable provisions in AWWA D110 and as specified.
- B. General requirements for materials, design, construction, and testing shall conform to AWWA D110, except as otherwise noted or indicated herein.
- C. Subgrade preparation shall conform to Sections 31 23 00 and 31 23 16.
- D. Design Responsibility
 1. Certificate of Design: Complete form in Section 01 33 00 and submit to the Construction Manager prior to constructing prestressed concrete tank or any elements thereof. Certificate shall bear the seal, registration number, and signature of a Tennessee registered Professional Structural Engineer.
 2. Support Data: Submit the following with the Certificate of Design:
 - a. Codes, standards, and specifications stating the tank was designed in conformance with
 - b. Material types and strengths to be used
 - c. Loading conditions considered in the tank design
 - d. Allowable stresses used in design
 - e. Foundation plan
 3. Calculations: Calculations will be returned without review or checking. A copy will be retained in the project file.
 4. Qualifications and Experience
 - a. Work shall be performed by a company that specializes in designing and constructing wire-wound prestressed concrete tanks using the circumferential prestress wire reinforcing method and with the proven ability to meet all specification requirements.
 - b. No company is considered qualified unless it has designed and constructed in its own name at least 24 wire-wound prestressed concrete tanks in the type specified conforming to AWWA D110 in the last 15 years of equal or greater size which have been in successful service for a minimum of 5 years.
 - c. Experience in designing and constructing AWWA D110 Type I, Type III, or Type IV tanks is not acceptable.
 5. Prequalification
 - a. The contractor shall state the name of the tank contractor proposed for the work in their bid documents. Bids not stating the name of the prequalified tank contractor will be rejected.

- b. Prequalified Tank Contractors: The following tank contractors are deemed prequalified for constructing Type II Tanks:
 - 1) Crom Corporation, Gainesville, FL
 - 2) Precon Corporation, Newberry, FL
 - 3) Preload, LLC, Louisville, KY
- c. Metro reserves the right to reject using any and all tank contractors who, in their judgment, are unqualified.
- E. To assure unit responsibility, the equipment specified herein, including the foundation, anchors and piling shall be furnished and coordinated by the tank manufacturer.
 - 1. Additionally, the tank manufacturer to provide any necessary connections for installing all equipment specified herein and indicated on the drawings.

1.06 PRE-INSTALLATION MEETINGS

- A. Convene minimum one week prior to commencing this Section's work.

1.07 DELIVERY STORAGE AND HANDLING

- A. Comply with the requirements specified in Section 01 66 10.

- B. Reinforcing Steel

- 1. For reinforcing steel fabricated on site, ship from mill in bundles, limited to one size and length, tagged with waterproof tag showing mill name, heat number, bar grade and size, and identifying number.
- 2. For reinforcing steel fabricated off site, deliver in bundles identified as to structure and shop drawing number. Identify each individual bar with a waterproof tag showing grade, size, and bar mark from shop drawings.
- 3. Protect reinforcing steel and wire fabric from damage and from dirt, oil, grease, other foreign matter, and rust-causing conditions.
- 4. Do not store reinforcement in direct contact with ground.

- C. Concrete Ingredients

- 1. Handle, control, and store concrete materials in accordance with ACI 304.

- D. Ductile Iron Pipe

- 1. During loading, transporting, unloading, and storage on site, exercise care to prevent damage to piping materials.
- 2. Do not drop pipe or fittings.
- 3. Store materials on site in enclosures or under protective coverings.

4. Keep materials clean and dry.
5. Do not store materials directly on ground.

1.08 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.09 WARRANTY

- A. Warranty the structure against any defective materials or workmanship and to be and to remain watertight and not show wet spots on the exterior due to water penetration from within under all conditions. Warranty is for a 5-year period after the completion and acceptance date.
- B. If any materials or workmanship prove to be defective within that period, the tank contractor shall repair or replace at no additional cost to Metro. The warranty shall be extended from the time the repair is completed as determined by Metro.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Concrete

1. Concrete for walls and dome roof shall have a minimum 4,500 psi compressive strength at 28 days and shall be air entrained.
2. Concrete for tank floor, footings, and pipe encasement shall have a minimum 4,500 psi compressive strength at 28 days and shall not be air entrained.
3. Proportioning the concrete shall be in accordance with ACI 301.
4. Concrete shall conform to Section 03 30 00 unless otherwise specified herein.
5. Bar and welded wire fabric reinforcement shall conform to Section 03 21 00.

- B. Shotcrete for walls shall conform to ACI 506.2 applied by either the dry-mix or wet-mix process, except as modified by the drawings and specifications. Shotcrete shall have a 4,500 psi minimum compressive strength at 28 days.

- C. Coarse and fine aggregate shall conform to ASTM C33.

D. Admixtures

1. Concrete for walls and dome roof shall be air entrained in accordance with Section 03 30 00 requirements. Concrete for floor construction shall not be air entrained.
2. A water-reducing admixture and a superplasticizer shall be incorporated in the concrete mix used for the tank floor.

3. Admixtures containing calcium chloride or causing accelerated concrete setting are NOT PERMITTED.
 4. Use admixtures from the same manufacturer or compatible admixtures in any one concrete batch. Provide a statement of compatibility from all manufacturers if admixtures are provided by more than one manufacturer.
- E. Reinforcement Steel
1. Reinforcement shall conform to ASTM A615, Grade 60.
 2. Welded wire fabric shall conform to ASTM A185.
- F. Prestressing steel shall be uncoated, cold-drawn, Class II wire conforming to ASTM A821, Type B with a minimum ultimate tensile strength 231,000 psi. Stranded prestressing wire, prestressing cable, and horizontal tendons are NOT PERMITTED. Vertical bonded tendons may be used.
- G. Non-prestressed mild reinforcing steel shall be new billet steel meeting ASTM A185 requirements with minimum 60,000 psi yield strength, f_y .
- H. Elastomeric Materials
1. Waterstops shall be polyvinylchloride (PVC) conforming to CRD C572. Waterstop splices shall be in accordance with manufacturer's recommendations.
 2. Bearing pads shall be neoprene or natural rubber in accordance with AWWA D110.
 3. Sponge filler shall be in accordance with AWWA D110.
- I. Steel Diaphragm
1. Provide a continuous steel diaphragm as the inside or outside shotcrete form for the tank walls in conformance to AWWA D110 requirements, except no horizontal joints will be permitted.
 2. The steel diaphragm used in constructing the core wall shall be 26-gauge conforming to ASTM A1008 requirements.
 3. All vertical joints in the diaphragm shall be rolled seamed, crimped, and sealed watertight using epoxy injection.
 4. Provide a minimum of 1-1/2 inch shotcrete cover over the inside steel diaphragm or 1-1/2-inch shotcrete over the core interior face reinforcing, whichever is greater.
- J. PVC Waterstops, Bearing Pads, and Sponge Filler
1. Plastic waterstops shall be extruded from an elastomeric plastic material which has a virgin PVC base resin.
 2. The waterstop profile and size shall be suitable for the hydrostatic pressure and movements to which it is exposed.

3. Bearing pads used in floor/wall joints shall consist of neoprene, natural rubber, or PVC.
 4. Sponge filler at the floor/wall joint shall be closed-cell neoprene.
- K. Epoxy
1. Epoxy Sealants
 - a. Epoxy used for sealing the steel shell shall conform to ASTM C881 requirements.
 - b. Epoxy used for sealing the steel shell shall be Type III, Grade 1, and shall be 100 percent solids, moisture insensitive, low modulus epoxy system.
 - c. When pumped, the epoxy maximum viscosity shall be 10 poises at 77 °F.
 - d. The epoxy sealants used in the tank construction shall be suitable for bonding to concrete, shotcrete, PVC, and steel.
 2. Bonding Epoxy
 - a. Epoxy resins used for enhancing the bond between fresh concrete and hardened concrete shall conform to ASTM C881 requirements.
 - b. Epoxy resins shall be a 2-component, 100 percent solids, moisture-insensitive epoxy and shall be Type II, Grade 2.
- L. Coating for exterior tank walls and roof
1. Walls and roof: Two coats of Themec Series 156 Enviro-Crete Modified Waterborne Acrylate, with color as approved by Metro for the exposed, above-grade walls and roof.
 2. Coating thickness: Each dry coat, 4 to 8 mils; minimum total dry mils for two coats, 12 mils
- M. Cover coat protection for below-grade wall areas (No below-grade tank wall exterior coating required unless designated on Drawings.)
1. Themec Series 46-465, one coat system, or approved equal

2.02 FLOOR AND FOUNDATION

- A. Integrate the tank wall structure with a rigid reinforced concrete slab as shown. If shown or required, provide rock anchors, micropile, or H-pile foundation system in accordance with recommendations in the geotechnical investigation report.

2.03 SEISMIC RESTRAINT CABLES

- A. Seismic restraint cables shall be seven-wire strand conforming to ASTM A416.
- B. The strand shall be protected with a fusion-bonded, grit-impregnated epoxy coating conforming to ASTM A882.
- C. The 7-wire strand's minimum yield strength shall be 270,000 psi.

2.04 ACCESSORIES

A. Roof Hatches

1. Provide aluminum or fiberglass reinforced plastic roof hatches with minimum dimensions as indicated on the Drawings. Secure to a minimum 11-inch by 6-inch concrete curb with Type 316 stainless steel expansion bolts. Aluminum roof hatches shall be in accordance with Section 05 53 00.
2. Manufacturers
 - a. Bilco Co., New Haven, CT
 - b. Halliday, Orlando, FL
 - c. Thompson Fabricating Co., Birmingham, AL
3. Provide completely assembled aluminum roof hatches with heavy pintle forged Type 316 stainless steel hinges, stainless steel pins, compression spring operators enclosed in telescopic tubes, positive snap latch with turn handles, suitable hasp for padlocking and neoprene draft seal. Provide automatic hand-open arm complete with vinyl grip handle. All hardware shall be Type 316 stainless steel.
4. Provide four (4), 6'-0" x 6'-0" aluminum roof hatches for access and future submersible mixers as shown on the Drawings. Include thickened floor for mixer mounting.
5. Provide two (2), 4'-0" x 4'-0" aluminum roof hatches for access to overflow and transfer pipes as shown on the Drawings.
6. Provide one (1) 9'-0" x 9'-0" fiberglass roof hatch for equipment as shown on the Drawings.
7. All hardware shall be Type 316 stainless steel.

B. Vents

1. Provide one complete fiberglass vent assembly located at the center of the dome roof, including vent cap, insect screen and securing angles. Secure the ventilator to a 6-inch wide concrete curb projecting not less than 6 inches above the roof line with Type 316 stainless steel fasteners. Provide a minimum 4-foot diameter roof opening.
2. Provide a minimum of [____], additional precast 4-foot wide eyelid vents at the dome roof perimeter and as shown on the Drawings for emergency tank overflow.
3. Provide sufficient vent capacity to allow net inflow or withdrawal rates of at least [____] gallons per minute without creating positive or negative pressures inside the tank.
4. Provide sufficient overflow capacity through the perimeter eyelid vents to allow [____] gallons per minute to pass through the vents with not more than a 5-inch rise in water surface. This overflow condition assumes the overflow pipes are plugged.

C. Inlet, Overflow and Transfer Piping

1. Provide overflow piping with flared inlets designed for [_____] gallons per minute with not more than a 3-inch rise in water surface above the flare. Top of the overflow flare inlet shall be at the height for maximum design storage volume.
2. Provide transfer piping with flared inlets designed for ## MGD.
3. Provide inlet piping with integrated Type 304 stainless steel influent box as shown on the Drawings. Tank manufacturer to design influent box based on the maximum service loads in each direction, including seismic forces. Include design and details for integrated influent pipe/ box arrangement to include sizing all materials, fasteners, and anchors. Provide calculations as outlined in Paragraph 1.04.
4. Use a minimum of Class 200 ductile iron pipe with Protecto 401 lining for inlet, overflow pipe, transfer pipe, and fittings. Use flanged joints with Type 316 stainless steel nuts and bolts. Coat exterior of pipes not encased in concrete with an approved epoxy coating in accordance with Section ## ## ## <PROJECT SPECIFIC>. Support the pipe with approved Type 316 stainless steel brackets.
5. Pipe Support Brackets and Bosses
 - a. Provide brackets and bosses for supporting pipes and influent boxes.
 - b. Tank manufacturer to determine size, size, number, spacing, and location of pipe supports and bosses.
 - c. Materials for pipe supports to be Type 304 stainless steel. Fastener and anchor bolts to be Type 316 stainless steel.
 - d. Include design and details for all pipe support brackets and bosses to include sizing and number.

D. Tank Connection Piping

1. Use a minimum of Class 200 ductile iron flanged or mechanical joint pipe with Protecto interior lining and fittings meeting ANSI A21.50, A21.15 or A21.51 and A21.10. Inlet pipe shall be encased in concrete below the bottom slab.
2. Provide Type 316 stainless steel handrail centered around the drain pipe as shown.

E. Wall Manholes

1. Provide [_____] , 1'-5" x 4'-4" rectangular Type 316 stainless steel wall manholes for access to the tank's interior. The cover plates and bolts shall also be Type 316 stainless steel. Cover plates shall be hinged. Gaskets shall be provided between the cover plate and the wall sleeve and attached to the cover.
2. Wall manholes shall be designed to resist hydraulic loading without excessive deflection.

F. Stair Access

1. Provide one aluminum corkscrew staircase as shown on the Drawings in accordance with OSHA safety standards and Section 05 51 00.

G. Walkways and Railings

1. Walkways and railings shall conform to OSHA safety standards and as specified.
2. Walkway shall be concrete around the dome roof perimeter as shown on the Drawings.
3. Provide aluminum guardrail around the tank perimeter and at all roof tank access locations as shown on Drawings and in accordance with Section ### ## ## <PROJECT SPECIFIC>.

H. Roof Mounted Hose Reels and Hoist

1. Hoses: Provide four (4) roof-mounted hose reels located near the roof hatches as shown on the Drawings. Hose reels shall be Hosecraft USA Model 922-23-24B or equal, stainless steel, sized for 25 feet of 1-1/2-inch hose.
2. Hoist: Provide one roof mounted davit crane located near the top of the staircase as shown on the Drawings. Davit crane and hoist shall be Them Model M5110E4SS, or equal, stainless steel materials with a 1,000-pound powered winch lifting capacity and a vertical reach of tank sidewall height plus 5 feet.

I. Curbs and Bosses

1. Tank manufacturer to design and provide all curbs and bosses necessary for the installation of accessories and equipment specified herein and/or indicated on the Drawings

J. Ogee/Curved Filet

1. Tank manufacturer to design and provide a shotcrete ogee or curved fillet at the interior base of the tank wall which is continuous around the perimeter to facilitate solids cleaning and flushing
 - a. Filet to include necessary reinforcement wire/bars to prevent spalling / cracking and any anticipated loads.
 - b. Filet to be provided with ant bearing pads or other means necessary to allow wall movement on slab without creating fixed connection to slab.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify subgrade elevations prior to starting tank construction.

3.02 GENERAL

- A. Clear the area to be excavated for the tank construction. Remove and dispose of debris, vegetation, and topsoil. Excavate to such depths and widths as will provide adequate room for constructing the tank and preparing the subgrade. Dispose of or store excavated materials as approved by the Construction Manager.
- B. Prepare subgrade in accordance with the Drawings and geotechnical report. Construct and compact the required structural backfill to the specified percent of maximum density in accordance with ASTM D1557.
- C. Prepare foundation surface for constructing tank floor and footings.
- D. Provide a 6-inch minimum of #7 crushed stone compacted foundation bearing base unless on an alternate minimum 2,500 psi concrete "mud mat."
- E. Construct tank in accordance with AWWA D110's applicable provisions.

3.03 INSTALLATION

A. Placing Concrete

- 1. Cast-in-place concrete floor and dome roof shall be installed in accordance with ACI 318 and 350.1/350.1R, except as specified herein.
- 2. No concrete shall be mixed or placed during freezing weather without the Construction Manager's explicit permission. For placing concrete when air temperature is below 40 degrees Fahrenheit (-40 °F), heat water, sand, and gravel so the concrete's temperature will be at least 50 °F. This temperature shall be maintained for 72 hours after placing. No concrete shall be placed on frozen ground.
- 3. In hot weather, concrete, when deposited, shall have a placing temperature that will not cause difficulty from loss of slump, flash set, or cold joint formation. In no case shall the temperature of concrete being placed exceed 95 °F.

B. Floors

- 1. The subgrade shall be prepared by fine grading to ensure reinforcing steel is properly placed with proper bottom cover.
- 2. A 6-mil polyethylene vapor-barrier conforming to ASTM E1745 shall be placed after subgrade preparation has been completed.
- 3. Plate bolsters shall be used to support reinforcing steel in the floor construction to ensure positive control when placing reinforcing steel.
- 4. The floor shall be vibratory screeded to effect concrete consolidation and to properly encase floor reinforcing steel.
- 5. Construct concrete floor in one continuous placement with no construction joints.
- 6. The floor shall be continuously water cured until tank construction is completed.

C. Core Walls

1. Rough broom all concrete surfaces to receive shotcrete to remove material which may prevent bonding. Reinforcing steel to be covered with shotcrete shall have a bondable surface and may require light sandblasting as directed by the Construction Manager.
2. Horizontal construction joints shall not be allowed in walls.
3. No curing compounds shall be applied to surfaces to be covered with shotcrete.
4. Temporary wall openings may be provided for access to and removal of construction materials from the tank interior subject to the Construction Manager's approval. Prestressing wires shall not be "bunched" at the opening, but shall be banded by displacing the number of wires required at the opening into circumferential bands immediately above or below the opening.
5. Provide continuous waterproof steel diaphragm within the tank wall between the water and the prestressing wire.
 - a. No form tie holes will be allowed.
 - b. Provide a minimum 1-1/2-inch concrete cover over the steel diaphragm's or 1-1/2-inch shotcrete cover over core wall interior face reinforcing, whichever is greater.
 - c. Provide wall bosses for attachment of tank interior piping bracing.
 - d. Provide a minimum 1-1/2-inch shotcrete cover on the diaphragm's outside face.
6. Walls shall be constructed in a predesigned manner utilizing steel shell diaphragm, shotcrete layers, and prestressing wire. Each shall conform to the following:
 - a. Diaphragm Erection
 - 1) The diaphragm shall be protected against damage before, during, and after erection. Nail or other holes shall not be made in the steel shell for erection or other purposes except for inserting wall pipes or sleeves, reinforcing steel, bolts, or other special appurtenances. Such penetrations shall be sealed with an epoxy sealant which complies with Paragraph 2.01.K.
 - 2) Prestressing wire shall be placed in accordance with AWWA D110.
 - 3) All wall pipes, sleeves, and manholes passing through the wall shall be sealed to the steel shell diaphragm by epoxy injection.
 - b. Shotcrete
 - 1) All shotcrete shall be applied by or under direct supervision of experienced nozzle men certified by the American Concrete Institute (ACI) as outlined in ACI certification publication CP-60.
 - 2) Each shotcrete layer shall be broomed prior to final set to affect satisfactory bonding of the following layer.

- 3) No shotcrete shall be applied to reinforcing steel or diaphragm encrusted with overspray.
- 4) No less than 1/2-inch thick shotcrete shall separate reinforcing steel and prestressing wire.
- 5) The steel shell diaphragm shall be encased and protected with no less than 1 inch of shotcrete in all locations.

c. Curing: Interior and exterior portions of the shotcrete wall shall be water cured for a minimum of 7 days or until prestressing is started.

D. Epoxy Injection

1. Epoxy injection shall be carried out from bottom to top of wall using a pressure pumping procedure.
2. Epoxy injection shall proceed only after the steel shell has been fully encased with shotcrete inside and outside.

E. Dome Roofs and Walkways

1. All concrete shall be consolidated using a vibrator to properly encase reinforcing steel and welded wire fabric.
2. All surfaces at the joint between the wall and the dome shall be coated with bonding epoxy which complies with Paragraph 2.01.K.
3. Plastic bolsters shall be used to support reinforcing steel and welded wire reinforcement to ensure positive control when placing steel.
4. The dome shall be water cured for 7 days after casting or until dome band prestressing is completed.

F. Prestressing

1. The initial tension in each wire shall be read and recorded to verify the total aggregate force is no less than the design requires. Averaging or estimating the wire's force on the wall shall not be considered satisfactory evidence of correct prestressing wire placement.
2. The prestressing steel wire shall be placed in a continuous and uniform helix in a pitch to provide in each linear foot of core wall height an initial force and unit compressive force equal to that shown on the Drawings. Splicing the wire shall be permitted only when completing the full wire coil application or when removing a defective wire section.
3. Shotcrete shall be used to completely encase each individual wire and to protect it from corrosion. To facilitate this encasement, the clear space between adjacent wires is to be no less than one wire diameter.
4. Prestressing shall be accomplished by a machine able to continuously induce a uniform initial tension in the wire before it is positioned on the tank wall. Tension in the wire shall be generated by methods not dependent on cold working or re-drawing the wire. In determining compliance with design requirements, the aggregate force for all tensioned wires per foot of wall shall be considered rather than the force per individual wire. Such

aggregate force shall be no less than that required by the design and as shown on approved drawings.

5. The tank construction company shall supply equipment at the construction site to measure tension in the wire after it is positioned on the tank wall. The stress measuring equipment shall include electronic direct reading stressometer accurate to within 2 percent, calibrated dynamometers, and a test stand to verify the equipment's accuracy.
6. After circumferential prestressing wires have been placed, they shall be protected by encasement in shotcrete. This encasement shall completely encapsulate each wire and permanently bond the wire to the tank wall.
7. When multiple wire layers are required, shotcrete cover between layers shall be no less than 1/8-inch thick.

G. Tank Finishes

1. Floor slab: Light broom finish
2. Interior shotcrete finish: Soft broom finish, ripple pattern acceptable
3. Dome roof and walkway: Light broom finish
4. Exterior shotcrete finish shall have a thickness of no less than 1 inch over the prestressing wires. Horizontal wall sections shall form true circles without flat areas, excessive bumps, or hollows. The covercoat shall receive a twice-rubbed "Flash and Slice" finish.

H. Tank Accessories

1. Stairs
 - a. Stairs shall be installed at locations shown on the Drawings. Stairs shall be installed to conform to OSHA requirements.
 - b. Stair supports shall be installed by stainless steel expansion bolts or stainless steel bolts with cast-in-place threaded inserts. Prior to installing expansion bolts, the reinforcing bars shall be located with a rebar locator. The reinforcing bar locations shall be marked on the concrete surface indicating the bar spacings and directions.
 - c. Install stairs in accordance with approved shop drawings.
2. Roof Hatches
 - a. Roof hatches shall be installed at the locations shown on the Drawings. The hatches shall be installed on a concrete curb with a minimum 11-inch inside height and a minimum 6-inch width. The hatches shall be installed with a watertight gasket and Type 316 stainless steel expansion bolts.
 - b. Install roof hatches in accordance with approved shop drawings.

3. Railings

- a. Railings shall be installed at the locations shown on the Drawings. Railings shall be installed to conform to OSHA requirements.
- b. Railings shall be installed by Type 316 stainless steel expansion bolts. Prior to installing expansion bolts, the reinforcing bars shall be located with a rebar locator. The reinforcing bar locations shall be marked on the concrete surface indicating the bar spacings and directions.
- c. Install railings in accordance with approved shop drawings.

4. Wall Manholes

- a. Manholes shall be installed at locations shown on the Drawings.
- b. The manhole invert shall be 3 feet above the floor.
- c. Install manholes in accordance with approved shop drawings.

I. Exterior Coating

1. Exterior paint system for above-grade tank walls and roof shall consist of two coats of Tnemec Series 156 Enviro-Crete Modified Waterborne Acrylate. Paint shall be applied to all exterior concrete surfaces above an elevation one foot below finished grade.
2. Application procedures and coverage rates shall be in accordance with the manufacturer's recommendations.
3. The concrete surface to be coated shall be free from all laitance, dirt, grease, and foreign material. All defective surfaces shall be repaired before applying the coating.
4. Finish work shall be performed by skilled workers familiar with this type of work.
5. Paint colors to be selected by Metro during construction. Paint scheme shall consist of a two-color system, including the main tank wall and roof color with a second color accent band at the wall top.

3.04 QUALITY CONTROL

A. Inspection and Testing

1. Concrete and Shotcrete Testing

a. Compression Tests

- 1) Compression test specimens shall be taken during construction from the first placement of each concrete class specified herein and at intervals thereafter as selected by the Construction Manager to insure continued compliance with these Specifications. See Cast-in-Place Concrete Specification 03 30 00 for Sampling and Testing requirements for conventional poured concrete.
- 2) Testing shall be performed by the Engineer-approved, Contractor-retained certified testing agency.

- 3) A set of four test cylinders shall be made for each 50 cubic yards of concrete, or fraction thereof, placed in one day. One cylinder shall be tested at 7 days, two at 28 days, and 1 held as a spare.
- 4) Pre-production shotcrete testing shall be in accordance with ACI 506.2. Test panels shall be made from shotcrete by each nozzle man to verify competency and shall represent the material being applied. The results from this testing shall be known prior to said nozzle men performing any work on the tank structure.
- 5) The method for making a test sample shall be as follows:
 - a) A 4-mesh wire fabric frame, 1 foot square, 3 inches in depth, shall be secured to a plywood panel and hung or placed in the location where shotcrete is being placed. This form shall be filled in layers simultaneously with the nearby application.
 - b) After 24 hours, the fabric and plywood backup shall be removed and the sample slab placed in a safe location at the site.
 - c) The sample slab shall be moist cured in a manner identical to the regular surface application.
 - d) The sample slab shall be sent to an approved testing laboratory and tested at the age of 7 days and 28 days.
 - e) Nine 3-inch cubes shall be cut from the sample slab and subjected to compression tests in accordance with current ASTM Standards.
 - f) Three cubes shall be tested at the age of 7 days; three shall be tested at the age of 28 days; 3 shall be retained as spares.

b. Air Content Tests

- 1) Air content tests shall conform to ASTM C231.
- 2) Tests for air content shall be made prior to concrete placement and whenever compression test specimens are made.

c. Slump Tests

- 1) Slump tests shall be made in accordance with ASTM C143.
- 2) Slump tests shall be made whenever compression test specimens are made.

2. Prestressing Wire Testing

- a. The tank contractor shall furnish a calibrated stress recording device that can be easily recalibrated. This device shall be used to determine wire stress levels on the wall during and after the wrapping process.
- b. At least one stress reading per foot of wall height or one stress reading per wire coil, whichever is greater, shall be taken immediately after the wire has been applied on the wall. Readings shall be recorded and shall reference the applicable height and layer of wire for which the stress is being taken.

- c. A written record for stress readings shall be kept. All stress readings shall be made on straight lengths of wire. If applied stresses fall below the design prestress in the steel, additional wire shall be provided to bring the prestressing up to the design prestressing force.
 - d. If the prestress in the steel is more than 7 percent over the design prestress, the wrapping operation shall be discontinued.
3. Hydrostatic Testing
- a. On completing the tank and prior to any specified backfill placement at the footing or wall, the tank shall be filled with clean water in the Construction Manager's and Engineer's presence and tested for watertightness in accordance with AWWA D110 and ACI 350.1/350.1R.
 - b. Watertightness testing shall be completed as follows:
 - 1) Fill the tank with water to the overflow pipe maximum water elevation and let it stand for 24-hours minimum.
 - 2) Inspect the exterior of the tank wall and footing for flowing water or damp spots. Damp spots shall be defined as spots where moisture can be picked up on a dry hand, the source being from inside the tank. Damp spots on the footing that are not measureable or flowing shall be acceptable, if total tank leakage is within allowable rates.
 - 3) There shall be no flowing water through the walls, wall-base joint, or floor slab. Damp spots that glisten on the tank surface and spots where moisture can be picked up on a dry hand will not be allowed.
 - 4) The maximum allowable leakage for a 24-hour period, after the initial 24-hour period in which the entire tank interior surface has been wetted, shall not exceed 0.05 of 1.0 percent of the tank volume.
 - 5) If the leakage exceeds the maximum allowable, the test shall be extended to a total of 5 days. If at the end of 5 days the average daily leakage does not exceed 90% of the maximum daily allowable, the test shall be considered satisfactory.
 - 6) Leakage through the floor, wall, or wall-base joint shall be repaired, and the tank shall be retested using the above procedure. Repair materials and methods shall be approved by the Engineer.

3.05 CLEANING

- A. After satisfactory watertightness testing has been completed and just prior to being placed into service, the tank shall be cleaned to remove debris, construction items, and equipment.

3.06 PROTECTION

- A. Aluminum surfaces shall be isolated from contact with concrete. Protect with a minimum 4-mil dry thickness coat of zinc chromate primer on the aluminum surfaces and a minimum 2 mil dry thickness coat of all-metal primer followed by one coat of minimum 3 mil dry thickness aluminum paint to the dissimilar metal.

3.07 MANUFACTURER'S FIELD SERVICES

- A. Furnish field representative experienced in installing tank to supervise installation.
 - 1. Furnish Installation Certificate attesting that the foundation and tank are properly installed.

3.08 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 26 05 10

ELECTRICAL WORK – GENERAL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete and operational systems for normal and standby electric power systems, normal and emergency lighting systems, grounding systems, and other specified systems including the installation and wiring for miscellaneous equipment and devices. Perform all work and testing as indicated and specified.
1. Provide conduit, wiring, and connections for power, control, lighting, instrumentation, and alarms for equipment furnished by others unless otherwise specified and indicated.
 2. Provide temporary circuits, overcurrent devices, conduit, wiring, and other equipment required during construction and changeover from existing to proposed electric system. Perform work at the convenience of Metro.
 3. Provide electrical system studies including a short circuit and protective device coordination study and an arc-flash study for the electrical distribution system constructed under this contract.
 4. Install all raceways and equipment to meet the seismic design criteria in Section ## ## ## **<PROJECT SPECIFIC>**. Raceways, supports, and equipment anchoring shall be provided as specified in the Contract Documents.
 5. Electrically powered equipment and devices provided under other Specification Divisions and Sections are connected to the project specified electrical systems as part of the electrical work. Refer to Paragraph 1.02 - Related Work.
- B. National Fire Protection Association (NFPA)
1. 70: National Electrical Code (NEC)

1.02 RELATED WORK

- A. Division 40: Process Integration
- B. Variable frequency drive (VFD) units shall be furnished, installed, and tested by the equipment supplier (pump, fan, etc.). All associated VFD unit conduit, wire, and terminations shall be provided under the electrical Sections.
- C. Furnish conduit, wire, and field connections for all motors, motor controllers, control devices, control panels, and electrical equipment per specification Divisions 11, 22, and 40 requirements as applicable.
- D. Furnish conduit, wiring, and terminations for all field-mounted instruments furnished and mounted under other Divisions including process instrumentation primary elements, transmitters, local indicators, and control panels. Install lightning and surge protection equipment wiring at process instrumentation transmitters. Install vendor furnished cables specified under other Divisions.

- E. Provide a complete raceway system for the data highway cables and specialty cable systems. Install the data highway cables and other specialty cable systems furnished under this Division and Division 40 in accordance with the system manufacturer's installation instructions. Prior to installation, review the raceway layout with the Division 40 system supplier and the cable manufacturer to ensure raceway compatibility with the systems and materials being furnished. Where redundant cables are furnished, install cables in separate raceways. Maintain 6-inch minimum separation between raceways.
- F. Mount and wire power factor correction capacitors furnished under other specification Divisions. Where capacitors are furnished with quick-release latch covers, furnish and install a bolt and nut on each latch. Capacitors shall be installed on channel supports at motors. Capacitors shall be installed 18 inches above finished floor minimum.
- G. Furnish and install all conduit and wiring between motor operated doors and windows and their control stations.
- H. Disconnecting, removing, and relocating existing electrical equipment is a part of this Contract, and is specified under Section 02 41 00 and this Section. Make equipment schedule for shock hazard free removal. Coordinate the demolition sequence with the construction sequence to maintain facility operation. Remove and demolish equipment and materials in a sequence ensuring the existing and proposed plant will function properly with no power disruption.
- I. Provide electrical relocation work associated with equipment relocation for the existing and new facilities, including disconnecting all existing wiring and conduits and providing new wiring and conduit to the relocated equipment. Schedule the equipment relocation so the work is free from shock hazards.
- J. Review the electrical underground system and the civil yard piping. Install the electrical underground system in a manner that avoids conflicts with manholes, catch basins, etc. provided under other specification Divisions.
- K. Sequencing and Scheduling
1. Coordinate electrical equipment installation with other building components.
 2. Arrange for chases, slots, and openings in the building structures during the construction progress to allow for the electrical installation.
 3. Coordinate installing required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
 4. Sequence, coordinate, and integrate electrical materials and equipment installation for efficient workflow. Coordinate large equipment installations requiring position prior to closing in the building.
- L. In addition to manufacturer's equipment shop drawings, submit electrical installation working drawings containing the following:
1. Concealed and buried conduit layouts, shown on floor plans drawn at not less than 1/4-inch = 1 foot in scale. The layout shall include locations for process equipment, motor control centers, transformers, panel boards, control panels and equipment, motor, switches, motor starters, large junction or pull boxes, instruments, and any other electrical devices connected to concealed or buried conduits.

2. Plans shall be electronically drawn on high quality reproducible, 36-inch by 24-inch bond paper, and shall be electronically presented in a neat, professional manner.
3. Concrete floors and/or walls containing concealed conduits shall not be poured until conduit layouts are accepted.

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00:

1. Shop Drawings and Data: Include manufacturer's drawings, bills of material, panel and equipment layouts, catalog data, schematics diagrams, interconnection diagrams, wiring diagrams, and other documentary or descriptive information as required for each assembly submitted in one package insofar as possible.
 - a. Bills of material: Include a numbered list with all components. Include manufacturer's name, catalog number, rating, and other identification. Place item number or similar identification on all other drawings where item appears.
 - b. Where additions and modifications are made to existing equipment, provide drawings which include retained existing equipment and new work.
 - c. For informational purposes only, submit equipment installation instructions in separate submittals from other shop drawings.
 - d. Shop drawings and data are required for the following list:
 - 1) Starting Equipment Data List - Submit blank list initially to verify acceptable format. Submit final list at project's completion.
 - 2) Short Circuit and Coordination Studies Arc-Flash Studies
 - 3) Harmonic Analysis
 - 4) Conduit and Fittings
 - 5) Wire and Cable
 - 6) Ladder Type Cable Tray and Fittings
 - 7) Wiring Devices
 - 8) Transformers
 - 9) Low Voltage Switchboards
 - 10) Low Voltage Switchgear
 - 11) Storage Battery and Charger
 - 12) Manholes, Handholes, and Associated Equipment and Devices
 - 13) Grounding Equipment and Devices
 - 14) Lighting Panels

- 15) Lighting Fixtures and Accessories
- 16) Lightning Protection System
- 17) Electric Heat Tracing
- 18) Control Stations
- 19) Enclosures
- 20) Control Panels
- 21) Safety Switches
- 22) Electric Heating Units and Accessories
- 23) 600 Volt Motor Control Centers and Motor Controls
- 24) Switchboards
- 25) Field Acceptance Test Reports
- 26) Record Drawings

- e. Mark shop drawings and data submitted showing only items applicable to specific contract.
- f. Include one-line diagrams, schematic diagrams, wiring diagrams, control sequence diagrams, relay diagrams, and metering. Submit only completed drawings showing all local and remote devices associated with each item. Submit one complete shop drawing package. Partial submittals will be returned without action.
- g. Submit time-current characteristic curves for all circuit breakers and fuses.
- h. Submit instruction manuals for equipment installation, operation, and maintenance. Also, include a parts list for equipment listed below. Specifically mark standard publications forming a part of this Contract. Cross out, blank out, or otherwise delete non-applicable items. Submittals which do not clearly indicate items and features provided shall be rejected.

- 1) Low Voltage Switchgear
- 2) Lightning Protection System
- 3) 600 Volt Motor Control Centers
- 4) Switchboards

- i. Install permanent nameplates on all devices or equipment pieces for which use or identification are not readily apparent, such as starters, relays, contactors, pushbuttons, indicating lights, and switches. Ensure nameplate position is readable after equipment installation.

1.04 QUALITY ASSURANCE

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Install electrical work in conformance with latest rules and requirements of National Fire Protection Association Standard No. 70 (National Electrical Code) and in accordance with state and local code requirements.

1.05 INTERFERENCE AND ERRONEOUS LOCATIONS

- A. Locations for electrical equipment, devices, outlets, and similar items, as indicated, are approximate only. Exact locations shall be determined during construction.
- B. Verify in field, all data and final locations for work installed under other Specification Sections, required for placing electrical work.
- C. In case of interference with other work or erroneous locations with respect to equipment or structures, furnish all labor and materials to complete the work.

1.06 SEISMIC DESIGN REQUIREMENTS

- A. Conform to the requirements indicated on the structural drawings.
- B. Conform to the seismic design requirements for this project.
- C. All raceways and equipment shall utilize earthquake resistant supporting systems as specifically required in each applicable Section.

1.07 APPROVAL AND MARKING EQUIPMENT

- A. Insure devices and materials are listed and/or labeled by Underwriters' Laboratories, Inc., wherever standards have been established by that agency. Where Underwriters' Laboratories listing is not available for equipment, submit certified test reports from nationally recognized testing laboratory, approved by the local inspecting authority, indicating the equipment conforms to local code requirements or any other applicable requirements. Tests and inspections for equipment approval shall be performed at no additional cost to Metro.
- B. Clearly mark equipment, devices, and material with manufacturer's name or trademark and rating in volts and amperes and other pertinent information on a nameplate.

1.08 ELECTRIC SERVICE

- A. Electrical power system for the facility operates at 480/277 volt, 3-phase, 4-wire, 60 Hertz.
 - 1. Provide electrical low voltage distribution system that operates on 208/120 volt, 3-phase and []-volt, []-phase, 60 Hertz obtained from the power system by dry-type transformer(s).
- B. Earth and rock excavation, backfill, concrete masonry, concrete reinforcement, and construction joints required for electrical work are included under this Section, and shall conform to requirements specified under applicable Sections of this Contract.

1.09 EQUIPMENT SPECIFIED ELSEWHERE

- A. Certain control equipment items and other equipment are indicated on electrical drawings for connection, but are specified in other Sections pertaining to plumbing, heating, ventilating and air conditioning, mechanical process, instrumentation, etc. Such items are not furnished as part of electrical work.

1.10 INCOMING SERVICE

- A. Contact the following organization to coordinate the incoming power requirements for the project:

Nashville Electric Service
1214 Church Street
Nashville, Tennessee 37246
<Mike Nelson>

- B. The organization identified above will furnish and install the following:

1. Pad-mounted transformer
2. Primary cable
3. Connection for all primary and secondary cables
 - a. Metering equipment as described below
4. Pole and pole-mounted transformer
5. Provide the following in accordance with the contract documents:
 - a. Concrete pad for transformer
 - b. Primary and secondary duct lines
 - c. Secondary cables of sufficient length for termination at the transformer
 - d. Grounding at pad and service pole
 - e. Conduit at service pole
 - f. Metering equipment as described below:
 - 1) <DESIGNER TO INSERT>
 - 2) <DESIGNER TO INSERT>
6. Secondary duct line
7. Secondary cables of sufficient length for termination at the transformer
8. Grounding at service pole
 - a. Provide all conduits and wire to service pole, extend conduit up pole for distance of 10 feet, and leave sufficient length of conductors to reach the electrical distribution

system overhead conductors. Connections at pole shall be made by the power company. Perform work at service pole in accordance with the power company's requirements.

9. Perform all work in accordance with power company's requirements and in a manner approved by the power company.
 10. Notify the power company in writing within two weeks after the contract award date concerning incoming service requirements.
- C. The final, complete installation shall comply with all state and local statutory requirements having jurisdiction. The Contractor shall arrange for all necessary permits, pay all fees, and arrange for all required inspections by local authorities. In general, all work shall comply with the National Electrical Code requirements all state codes and the codes and ordinances of the Metropolitan Government.

1.11 TELEPHONE SERVICE

- A. Provide all conduit and wire to service pole, extend conduit up pole as required by the telephone company. Connections at pole will be made by the telephone company. Perform work at service pole in accordance with telephone company's requirements.
1. Perform all work in accordance with telephone company's requirements and in a manner approved by the telephone company.
 2. Notify the telephone company in writing within two weeks after the contract award date concerning incoming service requirements.

PART 2 - PRODUCTS

2.01 METERING EQUIPMENT

- A. Power Company: (Primary) (Secondary) metering equipment furnished by the power company as follows:
1. <DESIGNER TO INSERT>
 2. <DESIGNER TO INSERT>
- B. Electrical Contractor: Furnish (primary) (secondary) metering equipment as follows:
1. <DESIGNER TO INSERT>
 2. <DESIGNER TO INSERT>

PART 3 - EXECUTION

3.01 METERING EQUIPMENT

- A. Install metering equipment as follows:
 - 1. Obtain from the power company the drilling templates, dimensions, and mounting arrangements for metering transformers. Transmit this information to electrical equipment manufacturer for cutting and drilling.
 - 2. Ensure the metering equipment installation shall be in accordance with power company requirements by submitting drawings, sketches, catalog information, and other appropriate material for power company approval.

3.02 REMOVAL AND RELOCATION OF MATERIAL AND EQUIPMENT

- A. Carefully dismantle and salvage electrical equipment, switches, fixtures, conduits, cables, wiring, and boxes, as necessary, to carry out proposed changes. Rehabilitate and relocate equipment items as required and as indicated or specified.
 - 1. Deliver material and equipment indicated for reuse or salvage by Metro to Metro at the Central WWTP site.
- B. Remove from site and dispose of material and equipment not indicated for reuse or salvage.

3.03 WORK IN EXISTING STRUCTURES

- A. Each bidder or his authorized representative shall, before preparing his proposal, visit all areas of the existing structures in which work under this bid is to be performed and inspect carefully the present installation. The proposal submission by this bidder shall be considered evidence that he or his representative has visited the buildings and structures and noted the locations and conditions under which the work will be performed and that he takes full responsibility for a complete knowledge about all factors governing his work.
- B. In general, any or all existing electrical equipment and services are to remain in operation and shall not be disturbed unless otherwise noted in these Specifications and/or on the Drawings or as required to properly execute the work.
- C. In each work area, disconnect and carefully remove the existing electrical equipment and devices so noted. Except for items indicated as having to be re-used, all such existing equipment and devices shall be turned over to Metro. If not required by Metro, remove them from the premises and site. All existing electrical equipment and devices indicated as not to be removed or abandoned are to be maintained in operation, and any circuits disturbed by construction shall be restored.
- D. Maintain existing electrical services and systems to and in the buildings throughout the project. All "down-time" shall be scheduled at least two weeks in advance with the Construction Manager's permission and such scheduling shall be rigidly adhered to.

3.04 DEMOLITION

- A. Survey the existing electrical systems and equipment identified for removal and representative from the other trades prior to performing any demolition work. Identify all conduit and equipment to be removed with tags or paint.

- B. Where a piece of equipment is to be removed, all associated ancillary components (e.g. solenoid valves, pressure switches, etc.) and associated wiring and conduit shall also be removed.
- C. Equipment, buildings, or structures scheduled for complete demolition shall be made safe from electrical shock hazard prior to demolition. Disconnect all electrical power, communications, alarm and signal system.
- D. Equipment scheduled to be turned over to Metro shall be carefully disconnected, removed, and delivered to Metro where indicated. Provide labor, hoisting, and transportation for the equipment. All other miscellaneous electrical materials, devices, etc., associated with the equipment being turned over shall be demolished and removed from the site.
- E. Remove electrical work associated with equipment scheduled for demolition except those portions indicated to remain or be reused.
- F. Unless otherwise specifically noted, remove unused exposed conduit and support systems back to concealment point including abandoned circuit above accessible ceiling finishes. Remove unused wiring back to source (or nearest point of usage).
- G. Disconnect abandoned outlets and removed devices. Remove abandoned outlets if the conduit services to them have been abandoned or are being removed. Provide blank covers for abandoned outlets which are not removed.
- H. Disconnect and remove abandoned panelboards, disconnect switches, control stations, distribution equipment, etc.
- I. Disconnect and remove abandoned luminaries. Remove brackets, stems, hangers, and other accessories.
- J. Repair adjacent construction and finishes damaged during demolition and extension work.
- K. Where electrical systems pass through the demolition areas to serve other portions of the premises, they shall remain or be suitably relocated, and the system restored to normal operation.
- L. Coordinate electrical power outages to the electrical systems and equipment with Metro. Where Metro cannot allow the duration for proposed outage, phase the retrofit work to allow the system or equipment to be re-connected to the electrical power system within the time frame allowed by Metro, or provide temporary power connections as required to maintain service to the systems or equipment. The temporary power can be from a generator or another part of the facility not affected by the outage, provided there is sufficient spare capacity.
- M. Continuous service is required on all circuits and outlets affected by these changes, except where Metro will permit an outage for a specific time. Obtain consent from Metro before removing any circuit from continuous service.
- N. The electrical and process equipment to be removed or relocated under this contract has been identified on the Drawings. The removal and or relocation for existing conduit, wire, and equipment have not been detailed on the Drawings. Survey the affected equipment and building areas before submitting bid proposal.
- O. Trace out existing wiring to be relocated or removed and perform the relocation or removal work, as required, for a complete operational and safe system.

- P. Remove exposed conduits, wireways, outlet boxes, pull boxes, and hangers made obsolete by the alterations, unless specifically designated to remain. Patch surfaces and provide blank covers for abandoned outlets which are removed.
- Q. All equipment, materials, controls, motor starters, branch and feeder breakers, panel boards, transformers, wiring, raceways, etc. furnished and installed to temporarily keep circuits energized shall be removed when the permanent installation is fully operational.

3.05 PROTECTION OF ELECTRICAL EQUIPMENT

- A. Protect electrical equipment from the weather, especially from water dripping or splashing on it, at all times during shipment, storage, and construction. Do not store equipment outdoors. Where equipment is installed or stored in moist areas or unheated buildings provide acceptable means to prevent moisture damage. Provide uniformly distributed heat source in electrical equipment to prevent condensation and damage to electrical insulation systems.

3.06 DEFECTIVE OR DAMAGED EQUIPMENT

- A. Thoroughly dry out equipment or material subjected to possible water damage and put through a special dielectric test, as directed, without additional cost to Metro.

3.07 EQUIPMENT ENCLOSURE

- A. The equipment enclosure classifications of the plant areas are indicated on the Drawings. Provide all equipment, devices, and materials meeting this schedule's requirements unless otherwise noted or specified.

3.08 STARTING EQUIPMENT DATA LIST

- A. Obtain data from the equipment supplier shop drawing submittals or equipment nameplates and prepare a complete tabulation of all motors over 1/3 HP, electric heaters over 3 kW, and starting equipment for both to be furnished on the project.

1. Include in tabulation form the following information:
 - a. Equipment name and identification
 - b. Manufacturer
 - c. Horsepower or kilowatt rating
 - d. Voltage
 - e. Phase
 - f. Speed
 - g. Full load current
 - h. Locked rotor current or code letter
 - i. Enclosure type (open drip-proof, totally enclosed, fan cooled, etc.)
 - j. NEMA size of starter or contactor

- k. Overload heater size
 - l. Starter type (full-voltage, reduced-voltage, autotransformer, etc.)
 - m. Breaker trip setting or fuse size
 - n. Voltage for starter operating coil
 - o. If starter is at a motor control center, list motor control center number.
2. Final electrical system acceptance is contingent upon submitting the complete motor and electric heater tabulation.
 3. Arrange tabulation in groups by MCC or building location.
 4. Furnish six copies of the tabulation to the Construction Manager when a submission is made.

3.09 AS-BUILTS

- A. At the project's completion, provide two drawing sets to Metro marked to show the as-installed equipment, devices, duct line locations, and wiring in the format requested by Metro. The markings on the drawings are to be neat, clean, and legible.

3.10 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 26 29 23

VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide complete simplex type Variable Frequency Drive (VFD) units and appurtenances including drive reactors, DC chokes, harmonic filters, enclosures, and certain auxiliary items, as indicated and as specified, to provide a complete operating system.
- B. VFD units shall be furnished by the driven equipment manufacturer (pump, fan, etc.) supplier. Unit installation shall be the Contractor's responsibility. All conduit and wire installations associated with each VFD shall be provided under Division 26.
- C. VFD units shall be manufacturer's standard technology and have been in production for a minimum of 2 years.
- D. Provide control system operation, input and control signals, status signals, and devices, as specified on the plan sheets.
- E. Provide VFD output filter or reactor, when cable length between VFD and motor is greater than 100 feet (30 m), to ensure motor terminals do not experience overvoltage condition as defined by NEMA Standard MG-1.
- F. Each VFD unit shall exhibit less than 5 % voltage total harmonic distortion and less than 3 % voltage distortion on each harmonic at their immediate upstream distribution bus as verified by calculation and testing. Harmonic current distortion shall be in accordance with Table 26 29 23-1. This bus shall be referred to as the point of common coupling (PCC).

1.02 REFERENCES

- A. American Society for Testing and Materials International (ASTM)
 - 1. D178: Standard Specification for Rubber Insulating Matting
- B. National Electrical Manufacturers Association (NEMA)
 - 1. ICS 2: Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 Volts
 - 2. AB 1: Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures
 - 3. KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
 - 4. MG 1: Motors and Generators
- C. National Fire Protection Association (NFPA)
 - 1. 70: National Electrical Code (NEC)

D. Underwriter's Laboratories Inc. (UL)

1. 489: Molded-Case Breakers, Molded-Case Switches, and Circuit Breaker Enclosures
2. 508: Electrical Industrial Control Equipment
3. 1066: Low Voltage AC and DC Power Circuit Breakers Used in Enclosures

1.03 SEISMIC DESIGN REQUIREMENTS

- A. Conform to the requirements indicated on the structural drawings.
- B. Conform to the requirements specified in Section ## ## ## <PROJECT SPECIFIC>.
- C. The manufacturer, supplier, and Electrical Contractor are responsible for conforming to the seismic design requirements for this project and for the work in this Section.

1.04 SUBMITTALS

- A. Submit shop drawings in accordance with Section 01 33 00.
- B. Submit shop drawings and manufacturers' product data in accordance with Section 26 05 10 requirements.
- C. Submit a complete equipment and materials list, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions for all major components.
- D. Furnish complete wiring and schematic diagrams for the equipment furnished. Each wiring diagram shall be legible and not reduced from the original design drafted format. Provide an equipment list on each wiring diagram for which it is applicable.
- E. Provide the panel layout and front view drawings.
- F. Submit time versus current curves for protection devices.
- G. Submit data sheets for all devices provided as part of the assembly.
- H. Provide all other details required to demonstrate the system has been coordinated and will properly function as a unit.
- I. Provide data to verify the drives can be used for motor lead lengths up to 100 feet (30 meters) without output filters. Include information from the VFD manufacturer or output filter or reactor manufacturer (if required) stating the motor terminal voltage limitations as defined by NEMA Standard MG 1, Part 31 are met. For VFDs located more than a cable length of 100 feet from the motor load, provide drawings which include information demonstrating an output filter or reactor is included within the VFD.
- J. Provide enclosure drawings and details showing all dimensions and construction details.
- K. Harmonic Analysis Report: Provide harmonic analysis report which is to be accepted by the Engineer prior to releasing drives for fabrication.
 1. Submit voltage THD frequency scan for each VFD type supplied for use in field testing.

2. Contractor shall contract with a specialty firm to perform a system harmonics study based on presubmittal information.
- L. Submit information relative to location and expertise for local service office and personnel.
- M. Submit a Statement of Compliance certificate indicating conformance to the specified Seismic Requirements. Certificate shall be signed and sealed by a Tennessee registered Professional Engineer.
- N. For informational purposes only, provide installation and anchoring details to meet earthquake requirements as specified and indicated on structural Drawings.
- O. For informational purposes only, submit manufacturer's printed installation instructions.
- P. Spare Parts Data: Submit a spare parts list for the specified equipment.
- Q. Operating and Maintenance Instruction Manuals
 1. Furnish
 - a. Operating instruction manuals outlining step-by-step procedures required for system startup and operation
 - b. Manufacturer's name, model number, service manual parts list
 - c. Brief description of equipment and basic operating features
 - d. Maintenance instruction manuals outlining maintenance procedures
 - e. Troubleshooting guide listing possible breakdown and repairs
 - f. Point-to-point connection wiring diagram for the system
 - g. Performance Test Reports: Upon completing the system installation, submit in booklet form all shop and field tests performed to prove compliance with specified performance criteria.

1.05 QUALITY ASSURANCE

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Provide VFD units in accordance with UL 508A, supplement SB, and Article 409 of the National Electrical Code. All VFD units shall be provided with a UL label.
- C. Ensure the conduit size and wire quantity, size, and type are suitable for the equipment supplied. Coordinate all design information with the Electrical Contractor. Review the proper installation of each type of VFD unit with the equipment supplier prior to installation.
 1. Services of Service Engineer, specifically trained on type of equipment specified. Person-day requirements listed exclusive of travel time.
 2. Assist with device locations, mounting methods, field erection, etc.: 0.5 person-day
 3. Functional Completion Testing: 1.0 person-day

4. Startup: 1.0 person-day
5. Commissioning: 0.5 person-day
6. At the end of start-up service, provide training from the startup/testing service engineer for 6 Metro staff maximum at the facility site: 1.0 person-day
7. Service-inspections during operation's first year, for use at Metro request, excluding repair, malfunction, or other trouble-shooting service calls: 2.0 person-day
8. Person-day is defined as one 8-hour day, excluding travel time.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Provide in accordance with Section 01 66 10 and as specified.
- B. Shipping
 1. Ship equipment and materials, except where partial disassembly is required by transportation regulations or for protection, complete with identification and item quantity.
 2. Pack spare parts in containers bearing labels clearly designating contents and equipment pieces for which they are intended.
 3. Deliver spare parts after installation as specified before start-up of drives. Deliver to Metro after completing work.
- C. Storage
 1. Inspect and inventory items upon delivery to site.
 2. Store and safeguard equipment, material, and spare parts.
 - a. If the equipment cannot be placed into service after its receipt, store in a closed building or structure, in a clean, dry, and ventilated area free from temperature, dirt, and moisture extremes. Acceptable storage temperatures are from 40 degrees F to 100 degrees F with temporary heaters provided within enclosures to prevent condensation. Provide heavy plastic envelope directly over motor control center to protect against dust, dirt, and moisture. Provide lifting angles outside of envelope.

1.07 WARRANTY AND SERVICE

- A. Provide as specified.
- B. Guarantee components, parts, and assemblies supplied by manufacturer against defects in materials and workmanship for a 24-month period after acceptance and startup, including onsite assistance, parts, and labor, travel time and expenses. All labor is to be performed by local factory trained service engineers.
- C. Ensure the equipment manufacturer has local branch office staff with trained, full-time employees who can test, inspect, repair, and maintain the equipment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Manufacturer shall have at least 5 years commercial experience in manufacturing, operating, and servicing equipment for a type, size, quality, performance, and reliability equal to that specified.
- B. VFD Units
 - 1. Allen Bradley
 - 2. Square D Company
 - 3. ABB Group
 - 4. Or approved equal
- C. VFD Input Filters and Output Filters/Reactors
 - 1. Trans-Coil, Inc.
 - 2. MTE Corporation
 - 3. Power Quality International

2.02 HARMONIC ANALYSIS

- A. Each VFD unit shall be designed with less than 5 % voltage total harmonic distortion at the PCC. Current distortion at the PCC will be in accordance with Table 26 29 23-1. For the analysis, it will be assumed the facility transformer feeding the electrical system is at a lightly (50 %) loaded condition.

Table 26 29 23-1 Maximum Harmonic Current Distortion In Percent IL Odd Harmonic						
Ratio	5 to 9	11 to 15	17 to 21	23 to 33	35 +	TDD
Less than 20	4.0	2.0	1.5	0.6	0.3	5.0
20 to 50	7.0	3.5	2.5	1.0	0.5	8.0
50 to 100	10.0	4.5	4.0	1.5	0.7	12.0
100 to 1,000	12.0	5.5	5.0	2.0	1.0	15.0
1,000 +	15.0	7.0	6.0	2.5	1.4	20.0

Notes:

- 1. Even harmonics are limited to 25 % of odd harmonics.
- 2. DC offset distortions are not allowed.
- 3. Ratio = Isc/IL where:
 - a. Isc = Maximum short circuit current at PCC.
 - b. IL = Maximum demand load current at PCC (fundamental frequency component)

- B. Provide all harmonic related data to the Engineer of Record identified in Section ### ## ##. **<PROVIDED BY DESIGN ENGINEER>**

- C. For each VFD unit, provide a harmonic analysis study at the connection point to the immediate upstream distribution bus (PCC), based on presubmittal data.
- D. Each VFD unit shall be designed with less than 5 % voltage total harmonic distortion and less than 3 % voltage distortion on each harmonic at the PCC. Current distortion is to be within the limits of Table 26 29 23-1. For the analysis, it will be assumed the electrical system is at a lightly loaded condition, 50 % load. If the VFD loads exceed 50 % system loading, assume the system is loaded at VFD full load ratings.
1. At each PCC, where more than one type or size VFD unit is to be connected, provide the following:
 - a. Contractor shall have the supplier of the largest drive (in HP) provide a harmonic study for each common coupling point based on presubmittal information
 2. The Contractor shall supply the following presubmittal information to the largest VFD supplier to complete the harmonics study.
 - a. Full load fundamental current for each VFD unit
 - b. Harmonic currents on per unit basis of full load fundamental for each VFD unit
 - c. Available fault current information from the electric utility and upstream transformer data
 - d. Distribution transformer sizes and impedances, if any
 - e. VFD input line reactor and/or isolation transformer sizes and impedances from the utility source to the VFD units
 - f. Conductor information between transformer secondary or generator terminals to the distribution buses and VFDs
 - g. Generator kW, impedance, subtransient reactance generator constants for the condition when the electrical system is powered from the generator
 3. The harmonics study results shall verify that the total harmonic voltage levels at each common coupling point are less than 5 % and that the voltage distortion on each harmonic is less than 3 %. In addition, harmonic currents at the PCC will be within the limits in Table 26 29 23-1. The study shall separately consider each VFD distribution bus as points of common connection (PCCs). The study shall specify additional equipment required (e.g., filters) at each harmonic where harmonic reduction is required to insure compliance.
- E. The study shall consider the following conditions:
1. The electrical system shall be powered by the electric utility, case 1, or solely by local generation, case 2.
 2. The study shall include an explanation for all assumptions, data sources, methodologies, and formulas used in the study and summarize the study results.
 3. The Contractor shall supply all equipment required as a result of the final accepted harmonics study to comply with the requirements in Paragraph 1.01 F.

2.03 PROVISIONS

A. Service Conditions

1. Ambient Temperature Range: 32 degrees F to 40 degrees C
2. Operational Humidity: Up to 90 % noncondensing
3. Environment: As indicated on enclosure schedule
4. Altitude: Below 1,000 feet above sea level
5. Input Power
 - a. Nominal Voltage: 480 volts (+/- 10 %), 3-phase, 3-wire
 - b. Nominal Frequency: 60 Hertz (+/- 2 Hertz.)
 - c. Service provided from feeder breaker on distribution bus.

B. Drive System: 0-500 HP Units

1. General
 - a. Furnish solid state variable frequency, microprocessor type with Pulse Width Modulated (PWM) output wave form converter. The VFD shall employ a full wave rectifier to prevent input line notching, a DC bus choke, DC bus capacitors, and Insulated Gate Bipolar Transistors (IGBT) as the output switching device to convert nominal 480 volts, 3-phase, 60 Hertz, 3-wire input power into adjustable-frequency 3-wire system at 0 to 480 volts, 3-phase, 0 to 60 Hertz output power. Provide output speed control for required motor under variable torque load or constant torque as required by the driven equipment.
 - b. Motor control circuits shall be wired in accordance with the requirements specified herein or indicated on the Drawings. Where not indicated, the control circuits shall be standard 2-wire "start-stop," and the Contractor shall furnish wiring accordingly. Controls shall be designed to allow for automatic restart when power is returned after a system outage, unless otherwise directed.
 - c. The VFD manufacturer shall be responsible for the successful application and operation of the entire drive and control system serving the motor and driven equipment. This includes the responsibility for obtaining all loads, torque, speed, and performance requirements from the respective sources and integrating these into a VFD system that fulfills this Specification's requirements.
 - d. The Contractor and VFD system manufacturer are cautioned regarding the review and compliance with the total Contract Documents. Typical examples are circuit breakers, motor circuit protectors, magnetic starters, relays, timers, control and instrumentation products, pilot devices, including pushbuttons, selector switches, pilot lights, enclosures, conduit, disconnect switches, terminal boxes, and other equipment.
 - e. Provide flux vector control type drives, also known as field-oriented control, with hard-wired motor speed feedback encoder or tachometer, for full torque at zero speed capability.

- f. Provide VFD control which ensures accurate zero to full load torque control at low frequencies, including zero speed, with torque repeatability accuracy of 2 % or better and torque response time less than 20 ms.
- g. Provide on drive a disconnecting device and fixed diode input rectifier (for a constant power factor).
- h. The drive unit shall be of either modular design to provide for ease and speed of maintenance or chassis style installed in an adequate enclosure.
2. For units rated 50 HP or less, provide 6 pulse drive with 5 % input line impedance minimum.
- a. If needed to obtain harmonic study requirements under Paragraph 2.02, provide harmonic trap filters. Filters shall be individual for each VFD as well as provided with contactors and controlled by the VFD to remove them from the line when the drive is not operating. Contactors shall be provided with spare contacts for remote alarm and to energize status lamp at VFD enclosure.
3. For units rated greater than 50 HP, provide VFD with passive harmonic drives with trap filters, adequate inductance, or an IGBT technology. ---
4. Provide active front end converter low harmonic drives to meet the harmonic study requirements as noted above for VFDs rated 125 HP or larger
5. If needed to obtain harmonic study requirements under Paragraph 2.02, provide harmonic trap filters. Filters shall be individual for each VFD as well as provided with contactors and controlled by the VFD to remove them from the line when the drive is not operating. Contactors shall be provided with spare contacts for remote alarm and to energize status lamp at VFD enclosure. All drive components shall be designed and sized for the abnormal condition of continuous operation of the driven equipment specified herein at loads up to 15 % above rated full load.
6. RMS harmonic drive output is not to provide more than 5 % increase in motor heating over similar motor operation with zero harmonics in the current.
7. The unit shall withstand drive output terminal line-to-line and line-to-ground short circuits without component failure during start-up and during operation. Drive to safely shutdown until short is cleared.
8. Provide NEMA type cabinet for each drive unit, as indicated on Drawings and enclosure schedule. NEMA 4 and NEMA 4X enclosures are to be provided with stainless steel hand operated quick disconnect devices and interior cooling systems. Provide hinged acrylic door with gasketing on front of door for each access to keypad controls.
9. For inverter rated squirrel cage motors, per NEMA Standard MG-1, Part 31.40.4.2, the following limit values at the motor terminals are to be observed:
- a. For motors with base rating voltage less than or equal to 600 volts, the peak instantaneous voltage must be limited to 1,600 volts or less, with a voltage rise time greater than or equal to 0.1 micro-seconds.
10. The VFD manufacturer shall guarantee the required voltage limits will be met with the motor installed up to 100 cable feet from the VFD drive unit. If the VFD manufacturer is not able to guarantee the above voltage limits will be met, provide a drive output filter or

reactor, appropriately rated, located within the VFD enclosure and near the VFD output terminals, which shall ensure the limitations listed above are maintained. A device located at the motor terminals is not acceptable.

11. When controlling for non-inverter rated squirrel cage motors, provide output filters to limit peak voltage at the motor terminal to less than 1,000 V, increase voltage rise time and reduce common mode current.
12. VFD shall be capable of full rated output when powered by incoming voltage with Total Harmonic Distortion (THD) in excess of 10 %.
13. Furnish series choke and capacitors on DC bus to reduce ripple in rectifier output and to reduce harmonic distortion reflected into incoming power feeders.
14. Properly size enclosure to dissipate heat generated by VFD within limits of specified service conditions.
 - a. Provide NEMA enclosure type as indicated on Drawings.
 - b. Provide integral fans or cooling systems as required by the application.
 - c. NEMA 4 and 4X type enclosures are to use hand-operated locking devices for door closing hardware.
 - d. Circuit breaker interlock must be able to be bypassed via lever on front door surface.
 - e. NEMA 1 and 12 type enclosures shall have keypad controls located on the enclosure's exterior.
 - f. Provide visual alarm indicator on cabinet door.
 - g. Fans shall be located to allow quick removal and replacement without disassembling drive components.

2.04 PERFORMANCE CHARACTERISTICS

- A. Output amps: 110 % of rated, continuous
- B. Current limit: Range 0 to 130 % for constant torque applications, 0 to 110 % for variable torque applications, for 1 minute minimum
- C. Acceleration time to top speed: 1-300 seconds, minimum, adjustable
- D. Deceleration time from top speed: 1-300 seconds, minimum, adjustable
- E. Frequency stability: +/- 0.5 % (at 25 degrees C, +10 degrees C) after reaching operating temperature
- F. Output voltage: Proportional to frequency with low speed boost

- G. Combined drive/and filtering efficiency, defined as motor shaft KW divided by VFD input KW, shall meet the following minimum requirements at the specified operating points:
 - 1. 97 % at 60 Hertz VFD output and 100 % load
 - 2. 92 % at 50 Hertz VFD output and 60 % load
- H. VFD fundamental power factor shall be 0.98 or higher at all speeds and loads.
- I. The VFD shall be able to sustain continued operation with a 30 % dip in nominal line voltage. Output speed may decline only if the VFD's current limit rating is exceeded.
- J. Losses to be utilized in drive system efficiency calculation shall include the input line reactor, phase shifting transformer, and harmonic trap filter with capacitors. Auxiliary controls such as internal VFD control boards and cooling fans shall be included in all loss calculations.

2.05 DRIVE PROTECTION

A. General

- 1. Fault detection and trip circuits shall protect VFD and connected motor against line voltage transients, single-phase, power line overvoltage and undervoltage, output overvoltage and overcurrent, and VFD overtemperature.
 - a. The VFD shall employ three current limit circuits to provide trip free operation.
 - b. The slow current regulation limit circuit shall be adjustable to a minimum 125 % of the VFD's variable torque current rating.
 - c. The rapid current regulation limit shall be adjustable to a minimum 170 % of the VFD's variable torque current rating.
 - d. The current switch off limit shall be fixed at a minimum 225 % of the VFD's variable torque current rating.
- 2. Internal Protection. Minimum circuitry as follows:
 - a. Current limiting, fast acting, semiconductor input fuses for protecting internal power semiconductors
 - b. Instantaneous output overcurrent trip maximum: 200 %
 - c. DC bus and control circuit transformer fusing
 - d. Grounded control chassis
 - e. Under and over voltage trip, 3 phases
 - f. Motor overload protection, with solid state relays
 - g. Circuit breaker, with door interlocked handle
 - 1) Provide means to allow entry into panel where required by authorized personnel.

- 2) Circuit breaker is to be rated [25,000 AIC], [42,000 AIC], [65,000 AIC], (100,000 AIC) minimum.
- h. Fault reset push button
 - i. Line to ground faults
 - j. Input metal oxide varistor and input line reactor for transient protection
 - k. VFD overtemperature
3. Troubleshooting. Provide diagnostic aids to indicate fault's cause, used to assist in troubleshooting circuit problems. Isolated Form C contacts for remote alarm indications are to include the following:
- a. Over/under voltage indication
 - b. Overcurrent trip indication
 - c. DC bus charged indication
 - d. Fault detection indication
 - e. Recycle start indication (to indicate the unit tried to pick up load for three previous tries and failed)
4. Provide power loss ride through capability, which will allow the logic to maintain control due to load inertia without faulting.
5. Provide a programmable automatic restart function, which will provide 3 restarts minimum with time delays between restarts following a fault condition other than a ground fault, short circuit, internal fault, or user programmable fault condition. Restart type is to be programmable for time delay or coasting motor restart.
6. For drives units rated 200 HP or more, provide uninterruptable power supply (UPS) to power control circuits and prevent inadvertent trip due to voltage sag conditions.
- a. The UPS shall be installed within the drive enclosure.
 - b. The UPS battery backup time shall be 5 minutes minimum or as recommended by the VFD manufacturer.
 - c. UPS shall be American Power Conversion Smart-UPS 1400 X LT or equal by MGE or Eaton Powerware.

2.06 CONTROL INTERFACE

- A. Provide VFD unit with appropriate power circuitry and auxiliary contacts for energizing and controlling the following devices associated with the motor, if required:
 - 1. Space heaters
 - 2. Solenoid valves

3. Remote indication of motor start and stop (isolated contacts)
4. Remote indication of drive fault (isolated contacts)

B. Minimum Control Features

1. LOCAL/REMOTE selection for Start/Stop control
2. LOCAL/REMOTE selection for Speed Control
3. Accept a grounded, isolated, 4-20 mA input remote speed control signal from an external device.
4. Provide a 4-20 mA output signal proportion to VFD output frequency for remote speed indication.

C. Control Devices

1. Provide operating, monitoring, or alarm indicating devices, door-mounted, with minimum as follows:
 - a. Drive System Disconnect Operator
 - b. System control selector switch (RUN/OFF/REMOTE) (When in RUN position drive will run). Control switch shall be oil-tight, 30 mm units.
 - c. System speed control selector switch (LOCAL/REMOTE) (When in LOCAL position, speed controlled by manual speed potentiometer). Control switch shall be oil tight, 30 mm units.
 - d. Manual keypad controls to set speed in manual mode
 - e. Speed indicating meter in percent speed to indicate speed for the converter powered motor.
 - f. Run time meter, mechanical type, round, UL Certified, non-reset type, with register to indicate hours and tenths of hours up to 99,999.9 hours.
 - g. Alarm and status lights: Provide LED cluster type, heavy duty, 30 mm oil tight units.
2. Control circuits shall be isolated from power circuits.
 - a. Unit to accept a 4-20 mA DC speed control signal from an isolated, ungrounded transmitter with unit in remote mode and from local door-mounted micro-processor type keypad with unit in local mode.
 - b. The input 4-20 mA signal is to be optically isolated from the drive run control circuit.
 - c. Furnish door-mounted switch on the enclosure for local/remote mode.
 - d. Keypad controls are to have adjustable minimum speed setting of 10 to 80 % of full speed and maximum speed setting of 50 to 100 % of full speed. The total speed

setting is to follow a linear time ramp, adjustable from 1-300 seconds for acceleration and deceleration control.

- D. Provide a Modbus network card and interface modules to allow serial communications on a Modbus network.
 - 1. Interface connection cable shall utilize a RJ-45 connector.
 - 2. Network is to allow a selection of standard and custom register values to communicate drive parameters, including:
 - a. Drive fault
 - b. Overload
 - c. Trip
 - d. Loss of control power
 - e. Speed
 - f. Power (kW)
 - g. Amps (Phase A, B, and C)
 - h. Voltage (Phase A-B, B-C, C-A)
 - 3. Provide all components and drive programming to allow network interface with control system.

2.07 -----SHOP TESTING

- A. Provide in accordance with Section 01 43 00.
- B. Provide a factory performance test for each VFD unit. The test shall simulate the expected load to be driven. The drive is to operate the actual motor load through the expected speed ranges. Test length is to be 2 hours minimum.
- C. Provide a factory burn-in test for 24 hours minimum and a control and alarm test on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
- D. Provide typical prototype factory test data for short circuit testing of each drive type supplied. Data is to verify each drive can be started into a line-to-line fault and line-to-ground fault on the drive terminals. Each drive can be operating at full load and be subjected to a line-to-line fault and line-to-ground fault on the drive terminals. All phases (A, B, and C) are to be included in test data.
- E. Provide certified documentation for all tests performed.
- F. Provide above stated tests in addition to routine factory tests.
- G. Metro is to have the option to witness all factory tests. Notify the Construction Manager two weeks before all tests.

2.08 SPARE PARTS

- A. Provide in accordance with Section 01 78 23 and as specified.
- B. Provide one spare board or card and three diodes for each horsepower size drive. Spares will be color-coded or otherwise keyed to their original counterpart so it is impossible to improperly install spare cards. In addition to the cards, the manufacturer shall provide three spares for all expendable items such as pilot lamps, power fuses, and control fuses. Provide one keypad for every three VFDs of the same model.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Examine VFD location for satisfactory preparation. Check conduits and raceway location for connection to units.
- B. Visually inspect delivered unit(s) and accessories for conformance with specification and Drawings.
- C. Verify availability for appropriate pacing signal.
- D. Maintain VFD in upright position at all times.
- E. Protect VFD against damage. Store drive in clean, dry environment with temperature and humidity within range as specified by drive manufacturer. Energize space heaters during storage as recommended by manufacturer.

3.02 INSTALLATION

- A. Erect, install, and start up equipment.
- B. The VFDs shall be installed as shown on the Drawings in accordance with the manufacturer's installation instructions and accepted shop drawings.
- C. Install VFDs to allow complete door swing required for component removal. This is specifically required where a VFD is set in the corner of a room.
- D. Factory-trained service personnel, other than sales representatives, shall supervise field installation, inspect, make final adjustments and operational checks, make functional checks of spare parts, and prepare a final report for record purposes. Adjust control and instrument equipment until this equipment has been field tested.

3.03 RUBBER MATS

- A. Three-foot wide rubber mats shall be furnished and installed on the floor and in front of each VFD assembly. The mats shall be long enough to cover the full length of each VFD system. The mats shall be 1/2-inch thick with beveled edges, canvas back, solid type with corrugations running the long way and shall be guaranteed extra quality, free from cracks, blow holes, or other defects detrimental to their mechanical or electrical strength. The mats shall meet ASTM D178 requirements for Type II, Class 4 insulating matting.

3.04 FIELD TESTING

- A. Provide in accordance with Section 01 43 00.
- B. Perform testing checkout and start-up for VFD equipment under technical direction of manufacturer's service engineer. Under no circumstances, energize any portion of the drive system without authorization from manufacturer's technical representative.
- C. Field Tests
 1. Test each drive over the total speed range it will be required to operate through for the load being driven for a minimum of two hours. Determine for each drive, motor, and load combination the following at minimum speed, maximum speed, and at 1/3 and 2/3 points between the minimum and maximum speeds:
 - a. Input power (kW), voltage, current, and RMS power factor on the line side of the drive isolation device
 - b. Output to the driven load in kilowatts
 - c. For each drive, measure the harmonic voltage distortion and harmonic current distortion for each harmonic at the main distribution bus for maximum and minimum load conditions.
 - d. Measure the total harmonic voltage distortion and total harmonic current distortion at each PCC for maximum and minimum load conditions.
 2. Test each drive by using the actual control signal for remote and local operation.
 3. Test each drive's alarm functions.
 4. Perform all tests in the Construction Manager's presence.
 5. Perform the above test in addition to the manufacturer's normal field tests.
 6. Submit final test report with summary comparing field test data with harmonic analysis design calculated values for each drive.
 7. Testing determined not in compliance with Contract Documents shall be repeated by the Contractor at no additional cost to Metro.

3.05 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 31 23 00

EXCAVATION AND FILL

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes

1. Excavation and fill for foundations, structures, and pavement; site drainage, structures, and features
2. Below-grade utilities within building footprints (Refer to Section 31 23 33 for all other utility trenching and backfill.)
3. Embankments
4. Dewatering excavations
5. Controlled fill using materials from imported and on-site sources
6. Soil and aggregate materials
7. Compaction and testing

1.02 REFERENCES

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

1. M147: Standard Specification for Materials for Aggregate and Soil-Aggregate Sub-base, Base, and Surface Courses.

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

1. C33: Specification for Concrete Aggregates
2. D421: Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants
3. D422: Test Method for Particle-Size Analysis of Soils
4. D698: Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lb/ft³)
5. D1556: Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
6. D1557: Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³)
7. D2167: Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method

8. D2216: Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass
 9. D2487: Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
 10. D2937: Standard Test Method for Density of Soil In Place by the Drive-Cylinder Method
 11. D2940: Standard Specification for Graded Aggregate Material for Bases or Sub-bases for Highways or Airports
 12. D4318: Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
 13. D6938: Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- C. Occupational Safety and Health Administration (OSHA) Standards and Regulations
1. 29 CFR 1926, Subpart P: Safety and Health Regulations for Construction, Excavations
- D. Tennessee Department of Transportation
1. Standard Specifications for Road and Bridge Construction, Section 205.04, Formation of Embankments

1.03 CLASSIFICATION OF EXCAVATION

- A. Excavation is part of the lump sum contract price for the entire project. Excavation is not classified.

1.04 DEFINITIONS

- A. Percent Compaction or Compaction Density: The field dry density for compacted material expressed as a percentage of the maximum dry density
- B. Field Dry Density or Field Density: In-place density as determined by ASTM D1556 (Sand Cone Method), ASTM D2167 (Rubber Balloon Method), ASTM D2937 (Drive Cylinder Method), or ASTM D6938 (Nuclear Method)
- C. Maximum Dry Density: Maximum laboratory density as determined by ASTM D698 (Standard Proctor) or ASTM D1557 (Modified Proctor) and occurring at the optimum moisture content of the material being tested
- D. Proof Roll: Multiple overlapping passes of a fully loaded rubber-tired vehicle (e.g., tandem axle dump truck having a gross load between 25 to 50 tons) judged acceptable by Engineer. Weight and contact pressure shall be as recommended by geotechnical engineer for the material being tested.
- E. Structural Fill: Engineered fill that will ultimately be subjected to structural loading such as imposed by footings, slabs, pavement, etc. Structural fill shall be placed in current and identified future structural areas.

1.05 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00.
 - 1. Temporary excavation and shoring drawings for worker protection in accordance with the General Conditions
 - 2. Gradation analysis
 - 3. Dewatering plan including groundwater disposition
 - 4. Manufacturer's catalog data and a sample of prefabricated drainage panel and filter fabric with manufacturer's installation instructions and details
 - 5. Materials Sources: Source name, location, sample date, sieve analysis, and laboratory compaction characteristics
 - 6. Test and Evaluation Reports
 - a. Field density testing reports: Provide results from field density testing of prepared subgrade and compacted fill.
 - b. Grain-size analysis and/or Atterberg limits, as appropriate
 - c. Laboratory compaction characteristics of soils
 - d. Water content
 - 7. Geotextile
 - a. At least two weeks prior to shipment, submit manufacturer's certificate of compliance and physical property data sheet indicating the requirements for materials and manufacture are in conformance as specified.
 - b. For informational purposes only, submit manufacturer's printed installation instructions.
 - 8. Existing structure survey or condition documentation data (see Paragraph 3.03)

1.06 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.
- B. Sustainability Standards Certifications
- C. Testing will be provided by the Contractor. Contractor shall be responsible for cost of testing and inspection conducted as a result of non-conforming work.
- D. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

1.07 DELIVERY STORAGE AND HANDLING

- A. Comply with the requirements specified in Section 01 66 10.

B. Geotextile Fabric

1. Provide rolls wrapped with protective covering to protect from mud, dirt, dust, and debris. Label each roll with number or symbol to identify production run.
2. Protect from sunlight during transportation and storage. Do not leave exposed to sunlight for more than two weeks during installation operations.

1.08 SITE CONDITIONS

A. Existing Conditions: **(DELETE IF NO PROJECT REPORT)**

1. Geotechnical Report: The report is attached for information only and is not part of the Contract Documents. Boring logs are included in the report and indicate conditions encountered only at test boring locations. Nothing in the Contract Documents shall be construed as a guarantee that other materials will not be encountered or material proportions will not vary from proportions shown on the test boring logs.

PART 2 - PRODUCTS

2.01 FILL MATERIALS

- A. Suitable Material: Material from on-site excavation and or permitted off-site sources that meets all the specified requirements for its intended use and is not unsuitable. Wet subgrade material which meets other requirements for suitable material and can be dried to a moisture content compatible with required compaction is suitable.
- B. Unsuitable Material: Material that fails to meet requirements for suitable materials or contains any of the following:
 1. Organic clay, organic silt, or peat as defined in ASTM D2487
 2. More than 3 percent by weight organic material or any large roots
 3. Stones or rock fragments over 4 inches in any dimension
 4. Porous biodegradable matter, excavated pavement, construction debris, rubbish, or refuse
 5. Ice, snow, frost, or frozen soil particles
- C. General Fill: Suitable, unclassified material
- D. Structural Fill: Suitable material classified by the Unified Soil Classification System (USCS) in accordance with ASTM D2487 as GW, GM, GC, SW, SM, SC, CL, or ML. Verify the largest particles in the fill are no greater in dimension than one-half the thickness of the compacted lift thickness.
- E. Structural Fill (Alternate): When approved by the Engineer, non-degradable rock (i.e., durable limestone shot-rock) may be used to construct compacted fills. Suitable shot-rock shall meet the following criteria:
 1. Non-degradable rock (TDOT 205.04) Maximum shot-rock size - 18 inches (occasional pieces up to 24 inches can be tolerated). Should be reduced to 12 inches in upper 2 feet beneath building areas and pavement.

2. Percentage of soil – maximum 10 percent by volume
3. Gradation – well-graded (including range of particle sizes) with adequate fines to effectively "choke" the voids between larger rock pieces. The amount of rock fines passing the No. 200 sieve should be less than 20 percent.
4. If thinner shot-rock lifts are required, the maximum particle size should be reduced accordingly. The maximum particle size should generally be 6 inches less than the lift thickness, i.e., for 18-inch lift thickness, maximum particle size should not exceed 12 inches.
5. For large area fills, shot-rock lift thicknesses up to 2 feet may be considered. For 2-foot thick lifts, the maximum particle size should be limited to 24 inches, and the materials should be worked and compacted with a minimum of three passes of a Caterpillar D8 bulldozer or equivalent.

F. Concrete Fill: Minimum compressive strength, 2,000 psi

G. Granular Fill

1. Densely Graded: ASTM D2940 for bases or
2. Densely Graded: Bank-Run Gravel with the following properties:
 - a. Natural deposit, unprocessed except when needed to remove deleterious materials and stones larger than maximum size allowed
 - b. Soil particles: ASTM C33 physical property requirements
 - c. Material source: Submit to Construction Manager for acceptance.
 - d. Gradation: Table 31 23 00-1.

Table 31 23 00-1	
Sieve Designation (Square Mesh)	Percentage Passing (By Weight)
6 inches	100
2 inches	95-100
No. 4	20-65
No. 50	10-25
No. 200	0-12

3. Open Graded: ASTM C33, coarse aggregate, No. 57 (The amount of rock fines passing the No. 200 sieve should be less than 20 percent) or
4. Open Graded: Screened Gravel or Crushed Stone, ASTM C33, coarse aggregate, No. 67. Soil particles shall conform to ASTM C33 physical property requirements.

H. Sand: Natural sand. Fine aggregate resulting from natural or manufactured processes within Grade "A" Sand gradation limits

I. Select Borrow

1. Well-graded, coarse-grained soil classified in accordance with ASTM D2487 as GW, GW-GM, GW-GC, SW, SW-SM, or SW-SC
2. Soil particles: ASTM C33, physical property requirements
3. Gradation: Table 31 23 00-2.

Table 31 23 00-2	
Sieve Designation (Square Mesh)	Percentage Passing (By Weight)
3 inches	100
1-1/2 inches	70-100
3/4 inches	50-85
No. 4	30-60
No. 50	10-25
No. 200	0-5

2.02 EQUIPMENT

- A. Compaction equipment shall be able to consistently achieve specified compaction requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Verify that the dewatering support systems are in place before commencing with excavation.
- B. Verify that the excavation safety and support systems meeting OSHA 29 CFR 1926, Subpart P requirements are in place before commencing with excavation.
 1. Minimum slopes for laying back excavations or materials are contained in OSHA 29 CFR 1926, Subpart P, Appendices A and B.
 2. Minimum requirements for shoring and bracing are contained in OSHA 29 CFR 1926, Subpart P, Appendix C.
- C. Verify that the fill materials submittals have been accepted by the Construction Manager before commencing with work requiring these materials.
- D. Verify that the erosion prevention and sediment control measures are in place and functioning properly.
- E. Verify that the tree protection fencing is in place.
- F. Immediately notify the Construction Manager if unexpected subsurface facilities or suspected hazardous materials are encountered during excavation. Discontinue affected work in area until notified to resume work.

G. Test Pits

1. Comply with requirements in Section 01 14 14.
2. Excavate test pits to field verify existing underground utility locations at crossings and at tie-in points before ordering materials or commencing excavation. Immediately notify the Construction Manager if conflicts are encountered.

3.02 PREPARATION

- A. Underpin adjacent structures that could be damaged by excavation work.
- B. Cut pavement with saw or pneumatic tools to prevent damage to remaining pavement. Dispose of large pieces of demolished pavement before proceeding with excavation.
- C. Remove subsurface structures and related obstructions as indicated.
- D. Remove boulders within excavation limits.
- E. Mark utility locations.
- F. Identify required lines, levels, contours, and datum locations.

3.03 PROTECTION OF IN-PLACE CONDITIONS

- A. Comply with requirements specified in Section 01 14 14.
- B. Support and protect from damage: existing pipes, poles, wires, fences, curbs, property line markers, and other features or structures which must be preserved in place to avoid being temporarily or permanently relocated.
- C. Excavation Near Existing Structures
 1. Discontinue digging by machinery when excavation approaches pipes, conduits, or other underground structures. Continue excavation using mini-sized equipment and hand tools. Include such manual excavation in work to be done when incidental to normal excavation and under items involving normal excavation.
 2. Excavate test pits near or at intersection with existing utilities or underground structures to determine the exact location for existing features.
- D. Excavation near Private Property
 1. Record existing condition for features on adjacent property by means of dated photographs or cameras. Provide construction photographs according to Section 01 32 33.
 2. Enclose uncut tree trunks adjacent to work in wooden boxes at a height necessary to protect tree from injury due to piled material, equipment, or operations. Operate excavating machinery and cranes to prevent injury to overhanging branches and limbs.
 3. Protect cultivated hedges, shrubs, and plants which would otherwise be damaged by the work.

4. Where protecting vegetation is not possible, dig up, temporarily transplant, and maintain. After active construction operations in the area have ceased, transplant vegetation to the original positions and provide water and nursery care until growth is re-established.
5. Do not use or operate tractors, bulldozers, or other power-operated equipment on paved and/or railroad track surfaces to be retained. Provide protection on pavement or tracks if construction traffic is unavoidable.

3.04 RESTORATION

- A. Restore private property and structures promptly. Begin restoration work within 24 hours of when damage occurred.
- B. Existing surfaces, features, or utilities to remain but are damaged during construction shall be repaired or replaced to at least the condition they were found immediately before work began, unless noted otherwise.
- C. Damaged Trees to Remain: Cut all damaged branches, limbs, and roots smoothly and neatly without splitting or crushing. Neatly trim, cut the injured portions, and apply grafting wax or tree healing paint. Replace damaged trees which subsequently die or continue to show lack of growth due to damage 1 year after substantial completion.
- D. Cultivated Vegetation: Includes, but is not limited to, hedges, shrubs, and plants. Damaged vegetation shall be replaced with equal kind and of at least the quality before work began.

3.05 EXCAVATION

- A. Excavate to accommodate new structures and construction operations. Underpin adjacent structures and utilities that may be damaged by excavating work.
- B. Excavate to lines and grades necessary to provide finish grades.
- C. Excavations not shored and deeper than 4 feet but no deeper than 20 feet shall have banks laid back to a minimum stable slope matching the excavated material's angle of repose.
- D. Excavations shored and deeper than 20 feet shall be designed by a Tennessee registered professional engineer per OSHA regulations, who is experienced in shoring design.
- E. Workers shall have an adequate means to exit from excavations that are 4 feet or greater in depth. The exit means shall not require more than 25 feet of lateral travel.
- F. Establish excavation limits to allow adequate working space for installing forms and for personnel safety.
- G. Carry out program of excavation, dewatering, and excavation support systems to eliminate possibility for undermining or disturbing existing structure foundations or the work.
- H. Provide dewatering system in accordance with Section 31 23 19.
- I. Provide sheeting and shoring in accordance with this Section and the drawings.
- J. Preserve material below and beyond the excavation lines.
- K. Locate stockpiled excavated material at least 10 feet from edge of excavations up to 10 feet deep to prevent cave-ins or bank slides. For unbraced excavations deeper than 10 feet,

minimum stockpile distance shall equal the excavation's depth. Braced excavations shall be designed to accommodate stockpile surcharge loads.

- L. Excavate for depressed mat foundations so the adjacent foundation mat sections will rest on undisturbed ground or engineered fill.
- M. Slope banks with machine to angle of repose or less until shored.
- N. Do not interfere with 45 degree bearing splay of foundations.
- O. Grade top perimeter of excavating to prevent surface water from draining into excavation.
- P. Trim excavation. Remove loose matter.
- Q. Remove lumped subsoil, boulders, and rock of all sizes.
- R. Notify Construction Manager of unexpected subsurface conditions.
- S. Remove excess and unsuitable material from site.
- T. Stockpile excavated material in area designated on site.
- U. Repair and replace items indicated to remain and damaged by excavation.

3.06 SUBGRADE PREPARATION

- A. The exposed surface shall be examined by an engineering geologist or soils engineer to determine if the proper bearing material has been exposed.
- B. Materials determined to be unsuitable by visual inspection shall be over-excavated below the foundation subgrade and backfilled with structural fill.
- C. Backfill with compacted open-graded granular fill screened gravel or crushed stone wrapped with nonwoven geotextile fabric. In no case shall the aggregate be placed directly on the exposed subgrade prior to placing the geotextile fabric.
- D. Compact subgrade and proof roll to identify soft spots or other deficiencies prior to filling operations or placing foundations. Correct deficiencies as specified for AUTHORIZED OVER-EXCAVATION and repeat proof roll procedure until successful.
- E. When subgrade is below controlled fill, scarify subgrade to bond with subsequent material lifts.
- F. Proof roll foundation subgrade prior to filling operation or placing foundation concrete. Repair soft or yielding subgrade per 3.07-A. Proof roll repaired subgrade. Repeat until stable subgrade is demonstrated.

3.07 AUTHORIZED OVER-EXCAVATION

- A. If proof roll test fails, remove unsuitable material plus an additional 6 inches and backfill with structural fill.

3.08 UNAUTHORIZED EXCAVATION

- A. Contractor is responsible for backfilling unauthorized excavations with structural fill.

3.09 FILL

- A. Fill to lines and grades necessary to provide finish grades.
- B. Use a placement method that does not disturb or damage other work or existing features.
- C. Maintain fill materials within +/- 2 percent of optimum moisture, as determined by approved testing firm and approved by the Engineer, to attain required compaction density.
- D. Place and compact soil fill materials in maximum 6-inch thick loose lifts (cohesive soils).
- E. Shot-Rock Fill
 - 1. Spreading: Larger rock pieces should lie flat and not overlap each other.
 - 2. Maximum lift thickness: 24 inches
 - 3. Compaction Requirements - The fill should be compacted by making multiple passes with a Caterpillar D6 bulldozer or equivalent. The number of passes should be sufficient to demonstrate the material is densified and stable
 - 4. If thinner shot-rock lifts are required, the maximum particle size should be reduced accordingly. The maximum particle size should generally be 6 inches less than the lift thickness, i.e., for 18-inch lift thickness, maximum particle size should not exceed 12 inches.
 - 5. For large area fills, shot-rock lift thicknesses up to 2 feet may be considered. For 2-foot thick lifts, the maximum particle size should be limited to 24 inches, and the materials should be worked and compacted with a minimum of three passes of a Caterpillar D8 bulldozer or equivalent.
- F. General fill may be used in open areas, over lot fill, and areas which are not load bearing.
- G. Use structural fill beneath and adjacent to buildings and structures, and beneath pavements.
- H. Use concrete fill where footing bearing surfaces are over-excavated, or footing is otherwise not bearing on undisturbed soil.
- I. Do not backfill against or on hydraulic structures until testing is completed. See Section 03 05 10 for leakage testing requirements of concrete containment structures. Conduct hydraulic testing as soon as practicable after structures are constructed and other necessary work has been done. Start backfilling promptly after completing tests.
- J. Deposit material evenly around structure to avoid unequal soil pressure.
- K. Do not place backfill against or on structures until they have attained sufficient strength to support the loads (including construction loads) to which they will be subjected without distortion, cracking, or other damage.

3.10 COMPACTION

- A. Compact to density specified and indicated for various material types. Control moisture content for material being placed as specified, or if not specified - at a level slightly lower than optimum.

- B. Compaction Density: Provide densities in Table 31 23 00-3. The values listed are minimum percentages, unless noted otherwise.

Table 31 23 00-3	
Area	Percentage of Maximum Dry Density as defined by ASTM D698 (Standard Proctor)
Scarified subgrades	98
Under pavement, slabs	98
Under structures or within 25 feet of structures	98
Stormwater Management (SWM) basin embankment	100
Under exterior concrete slab and sidewalks	98
Open or grassed areas	90
Topsoil	90 (maximum)

3.11 COMPACTION CONTROL SHOT-ROCK FILL

- A. Conventional density testing of compacted shot-rock fill is not practical. A trained engineering technician working under the geotechnical engineer’s direction shall closely observe and document shot-rock fill placement and compaction techniques, including fill constituents and lift thickness.

3.12 BACKFILLING AGAINST STRUCTURES

- A. Backfill shall not be placed against foundation walls until all interior floors have been placed and the concrete has attained design strength. This includes the floor level at grade or the next level above grade if no floor is within 2 feet of finished grade.
- B. Backfill shall not be placed against cantilever walls until the concrete has attained design strength.

3.13 EMBANKMENT FILL AND COMPACTION

- A. Begin filling in lowest section of work area. Grade fill surface approximately horizontal, but provide with sufficient longitudinal and transverse slope to allow for surface water runoff from every point.
- B. Install temporary dewatering sumps in low areas during filling operation where excessive rain runoff amounts collect.
- C. Reduce fill material moisture content, if necessary, in source area by aerating it over during warm and dry atmospheric conditions. A large disc harrow with 2- to 3-foot diameter disks may be required for working soil in a drying operation.
- D. Compact uniformly throughout. Keep fill surfaces sufficiently smooth and free from humps and hollows to allow for proper and uniform compaction. Do not permit hauling equipment to follow a single track on the same layer. Direct equipment to spread out to prevent over compaction in localized areas.
- E. To mitigate difficulties associated with achieving adequate compaction at the edges of compacted fills, overbuild fill pads by 5 feet horizontally then cut back to desired slope.

- F. Slightly slope fill surface to ensure drainage during wet weather periods. Do not place fill while rain is falling or after a rainstorm until the Construction Manager considers the conditions to be satisfactory. During such periods and upon suspending filling operations for periods exceeding 12 hours, roll smooth the fill surface using a smooth wheel static roller to prevent excessive absorption of rainfall and surface moisture. Prior to resuming compaction operations, scarify and recompact the exposed subgrade (after mud removal, if muddy, or prior to placing next fill lift if moisture is acceptable).
- G. When fill is placed against an earlier fill or against in-situ material under and around structures (including around piping beneath structures or embankments) slope the junction between two fill sections at 1.5 to 1 (horizontal to vertical). Bench the existing fill edge 24 inches to form a serrated edge with compact stable material against which to place the new fill. Ensure the rolling extends over the junction between fills.
- H. Clean debris, remove loose material, scarify, verify moisture condition, and recompact and proof roll previously placed fill which has had time to become desiccated or littered with debris.
- I. After spreading each loose lift to the required thickness and adjusting its moisture content, roll with sufficient number of passes to obtain the required compaction. One pass is defined as the required number of successive trips which by means of sufficient overlap will insure complete coverage and uniform compaction for an entire lift. Do not make additional passes until previous pass has been completed.
- J. Fill surface shall be firm and stable when rolled. Reduce moisture content when fill material sinks and weaves under rollers and equipment. Spread out rolling operations over the maximum practicable area to minimize sinking and weaving conditions. Suspend fill operations on embankment portions where inundations produce surface cracks.
- K. Remove material which fails testing requirements and replace work.

3.14 GEOTEXTILE

- A. Install geotextile fabric in accordance with manufacturer's printed instructions where indicated on the Drawings or required by the Contractor's design..
- B. Place geotextile fabric on the foundation subgrade prior to placing aggregate material.
- C. Overlap geotextile fabric 18 inches minimum for unsown lap joint. Overlap fabric 6 inches at seam for sewn joint.
- D. Do not permit traffic or construction equipment to travel directly on geotextile fabric.
- E. Place geotextile fabric in relatively smooth condition to prevent tearing or puncturing. Lay geotextile fabric loosely, but without wrinkles or creases, so placing the backfill materials will not stretch or tear the geotextile fabric. Leave sufficient slack in geotextile fabric around irregularities to allow for readjustments.
- F. Patch all tears in geotextile fabric by placing additional section of geotextile fabric over tear with a minimum 3-foot overlap.
- G. Extend the geotextile fabric and wrap around aggregate material along the foundation perimeter.

3.15 FIELD QUALITY CONTROL

- A. See Section 01 43 00 for general field inspection and testing requirements.
- B. Perform inspection at least twice daily to confirm lift thickness and compaction effort for entire fill area.
- C. Perform particle size distribution and gradation analyses using ASTM D422 and following standard practices in ASTM D421. Perform 2 tests for every source and submit results to the Construction Manager for acceptance. Repeat the Proctor compaction test for every 5,000 cubic yards of material used.
- D. Perform field density testing in accordance with ASTM D1556, ASTM D2167, ASTM D2937, or ASTM D6938.
- E. Evaluate field density test results in relation to maximum dry density as determined by testing material in accordance with ASTM D698 Standard Proctor.
- F. For cohesive fill soils, perform tests in accordance with ASTM D4318 to determine Liquid Limit, Plastic Limit, and Plasticity Index. Submit test results to the Construction Manager for acceptance. Perform one test minimum per 5,000 cubic yards of soil for use as fill material and whenever material classification is in doubt as determined by the Construction Manager.
- G. Field density test locations shall be mutually acceptable to testing laboratory and the Engineer.
- H. In the event compacted material does not meet specified in-place density, re-compact material and re-test area until specified results are obtained.
- I. Field density test frequency as specified in Table 31 23 00-4, with 2 tests minimum per lift (or alternate lift):

Area	Frequency
Roadways	1 per lift for each 250 linear feet of fill placed
Paved Areas	1 per lift for each 10,000 square feet of fill placed
Open Areas	1 per lift for each 25,000 square feet of fill placed
Isolated Footing Perimeter	1 per alternate lift for each 25 linear feet
Footing and Wall Backfill	1 per alternate lift for each 50 linear feet (both sides of wall)
Structural Areas (excludes roadways and paved areas)	1 per lift for each 2,500 square feet of fill placed
Regardless of the minimum testing frequency specified, field density tests shall be performed by the Contractor in sufficient number for the Contractor's quality control purposes to ensure the specified density is obtained.	

3.16 ADJUSTING

- A. Shrinkage
 - 1. Build embankments or backfill to a height above finished grade which will, in the Construction Manager's opinion, allow for material shrinkage or consolidation. Initially,

provide at all points an excess of at least 1 percent of total backfill height measured from stripped surface to top of finished surface.

2. Supply specified materials to build up low places when embankment or backfill settles below the finished grade at any time before substantial completion.

3.17 TOLERANCES

- A. Construct finished surfaces to +/- 1 inch of the elevations indicated.
- B. Grade cut and fill areas to +/- 0.20 feet of the grades indicated.
- C. Complete embankment edges to +/- 6 inches of the slope lines indicated.
- D. Provide the Construction Manager with adequate survey information to verify compliance with above tolerances.

3.18 PROTECTION

- A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate the possibility of undermining or disturbing foundations for partially and completed structures, pipelines, and embankments or existing structures and pipelines.

3.19 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 70 00.

END OF SECTION

SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Design, furnish, operate, maintain, and remove temporary dewatering systems to control groundwater and surface water to maintain stable, undisturbed subgrades, and permit work to be performed under dry and stable conditions. Work to be done as part of dewatering includes, but is not limited to the following:
 - 1. Lowering the groundwater level
 - 2. Lowering hydrostatic pressure
 - 3. Preventing surface water from entering the excavation during construction
 - 4. Implementing erosion control measures for disposing discharge water
 - 5. Providing and monitoring observation wells and geotechnical instrumentation, as specified and indicated
- B. Groundwater within the excavation area shall be lowered to at least 2 feet below the lowest excavation levels as specified and as indicated.
- C. Common dewatering methods include, but are not limited to, sump pumping, deep wells, well points, or combinations thereof.
- D. The Contractor shall obtain the required NPDES permit and/or equivalent state permit for discharge from the Contractor's dewatering systems in accordance with 40 CFR Part 122. The discharge location shall be in accordance with permit requirements.

1.02 REFERENCES

- A. Code of Federal Regulations, Title 40 – Protection of Environment (CFR)
 - 1. 40 CFR Part 122: EPA Administered Permit Programs, The National Pollutant Discharge Elimination System

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:
- a. Submit a dewatering plan and, if applicable, a groundwater recharge plan at least 2 weeks prior to starting dewatering work. Do not submit design calculations. Metro and third parties will review the information for an overall project understanding relating to access, maintenance for existing facilities, and proper site utilization. The Contractor shall remain responsible for the adequacy and safety of the construction's means, methods, and sequencing. The plan shall include the following items as a minimum:
 - b. Dewatering plan and details stamped and signed by a Tennessee registered professional engineer
 - c. Certificate of Design: Refer to Section 01 33 00
 - d. An equipment list including, but not limited to, pumps, prime movers, and standby equipment
 - e. Detailed description for dewatering, maintenance, and system removal procedures
 - f. Monitoring plan and details including, but not limited to, observation well number and locations (minimum 3) and geotechnical instruments such as settlement markers (reference points on structures - minimum 2 per structure), piezometers (minimum 3), and frequency for reading the monitoring devices
 - g. Erosion and sedimentation control measures and methods for pumped water disposal
 - h. List with all applicable laws, regulations, rules, and codes to which dewatering design conforms
 - i. List with assumptions made for dewatering design and for groundwater recharge systems including, but not limited to, groundwater levels, soil profile, permeabilities, and pumping and/or recharge duration
 2. Measurement records consisting of observation well groundwater records and the geotechnical instrumentation readings within 1 day of monitoring
 3. A modified dewatering plan within 24 hours, if open pumping from sumps and ditches results in boils, loss of fines or ground softening.

1.04 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.
- B. If subgrade soils are disturbed or become unstable due to dewatering operation or an inadequate dewatering system, notify the Construction Manager, stabilize the subgrade, and modify system to perform as specified.
- C. Notify the Construction Manager immediately if settlement or movement is detected on structures. If the Construction Manager deems the settlement or movement is related to the dewatering, take actions to protect the adjacent structures and submit a modified dewatering plan to the Construction Manager within 24 hours. Implement the modified plan and repair damage incurred to adjacent structures.

- D. Immediately notify the Construction Manager if oil or other hazardous materials are encountered after dewatering begins.

1.05 HYDRAULIC UPLIFT OF STRUCTURES

- A. The Contractor shall be responsible for protecting all structures against hydraulic uplift until such structures have been accepted finally by Metro.
- B. In this regard, the Contractor is advised that all tanks, when completed, are designed to resist hydraulic uplift from groundwater up to the elevation indicated on the structural drawings. The concrete slab bottoms shall be placed in dry subgrade conditions, using well points or other dewatering means, to keep the water elevation sufficiently low to continue the work.

1.06 PRECAUTIONS AGAINST HYDROSTATIC UPLIFT DURING CONSTRUCTION

- A. The Contractor shall maintain a low groundwater elevation in the vicinity of the structures until they are complete. In case of extremely high water while constructing the structures, it may be necessary to flood the structures to maintain stable conditions.

1.07 DELIVERY STORAGE AND HANDLING

- A. Comply with the requirements specified in Section 01 66 10.

1.08 SITE CONDITIONS <PROJECT SPECIFIC, DELETE IF NOT APPLICABLE>

- A. Subsurface Conditions: Refer to attached Geotechnical Report.
 - 1. Geotechnical Report: The report is attached FOR INFORMATION ONLY and is not part of the Contract Documents. Boring logs are included in the report and indicate conditions encountered only at test boring locations. Nothing in the Contract Documents shall be construed as a guarantee that other materials will not be encountered or that the material proportions will not vary from the proportions shown on the test boring logs.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Provide observation wells.
- B. Provide settlement markers, piezometers, and other geotechnical instruments in accordance with the submitted dewatering plan or as specified.
- C. Provide casings, well screens, piping, fittings, pumps, power, and other items required for dewatering system.
- D. Provide sand and gravel filter around the well screen. Wrapping geotextile fabric directly around the well screen shall not be allowed.
 - 1. Filter sand: ASTM C33; natural river or bank sand; washed; free from silt, clay, loam, friable or soluble materials, and organic materials; graded to suit well screen
- E. When deep wells or well points are used, provide pumping units able to handle large air and water volumes at the same time.

- F. Provide auxiliary dewatering equipment in the event of breakdown. Equipment shall include pumps and hoses and be stored on site. Provide at least 1 spare pump for every 5 pumps used.
 - 1. Provide valves and fittings to isolate each well from header pipe and to prevent loss of pump prime.
- G. Provide and maintain erosion and sedimentation control devices as indicated or specified and in accordance with the dewatering plan.
- H. Provide temporary pipes, hoses, flumes, or channels for transporting discharge water to the discharge location.
- I. Provide cement grout having a 1:1 water to cement ratio by volume.
 - 1. Grout: Mixture of Portland cement and bentonite clay or sand suitable for sealing abandoned wells and piping

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Executing earth excavation, installing earth retention systems, and dewatering shall not commence until the related submittals have been accepted in accordance with Section 01 33 00 and the geotechnical instrumentation has been installed.
- B. Provide and maintain dewatering system in accordance with the dewatering plan.
- C. Perform dewatering program so as to prevent undermining or disturbing existing structure foundations or ongoing or previously completed work.
- D. Do not excavate until the dewatering system is operational.
- E. Unless otherwise specified, continue uninterrupted dewatering until all structures, pipes, and appurtenances below groundwater level have been completed so they will not be floated or otherwise damaged by an increase in groundwater elevation.
- F. Discontinue open pumping from sumps and ditches when such pumping results in boils, loss of fines, ground softening, or slope instability. Modify dewatering plan and submit revised plan to the Construction Manager for acceptance.
- G. Where subgrade materials are disturbed or become unstable due to dewatering operations, remove and replace the materials in accordance with Section 31 23 00.
- H. Dewatering System
 - 1. Locate system components to allow continuous dewatering operations without interfering with permanent work installations and existing public rights-of-way, sidewalks, and adjacent buildings, structures, and improvements.
 - 2. Drill wells in sizes and to depth indicated. Provide temporary surface casing when required to stabilize soil while advancing well.
 - 3. While drilling and installing well, keep bore hole filled with natural or organic drilling fluid. Bentonite clay drilling fluid is not permitted.

4. Attach well screen to riser pipe. Attach centralizers to riser pipe at maximum 20-foot spacing to keep screen and riser centered in bore hole. Insert well screen and riser pipe into well to elevation indicated.
5. Install sand filter surrounding well screen.
6. Develop wells by surging or jetting to remove clay, silt, and sand from well screen and immediate vicinity of bore hole.
7. Test well for proper water flow through well screen and pumping rate for dewatering system operation. Repeat development until well meets performance requirements.
8. Cover and seal top of well until pump is installed.
9. Install pump in accordance with manufacturer's instructions.
10. Connect pump to discharge header. Install valves to permit pump isolation.

I. Dewatering Discharge

1. Install and monitor recharge and discharge systems in accordance with the submitted dewatering plan.
2. Install sand and gravel filters in conjunction with well points and deep wells to prevent fines from migrating from the existing soil during the dewatering operation.
3. Transport pumped or drained water to discharge location without interfering with other work and/or damaging pavement, other surfaces, or property.
4. Provide separately controllable pumping lines.
5. The Construction Manager reserves the right to sample discharge water at any time.
6. Immediately notify the Construction Manager if suspected contaminated groundwater is encountered. Do not pump water found to be contaminated with oil or other hazardous material to the discharge locations.

J. Monitoring Devices and Records

1. Install, maintain, monitor, and take readings from the observation wells and geotechnical instruments in accordance with the dewatering plan.
2. Test each monitoring well point to verify installation is performing properly.
3. Install piezometers, calibrate, and test for proper operation of monitoring wells.
4. Protect monitoring well standpipes from damage by construction operations.
5. Maintain continuous accessibility to monitoring wells during construction operations.
6. Maintain monitoring wells until groundwater is allowed to return to normal level.
7. Install settlement markers on structures within the dewatering zone of influence a distance equal to twice the excavation depth, from the closest edge of the excavation. Conduct and report settlement surveys to 1/8-inch.

8. For large rectangular, square, or circular mass excavations the zone of influence shall be defined by the actual cone of watering influence corresponding to a 10 percent increase in effective vertical stress.
- K. Install and maintain erosion/sedimentation control devices at the discharge point as indicated or specified and in accordance with the dewatering plan.
- L. Surface water control system
1. Provide ditches, berms, siltation tubes, settling ponds, and other devices to divert and drain surface water from excavation area.
 2. Divert surface water and seepage water within excavation areas into sumps and pump water into drainage channels in accordance with requirements of agencies having jurisdiction.
 3. Control and remove unanticipated water seepage into excavation.
- M. System operation and maintenance
1. Operate dewatering system until backfilling is complete.
 2. Provide 24-hour supervision of dewatering system by personnel skilled in operating, maintaining, and replacing system components.
 3. Conduct daily observation of dewatering system and monitoring system. Make required repairs and perform scheduled maintenance.
 4. Start emergency generators at least twice each week to check operating conditions.
 5. When dewatering system cannot control water within excavation, notify the Construction Manager and stop excavation and/or foundation work.
 - a. Supplement or modify dewatering system and provide other remedial measures to control water within excavation.
 - b. Demonstrate dewatering system operation complies with performance requirements before resuming excavation operations.
 6. Modify dewatering and surface water control systems when operation causes or threatens to cause damage to new construction, existing site improvements, adjacent property, and/or soil erosion control and sediment control features. Also, modify dewatering and surface water control systems when operation causes site or drainage ditch erosion, sediment discharge from the immediate site, sediment laden water discharge from the immediate site or adjacent water wells, or as required to comply with Tennessee and the Metropolitan Government regulations.
 7. Correct unanticipated pressure conditions affecting dewatering system performance.
 8. Do not discontinue dewatering operations without Construction Manager's approval.
- N. Water disposal
1. Discharge water into drainage channels or settling basins in accordance with the state and municipal regulatory guidance.

O. Removal

1. Do not remove dewatering system without written acceptance from the Construction Manager.
2. Backfill and compact sumps or ditches with screened gravel or crushed stone wrapped with geotextile fabric in accordance with Section 31 23 00.
3. All dewatering wells shall be abandoned upon completing the work and completely backfilled with cement grout.
4. Remove piezometers and monitoring wells.
5. Repair damage caused by dewatering and surface water control systems or resulting from failure of systems to protect property.

3.02 FIELD QUALITY CONTROL

- A. After dewatering system is installed, perform pumping test to determine when selected pumping rate lowers water level in well below pump intake. Adjust pump speed, discharge volume, or both to ensure each pump operates properly.
- B. Monitor and record the average discharge flow rate for each deep well, eductor header, and well point daily until steady state conditions occur. Then monitor and record conditions twice each week.
- C. Monitor and record the groundwater elevation daily until dewatering system is discontinued. Then monitor and record conditions weekly until work is complete, monitoring wells are removed, or until directed by Construction Manager.
- D. Monitor groundwater discharge for sand content. Sample and test water from each well weekly for sand content. Maximum permitted sand content is 5 parts per million.
- E. Monitor groundwater discharge for contamination while performing pumping in vicinity of potentially contaminated sites. Sample and test water weekly for contaminants.
- F. Survey existing adjacent buildings, structures, and improvements weekly to detect movement in comparison to original elevations during dewatering operations.
 1. Notify Construction Manager immediately about measured movement.
- G. Submit initial installation reports including the following:
 1. Installation and development reports for well points and pumps
 2. Installation and baseline reports for monitoring wells and piezometers
 3. Monitoring well water analysis test reports
 4. Initial dewatering flow rates
- H. Submit weekly monitoring reports including the following:
 1. Dewatering flow rates

2. Piezometer readings
3. Discharge water analysis test reports
4. Maintenance records for dewatering and surface water control systems

3.03 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 31 23 33

TRENCHING AND BACKFILL

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The work included in this Section consists of clearing and grubbing, loosening, loading, removing, and disposing of, in the specified manner, all wet and dry materials (including rock) encountered that must be removed for construction purposes; furnishing, placing, and maintaining all sheeting, shoring, bracing, and timbering necessary for the proper protection and safety of the work, the workmen, the public, and adjacent property and improvements; the dewatering of trenches and other excavations; the preparation of satisfactory pipe beds; the backfilling, tamping and compaction of trenches, foundations, and other structures; the preparation of fills and embankments; the removal of unsuitable material from outside the normal limits of excavation and, where ordered by the Construction Manager, their replacement with suitable materials; and all other grading or excavation work incidental to or necessary for the work.
- B. This work shall be performed as specified below. Work required under this Section will not be measured and paid for as a separate pay item, unless stated otherwise in the Agreement.

1.02 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:
 1. Qualifications of Independent Testing Laboratory, four weeks prior to earthwork
 2. Temporary excavation and shoring drawings for worker protection in accordance with the General Conditions
 3. Gradation analysis
 4. Dewatering plan including disposition of groundwater
 5. Materials Sources: Name of source, location, date of sample, sieve analysis, and laboratory compaction characteristics
 6. Test and Evaluation Reports
 - a. Field density testing reports: Provide results from field density testing of prepared subgrade and compacted fill.
 - b. Grain-size analysis
 - c. Laboratory compaction characteristics of soils
 - d. Water content
 7. Compaction method and removal sequence of shoring

1.03 QUALITY ASSURANCE

- A. Comply with the requirements specified in Section 01 43 00.
- B. Sustainability Standards Certifications
- C. Sample backfill materials in accordance with ASTM D75
- D. Protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent cave-in of loose soil. Protection shall be in accordance with OSHA 29 CFR 1926, Subpart P.

PART 2 - PRODUCTS

2.01 AGGREGATE

- A. No. 7 crushed stone (1/2 inch clean stone) as specified by ASTM C-33 Standard Specification for Concrete Aggregates and TDOT Standard Specifications for Road and Bridge Construction Section 903.22, Class B backfill
- B. No. 57 crushed stone (1 inch clean stone) as specified by ASTM C-33 Standard Specification for Concrete Aggregates and TDOT Standard Specifications for Road and Bridge Construction Section 903.22
- C. Base Rock: TDOT Mineral Aggregate Base, Class A, Aggregate Grading D, as specified in Section 903.05 of the TDOT Standard Specifications for Road and Bridge Construction

2.02 EARTH BACKFILL

- A. Soil, loam, or other excavated material suitable for use as backfill
- B. Free from roots or organic matter, refuse, boulders and material larger than 1/2 cubic foot, or other deleterious materials

2.03 FLOWABLE FILL

- A. Select and proportion ingredients to obtain compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.
- B. Materials
 1. Cement: ASTM C150, Type I or Type II
 2. Aggregate: ASTM C33, Size 7
 3. Fly Ash (if used): ASTM C618, Class C
 4. Water: Clean, potable, containing less than 500 ppm of chlorides

PART 3 - EXECUTION

3.01 PREPARATION OF THE SITE

- A. Before starting construction, remove from the work site all vegetative growth (except as hereinafter excluded), debris, and/or other objectionable matter as well as any buildings and/or other structures that the Drawings and/or the Construction Manager specifically indicate are to be removed. Dispose of this refuse material in a manner that complies with all applicable laws and regulations.
- B. In certain areas, it may be desirable for existing trees, shrubs, or other vegetation on the site to be preserved for the permanent landscape. Such vegetation may be shown on the drawings, specifically listed in the specifications, marked on the site, or identified by the Construction Manager. Do not damage or remove such growth without written permission from the Construction Manager.
- C. If the area to be excavated is occupied by trees, brush, or other vegetative growth, clear such growth, grub the excavated area, and remove all large roots to a depth of not less than 2 feet below the bottom of the proposed construction. Dispose of the growth removed in compliance with all applicable laws and regulations. Fill all holes or cavities created during this work that extend below the subgrade elevation with suitable material and compact to the same density as the surrounding material.
- D. Trees, cultivated shrubs, etc., that are situated within public rights-of-way and/or construction easements through private property but not directly within the excavation area shall remain undisturbed unless it is necessary to remove them so that the work can be performed safely and unless their removal is specifically ordered by the Construction Manager. Take special precautions to protect and preserve such growth throughout all stages of the construction.
- E. If excavation is to be completed under any pavement or concrete, the pavement and/or concrete must be cut or sawed to straight, clean lines before excavation begins.
- F. Preparation of the site shall be considered an integral part of the excavation and one for which no separate payment shall be allowed.

3.02 UNSUITABLE MATERIALS / TRENCH STABILIZATION

- A. Wherever muck, quicksand, soft clay, swampy ground, or other material unsuitable for foundations, subgrade, or backfilling is encountered beneath the level of the lines, grades, and/or cross sections on the drawings, remove it and continue excavation until suitable material is encountered, or as directed by the Construction Manager.
- B. The material removed shall be disposed of in the manner described in paragraph 3.04 of this Section.
- C. Then refill the areas excavated for this reason with No. 57 crushed stone or other crushed stone material approved by the Construction Manager up to the level of the lines, grades, and/or cross-sections shown on the drawings. The material shall be placed over the full width of the trench or excavated area in 6-inch lifts and mechanically compacted prior to placing succeeding lifts.
- D. The Construction Manager may require No. 57 crushed stone or larger base rock for stabilizing the trench bottom below the top 6 inches of the refill.

3.03 ROCKS AND BOULDERS

- A. Any material that is encountered within the limits of the required excavation that cannot be removed except by drilling and/or blasting, including rock, boulders, masonry, hard pan, chert, shale, street and sidewalk pavements, and/or similar materials shall be considered as unclassified excavation, and no separate payment will be made therefore.
- B. Should rock be encountered in the excavation, remove it by blasting or otherwise. Where blasts are made, cover the excavation with enough excavation material and/or timber or steel matting to prevent danger to life and property. Secure all permits required by law for blasting operations and the additional hazard insurance required. Observe all applicable laws and ordinances pertaining to blasting operations. Perform a mandatory pre-blast survey prior to commencing any blasting activities.
- C. Excavate rock over the horizontal limits of excavation and to a depth of not less than 6 inches below the outside bottom of pipe up to 30 inches in diameter and not less than 12 inches below the outside bottom of larger pipes if rock extends to such depth. Then backfill the space below grade with No. 57 crushed stone or other approved material, mechanically compact to the proper grade and make ready for construction.

3.04 DISPOSAL OF MATERIALS

- A. Whenever practicable, all materials removed by excavation that are suitable for backfilling pipe trenches or for other purposes shown on the Drawings or directed by the Construction Manager shall be used for these purposes. Any surplus materials not so used shall be managed as either consisting solely of earth, rock, concrete and/or asphalt paving materials (“clean spoil”) or, if determined to be something other than clean spoil, as waste materials.
- B. Clean spoil may be deposited off site in spoil areas at site locations in accordance with local regulations. For all such areas, provide certification that proper material handling was in compliance with all applicable laws and regulations.
- C. Unless otherwise provided in the Contract Documents, waste materials must be properly classified by Contractor and lawfully transported to and disposed of in an appropriate permitted landfill. Provide proof of each such transport and disposal to the Construction Manager within 24 hours after such disposal.
- D. Once any part of the Work is completed, properly remove all surplus clean spoil and lawfully dispose of all waste materials left within the constructions limits of that Work. Upon completion of the Work, all plants, rubbish, unused materials, concrete forms, and other like material shall be removed from the job site.
- E. The site shall be left in a state of order and cleanliness.
- F. The depositing of clean spoil and the disposal of waste materials in the manner described above shall be considered an integral part of the excavation work and one for which no separate payment shall be made.
- G. Trench Protection
 - 1. During working hours: Maximum amount of exposed pipe trench shall be 100 feet.

2. During nonworking hours inside roadway, use one of the following methods of trench protection:
 - a. Steel plate, minimum ¾-inch thick, over entire trench or excavation overlapping each pavement edge by 1 foot minimum
 - b. Concrete jersey type barriers placed around entire trench or excavation
 - c. Cones, barrels, illumination markers and orange safety fencing/posts
3. During nonworking hours outside roadway, use one of the following methods of trench protection:
 - a. Concrete barriers and/or equipment placed around entire trench or excavation
 - b. Cones, barrels, and/or orange safety fencing/posts

3.05 EXCAVATION FOR TRENCHES, FACILITIES AND STRUCTURES

- A. Unclassified excavation for pipelines shall consist of the excavation necessary for the construction of all piping and their appurtenances (including manholes, inlets, outlets, headwalls, collars, concrete saddles, and pipe protection) that are called for by the drawings. It shall include clearing and grubbing, where necessary, backfilling, tamping and compacting pipe trenches and around structures, and disposing of waste materials, all of which shall conform to the applicable provisions set forth elsewhere in these specifications.
- B. Contractor may, if he chooses, use a motor powered trenching machine. If he does, however, he shall be fully responsible for the preservation or repair of existing utility service connections and the adequate compaction of backfill material.
- C. Unless the construction of lines by tunneling, jacking, or boring is called for by the Drawings or specifically authorized by Engineer, make excavation for pipelines in open cut trenches true to the lines and grades shown on the Drawings or established by the Construction Manager on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed as shown in the standard details of the Plans. When approved in writing by the Construction Manager, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to non-vertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline. If a motor powered trenching machine is approved by the Construction Manager, the trench width will conform to the standard details of the Plans. Trench width for trenching machines will require a minimum spacing of 12-inches between the pipe wall and vertical rock surfaces and 6-inches between the pipe wall and horizontal rock surface. Contractor shall comply with all backfill compaction requirements regardless of trenching method that is approved by the Construction Manager.
- D. Perform all work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossings when and where the Construction Manager deems necessary to maintain vehicular or pedestrian traffic.
- E. In all cases where materials are deposited along open trenches, place them so that in the event of rain or surcharge loading from such deposits no damage will result to the work and/or to adjacent property.

3.06 SHEETING, SHORING AND BRACING

- A. Special care shall be taken to avoid damage wherever excavation is being done. Sufficiently sheet, shore, and brace the sides of all excavations to prevent slides, cave-ins, settlement, or movement of the banks and to maintain the specified trench widths. Use solid sheets in wet, saturated, or flowing ground. All sheeting, shoring, and bracing shall have enough strength and rigidity to withstand the pressures exerted, to keep the walls of the excavation properly in place, and to protect all persons and property from injury or damage. Separate payment will not be made for sheeting, shoring, and bracing. These are considered an incidental part of the excavation work.
- B. Wherever employees may be exposed to moving ground or cave-ins, shore and lay back exposed earth excavation surfaces more than 5 feet high to a stable slope or else provide some equivalent means of protection. Effectively protect trenches less than 5 feet deep when an examination of the ground indicates hazardous ground movement may be expected. Guard the walls and faces of all excavations in which employees are exposed to danger from moving ground by a shoring system, sloping of the ground, or some equivalent protection.
- C. Comply with all OSHA standards in determining where and in what manner sheeting, shoring, and bracing are to be done.
- D. Where excavations are made adjacent to existing buildings or structures or in paved streets or alleys, take particular care to sheet, shore, and brace the sides of the excavation so as to prevent any undermining of or settlement beneath such structures or pavement. Underpin adjacent structures wherever necessary, with the approval of the Construction Manager.
- E. Sheeting, shoring, or bracing materials shall not be left in place unless this is called for by the Drawings, ordered by Engineer, or deemed necessary or advisable for the safety or protection of the new or existing work or features. Remove these materials in such a manner that the new structure or any existing structures or property, whether public or private, will not be endangered or damaged and that cave-ins and slides are avoided.
- F. All holes and voids left in the work by the removal of sheeting, shoring, or bracing shall be filled and compacted as specified herein.
- G. All trench boxes used shall be designed to provide protection equal to or greater than that of an appropriate shoring system.

3.07 DEWATERING OF EXCAVATION

- A. Contractor shall provide and keep in operation enough suitable pumping equipment whenever necessary or whenever directed to do so by the Construction Manager. He shall give special attention to excavations for those structures that, prior to proper backfilling, are subject to flotation from hydrostatic uplift. Dewatering shall occur only in accordance with applicable laws and regulations, approved permits, industry best management practices, and Section 31 23 19.

3.08 BORROW EXCAVATION

- A. Whenever the backfill of excavated areas or the placement of embankments requires more material than is available from authorized excavations, or whenever the backfill material from such excavations is unsuitable, obtain additional material from other sources. This may require the opening of borrow pits at points accessible to the work. In such cases, make suitable arrangements with the property owner and pay all incidental costs, including any royalties, for the use of the borrowed material. Before a borrow pit is opened, the quality and

suitability of its material shall be approved by Engineer. Testing of the material for suitability shall be at Contractor's expense. All state and local regulations concerning borrow pits, drainage and erosion control shall be strictly followed.

- B. Furnish the Construction Manager with copies of a written agreement with the owner of the property on which the borrow sites are located, approval of the owner(s) of any utilities within the proposed borrow area, and approvals from regulatory agencies.
- C. In all instances, excavate and maintain borrow pits in a manner satisfactory to the owner of the property.
- D. Excavate borrow pits in such a way that the remaining surfaces and slopes are reasonably smooth and that adequate drainage is provided over the entire area. Construct drainage ditches wherever necessary to provide outlets for water to the nearest natural channel, thus preventing the formation of pools in the pit area. Leave the sides of borrow pit cuts at a maximum slope of 2:1, Horizontal:Vertical, unless otherwise directed by the Construction Manager. Refer to Section 01 35 43 for Erosion Control.
- E. Properly clear and grub borrow pits and remove all objectionable matter from the borrow pit material before placing it in the backfill.
- F. The taking of materials from borrows pits for use in the construction of backfill, fills, or embankments shall be considered an incidental part of the work; no separate payment shall be made for this.

3.09 PIPE ZONE

- A. Pipe zone for pipe used on sewer installations shall consist of an envelope of No. 57 (TDOT) crushed stone from 6 inches below pipe bell to 8 inches above pipe crown for full trench width. No. 7 (TDOT) crushed stone may be used for pipe 12-inches and smaller in lieu of No. 57 for the pipe envelope to aid consolidation by the contractor.
- B. Hand grade and mechanically consolidate each lift to provide a firm, unyielding surface.
- C. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe.
- D. The bedding material shall be shaped for bell and spigot pipe at proper intervals to provide uniform bearing under the entire length of the pipe.
- E. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.
- F. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.
- G. Restrain pipe as necessary to prevent movement during backfill operations.
- H. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes installed in same trench.
- I. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter
- J. Pipe over 10-inch Diameter: Maximum 8-inch lifts

- K. Thoroughly consolidate each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under pipe haunches with a rod to ensure that voids are completely filled before placing each succeeding lift.
- L. Where a trench box is used with flexible pipe installation, lift the box to relocate for further pipe installation operations to above the pipe exterior crown and compact each pipe zone lift of bedding material.
- M. After the full depth of the pipe bedding material has been placed, as specified, mechanically compact the material over the area between the sides of the pipe and the trench walls.
- N. Do not use power-driven impact compactors to compact pipe bedding material.

3.10 GENERAL BACKFILLING METHODS

- A. Backfilling operations shall be performed so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary. This work shall be done at no cost.
- B. Backfilling and cleanup operations shall closely follow pipe laying. Pipe laying operations may advance a maximum of 100 linear feet ahead of backfilling operations and 1,000 linear feet ahead of excess spoil removal and cleanup operations. On completion of each individual sewer line or 1,500-foot segment, begin cleanup and property restoration prior to installation of another line, unless written permission is obtained from the Construction Manager.
- C. Backfilling operations around facilities and structures shall be conducted in the same manner as specified for pipelines except that even greater care is necessary to prevent damage to the utility structure.
- D. Consolidating by flooding will not be permitted under or adjacent to paved or unpaved traffic areas. If tests for in-place density consistently fail to meet the requirements, Engineer may require Contractor to change his method of compaction.

3.11 BACKFILLING UNDER PAVEMENT

- A. Location: Edge of ditch line is located under roadways or other paved areas or within 3 feet of the edge of pavement
- B. Limits of Backfill: From the top of the bedding envelope to the pavement subsurface. If the backfill is not directly under pavement, the top one-foot of backfill shall be restored to equal or better condition.
- C. The minimum backfill material requirements under roadway type driveway and private areas shall be No 57 (TDOT) crushed stone (1-inch clean stone) placed in lifts and mechanically compacted, in conformance with the standard detail of the Plans, to the top of the surface restoration subgrade level. Subgrade and any makeup crushed stone shall be mechanically compacted Mineral Aggregate Type A Base, Grading D, Item No. 303-01 (TDOT) “Crusher Run” type. Backfill material shall be compacted to 98% of the Standard Proctor Density at 2% less than optimum moisture content as determined by AASHTO T99, Method D.
- D. The minimum backfill material requirements under Metro and TDOT public roadways shall be No 57 (TDOT) crushed stone (1-inch clean stone) placed in lifts and mechanically compacted, in conformance with the standard detail of the Plans, to within 18 inches of the existing roadway surface. Backfill material shall be compacted to 98% of the Standard Proctor

Density at 2% less than optimum moisture content as determined by AASHTO T99, Method D. However, backfilling must be conducted to the satisfaction of the agency having primary jurisdiction of the improvement area, and the more stringent regulations shall apply.

- E. For trench restoration in Metro and TDOT public roadways, a minimum depth 18-inch concrete flowable fill cap will be placed in the trench to or near the existing surface. For Metro or TDOT roadways identified to be full width milled and surface course paved, the flowable fill cap shall be placed to bring trench level with surrounding pavement. For Metro or TDOT roadways identified to be asphaltic "patch" final restoration paving as in transverse cuts, the flowable fill cap shall be placed to bring trench surface 2-inches below or flush for later milling to the surrounding pavement. However, backfilling must be conducted to the satisfaction of the agency or owner having primary jurisdiction of the improvement area and the more stringent regulations shall apply.

3.12 BACKFILLING OUTSIDE OF PAVED AREAS

- A. Location: Edge of ditch line is located more than 3 feet from the edge of paved areas.
- B. Limits of Backfill: From the top of the bedding envelope to the pavement subsurface. If the backfill is not directly under pavement, the top one-foot of backfill shall be restored to the equal or better condition.
- C. Backfill material shall consist of either fine, loose earth like sandy soil or loam, or of granular material that is free from clods, vegetation matter, debris, stone, and/or other objectionable materials and that has a size of no more than four inches. Backfill material shall be placed in lifts not to exceed 12-inches and compacted to 90% of its maximum density at +/- 2% of optimum moisture content as determined by the Laboratory Standard Proctor Test (ASTM D698- latest revision) in conformance with the standard detail of the Plans. A compaction tolerance of minus two percent (-2.0%) shall be allowed.

3.13 MAINTENANCE

- A. Restore and maintain in good condition all excavated areas, trenches, fills, embankments, and channels until final acceptance by the Construction Manager.
- B. Maintain trench backfill at the approximate level of the original ground surface by periodically adding backfill material wherever necessary and whenever directed to do so by the Construction Manager. Continue such maintenance until final acceptance of the project or until the Construction Manager issues a written release.

3.14 SLOPES

- A. All open slopes shall be neatly trimmed and finished to conform either to the slope lines shown on the Drawings or the directions of the Construction Manager. Leave the finished surfaces of bottom and sides in reasonably smooth and uniform planes like those normally obtainable with hand tools, though Contractor will not be required to use hand methods if he is able to obtain the required degree of evenness with mechanical equipment. Conduct grading operations so that material is not removed or loosened beyond the required slope.

3.15 EMBANKMENTS

- A. This work shall consist of forming embankments, other than for building pads, with materials from excavation or other approved sources and in conformance with the lines, grades, and cross-section shown on the drawings.

- B. Complete the clearing and grubbing of embankment areas before placing embankment thereon.
- C. Conduct all embankment operations in accordance with the requirements of the approved erosion control plan.
- D. Embankment under building pads should be in accordance with recommendations from a licensed Geotechnical Engineer.
- E. Use only acceptable materials in embankment formation. Place no frozen material, stumps, logs, roots, or other perishable materials in any embankment. Place no stone or masonry fragment greater than 4 inches in any dimension within 12 inches of the finished subgrade elevation.
- F. Remove topsoil from all embankment areas to a depth of approximately 6 inches, or to a greater depth wherever the soils investigation report so indicates.
- G. Form soil, soft shale, soft sandstone, weathered rock, bank gravel or creek gravel embankment by distributing the material in successive uniform horizontal layers no more than 12 inches thick (loose depth) to the full width of the cross-section. However, layers less than 12 inches in loose thickness will be required whenever necessary to obtain the specified density. Compact each layer as specified below. Shape the upper surface of the embankment so as to provide complete drainage of surface water at all times. The forming of ruts will not be permitted.
- H. In embankments constructed principally of unweathered limestone, hard shale, or hard sandstone, the layer thickness shall not exceed 2 feet; the maximum dimensions of boulders or large rocks placed in the embankment shall be 2 feet vertically and horizontally. Larger pieces may be placed in the embankment face when permitted by the Construction Manager. Keep rocks with any dimension greater than 2-feet at least 2-feet below the subgrade elevation. Do not dump the rock into final position, but instead distribute it by blading or dozing in a manner that will ensure proper placement in the embankment so that voids, pockets, and bridging will be reduced to a minimum. The slope shall conform substantially to the requirements of the Drawings.
- I. In areas where layers of rock and shale or soil are encountered and embankments are constructed of a mixture of rock and shale or rock and soil, place, manipulate and compact the material in layers no more than 8 inches thick; however, when the thickness of the rock exceeds 8 inches, the thickness of the embankment layers may be increased (except beneath building areas) as necessary due to the nature of the material and as approved by the Construction Manager. In no case, allow the layer thickness to exceed 2 feet. Do not dump the mixture into final position, but distribute it by blading or dozing in a manner that will ensure proper placement in the embankment so that voids, pockets, and bridging will be reduced to a minimum. Then compact the mixture with suitable compaction equipment.
- J. Compact the embankment to a density of at least 95% of the maximum density as determined by ASTM D698 (Standard Procter).
- K. During compaction, embankment material that does not have enough moisture for proper compaction, shall have water added and thoroughly mixed as necessary to obtain proper compaction. Embankment material containing an excess of moisture shall be allowed to dry before compacting; manipulating as necessary to speed drying.
- L. Perform construction operations so that simultaneous rolling and placing of material in the same lane or section is prevented. To avoid uneven compaction, see that hauling equipment

traverses the full width of the cross-section as much as possible. Compact each layer as necessary before depositing material for the next layer.

- M. The density requirements shall be the controlling factor in compaction. Use only such equipment as will satisfy the density requirements at all times.
- N. For embankment adjacent to structures, including utility structures, first construct backfill in accordance with the guidelines included within this Section.
- O. When embankment is placed around adjoining or opposite faces of a structure, compact it to the same level on all sides before proceeding to the next layer next to the structure. As a precaution against wedging action, begin compaction for each layer next to the structure.
- P. Construct embankments adjacent to structures as outlined to the height of the structure and slope far enough away from the structure to permit easy access of compacting equipment used in normal embankment construction.

3.16 PROTECTION

- A. Formulate excavation, backfilling, and filling schedule and procedures to eliminate the possibility of undermining or disturbing foundations of partially and completed structures, pipelines and embankments or existing structures and pipelines.

3.17 MEASUREMENT AND BASIS OF PAYMENT

- A. Trenching and backfill will be considered incidental to the work with which it is associated and will not be measured for payment as a separate pay item unless otherwise stated in the Agreement.

3.18 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 31 50 00

TRENCH SAFETY SYSTEMS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope (1.02)
- C. Submittals (1.03)
- D. Measurement and Payment (1.04)
- E. General (1.05)

1.02 SCOPE

- A. Trench Safety Systems

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 - Submittals.
- B. Submit a Project Trench Safety Systems Program and identify the TOSHA and OSHA competent person for the safety program. The Construction Manager will not issue an approval of the Project Trench Safety System Program.
- C. Understand that MWS and the Construction Manager do not assume any responsibility for acceptance and/or review of a submitted Project Trench Safety Systems Program.
- D. Submit the design drawings and calculations for special shoring sealed by a registered TN Professional Engineer when required per TOSHA and OSHA standards.

1.04 MEASUREMENT AND PAYMENT

- A. Consider expenses for trench safety systems, operations, and designs to be incidental to the Work with no separate payment allowed.

1.05 GENERAL

- A. Provide trench safety systems necessary to complete the Work in accordance with TOSHA and OSHA standards.
- B. Assume sole responsibility for the implementation of the trench safety systems.
- C. Provide maintenance and daily examinations of trench safety systems for the duration of the Work. Maintain records of daily examinations of the Project Trench Safety Systems Program.
- D. Protect existing structures, streets, walkways, utilities, and other improvements against damages during excavation.

- E. Take responsibility for damages and assume expenses for direct or indirect injury caused by the trench safety system activities to above ground facilities or below ground facilities.
- F. Install and operate necessary dewatering and surface water control measures.
- G. Cease Work immediately if evidence of potential karst features, cave-ins, or slides are observed and move personnel to safe locations until the necessary precautions have been taken to safeguard personnel.
- H. Indemnify and hold harmless MWS and the Construction Manager concerning trench safety systems, including, but not limited to, failure to issue a stop work order for unsafe conditions.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide suitable trench safety systems materials.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install and maintain trench safety systems in conformance with TOSHA and OSHA standards.
- B. Verify that the field conditions encountered during the Work are compatible with the Project Trench Safety Systems Program.
- C. Verify that Project Trench Safety Systems Program components are certified for the conditions present.
- D. Coordinate and provide safe access at all times within the excavation for the Construction Manager to access the Work.

END OF SECTION

SECTION 32 12 00

FLEXIBLE PAVING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes
 - 1. Aggregate base course
 - 2. Asphalt concrete pavement

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. M140: Standard Specification for Emulsified Asphalt
 - 2. M147: Standard Specification for Materials for Aggregate and Soil-Aggregate Sub-base, Base, and Surface Courses
 - 3. M208: Standard Specification for Cationic Emulsified Asphalt
 - 4. M320: Standard Specification for Performance-Graded Asphalt Binder
 - 5. T89: Standard Method of Test for Determining the Liquid Limit of Soils
 - 6. T90: Standard Method of Test for Determining the Plastic Limit and Plasticity Index of Soils
 - 7. T99: Standard Method of Test for Moisture-Density Relations of Soils Using a 5.5-lb Rammer and a 12-in. Drop
 - 8. T104: Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate
- B. American Society for Testing and Materials (ASTM)
 - 1. C125: Standard Terminology Relating to Concrete and Concrete Aggregates
 - 2. D242: Standard Specification for Mineral Filler for Bituminous Paving Mixtures
 - 3. D946: Standard Specification for Penetration-Graded Asphalt Cement for Use in Pavement Construction
 - 4. D977: Standard Specification for Emulsified Asphalt
 - 5. D2027: Standard Specification for Cutback Asphalt (Medium-Curing Type)
- C. Tennessee Department of Transportation (TDOT)
 - 1. TDOT Standard Specifications for Road and Bridge Construction, latest edition

2. TDOT Standard Drawings

D. Local Municipality

1. The Metropolitan Government of Nashville and Davidson County (Metro), Nashville Department of Transportation and Multimodal Infrastructure (NDOT), formerly the Department of Public Works (MPW), Standard Drawings ST-250, ST-251, ST-252, ST-252B, ST-253, ST-254, ST-255, ST-260, ST-261, ST-263, ST-270, ST-271, ST-273, ST-274, and ST-275.

1.03 DEFINITIONS

- A. Gravel: Coarse aggregate resulting from natural disintegration and abrasion of rock or processing of weakly bound conglomerate
- B. Crushed Gravel: Product resulting from artificially crushing gravel with substantially all fragments having at least one face resulting from fracture
- C. Crushed Stone: Product resulting from the artificially crushing rocks, boulders, or large cobblestones, substantially all faces of which have resulted from the crushing operation

1.04 SUBMITTALS

- A. Submit Sustainable design shop drawing submittals in accordance with Section 01 33 00.
- B. Test Results
 1. Base course testing results, see 3.07 – Field Quality Control in this Section
 2. Pavement test results, thickness, see 3.07 – Field Quality Control in this Section
- C. Submit haul route, procedures, and schedule for operation times.

1.05 QUALITY ASSURANCE

- A. Comply with requirements specified in Section 01 43 00.
- B. Comply with 3.07 – Field Quality Control in this Section.
- C. Sustainability Standards Certifications
- D. Codes and Standards: Comply with the latest edition of Tennessee highway or transportation department standard specifications and with local governing regulations.
- E. Permits: The Contractor shall secure the required excavation and/or temporary lane/road closure permits to work within Metro or TDOT right-of-way.
- F. Coordination: Roadway reconstruction shall be in accordance with the applicable Drawings. Roadways maintained by Metro shall be reconstructed in accordance with standard drawings issued by Metro. Roadways maintained by TDOT shall be reconstructed in accordance with standard drawings issued by TDOT. Roadway reconstruction shall be coordinated with the Nashville Department of Transportation and Multimodal Infrastructure (NDOT) inspector.

1.06 DELIVERY STORAGE AND HANDLING

- A. Comply with requirements specified in Section 01 66 10.
- B. Transport bituminous mixtures in covered trucks during
 - 1. Rainy weather
 - 2. Air temperature is less than 60 °F.
- C. Adjust weight, type, capacity, haul routes, and operation method for hauling vehicles so
 - 1. No damage results to existing streets, subgrade or base course
 - 2. Noise and air pollution levels are not noticeably increased along selected haul route
- D. Haul routes through residential areas should be avoided.
- E. Submit haul route, procedures for transport, and schedule for operation times to Metro for acceptance.

1.07 PROJECT CONDITIONS

- A. Weather Limitations: Apply prime and tack coats, asphalt concrete surface, and binder course in accordance with TDOT specifications, Sections 402, 403, 404, 407, and 411. Bituminous material shall be applied only when the designated surface is dry, firm, and properly cured. Prime coat may be applied to a surface that is slightly damp, but never to a wet surface.

PART 2 - PRODUCTS

2.01 AGGREGATE MATERIALS

- A. According to AASHTO M147, unless noted otherwise
- B. Aggregate, including blended filler, shall have
 - 1. Liquid limit (LL) of not more than 25 as determined by AASHTO T89
 - 2. Plasticity index (PI) of not more than 6 as determined by AASHTO T90
- C. At least 45 percent, by count, of aggregate particle numbers retained on No. 4 sieve shall have at least one fractured face.
- D. Remove oversized material by screening or crushing to required sizes.
- E. Soundness: AASHTO T104, 5 cycles, no greater than 18 percent weight loss
- F. Filler for Blending
 - 1. Use filler for meeting gradation requirements or for satisfactory material binding. Uniformly blend with base course material at screening plant.
 - 2. Obtain material from sources accepted by the Construction Manager.

3. Material shall be free of agglomerations or lumps and contain no more than 15 percent of material retained on No. 4 (4.75 mm) sieve.

2.02 AGGREGATE BASE COURSE

- A. Gradation: Within TDOT Specifications limits, Section 303, Type A Base, Class A aggregate, Grading D

2.03 PAVEMENT MATERIALS

- A. Crushed stone, crushed gravel, crushed slag, and sharp-edged natural sand
- B. Sand prepared from stone, blast-furnace slag, or gravel, or combinations thereof may not be used.
- C. Mineral Filler: Rock or slag dust, hydraulic cement, or other inert material complying with ASTM D242
- D. Binder Course Aggregate: TDOT Specifications, Sections 307 and 407
- E. Surface Course Aggregate: TDOT Specifications, Section 411
- F. Asphaltic Materials
 1. Asphalt Cement: Performance Grade, TDOT Specification, Sections 407 and 411, AASHTO M320, PG 64-22 and PG 70-22
 2. Prime Coat: Emulsified Asphalt, TDOT Specification, Section 402, AASHTO M140 and M208, Grade AE-P or CAE-P, Aggregate for cover material, size 7, 8, or 78.
 3. Tack Coat: Emulsified asphalt, TDOT Specification, Section 403, AASHTO M140 and M208, SS-1, SS-1h, CSS-1, CSS-1h, TST-1P, or CQS-1h, diluted with water not to exceed 30 percent by volume. The application temperature ranges for the following SS-1, SS-1h, CSS-1, CSS-1h, TST-1P, or CQS-1h shall be between 60 °F - 140 °F.

2.04 ACCESSORIES

- A. Herbicide
 1. Manufacturers
 - a. Allied Chemical Corporation
 - b. Achem Products, Inc.
 - c. Ciba-Geigy Corporation
 - d. Dow Chemical U.S.A.
 - e. E.I. DuPont De Nemours & Co., Inc.
 - f. FMC Corporation
 - g. Thompson-Hayward Chemical Company

- h. U.S. Borax and Chemical Corporation
2. Commercial chemical for weed control, registered by the U. S. Environmental Protection Agency (EPA)
3. Provide granular, liquid, or wettable powder form

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Check subgrade for soundness, outline, and contour.
- B. Excavations in pavement area shall require the pavement surface edges to be saw cut or cold plane milled to provide a straight and smooth edge.

3.02 SUBGRADE PREPARATION

- A. Scrape down subgrade bumps and irregularities to obtain smooth, even surface.
- B. Proof roll as specified in Section 31 23 00.
- C. Remove and replace soft or spongy areas as specified in Section 31 23 00.

3.03 PAVEMENT PREPARATION

- A. Remove loose material from compacted base course immediately before applying herbicide treatment or prime coat.
- B. If base course becomes rutted, loose, or uneven due delays in placing subsequent courses, proof roll prepared surface to check for unstable areas. Provide additional compaction or remove unstable areas, backfill, and compact. Do not begin paving work until deficient areas have been re-graded and corrected and are ready to receive paving.
- C. Herbicide Treatment: Apply chemical weed control agent in compliance with manufacturer's recommended dosage and application instructions.
- D. Prime Coat: Apply prime coat in accordance with TDOT Specifications, Section 402.
 1. Apply at rate of 0.20 to 0.50 gallons per square yard, over compacted subgrade.
 2. Apply material to penetrate and seal surface, but not to flood surface.
 3. Cure and dry as long as necessary to attain penetration and volatile evaporation.
- E. Tack Coat: Apply tack coat in accordance with TDOT Specifications, Section 403.
 1. Apply to contact previously constructed asphalt surfaces or Portland cement concrete and surfaces abutting or projecting into asphalt concrete pavement.
 2. Distribute at rate of 0.02 to 0.05 gallons of residual bitumen per square yard of surface. When asphalt cement is used as a tack coat, the application rate shall be 0.05 to 0.10 gallons per square yard of surface.

3. Allow tack coat to dry until at proper condition to receive paving.
4. Exercise care in applying bituminous materials to avoid smearing adjoining concrete surfaces. Remove and clean damaged surfaces.

3.04 BASE COURSE INSTALLATION

- A. Place materials when surface is dry and atmospheric temperature is above 40 °F.
- B. Construct in two or more layers in approximate equal lifts. Maximum compacted lift is 6 inches.
- C. Deposit material on foundation or previously placed layer to minimize segregation and facilitate spreading to uniform layer.
- D. If material blending is done on roadway, inter-mix aggregate and blending material by blade graders, discs, harrows, or other equipment to produce uniform distribution or gradation throughout finished mixture. Avoid excessive manipulation or mixing, which will cause segregation between coarse and fine materials.
- E. Place and spread each layer to thickness, width, and contour.
- F. Compact each layer to 95 percent of maximum dry density unless otherwise noted before proceeding to subsequent layers. Refer to Section 31 23 00 for required compaction and testing requirements.
- G. Prior to and during compaction, shape material and maintain to dimensions and contour. Keep each layer's surface true and smooth.

3.05 PLACING MIX

- A. Place asphalt concrete mixture on prepared surface. Spread and strike-off. Spread mixture at minimum temperature in accordance with TDOT Sections 307.05, 407.11, and 411.05. Place inaccessible and small areas by hand. Place course to required grade, cross-section, and compacted thickness.
- B. Place in strips not less than 10 feet wide, unless otherwise acceptable to the Construction Manager.
- C. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips.
- D. Grade Control: Establish and maintain required lines and elevations to within 3/8 inches maximum.
- E. Joints: Make joints between old and new pavements or between successive days' work to ensure continuous bond between adjoining work. Construct joints to have same texture, density, and smoothness as other sections of asphalt concrete course. Clean contact surfaces and apply tack coat.

3.06 ROLLING

- A. General: Begin rolling when mixture will bear roller weight without excessive displacement. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

- B. Rolling: Perform rolling until course has obtained 92 percent density and roller marks are eliminated.
- C. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphalt concrete. Compact by rolling to maximum surface density and smoothness.

3.07 FIELD QUALITY CONTROL

A. Base Course Testing

- 1. Optimum Moisture Content and Maximum Density: Comply with AASHTO T99, Method C, with fraction of aggregate replacement retained on 3/4 inch sieve. Replace with No. 4 to 3/4 inch material.

B. Pavement Testing

- 1. General: Test in-place asphalt concrete courses for compliance with requirements for thickness and surface smoothness. Repair or remove and replace unacceptable paving.
- 2. Thickness Tolerances: In-place compacted thickness will not be acceptable if it exceeds the following allowable variation from required thickness:
 - a. Base Course Thickness: Less than +/-1/4 inch
 - b. Surface Course Thickness: Less than +/-1/4 inch
- 3. Surface Smoothness Tolerances: Test finished surface for smoothness on each asphalt concrete course using 12-foot straightedge applied parallel with and at right angles to the paved area's centerline. Surfaces will not be acceptable if they exceed the following tolerances for smoothness.
 - a. Binder Course: 1/4 inch
 - b. Surface Course: 1/8 inch
 - c. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.
 - d. Profile and Section: Variation from true shall not exceed +/- 3/8 inch.

3.08 PROTECTION

A. After final rolling

- 1. Do not permit vehicular traffic on pavement until it has cooled and hardened.
- 2. Protect paving from traffic until mixture has cooled enough not to become marked.

3.09 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 32 13 00

RIGID PAVING

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes

1. Jointed, unreinforced, and reinforced concrete paving

1.02 REFERENCES

A. American Concrete Institute (ACI)

1. 305R: Hot Weather Concreting
2. 306R: Cold Weather Concreting

B. American Society of Testing and Materials (ASTM)

1. A36: Standard Specification for Carbon Structural Steel
2. A185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
3. A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
4. C33: Standard Specification for Concrete Aggregates
5. C138: Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
6. C150: Standard Specification for Portland Cement
7. C173: Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
8. C231: Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
9. C260: Standard Specification for Air-Entraining Admixtures for Concrete
10. C309: Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
11. C494: Standard Specification for Chemical Admixtures for Concrete
12. C1315: Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
13. C1602: Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete

14. D1751: Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
15. D6690: Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

C. Tennessee Department of Transportation (TDOT)

1. TDOT Standard Specifications for Road and Bridge Construction, Sections 303, 501, and 604, latest edition

1.03 DEFINITIONS

- A. Cold Weather: Refer to ACI 306R. A period when for more than 3 successive days the average daily outdoor temperature drops below 40 °F. The average daily temperature is the average of the highest and lowest temperature during the period from midnight to midnight. When temperatures above 50 °F occur during more than half of any 24-hour duration, the period shall no longer be regarded as cold weather.
- B. Hot Weather: Refer to ACI 305R. Any combination of the following conditions that tend to impair the quality of freshly mixed or hardened concrete by accelerating the moisture loss rate and cement hydration rate, or otherwise resulting in detrimental results.
 1. High ambient temperature
 2. High concrete temperature
 3. Low relative humidity
 4. Wind velocity
 5. Solar radiation

1.04 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01 33 00.
 1. Sustainable Design Submittals
 2. Concrete: Aggregate, cement, and admixtures product data
 3. Joint material product data
 4. Curing compound product data
 5. Concrete Test Results

1.05 QUALITY ASSURANCE

- A. Comply with requirements specified in Section 01 43 00.
- B. Comply with tolerance requirements in 3.10 in this Section.
- C. Comply with field quality control requirements in 3.11 in this Section.

- D. Work shall conform to all requirements in ACI 330.1 published by the American Concrete Institute, Farmington Hills, Michigan, except as modified by these contract documents.

1.06 DELIVERY STORAGE AND HANDLING

- A. Comply with requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 AGGREGATE

- A. Aggregate Base: Match existing aggregate base thickness as indicated in the Drawings, or minimum 6 inches thick, unless noted otherwise.
 - 1. Aggregate: TDOT Specifications, Section 303, Class A Aggregate, Grading D.

2.02 CONCRETE FORMWORK

- A. Forms
 - 1. Forms shall be made from steel, wood, or other material able to support concrete and mechanical concrete placing equipment that is sufficiently rigid to maintain the specified tolerances.
 - 2. Forms shall be clean and free from dirt, rust, and hardened concrete.

2.03 CONCRETE

- A. Concrete: TDOT Specifications, Sections 501 and 604, Class A, Type IA should be used when air entrainment is specified.
 - 1. Cement: Portland cement, ASTM C150/C150M Type IA.
 - 2. Aggregate: ASTM C33 physical properties; nominal maximum size, 1 inch.
 - 3. Admixtures
 - a. Air Entrainment: ASTM C260 to provide air content (at delivery) between 6.5 to 8 percent as measured by ASTM C138, ASTM C173, or ASTM C231
 - b. Water Reducing: ASTM C494, Type D, slump 4-1/2 inches for non-vibrated placement
- B. Water: Clean and not detrimental to concrete.
- C. Strength: Minimum compressive strength of Class CP, 3,000 at 28 days.
- D. Thickness: Shall match existing concrete thickness or as specified on Drawings.

2.04 CONCRETE REINFORCEMENT

- A. Reinforcing Steel: TDOT Specifications, Sections 501, 604, and 907 or as indicated on Drawings.
 - 1. Longitudinal joint deformed steel tie bars: Sections 501.15 (a) and 907, TDOT Specifications.
 - 2. Traverse expansion joint dowels: Sections 501.15 (b) and 907, TDOT Specifications.
 - 3. Traverse contraction joints dowels or dowel bars: Sections 501.15 (c) and 907, TDOT Specifications.
 - 4. Concrete reinforcement: Sections 501.14 and 907, TDOT Specifications.

2.05 CONCRETE FINISHES

- A. See Section 03 30 00 for additional requirements.
- B. Float and normal broom finish.

2.06 JOINTS

- A. Expansion Joint Filler: Section 03 15 00, bituminous type, ASTM D1751.
- B. Joint Sealer: Hot poured elastic type, ASTM D6690, Type II.

2.07 ACCESSORIES

- A. Curing Compound: TDOT Specifications, Section 501.18, white pigmented type.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Do not place aggregate base on subgrade that is frozen or contains frost.

3.02 PREPARATION

- A. Excavate and shape subgrade to line, grade, and cross-section.
- B. Remove all soft subgrade material encountered while compacting and backfill with aggregate base.
- C. Repeat fine grading and compaction for subgrade areas subjected to vehicular construction traffic and equipment.
- D. Apply aggregate base to subgrade and compact to thickness as indicated on the Drawings.
- E. Moisten aggregate base immediately before placing concrete to minimize water absorption from fresh concrete.
- F. Provide clean and dry concrete surfaces, free from oil, dirt, or foreign materials immediately before applying compounds or painting.

3.03 COMPACTION

- A. Refer to Section 31 23 00 for additional compaction requirements.
- B. Moisture: Maintain moisture content that is 3 percent of optimum moisture to attain required compaction density.
- C. Subgrade: Compact as specified in Section 31 23 00.
- D. Aggregate Base: Compact to 95 percent of maximum dry density, unless noted otherwise.

3.04 FORMWORK

- A. Set, align, and brace forms so the pavement will meet the specified tolerances.
- B. Apply form release agent to inside face of forms before placing concrete.
- C. The edge of previously placed concrete may be used as a form. Do not apply form release agent to previously placed concrete unless preventing a bond between the new and the old concrete is desired.

3.05 PLACING REINFORCEMENT

- A. Set reinforcement as specified on Drawings.
- B. Tie steel reinforcement to insure reinforcement will not be displaced during concrete placement.

3.06 PLACING CONCRETE

- A. Place concrete on uniform aggregate base.
- B. Consolidate and strike off to proper elevation.
- C. Place concrete continuously to prevent cold joints from forming.
- D. Where placing operations stop, install bulkhead to form straight joint.
- E. Texture pavement surface with broom.
- F. Follow recommendations in ACI 305R when placing concrete during hot weather.
- G. Follow recommendations in ACI 306R when placing concrete during cold weather.

3.07 JOINTS

- A. Joint Spacing
 - 1. Match existing joint spacing.
 - 2. Maximum allowable is 30 times the pavement thickness, 12.5 feet maximum.
- B. Make contraction joints by sawing to depth of 1-1/4 inches.
- C. Cut saw joints as soon as possible without raveling concrete edges.

- D. Install full depth expansion joints using 1-inch thick joint material around castings and where pavement abuts structures.

3.08 REPAIR/RESTORATION

- A. Repair damaged work by replacing with new pavement to the nearest construction isolation joint.

3.09 FINISHING

- A. Float: Use magnesium or aluminum hand floats or power floats with slip on float shoes after concrete has stiffened to a point where 1/4-inch maximum indentation can be imparted by normal foot pressure. Do not use combination blades for floating.
- B. Float finish shall result in uniform smooth granular texture.
- C. After floating, check slab tolerances with 10-foot straightedge. Fill low spots with fresh concrete.
- D. Do not sprinkle with dry cement or add water.
- E. Broom Finish
 - 1. Normal Broom Finish: Use fine, soft-bristled broom to produce a non-skid surface.

3.10 TOLERANCES

- A. Construct pavement to comply with the following tolerances:
 - 1. Elevation: 1/2 inch
 - 2. Thickness: +3/8 inch, -1/4-inch
 - 3. Surface: In any direction, the gap below a 10-foot unlevelled straightedge resting on high spots shall not exceed 1/2-inch.
- B. Joint reinforcement: Alignment of tie bar end relative to line perpendicular to edge of pavement: 1/2-inch per foot of tie bars
- C. Dowels
 - 1. Lateral alignment and spacing: 1 inch
 - 2. Vertical alignment: 1/4-inch
 - 3. Alignment of dowel bar end relative to line perpendicular to edge of pavement: 1/4-inch per foot of dowel
- D. Joint spacing
 - 1. Contraction joint depth: +1/4-inch
 - 2. Joint width: +1/8-inch

3.11 FIELD QUALITY CONTROL

- A. Refer to Section 31 23 00 for compaction and testing requirements.
- B. Submit compaction test results to the Construction Manager for review and acceptance.
- C. Concrete Testing: Section 03 30 00. Maintain records for placed concrete including record date, pour location, quantity, air temperature, and test samples taken. Submit test results to Engineer for acceptance.
- D. Defective Concrete: As defined in Section 03 30 00.

3.12 PAINTING AND STRIPING

- A. Refer to Section 32 17 00 for additional requirements.
- B. Paint pavement markings and striping after concrete has cured for at least 14 days.
- C. Protect markings from traffic until completely dry to prevent tracking.

3.13 PROTECTION

- A. Protect concrete from damage and replace if damage occurs.
- B. Do not open the pavement to vehicular traffic until the in-place compressive strength is at least 3,000 psi, or until the pavement is accepted by the Engineer for opening to traffic.

3.14 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 32 13 13

PERVIOUS CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The work to be performed under this Section will be in conformance with the appropriate referenced plans and Drawings for constructing the proposed porous concrete pavement.
- B. Traditional Portland cement pavement testing procedures based on strength, air content, and slump control are not applicable to this pavement material type. As continued product testing yields test methods reproducible in the field, these recommended specifications will be modified.

1.02 REFERENCES

- A. ASTM C 29: Test for Unit Weight and Voids in Aggregate
- B. ASTM C 33: Specifications for Concrete Aggregates
- C. ASTM C 42: Test Methods for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- D. ASTM C 117: Test Method for Material Finer than 75um (No. 200) Sieve in Mineral Aggregates by Washing
- E. ASTM C 138: Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
- F. ASTM C 140: Standard Test Methods for Sampling and Testing Concrete masonry Units and Related Units
- G. ASTM C 150: Specifications for Portland Cement (Types I or II only)
- H. ASTM C 172: Standard Practice for Sampling Freshly Mixed Concrete
- I. ASTM C 260: Standard Specification for Air-Entraining Admixtures for Concrete
- J. ASTM C 494: Specification for Chemical Admixtures for Concrete
- K. ASTM C 595: Specifications for Blended Hydraulic Cements (Types IP or IS only)
- L. ASTM C 618: Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete
- M. ASTM C 989: Specification for Ground Granulated Blast Furnace Slag for Use in Concrete and Mortars
- N. ASTM C 1077: Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
- O. ASTM C 1116: Standard Specification for Fiber-Reinforced Concrete and Shot Crete

- P. ASTM C 1157: Performance Specification for Hydraulic Cement
- Q. ASTM D 448: Specification for Standard Sizes of Coarse Aggregates for Highway Construction
- R. ASTM D 1557: Tests for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using 10-Pound Rammer and 18-inch Drop
- S. ASTM E 329: Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
- T. ACI 211.3R-97: Guide for Selecting Proportions for No-Slump Concrete
- U. ACI 305R-99: Hot Weather Concrete
- V. ACI 396R-88: Cold Weather Concrete
- W. Tennessee Department of Transportation (TDOT), Standard Specifications for Road and Bridge Construction

1.03 SUMMARY

- A. This Section includes porous concrete pavement.
- B. Related Sections
 - 1. Division 31 Section – Earth Moving for excavation and compacted subgrade
 - 2. Qualification data for installer

1.04 SUBMITTALS

- A. Product Data: Provide for each type of manufactured material and product indicated.
- B. Design Mixtures: For each concrete pavement mixture, include alternate mixture designs when material characteristics, project conditions, weather, test results, or other circumstances warrant adjustments.
- C. Aggregates Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance, based on comprehensive testing of current materials.
- D. Material Certificates: Signed by manufacturers certifying each of the following materials complies with requirements:
 - 1. Cementitious Content
 - 2. Fly Ash
 - 3. Ground Granulated Blast Furnace Slag
 - 4. Admixtures
 - 5. Fibers
- E. Minutes from pre-installation conference

1.05 QUALITY ASSURANCE

A. Requirements for product certification

1. Contractor

- a. Pervious concrete contractors must demonstrate they completed the National Ready Mixed Concrete Association (NRMCA) Pervious Concrete Contractor certification program and have achieved certification as a pervious concrete installer.
- b. Pervious concrete contractors must demonstrate their experience by submitting a list of three (3) successfully completed projects. Include the project name, project location, the Owner, Engineer, Construction Manager (if applicable), a contact name, phone number and e-mail for each project representative.
- c. Upon request, any applicable test results for the reference projects shall be provided.

2. Pre-installation Meeting

- a. Prior to placing any material, Metro, Contractor, subcontractor, Construction Manager, Ready-Mix producer, testing laboratory representative, and anyone with technical knowledge about the product shall meet to discuss this product's production, placement, and testing.

3. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

4. Trial Placement

- a. Contractor shall place, joint and cure a small trial placement of no less than 100 square feet, so all parties get familiar with producing and placing the product.
- b. Contractor must demonstrate to all parties concerned that the Contractor can meet the specifications for pavement thickness and in-place unit weight and that a satisfactory pavement can be installed at the site location.
 - 1) The test panel or panels may be placed at any of the specified Portland cement pervious locations.
 - 2) The test panel or panels shall be tested for the following:
 - a) Thickness in accordance with ASTM C 42
 - b) Void structure in accordance with ASTM C 138
 - c) Core unit weight in accordance with ASTM C 140, Paragraph 6.3
 - 3) Satisfactory test panel or panels performance will be determined by the following:
 - a) Compacted thickness to be not less than 1/4 inch below specified thickness
 - b) Void Structure: 20 percent +/-5 percent
 - c) Unit Weight: +/-5 pcf of the design unit weight

- d) If the requirements in Item 1.04.A.4.b are not met, the test panel shall be removed at Contractor's expense and disposed in the proper manner. If the test panel or panels meet the above-mentioned requirements, it can be left in place and be included in the completed work. The test panel or panels color and texture should be used as a guide for the remaining portion of the job.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Portland Cement

1. Cement shall be Portland cement conforming to ASTM C 150 (Type I or II) or ASTM C-595 (Type IP, IS).

B. Fly Ash should conform to ASTM C 618.

C. Ground Granulated Blast Furnace Slag should conform to ASTM C 989.

D. Aggregates

1. Aggregates shall be furnished in sizes No. 7, No. 8, or No. 89, as described in TDOT Standard Specifications, Section 903.03 or ASTM C 33.
2. Other aggregate sizes may be used with Engineer acceptance.

E. Water shall be potable or in accordance with TDOT Standard Specifications, Section 918.01.

F. Admixtures

1. Type A Water Reducing Admixtures shall comply with ASTM C 494.
2. Type B Retardation Admixtures shall comply with ASTM C 494.
3. Type D Water Reducing/Retarding Admixtures shall comply with ASTM C 494.
4. Hydration stabilizers may be used but must meet ASTM C 494, Type B or D.
5. Air Entraining Agent shall comply with ASTM 260 and shall be used to improve resistance to freeze/thaw cycles.

G. Fibers must conform to ASTM C 1116.

H. Base material shall conform to Size No. 57 as described in ASTM C 33.

I. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces

1. Use flexible or curved forms for curves with a 100-foot or less radius.
2. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent concrete surface treatments

2.02 PROPORTIONS

A. Cement and/or Cementitious Content

1. The total cementitious material shall not be less than 600 lbs/cu.yd.

B. Fly Ash and Ground Granulated Blast Furnace Slag

1. Fly ash conforming to ASTM C 618 may be used in amounts not exceeding 20 percent by weight of the total cementitious material.
2. Ground granulated blast furnace slag conforming to ASTM C 989 may be used in amounts not exceeding 50 percent by weight of the total cementitious material.

C. Water

1. Water quantity shall be so the cement past displays a wet metallic sheen without causing the cement paste to flow from the aggregates. A dull-dry appearance mix may be produced if insufficient mix water has been used.

D. Aggregate Content

1. The aggregate volume specified above shall be equal to approximately 27 cubic feet per cubic yard when calculated as a function of the unit weight determined in accordance with ASTM C 29 dry rodded procedure.
2. If fine aggregate is used, its volume should not exceed 3 cubic feet and should be included in the total aggregate volume.
3. Final aggregate content will depend on the specific gravity for the aggregate to be used and the desired void content to be obtained in the hardened pervious concrete.

E. Admixtures shall be used according to manufacturer's instructions.

F. Fibers shall be added at a rate not less than 1.5 lbs. per cubic yard or as recommended by the manufacturer.

PART 3 - EXECUTION

3.01 SUBGRADE PREPARATIONS AND FORMWORK

A. Subgrade Material

1. Before installing the pervious concrete pavement, insure the subgrade is a 6-inch minimum granular or gravelly soil.

B. Base Preparation

1. Install base material to width and thickness specified.
2. Base material must be moist with no freestanding water before concrete placement.

C. Forms

1. Forms shall be made with wood or steel.
2. Forms shall have ample strength and stability to withstand loads during concrete placement operations.
3. Forms should be accurately set to the required grade and alignment.

D. Pervious Concrete Thickness

1. Pervious concrete shall be placed in such a manner as to yield the proper thickness and void content once compacted.

3.02 MIXING AND TRANSPORTATION

A. Mix Time

1. The truck mixer shall be operated at the drum speed recommended by the manufacturer and shall not be less than 70 nor more than 300 revolutions.

B. Transportation

1. The pervious concrete shall be transported in a ready-mix truck.
2. The elapsed time from when the water is added to the mix until the concrete is deposited in place at the work site shall not exceed 90 minutes, unless otherwise approved by the Construction Manager. This time may be increased to 120 minutes when using an approved retarding admixture or the hydration stabilizer specified in Section 2.01 F.

C. Discharge

1. The pervious concrete contractor or his/her qualified agent will inspect each batch for appearance of concrete uniformity. This person will be determined at the Pre-Construction Meeting.
2. A slight water adjustment may then be required at the work site to achieve the proper consistency.
3. A minimum of 20 revolutions at the manufacturer's designated mixing speed shall be required following any such adjustment.
4. Mixture discharge shall be as rapid and continuous as possible.
5. Concrete shall be deposited as close to its final position as practicable and at a point so the fresh concrete enters and adheres to the mass of previously placed unhardened concrete. As deposited, the mixture shall be placed where it will require as little re-handling as possible. Placement should minimize the mix's vertical drop from the chute to discourage non-uniform consolidation.

D. Placing and Finishing Equipment

1. Conventional paving equipment or manual and vibrating screeds may be used for the strike off operation.

2. A full width heavy roller or other full width compaction devices that provide 5-10 psi vertical force (e.g., Bunyan reverse-turn roller) shall be used immediately following the strike off operation and removal of the additional thickness.
3. The pervious concrete pavement cross-section shall not deviate more than +3/8 inch in 10 feet from the required grade.
4. No other finishing operation is required after mechanical or other approved strike off and compaction operations.
5. Placement width should not exceed 15 feet unless a contractor has sufficient mechanical consolidating equipment.

E. Curing

1. The pavement surface shall be covered with a minimum 4-mil thick polyethylene sheeting immediately following compaction rolling.
2. If adverse ambient conditions exist (temperature, wind, or humidity), spray a fog or light mist above the surface prior to covering. Sheeting must be secured during cure time and must cover all edges of the placed pavement, including sides.
3. Sand or dirt should not be used to hold down sheeting.
4. No traffic shall be allowed during cure time.
5. Recommended cure times
 - a. Portland Cement Type I, II, or IS – 7 days minimum
 - b. Portland Cement Type I or II with Class F or C fly-ash or Type IP – 10 days minimum

F. Jointing

1. Joints shall be constructed of the type and dimensions and at the locations required by the Drawings and in accordance with the following:
 - a. Control (contraction) joints shall be spaced at 20-foot centers and shall be at a depth 1/4 of the pavement thickness.
 - b. Longitudinal control joints shall be installed at the mid-point of the constructed pavement, if the pavement width exceeds 15 feet.
 - c. Both joint types can be installed in the plastic concrete or saw cut after the pavement has hardened sufficiently (normally after curing). Installing saw cut joints may be delayed until the completing the recommended curing period.
 - d. Transverse construction joints shall be constructed when placing is interrupted a sufficient length of time so the concrete begins to harden. A bonding agent suitable for bonding fresh concrete to existing concrete shall be brushed, rolled, or sprayed on the existing pavement surface edge.
 - e. Expansion joints shall be formed by using pre-molded joint filler when pavement abuts slabs or other adjoining structures.

3.03 TESTING, INSPECTION AND ACCEPTANCE

A. Requirements for Project Certification

1. Laboratory Testing

- a. All laboratory test procedures shall be established by the mutual consent of the Contractor and Construction Manager.
- b. Contractor shall retain an independent testing laboratory.
- c. The laboratory must provide evidence it conforms to the following requirements.
 - 1) ASTM E-329 Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials used in Construction
 - 2) ASTM C 1077 Standard Practice for Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
- d. All samples shall be identified by date and batch mix or truckload.
- e. Laboratory testing shall be done expeditiously, and the results shall be communicated to all concerned in a timely manner.

2. Testing and Acceptance

- a. The Contractor shall require a pervious concrete material supplier to provide a mix compliance statement on each shipping document.
- b. No deviation from the approved mix design will be accepted without the Engineer's concurrence.
- c. At the Construction Manager's request, if batch certification is not adequate, 1 test for each placement day minimum shall be conducted to verify the rodded weight of material as delivered. The test shall be conducted in accordance with ASTM C172 and C-29. Mix shall be within +5 percent of the design unit weight.
- d. After a minimum of 7 days following each placement, 3 samples shall be core drilled. The cores shall be measured for thickness, void structure, and unit weight. Untrimmed, hardened core samples shall be used to determine placement thickness in accordance with ASTM C 42. The average from all cores shall not be less than the required thickness with any core being more the 1/2-inch less than the required thickness. After thickness determination, core ends shall be trimmed to facilitate void structure determination in accordance with ASTM C 138. A 20 percent +/- 5 percent void content should be met.
- e. Unit weight determination in the saturated condition shall be in accordance with ASTM C-140, Paragraph 6.3. Satisfactory unit weight values range from + 5 pcf of the design unit weight.

3.04 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 32 15 00

TREE PROTECTION AND PRUNING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Clear site areas only as necessary for new construction shown on the Drawings.
- B. Prune canopy and damaged vegetation from construction.

1.02 RELATED DOCUMENTS

- A. Drawings and Divisions 01, 02, 31, and 32 Specification Sections, apply to this Section.
- B. Article II of Chapter 17.24-Metro Government of Nashville and Davidson County's Zoning Code

1.03 QUALITY CONTROL

- A. Personnel Qualifications: Services related to tree or root pruning and tree removal shall be performed by arborists who have been certified by the International Society of Arboriculture. Have on site, in a supervisory role, a person knowledgeable in horticultural practices at all times during pruning operations.
- B. Pre-Construction Meeting: A pre-construction meeting will be held at the site prior to commencing the work to review extent of work, procedure, and methods. Receive the Construction Manager's approval prior to commencing the work.

PART 2 - PRODUCTS

2.01 TREE PROTECTION FENCING

- A. Provide 4-foot high minimum chain-link fencing and secure using appropriate posts spaced not greater than 10 feet apart.

2.02 TEMPORARY TREE PROTECTION ZONE SIGNAGE

- A. Tree protection signage identifying the tree protection zone shall be made from a durable material that can be maintained and will remain legible during construction.

PART 3 - EXECUTION

3.01 GENERAL

- A. Use sharp, sterilized hand tools at all times during these operations.
- B. Perform the work in this Section so as to prevent harming, damaging, or destroying any existing trees to remain, new construction, or existing grades.

- C. If trees or shrubs are damaged during clearing and grubbing, use branch collar pruning methods to prune back dead branches to the first healthy growth.
- D. Prune in accordance with standards established by the National Arborists Association.

3.02 TREE PROTECTION

- A. Tree Protection Zone: A circular tree protection zone shall be established around each protected tree as shown in Figure 17.24.110 in Metro Government of Nashville and Davidson County's Zoning Code and on the Drawings.
- B. Tree protection fencing shall be erected prior to commencing any grading or construction activities and shall remain in place until final inspection.
- C. Any broken or dislodged tree protection fencing shall be repaired immediately.
- D. No disturbances or any construction activity including construction runoff shall occur within tree protection zones, except for work performed by Arborists.
- E. Place silt screening along the outer uphill edge of tree protection zones.
- F. Each tree protection zone shall receive Tree Protection Zone signs.

3.03 PRUNING

- A. Clearance pruning shall be provided using branch collar pruning method and in accordance with the accepted standards established by the National Arborists Association.
- B. Visibility pruning shall be provided to establish a clear view through the designated wooded areas from 30 inches above finished grade to 6 feet above finish grade. All trees above 2-inch caliper shall remain but receive pruning to accomplish the clear zone specified. Pruning shall be provided using branch collar pruning method and in accordance with the accepted standards established by the National Arborists Association.
- C. When pruning results in discarded branches or limbs with a 6-inch or less diameter, use a chipper/shredder to chip wood into mulch. Distribute mulch in naturalized areas and/or for temporary erosion control in depths not to exceed 3 inches. Any materials not acceptable for chipping operations shall be disposed of off-site and in accordance with all Metro dumping requirements.

3.04 CLEAN UP

- A. Immediately dispose of cleared and grubbed materials in accordance with local, state, and federal laws and regulations.
- B. Waste materials shall not be used as backfill or otherwise incorporated into the work.

3.05 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 32 16 00

CURBS, GUTTERS, SIDEWALKS, DRIVEWAY RAMPS, AND DRIVEWAYS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Section includes

1. Concrete curbs, gutters, driveway ramps, and driveways
 - a. Applies to any replacement that is required during the course of the work

1.02 REFERENCES

A. American Society of Testing and Materials (ASTM)

1. A82: Standard Specification for Steel Wire, Plain, for Concrete Reinforcement
2. A185: Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete
3. A497: Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete
4. C33: Standard Specification for Concrete Aggregates
5. C1602: Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
6. D6690: Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

B. Tennessee Department of Transportation (TDOT)

1. TDOT Standard Specifications for Road and Bridge Construction, latest edition

C. Local Municipality

1. Metropolitan Government of Nashville and Davidson County, Nashville Department of Transportation and Multimodal Infrastructure (NDOT), formerly the Department of Public Works (MPW), standard drawings ST-200, ST-201, ST-209, ST-210, and ST-211

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00.

1. Concrete: Aggregate, cement, and admixtures product data
2. Joint material product data
3. Curing compound product data

1.04 CONCRETE TEST RESULTS QUALITY ASSURANCE

- A. Comply with requirements specified in Section 01 43 00.
- B. Comply with tolerances as specified in 3.06 in this Section.
- C. Comply with field quality control as specified in 3.07 in this Section.

1.05 DELIVERY STORAGE AND HANDLING

- A. Comply with requirements specified in Section 01 66 10.

PART 2 - PRODUCTS

2.01 WATER

- A. Water: Use potable water or within ASTM C1602/C1602M limits.

2.02 AGGREGATE BASE

- A. TDOT Specifications, Section 303, Class A Aggregate, Grading D
- B. Aggregate Base: Minimum 4 inches thick, unless noted otherwise

2.03 CONCRETE FORMWORK

- A. Forms
 - 1. Forms shall be made from steel, wood, or other material able to support concrete and mechanical concrete placing equipment that is sufficiently rigid to maintain the specified tolerances.
 - 2. Forms shall be clean and free from dirt, rust, and hardened concrete.

2.04 CONCRETE

- A. Concrete: TDOT Specifications, Sections 604, 501, 701, and 702

2.05 CONCRETE REINFORCEMENT

- A. Reinforcing Steel: Reinforcing steel, steel welded wire reinforcement (WWR), and dowels according to TDOT Specifications, Section 604

2.06 CURB AND GUTTER

- A. In accordance with NDOT standard drawings

2.07 SIDEWALKS, DRIVEWAY RAMPS, AND DRIVEWAYS

- A. Concrete thicknesses are as minimum specified unless noted otherwise.
 - 1. Sidewalk pedestrian areas – 4 inches thick
 - 2. Residential driveways – 6 inches thick

3. Commercial driveways – 8 inches thick

B. In accordance with the NDOT standard drawings

C. Reinforcement: ASTM A185/A185M. WWR 6X6 – W2.0XW2.0 (Grade 60), unless otherwise noted

2.08 CONCRETE FINISHES

A. Sidewalks, driveway ramps, and driveways: Normal broom finish

B. Curbs and Gutters: Normal broom finish

2.09 ACCESSORIES

A. Expansion Joint Filler: TDOT Specifications, Sections 701 and 702

B. Curing Compound: Section 03 30 00

PART 3 - EXECUTION

3.01 PREPARATION

A. Excavate and shape subgrade to line, grade, and cross-section.

B. Remove all soft subgrade material encountered while compacting and backfill with aggregate base.

C. Moisten aggregate base immediately before placing concrete to minimize water absorption from fresh concrete.

D. Provide clean, dry concrete surfaces free from oil, dirt, or foreign materials immediately before applying compounds or paint.

3.02 COMPACTION

A. Refer to Section 31 23 00 for additional compaction requirements.

B. Subgrade: Compact as specified in Section 31 23 00.

C. Aggregate Base: Compact as specified in Section 31 23 00.

3.03 CURB CONSTRUCTION

A. In accordance with TDOT Specifications, Section 702

B. Use fine grade and compact subgrade.

C. Place aggregate base and compact. Top of aggregate base shall be at the proper level to receive concrete.

D. Brace forms to prevent shape change or movement in any direction resulting from the concrete's weight during placement.

- E. Construct short-radius curved forms to exact radius.
- F. Construct curbs to line and grade indicated. Driveway ramp cross slopes shall not exceed 1/4-inch per foot.
- G. Construct curbs and driveway ramps as indicated.
- H. Place expansion joints according to NDOT standard drawings.
- I. Place contraction joints according to NDOT standard drawings.
- J. Remove forms after the concrete has set sufficiently to support its own weight.
- K. Finish exposed concrete surfaces with a broom or similar device that will produce a uniformly textured surface, free from form marks, honeycomb, and other defects.
- L. Remove and replace defective concrete.
- M. Finished curbs shall present a uniform appearance for grade and alignment. Remove any curb section showing abrupt changes in alignment or grade, or is more than 1/4 inch away from its location as staked. Construct new curb in its proper location.
- N. Apply curing compound to exposed surfaces after finishing concrete. Curing shall continue for 5 days minimum.
- O. Backfill according to TDOT Specifications, Section 702.

3.04 SIDEWALK CONSTRUCTION

- A. In accordance with TDOT Specifications, Section 701
- B. Place, process, finish, and cure concrete according to Section 03 30 00.
- C. Sidewalk cross slope shall not exceed 1/8-inch per foot.
- D. Slope sidewalks towards roadway at 1/8-inch per foot, unless noted otherwise.
- E. Place preformed asphalt expansion joints according to NDOT standard drawings.
- F. Place preformed asphalt expansion joint material between back of curbs and sidewalks.
- G. Provide contraction joints transversely to the walks at locations opposite the contraction joints in the curb and according to NDOT standard drawings.
- H. Broom sidewalk surface with a fine-hair broom at right angles to the length of the walk and tool at all edges, joints, and markings. Mark the walks transversely at 5-foot intervals with a jointing tool, unless noted otherwise. After completing the finishing, apply a curing compound to exposed surfaces.
- I. Finished sidewalk shall present a uniform appearance for grade and alignment. Remove any sidewalk section showing abrupt changes in alignment or grade, or is more than 2 inches away from its location as staked. Construct new sidewalk in its proper location.

3.05 FINISHING

A. Float (for sidewalks and flatwork)

1. Use magnesium or aluminum hand floats or power floats with slip on float shoes after concrete has stiffened to point where 1/4-inch maximum indentation can be imparted by normal foot pressure. Do not use combination blades for floating.
2. Float finish shall result in uniform smooth granular texture.
3. After floating, check slab tolerances with a 10-foot straightedge. Fill low spots with fresh concrete.
4. Do not sprinkle with dry cement or add water.

B. Broom Finish

1. Normal Broom Finish: Use fine, soft-bristled broom to produce a non-skid surface.
2. Texture shall be reviewed by Construction Manager.
3. Sidewalks: With trowel and radius edge using 1/4-inch radius, texture pavement perpendicular to travel direction.
4. Curbs and Gutters: Texture pavement parallel to travel direction.

3.06 TOLERANCES

A. Subgrade: Smooth and free from irregularities at the specified relative compaction. The subgrade shall be considered to extend over the full width of the base course.

1. Elevation: +/-1/2-inch from the indicated grade and cross-section

B. Forms: Check constructed forms are within tolerance by using a 10-foot straightedge along the top of forms. Allowable tolerance is:

1. Grade: +/-1/8-inch over 10 feet (0.1 percent)
2. Alignment: +/-1/8-inch

3.07 FIELD QUALITY CONTROL

A. Refer to Section 31 23 00 for compaction and testing requirements.

B. Submit compaction test results to Construction Manager for review.

C. Concrete Testing: Section 03 30 00. Maintain records for placed concrete including record date, pour location, quantity, air temperature, and test samples taken. Submit test results to Construction Manager for acceptance.

D. Defective Concrete: As defined in Section 03 30 00.

3.08 PROTECTION

A. Protect concrete from damage and replace if damage occurs.

3.09 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 32 17 00

PAVING SPECIALTIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Section includes: Pavement marking
 - 1. Repair and replace markings disturbed during the course of the work or add new markings as indicated on the drawings.

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO) Publications
 - 1. M247: Standard Specification for Glass Beads Used in Pavement Markings
 - 2. M248: Ready-Mixed White and Yellow Traffic Paints
 - 3. M249: Standard Specification for White and Yellow Reflective Thermoplastic Striping Material (Solid Form)
- B. Federal Specifications (FS)
 - 1. Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)
 - 2. FS TT-P-85E: Paint, Traffic, Solvent Based
 - 3. FS TT-P-115E: Paint, Traffic, Solvent Based
- C. Tennessee Department of Transportation (TDOT)
 - 1. TDOT Standard Specifications for Road and Bridge Construction, Section 716, latest edition

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00.
 - 1. Ready-mixed white and yellow traffic paints
 - 2. Glass beads used in pavement markings
 - 3. Plastic pavement markings, Thermoplastic

1.04 QUALITY ASSURANCE

- A. Comply with requirements specified in Section 01 43 00.

B. Sampling and Testing

1. Provide material certificates from manufacturer stating the materials used meet specified requirements. Submit certificates to Construction Manager for acceptance.
2. Identify material by designated name, specification number, batch number, manufacturer's formulation number, project contract number, intended use, and quality involved.
3. At Construction Manager's discretion, samples may be tested by Construction Manager before acceptance, or material may be accepted for use based on any of the following data furnished by the Contractor:
 - a. Test report showing proposed batch meets specified requirements
 - b. Test report showing previous batch manufactured using same formulation as that used in manufacturing proposed batch met specified requirements
 - c. Report showing test results on proposed batch for the following properties required in material specification: weight per gallon, viscosity, fineness of grind, drying time, and gradation
4. If materials are accepted based on reports furnished by Contractor, samples will be retained by Construction Manager for possible future testing should material appear defective during or after application. When tested by Construction Manager and samples fail to meet specification requirements, materials represented by samples shall be replaced and the testing cost will be deducted from payments due Contractor.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements specified in Section 01 66 10.
- B. Furnish paint in sealed containers that legibly indicate the following at time of use:
 1. Designated name
 2. Formula or specification number
 3. Batch number
 4. Color
 5. Manufactured date
 6. Manufacturer's name
 7. Formulation number
 8. Directions

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Paint: Lane Marking Paint, Chlorinated rubber-alkyd type, AASHTO M248 Type F
- B. Paint: FS TT-P-115E or FS TT-P-85E
 - 1. Width: 4 inches
 - 2. Color: Yellow or white as indicated on Drawings
 - 3. Paint shall be homogeneous, easily stirred to smooth consistency, and show no hard settlement or other objectionable characteristics during a 6-month storage period.
- C. Reflective Spheres: In accordance with TDOT Specification, Section 918.08
- D. Plastic Pavement Markings
 - 1. Preformed plastic pavement marking, yellow and white colors, shall be prefabricated plastic with reflective glass spheres and shall conform to TDOT Specification, Section 918.08.
 - 2. Thermoplastic pavement marking, yellow and white colors, shall be an Alkyd/Maleic based thermoplastic material with reflective glass beads and shall conform to AASHTO M249 and TDOT Specification, Section 918.23.

2.02 EQUIPMENT

- A. Machines, tools, and equipment used in performing work shall be able to apply stripe widths indicated at paint coverage rate specified and provide an even uniform thickness with clear-cut edges.
- B. Paint Applicator
 - 1. Traffic Line Paint Applicator
 - a. Self-propelled or mobile-drawn pneumatic spraying machine with suitable arrangements of atomizing nozzles and controls to obtain specified results
 - b. Application speed: Not less than 5 mph
 - c. Spray mechanism tanks with air-driven mechanical agitators
 - d. Equip with conveniently located quick action valves and include necessary pressure regulator and gauges in operator's full view and reach.
 - e. Provide paint strainers in supply lines to ensure freedom from residue and foreign matter that may cause spray guns to malfunction.
 - 2. Provide pneumatic spray guns for applying paint for letters, handicapped symbols. Apply paint by hand in areas where mobile paint applicator cannot be used.

C. Thermoplastic Pavement Markings Applicator

1. Application machine shall be equipped with an automatic counting mechanism able to record the number of linear feet of material applied.
2. Equipment shall be constructed to continuously mix and agitate the material.
3. Equipment shall be constructed to insure continuous uniformity in the strip dimensions.
4. Apply glass spheres to the surface of the completed strip.
5. Applicators shall be mobile and maneuverable to the extent the straight line can be followed and normal curves can be made in a true arc.

D. Preformed Plastic Pavement Markings

1. Material shall be installed according to the vendor's specifications.

E. Provide stencils for arrows, letters, bike symbols, and handicapped symbols. All symbols and letters shall be in accordance with MUTCD.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Cure pavement surfaces in accordance with TDOT specifications before applying pavement markings.

3.02 PREPARATION

- A. Sweep and clean surface to eliminate loose material and dust.
- B. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water, or a combination of these methods.
- C. Remove rubber deposits and other coatings adhering to pavement with scrapers, wire brushed, sandblasting, accepted chemicals, or mechanical abrasion.

3.03 PAINTING

A. Application

1. Apply paint pneumatically.
2. Apply evenly to clean, dry pavement surfaces at a rate producing initial (wet) thickness of 15 mils and only when air and pavement temperatures are above 40 °F and less than 90 °F. Maintain paint temperature within these same limits.
3. Provide guidelines and templates to control paint application. Take special precautions when marking letters and handicapped symbols. Sharply outline edges of markings.
4. Maximum paint drying time requirements will be enforced to prevent undue softening of bitumen and pickup, displacement, or discoloration by tires of traffic. If there is a

deficiency in drying markings, discontinue painting operations until the cause for slow drying can be determined and corrected.

5. Apply paint with equipment to produce uniform straight edges. Apply in 2 coats at manufacturer's recommended rates.

3.04 PLASTIC PAVEMENT MARKINGS

- A. Apply to clean dry pavement surfaces.
- B. Provide guidelines and templates to control paint application. Take special precautions when marking letters and handicapped symbols. Sharply outline edges of markings.
- C. Thermoplastic pavement marking shall be applied by the screed extrusion method, wherein 1 side of the shaping die is the pavement and the other 3 sides are contained by, or are part of, suitable equipment for heating and controlling material flow.
- D. Thermoplastic pavement markings shall be applied to pavement when the pavement temperature is a minimum 50 °F and rising before application begins.
- E. Before thermoplastic pavement markings are to be applied to Portland cement concrete pavement, the Contractor shall apply a binder sealer material as recommended by the thermoplastic manufacturer.
- F. Thermoplastic pavement markings shall be installed with a 0.090-inch minimum average film thickness.
- G. Preformed plastic pavement markings shall be installed according to vendor's specifications.

3.05 CLEANING

- A. Remove rubbish, debris, equipment, and excess material from site resulting from this work. Clean adjoining surfaces soiled by and during this work.

3.06 PROTECTION

- A. Protect markings from traffic until dry to prevent tracking.

3.07 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 32 31 19

DECORATIVE METAL (PICKET) FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION

A. Provide decorative metal fences and gates as indicated and specified.

1. Section includes
 - a. Decorative metallic-coated steel tubular picket fences
 - b. Swing gates

1.02 REFERENCES

A. American Society for Testing and Materials (ASTM)

1. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
2. A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
3. A500: Cold Formed Welded and Seamless Carbon Steel Structural Tubing
4. A510: Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
5. A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
6. A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
7. A792: Standard Specification for Steel Sheet, 55 % Aluminum-Zinc Alloy-Coated by the Hot-Dip Process
8. A1008: Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable
9. A1011: Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
10. B117: Practice for Operating Salt-Spray (Fog) Apparatus
11. C387: Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
12. D523: Test Method for Specular Gloss

13. D714: Test Method for Evaluating Degree of Blistering in Paint
 14. D822: Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus
 15. D1654: Test Method for Evaluating Painted or Coated Specimens Subjected to Corrosive Environments
 16. D2244: Test Method for Calculating Color Differences from Instrumentally Measured Color Coordinates
 17. D2794: Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)
 18. D3359: Test Method for Measuring Adhesion by Tape Test
 19. F2408: Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets
- B. American Welding Society (AWS)
1. D1.1: Structural Welding Code
- C. Builders Hardware Manufacturers Association Inc. (BHMA)
1. A156.1: Butts and Hinges
- D. Federal Regulations
1. 40 CFR 59, Subpart D: National Volatile Organic Compound Emission Standards for Consumer and Commercial Products
- E. Master Painters Institute (MPI)
1. 20: Primer, Zinc Rich, Epoxy
 2. 72: Polyurethane, Two-Component, Pigmented, Gloss (Gloss Level 6)
 3. 77: Epoxy, Gloss
 4. 101: Primer, Epoxy, Anti-Corrosive for Metal
- F. National Association of Architectural Metal Manufacturers (NAAMM)
1. MBG 531: Metal Bar Grating Manual
- G. National Ornamental & Miscellaneous Metals Association (NOMMA)
1. Guideline 1: Joint Finishes.
- H. The Society for Protective Coatings (SSPC)
1. PA1: Paint Application Specification Shop, Field, and Maintenance Painting for Steel

I. Underwriters' Laboratories, Inc. (UL)

1. 325: Standard for Safety Door, Drapery, Gate, Louver, and Window Operators and Systems

1.03 SUBMITTALS

A. Submit the following shop drawings in accordance with Section 01 33 00.

1. Product Data: For each product type indicated
 - a. Fence: Montage II, Invincible, 2-rail, 14-gauge, by Ameristar Fence Products or approved equal
 - b. Gate: Montage II, Invincible by Ameristar Fence Products or approved equal
2. Shop Drawings
 - a. Gates: Include typical installation plan drawing, elevations, sections, details, and attachments to other work.
 - b. Fence: Include typical installation plan drawing, elevations, sections, details, and attachments to other work.
3. Samples: For each fence material and for each color specified
 - a. Provide samples 12 inches in length for linear materials.
4. Welding certificates from manufacturer and from Contractor performing any welding work.
5. Product Test Reports: Comprehensive test evaluations for decorative metallic-coated steel tubular picket fences including finish, performed by a qualified testing agency and indicating compliance with referenced standard

1.04 QUALITY ASSURANCE

- A. Comply with requirements specified in Section 01 43 00.
- B. Installer Qualifications: Fence system contractors must demonstrate their experience by submitting a list with at least 5 completed projects performed according to the job owner's, engineers' or architects' satisfactions at that time.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1, Structural Welding Code - Steel.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements specified in Section 01 66 10.

1.06 PROJECT/SITE CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by MWS or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Construction Manager not less than 2 days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Construction Manager's written permission.
 - 3. Underground Service Alert Requirements: Comply with Underground Utility Damage Prevention Act, of Tennessee requirements for notification prior to excavation. Contact Tennessee 811 at 800.351.111 (or dial 811) no less than 3 working days and no more than 10 working days prior to starting exploratory excavation. Verify if a representative from each utility or agency will be present during excavation and coordinate with said individual(s). Take any precautions required by the utility owner.
- B. Field Measurements: Verify layout information for fences as shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

1.07 COORDINATION

- A. Coordinate work for ornamental metal picket fence system with work for other trades as required to provide a complete system.

PART 2 - PRODUCTS

2.01 STEEL

- A. Steel material for fence panels and posts shall conform to ASTM A653, with a minimum 45,000 psi yield strength and a minimum 0.60 oz./ft² zinc (hot-dip galvanized) coating weight, Coating Designation G-60.
- B. Materials for fence, posts, and gates shall be in accordance with manufacturer's instructions.
- C. Fence system shall meet vertical load, horizontal load, and infill performance for industrial weight fences, ASTM F2408.

2.02 MISCELLANEOUS MATERIALS

- A. Concrete: Normal-weight, air-entrained, ready-mix concrete complying with requirements in Section 03 30 00 with a minimum 3,000 psi 28-day compressive strength, 3-inch slump, and 1-inch maximum aggregate size

2.03 DECORATIVE METALLIC-COATED STEEL TUBULAR PICKET FENCES

- A. Comply with ASTM F2408, for industrial application unless otherwise indicated.
 - 1. Manufacturers
 - a. Ameristar Fence Products, or approved equal. The system shall include all components required, panels, posts, gates, and hardware.

2. The coatings on the fence and gate shall be
 - a. Epoxy primer and acrylic topcoat
 - b. The minimum cumulative thickness of epoxy and acrylic coats shall be 2 mils.
 - c. The color shall be black.
3. Fence panels shall include posts, rails, pickets, and post caps. The fence rails and pickets shall be welded as specified in manufacturer's instructions.

B. Posts

1. Post size shall be as specified by manufacturer's instructions.
2. Swing Gate Posts: As specified by the manufacturer's instructions or as indicated on the Drawings

C. Post Adornment: To be selected by MWS

D. Rails: 2-rail (standard), 4-inch gap, as specified by manufacturer's instructions

E. Pickets: As specified by manufacturer's instructions

F. Fasteners

1. Brackets: Industrial line bracket and industrial flat mount bracket
2. Fasteners for industrial brackets
3. Hardware and connectors as specified by manufacturer's instructions

G. Finish: Manufacturer's standard finishing system, ASTM F2408

2.04 SWING GATES

A. Manufacturers

1. Ameristar Fence Products, or approved equal

B. Gate Configuration: As indicated

C. Gate Frame Height: As indicated

D. Gate Opening Width: As indicated

E. Steel Frames and Bracing: In accordance with manufacturer's instructions

F. Hardware: Brackets, Industrial Hinge Kit

G. Locks: To be supplied by others

H. Finish exposed welds to comply with NOMMA Guideline 1, Finish #4 - good quality, uniform undressed weld with minimal splatter.

I. Galvanizing

1. For items other than hardware indicated to be galvanized, hot-dip galvanize to comply with ASTM A123 unless otherwise indicated
2. For hardware items, hot-dip galvanize to comply with ASTM A153

J. Metallic-Coated Steel Finish: In accordance with manufacturer's instructions

2.05 STEEL FINISHES

- A. Powder Coating: Immediately after cleaning, apply primer and topcoat in accordance with manufacturer's instructions.
1. Color and Gloss: As indicated by manufacturer's designations
 2. Remove and refinish, or recoat work that does not comply with specified requirements.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. With installer present, examine areas and conditions for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting work performance.
- B. Do not begin installation before final grading has been completed, unless otherwise permitted by Construction Manager.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION

- A. Stake locations for fence lines, gates, and terminal posts. Do not exceed 500-foot or line of sight intervals between stakes. Indicate locations for utilities, lawn sprinkler systems, underground structures, benchmarks, and property monuments.

3.03 DECORATIVE FENCE INSTALLATION

- A. Install fences in accordance with manufacturer's written instructions.
- B. Install fences by setting posts as indicated and fastening rails and infill panels to posts. Use 1-way bolts to prevent removal.
- C. Post Excavation: Drill or hand-excavate holes for posts in firm, undisturbed soil. Excavate holes to a diameter of not less than 4 times the post size and a depth of not less than 36 inches.
- D. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
1. Verify the posts are set plumb, aligned, and at correct height and spacing. Hold in position during setting with concrete or mechanical devices.
 2. Concrete Fill: Place concrete around posts and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.

3. Concealed Concrete: Top 2 inches below grade to allow covering with surface material. Slope top surface of concrete to drain water away from post.
4. Space posts uniformly as indicated in manufacturer's instructions.

3.04 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions to be level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.05 FIELD QUALITY CONTROL

A. Fences

1. Insure there is no damage to the fence system prior to installing and after installation is complete.
2. Insure bottom of fence panels are at appropriate height above finished ground level.
3. Check fences for being plumb.
4. Insure brackets are installed in accordance with manufacturer's instructions.

B. Gates

1. Insure there is no damage to the gate prior to installing and after installation is complete.
2. Check gates for being plumb.
3. Insure brackets are installed in accordance with manufacturer's instructions.
4. Adjust gates to operate smoothly, easily, and quietly and free from binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that the latches and locks engage accurately and securely without forcing or binding.

3.06 FINAL CLEANING

- A. Clean up debris and unused material and remove from site.
- B. Dispose of excavated materials in permitted sites and in non-wetland areas and above the 100-year, Federal Emergency Management Agency floodplain. Waste disposal areas shall not affect any state/U.S. waters, unless these areas are specifically covered by an ARAP, 404, or NPDES permit obtained by the Contractor.

3.07 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 32 84 00

LANDSCAPE IRRIGATION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Furnish all labor, materials, equipment, and services necessary to completely install the irrigation system as drawn and specified. The work includes, but is not limited to the following:
1. Trenching backfilling and compaction for irrigation lines
 2. Automatically controlled irrigation system: main and lateral lines; electric valve and boxes, wiring, controller relocation, sprinklers, couplings, connectors and fittings
 3. Test all systems and make operative.
 4. Submit record drawings and maintenance manual.
 5. 1-year guarantee period
 6. Water Source: As shown on the Drawings
- B. The work in this Section shall be provided as a subcontract to the landscape contractor.

1.02 RELATED DOCUMENTS

- A. Drawings and Division 01 and Division 32 Specification Sections apply to this Section.

1.03 PERFORMANCE REQUIREMENTS

- A. Irrigation zone control shall be automatic operation with controller and automatic control.
- B. Location for Sprinklers and Specialties: Design location is approximate. Make necessary minor adjustments to avoid plantings and obstructions such as signs and light standards. Maintain 100 percent irrigation coverage for areas indicated.
- C. Delegated Design: Design 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- D. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
1. Irrigation Main Piping: 200 psig
 2. Circuit Piping: 150 psig

1.04 QUALITY CONTROL

- A. Applicable Codes
 - 1. National Electrical Code
 - 2. All applicable local codes and ordinances
 - 3. Should Drawing or Specification requirements differ from local requirements, consider the Contract Document requirements to be the minimum acceptable and comply with any more stringent local requirements.
- B. Testing: Perform testing required by specifications.
- C. Permits and Fees
 - 1. Obtain all permits and pay all required fees to any agency having jurisdiction over the work.
 - 2. Arrange inspections required by local ordinances during the course of construction.
 - 3. Upon completing the work, furnish satisfactory evidence to show all work has been installed in accordance with the ordinance and code requirements.
- D. Installer Qualifications: An employer with workers who include a certified irrigation designer qualified by The Irrigation Association, or Professional Class member of the American Society of Irrigation Consultants, or Professional Technical Class member of the American Society of Irrigation Consultants
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency and marked for intended location and application

1.05 SUBMITTALS

- A. Product Data: Include rated capacities and operating characteristics for each product type indicated.
- B. Substitutions
 - 1. The sprinkler system has been designed specifically for use with irrigation equipment as manufactured by RainBird Sales Inc., Turf Division. Pipe sizes have been determined by computing pressure losses in piping based on consumption and required operating pressure of specified sprinklers. Positioning and placing for sprinklers have also been determined by operating characteristics for specified sprinklers.
 - 2. Substitution of similar TORO products for RainBird products are an acceptable substitution, provided the cut sheets for all proposed products are sent to the Construction Manager for records prior to beginning installation. Sprinkler substitutions from another manufacturer will be considered upon submitting data as outlined below to establish the proposed alternate will produce equivalent operation and design intent.
 - 3. Using materials differing in quality, size, or performance from those specified will only be allowed upon Construction Manager's written approval.

4. Bidders desiring to make a substitution for specified sprinklers shall submit the following to the Construction Manager:
 - a. Actual samples for each sprinkler head type proposed as a substitute
 - b. Manufacturer's catalog sheet showing full specifications for each sprinkler type proposed as a substitute including GPM discharge, minimum allowable operating pressure at sprinkler, maximum allowable spacing, and throw distance (coverage)
 - c. If a design change is required, detailed drawings must accompany the approval requests for the substitute.
 - d. Approval for the substitute sprinkler shall not relieve the Contractor of his responsibility to demonstrate the final installed sprinkler system will operate according to intent of the originally designed and specified system.
- C. Submit record drawings showing any deviations from the plans as approved by the Engineer in the field in accordance with Division 1 - General Requirements.
- D. Submit Operation and Maintenance Manual including manufacturers' cut sheets for all materials used and basic operating guidelines in accordance with Division 1 - General Requirements.

1.06 SITE INSPECTION

- A. Become familiar with all site conditions.
- B. Should utilities not shown on plans be found during excavations, promptly notify the Construction Manager for instructions as to further action.
- C. Make necessary adjustments in the layout as may be required to connect to existing stub-outs should such stubs not be located exactly as shown and as may be required to work around existing work, at no additional cost to MWS.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent dirt, debris, and moisture from entering.
- B. Store plastic piping where it is protected from direct sunlight. Support to prevent sagging and bending.

1.08 FINAL ACCEPTANCE

- A. Final acceptance may be obtained upon the satisfactory completion of all work.

1.09 GUARANTEE

- A. Fully guarantee all work for 1 year from date of Substantial Completion against all defects in material, equipment, and workmanship.
- B. Guarantee covers repairing damage to or replacing any part of the premises due to leaks or other defects in material, equipment, and workmanship, to MWS satisfaction. Repairs shall be performed promptly at no additional cost to MWS.

PART 2 - PRODUCTS

2.01 PIPE

- A. Main line: PVC (polyvinyl chloride) pipe, Schedule 40 meeting ASTM D-1785
- B. Sleeves under pavement: PVC pipe, Schedule 40 meeting ASTM D-1785
- C. Laterals: PVC pipe, Schedule 160/200 or better meeting ASTM D-1785
- D. Sleeves under paving and curbs: PVC pipe, Schedule 40, 4-inch diameter meeting ASTM D-1785

2.02 PIPE FITTINGS

- A. Fittings
 - 1. Meeting ASTM standards, Schedule 40, Standard Weight, at PVC pipe
 - 2. Joints solvent welded using solvent cement meeting ASTM D-2564 as recommended by manufacturer
 - 3. Swing joints and risers to head shall be threaded with male threads wrapped with Teflon Tape.

2.03 SPRINKLER AND COMPONENT MANUFACTURER

- A. Basis-of-Design Product: Unless otherwise indicated in these specifications and subject to compliance with requirements, provide Rain Bird Corporation products or comparable product by one of the following:
 - 1. Toro Company (The), Irrigation Division.
 - 2. Hunter Industries Incorporated.

2.04 RISERS

- A. Spray Heads and rotors less than 4 gpm
 - 1. Swing joint assembly using polyethylene swing pipe with 0.490-inch inside diameter as manufactured by RainBird, or approved equal, with 2 barbed ells and 1 marlex ell at connection to irrigation head
 - 2. Maximum 2-foot length of swing pipe
 - 3. Refer to detail.
 - 4. For rotor head with greater than 4 gpm output, use PVC triple elbow swing joint.

2.05 NOZZLES

- A. MP Rotator as manufactured by Walla Walla Sprinkler Company, 509.525.7660 or www.mpwater.com. Local rep: 615.244.8870

2.06 SPRINKLERS

A. Description

1. Pop-up Height: As indicated on the Drawings
2. Sprinkler Construction: ABS and other corrosion-resistant metals
3. Radius flow and arc as indicated on the Drawings
4. Case: ABS

2.07 VALVES

- A. Electric Valves: Sized as required based on existing equipment, glass-filled nylon body, equivalent to RainBird control valves
- B. Tubing End Closure: Rainbird Model No. ROC16F cap or approved equal
- C. Air/Vacuum Relief Valves: Rainbird Model No. AR valve kit as indicated on Drawings
- D. Automatic Drain Valves: Spring-loaded-ball type, corrosion-resistant construction, and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig

2.08 QUICK COUPLER

- A. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key. Provide locking top option with matching keys.

2.09 DRIP IRRIGATION COMPONENT MANUFACTURER

- A. Basis-of-Design Product: Unless otherwise indicated in these specifications and subject to compliance with requirements, provide Rain Bird Corporation products or comparable product by one of the following:
 1. Toro Company (The), Irrigation Division
 2. Netafim USA
- B. Freestanding Emitters: Device to deliver water at approximately 20 psig.
 1. Body Material: PE or vinyl, with flow control
 2. Riser to Emitter: PE or PVC flexible tubing
 3. Capacities and Characteristics
 - a. Flow: As indicated on the Drawings
 - b. Tubing: PE or PVC; 1/8-inch minimum ID
 - c. Mounting Height: As indicated on the Drawings

- C. Manifold Emitter Systems: Manifold with tubing and emitters
1. Manifold: With multiple outlets to deliver water to emitters
 - a. Body Material: Plastic
 - b. Outlet Caps: Plastic, for outlets without installed tubing
 - c. Operation: Automatic pressure compensating
 2. Tubing: PE or PVC, 1/8-inch minimum ID
 3. Emitter: Device to deliver water at approximately 20 psig
 - a. Body Material: PE or vinyl, with flow control
 4. Capacities and Characteristics
 - a. Manifold: Design flow, outlets, and emitters as indicated on the Drawings
- D. Multiple-Outlet Emitter Systems: Emitter with tubing and button-type outlets
1. Emitter: With multiple outlets to deliver water to remote outlets
 - a. Body Material: Plastic, with flow control
 - b. Outlet Caps: Plastic, for outlets without installed tubing
 - c. Operation: Automatic pressure compensating
 - d. Emitters: Devices to deliver water at approximately 20 psig
 2. Tubing: PE or PVC; 1/8-inch minimum ID
 3. Capacities and Characteristics
 - a. Emitter
 - 1) Flow and Number of Outlets: As indicated on the Drawings
 - 2) Mounting Height: As indicated on the Drawings
- E. Drip Tubes with Direct-Attached Emitters
1. Tubing: Flexible PE or PVC with plugged end
 2. Emitters: Devices to deliver water at approximately 20 psig
 - a. Body Material: PE or vinyl, with flow control
 - b. Mounting: Inserted into tubing at set intervals
 3. Capacities and Characteristics
 - a. Tubing Size, Emitter Spacing, and Emitter Flow: As indicated on the Drawings

- F. Off-Ground Supports: Plastic stakes
- G. Application Pressure Regulators: Brass or plastic housing, NPS 3/4 (DN 20) with corrosion-resistant internal parts; able to control outlet pressure to approximately 20 psig
- H. Filter Units: Brass or plastic housing, with corrosion-resistant internal parts; the size and capacity required for devices downstream from unit
- I. Air Relief Valves: Brass or plastic housing with corrosion-resistant internal parts
- J. Vacuum Relief Valves: Brass or plastic housing with corrosion-resistant internal parts

2.10 BACKFILL UNDER PAVING

- A. By Contractor with sand pipe envelope and crushed stone backfill per MWS specifications

2.11 VALVE BOX AND COVER

- A. For electric valves and drip filter regulator: plastic box. Size as required for valves and service, 12-inch rectangular as manufactured by Ametek or equal with provisions for locking

2.12 MOISTURE AND RAIN SENSORS

- A. Adjustable from 1 to 7 days, to shut off water flow during rain

2.13 CONTROLLER

- A. Subject to compliance with requirements and compatibility with all irrigation components, provide Rain Bird Corporation automatic controller or comparable product by one of the following:

1. Irritrol Systems
2. Toro Company
3. Weathermatic
4. Locate as indicated on the Drawings.

- B. Controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 60 minutes. Include switch to manually or automatically operate each station.

1. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof with locking cover and 2 matching keys; include provision for grounding
 - a. Body Material: Molded plastic
 - b. Mounting: Surface type for wall
2. Interior Control Enclosures: NEMA 250, Type 12, drip-proof, with locking cover and 2 matching keys
 - a. Body Material: Molded plastic

- b. Mounting: Surface type for wall
- 3. Control Transformer: 24-V secondary, with primary fuse
- 4. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate 2 or more times daily
 - a. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation
 - b. Nickel-Cadmium Battery and Trickle Charger: Automatically powers timing device during power outages
 - c. Surge Protection: Metal-oxide-varistor type on each station and primary power
- 5. Wiring: UL 493, Type UF multi-conductor with solid-copper conductors; insulated cable; suitable for direct burial
 - a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers
 - b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum between controllers and automatic control valves, color-coded different from feeder-circuit-cable jacket color with jackets of different colors for multiple-cable installation in same trench
 - c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint, and epoxy resin moisture seal suitable for direct burial

PART 3 - EXECUTION

3.01 GENERAL

- A. Verify existing and proposed locations for all site utilities (i.e., gas, water, electric, telephone) prior to any trenching and pipe laying.
- B. Piping and head layout is shown in schematic form only. All piping shall be installed directly behind curb where possible and, in all cases, is to be routed around existing or proposed site elements, including root balls of existing or proposed trees and shrubs. Refer to the landscape planting drawings for approximate tree locations and closely coordinate work and schedule with grading and planting work.
- C. Contractor is responsible for full and complete coverage of all irrigated areas and shall make any necessary adjustments at any time, at no additional cost to MWS.
- D. Exact location and configuration for islands and other features may vary from that shown on these drawings. Verify location and configuration at the site prior to trenching for sleeves and piping under paving and make any minor adjustments to irrigation system layout.
- E. Contractor is responsible for completely covering all planting by irrigation system. Planting and sod zones should be separated.
- F. Maintain all warning signs, barricades, bracing, flares, and red lanterns as required by safety regulations and local ordinances.

3.02 INSTALLATION

A. General

1. Lay out according to site coordinates and actual field dimensional controls. Verify piping and sleeve locations before trenching.
2. Refer to Drawings for main line irrigation supply's source point.
3. Arrange all warning signs, barricades, bracing, flares, and red lanterns as required by safety regulations and local ordinances.

B. Excavating and Trenching

1. Excavating, trenching, and backfilling are specified in Division 31 Section - Earthwork.
2. Restore all surfaces and existing underground installations damaged or cut as a result of the excavations to their original condition and in a manner approved by the Construction Manager. All excavation shall be unclassified. Trenches shall be 4 inches wide and to the depth required as specified herein and shown in the Drawings.
3. Over excavation shall be backfilled with a sand cushion at the Contractor's expense. Remove all unsuitable or excess material from the site.
4. Dewater excavations as required for dry work including surface and groundwater.
5. Trenches shall have sides as nearly vertical as possible, and bottoms shall be shaped to provide continuous bedding for each pipe section along its entire length in undisturbed soil or thoroughly compacted fill.
6. Trenches for pipelines shall be sufficient depths to provide 12-inch minimum cover for lateral and main line pipes from finished grade.

C. Pipe Installation

1. Pipe installation includes all irrigation piping required for water and electrical wiring to complete the automatic irrigation system.
2. Provide firm, uniform bearing for entire length of each pipeline to prevent uneven settlement. Wedging or blocking the pipe will not be permitted. Remove foreign matter or dirt from inside the pipe before joining and keep piping clean by approved means during and after laying the pipe.
3. Assemble pipe and solvent weld. Thoroughly clean dust, dirt, and moisture from joint before applying solvent with non-synthetic bristle brush.
4. Contractor shall install all pipe and wiring under paving in sleeves as specified. All mains and piping under pavement shall be pressure tested and activated immediately.
5. Carefully coordinate with all other trades on the project with respect to other underground utility lines. Deepest line for any trade shall be installed first.

D. Irrigation Heads

1. Prior to installation, verify planting areas and tree locations configuration and stake head layout accordingly.
2. Pop-up spray heads and rotor heads with less than 4 gpm: Attach sprinkler with swing pipe as specified. Adjust riser height after planting. Add automatic drain valves in the bottom inlet for 6-inch and 12-inch pop-ups when side inlets are used for connection to swing pipes.

E. Wiring

1. Supply wire from automatic controller(s) to the valves in accordance with the specifications. Use PVC conduit for all wire locations under paving. In landscaped areas, the Contractor may add conduit for wires at his option, in lieu of tucking wire under main lines and lateral lines.
2. Secure all wire-to-wire connections by approved means.
3. All wire from controller to valves shall be tucked under piping.
4. Test wires prior to backfilling to insure continuity from valve location to controller location. Any wire not indicating continuity shall be repaired or replaced immediately.

F. Controller

1. Install the specified controller at the location approximately shown on the Drawings. Verify exact location with Contractor.
2. Work provided by Contractor
 - a. A 120-volt power connection - in the form of a conduit and junction box near the controller location
 - b. Conduit to the controller.
3. Coordinate with applicable disciplines.
4. Pull valve wires, program controllers, and put controller in operation.

G. Electric Valves: Supply and install in accordance with the materials list and the manufacturer's recommendations. Set in a level position.

H. Valve Boxes: Set flush with finish grade (adjust as necessary). Set over all valves. Size accordingly.

I. Drain Valves: Install drain valves at low points on the system and in accordance with manufacturer's recommendations. Install drain valves to allow for complete drainage and system blowout in the winter.

3.03 DRIP IRRIGATION SPECIALTY INSTALLATION

A. Install freestanding emitters on pipe riser to mounting height indicated.

- B. Install manifold emitter systems with tubing to emitters. Plug unused manifold outlets. Install emitters on off-ground supports at height indicated.
- C. Install multiple-outlet emitter systems with tubing to outlets. Plug unused emitter outlets. Install outlets on off-ground supports at height indicated.
- D. Install drip tubes with direct-attached emitters on ground.
- E. Install drip tubes with remote-discharge on ground with outlets on off-ground supports at height indicated.
- F. Install off-ground supports at length required for indicated mounted height of device.
- G. Install application pressure regulators and filter units in piping near device being protected and in control-valve boxes.
- H. Install air relief valves and vacuum relief valves in piping and in control-valve boxes.

3.04 TESTING

- A. Complete testing prior to backfilling. In all cases, fittings and couplings must be visible for the full test period. However, sufficient backfill material may be placed in trenches between fittings to prevent arching or slipping under pressure.
- B. Pressure Tests
 1. Cap or plug all openings as soon as lines are installed to prevent materials from entering which could obstruct pipe. Leave in place for testing and until removal is necessary for completing installation.
 2. Thoroughly flush out all water lines before installing heads, valves, and other hydrants.
 3. Test piping for tightness when solvent-welded joints have cured at least 24 hours and with risers capped.
 4. Apply a continuous 100 psi static water pressure on main lines and sub-mains for 2 hours, with 5 psi loss.
 5. Repair all leaks and defects immediately and repeat test until no leaks occur.
 6. Flush system thoroughly with clean water; clean strainers.
 7. Coordinate the system testing with structural soils placement to minimize any disturbance to the mix's compaction.
- C. Test irrigation system controls for compliance. Connect remote control valves to controller in a clockwise sequence to correspond with station setting beginning with Stations 1, 2, 3, etc.

3.05 BACKFILL AND COMPACTION

- A. Do not backfill until pipe systems have been tested and approved.
- B. After system is operating and required tests and inspections have been made, backfill excavations and trenches as follows:

1. Backfill Under Paving: Crushed stone
2. Backfill in Landscape Areas
 - a. Backfill trenches with material removed during excavation compacted to 90 percent.
 - b. Compact all excavation to prevent settling. Hand rake excavation areas and adjoining areas to leave grade at the previous elevation and in a good or better condition than before installation. Water flood compaction will not be permitted.
 - c. Repair settled areas throughout the guarantee period including repairing affected landscape work.

3.06 FINAL ADJUSTMENT

- A. After planting and irrigation installation has been completed, make final adjustment to irrigation system.
- B. The system shall be completely flushed to remove any and all debris from the lines by removing nozzle from all heads on ends of lines and turning on the system.
- C. Check all heads for correct operation, alignment, and throw direction.
- D. Check each spray head section for operating pressure and balance in relation to all other sections by using the flow adjustment on top of each valve.
- E. Check nozzles for complete coverage. Prevailing wind or other conditions may indicate the arc or spray angle should be other than as shown on the plan. In this case, revise nozzle degree to provide correct coverage, at the Contractor's expense.
- F. Adjust head and valve heights as necessary.
- G. Make any other adjustments determined necessary to provide complete and uninterrupted coverage.

3.07 CLEANUP

- A. Keep site clean on a daily basis by removing trash and debris resulting from construction operation.
- B. Keep all walks, roads, and circulation routes free from debris, materials, and equipment at all times.
- C. Upon completing the irrigation work, clean up all work and storage areas by removing trash piles, surplus material, or other material from site.
- D. Restore any pavement, curbs, ground, etc. disturbed by irrigation operations to its original condition.

3.08 MAINTENANCE AND COMPLETION OF THE WORK

- A. Instruct MWS staff in the controller's proper functioning and scheduling. Provide a user's manual that includes cut sheets for all products specified and a complete owner's manual for controller operation.

- B. Instruct MWS staff in the proper functioning and management for the irrigation pump(s) and filter(s). Provide a user's manual that includes cut sheets for all products specified and a complete owner's manual for pump system operation.
- C. The Contractor shall provide for draining the system during the winter as appropriate and for starting up in spring during the construction period.

3.09 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 32 92 00

TURF AND GRASSES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Replace and repair turf and grasses disturbed during the course of the work or install new turf and grasses indicated on the drawings.
- B. Section includes
 - 1. Seeding
 - 2. Hydroseeding
 - 3. Sodding
 - 4. Wildflowers and Native Grasses

1.02 DEFINITIONS

- A. Duff Layer: Surface layer of native topsoil composed mostly with decayed leaves, twigs, and detritus
- B. Finish Grade: Planting soil finished surface elevation
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Pests: Living organisms found where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- F. Planting Soil: Use a standardized topsoil, existing native surface topsoil, existing in-place surface soil, imported topsoil, or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation for subsoil remaining after excavation is complete or top surface of a fill or backfill before planting soil is placed
- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms
- I. Surface Soil: Soil present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.03 SUBMITTALS

- A. Product Data: For each product type indicated.
 - 1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.
- B. Grass Seed Certification: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the production year and packaging date.
 - 1. Supply certification for each seed mixture for turfgrass sod. Include source identification and supplier's name and telephone number.
- C. Product Certificates: For soil amendments and fertilizers, from manufacturer
- D. Material Test Reports: For existing native surface topsoil, existing in-place surface soil and imported or manufactured topsoil
- E. Maintenance Instructions: Recommended procedures to be established by MWS for maintaining turf on MWS facility sites during a calendar year. Submit before the required initial maintenance periods expire.

1.04 QUALITY ASSURANCE

- A. Installer: A landscape installer whose work has resulted in successful turf establishment
 - 1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 2. Installer's Field Supervision: Require installer is to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 3. Pesticide Applicator: State licensed, commercial
- B. Soil-Testing Laboratory: An independent laboratory or university laboratory, recognized by the Tennessee Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating organic matter percentages; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content in the soil.
 - 1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 - 2. The soil-testing laboratory shall oversee soil sampling with depth, location, and sample numbers to be taken per the Contract requirements. Three minimum representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.

3. Report tested soil's suitability for turf growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1,000 square feet or volume per cubic yards for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants
 - b. 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.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, and the manufacturer's name and address and indicate conformance with state and federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "*Specifications for Turfgrass Sod Materials*" and "*Specifications for Turfgrass Sod Transplanting and Installation*" in TPI's "*Guideline Specifications to Turfgrass Sodding.*" Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.
- C. Bulk Materials
 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, soil-bearing water runoff discharge, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 3. Accompany each bulk fertilizer, lime, and soil amendment delivery with appropriate certificates.

1.06 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

1.07 MAINTENANCE SERVICE

- A. Initial Turf Maintenance Service: Provide full maintenance. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but not less than the following periods:
 1. Seeded Turf: 60-days from Substantial Completion date
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
 2. Sodded Turf: 60-days from Substantial Completion date

3. Wildflower and Native Grasses Stand: 60-days from Substantial Completion date
 - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

PART 2 - PRODUCTS

2.01 SEED

A. Seed Quality

1. All seed shall be tested in a certified seed laboratory with certified results presented to the Construction Manager in writing prior to planting. All seed shall be of the previous season's crop, and the analysis date shall be within the past 7 months of the time used on the Project.
2. All seed must be labeled and free from noxious weeds. All seed is to be at least 95% pure. Each seed type shall have a seed tag indicating botanical name, common name, purity, and germination. At the Contractor's option, seed mix may be pre-mixed by the source in the specified proportions. If pre-mixing is provided, obtain a certified copy of the mix and include all seed tags for individual seeds along with the mixed seed.
3. Fresh, clean, dry, new-crop seed complying with AOSA's "*Journal of Seed Technology, Rules for Testing Seeds*" for purity and germination tolerances

- #### B. Fescue Seed Mix (for areas disturbed by construction operations, not otherwise planted with sod, shrubs, or wildflower seed):
- Seed shall be true to name and meet the specifications in TDOT Section 801. Select hybrid for specific site conditions. Provide seed at a rate of 260 lbs. per acre.

C. Wildflower and Native Grasses Seed Mix

1. Sources: Wildflower and native grass seed shall be provided by an established seed nursery source. Recommended sources are:
 - a. Prairie Nursery, Westfield, WI (800) 476.9453
 - b. Wildseed, Inc., Eagle Lake, TX (800) 848.0078
 - c. Applewood Seed Co., Arvada, CO (303) 431.7333
 - d. Nashville Natives, (615) 799.8719
 - e. Provide species selection, mix, and rates as determined on the Drawings.

2.02 TURFGRASS SOD

- A. Turfgrass Sod: Comply with Specifications for Turfgrass Sod Materials in TPI's "*Guideline Specifications to Turfgrass Sodding*." Furnish viable sod of uniform density, color, and texture; strongly rooted; and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod with grass species as noted on the Drawings with not less than 95% germination, not less than 95% pure seed, and not more than 5% other grasses.

- C. Obtain solid sod from sources having growing conditions similar to the area to be planted.
- D. Sod shall be true to species name and type identified in the Plant Schedule.
- E. Sod shall contain no more than 5% of other grasses.
- F. Sod shall be well cultivated; weed, disease, and insect-free; of good texture; and free from extraneous roots, stones, and other foreign matter.
- G. Sod shall contain no nutgrass. Remove sod with nutgrass from the site immediately.

2.03 INORGANIC SOIL AMENDMENTS (REFER TO 32-93-00 LANDSCAPE PLANTING)

2.04 ORGANIC SOIL AMENDMENTS (REFER TO 32-93-00 LANDSCAPE PLANTING)

2.05 FERTILIZERS (REFER TO 32-93-00 LANDSCAPE PLANTING)

2.06 PLANTING SOILS (REFER TO 32-93-00 LANDSCAPE PLANTING)

2.07 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Hay or straw mulch shall meet specifications set forth in TDOT Section 918.18.
 - 1. Fescue Seed Mix: Apply at the rates set forth in TDOT Section 918.18.
 - 2. Slope Seed Mix: For areas not subject to erosion, apply at a rate of 1.5 to 2.0 tons per acre.

2.08 PESTICIDES

- A. General: Use pesticide, registered and approved by U. S. EPA, acceptable to authorities having jurisdiction, and a type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling germination or growth of weeds within planted areas at the soil level directly below the mulch layer
- C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth for weeds which have already germinated

2.09 EROSION CONTROL BLANKETS MATERIALS

- A. The erosion control blankets shall be in accordance with TDOT's Specifications, Section 805.
- B. Contractor is to submit the manufacturer's application instructions and specifications for the erosion control blankets.
- C. Erosion control blankets shall meet TDOT Specifications, Section 918.28.

D. Erosion blanket: Biodegradable straw/coconut fiber mat enclosed in a uniform, open plain weave of heavyweight photodegradable polypropylene netting with related staples meeting TDOT Section 918.19 for slopes 3:1 or greater.

1. CS150 as manufactured by North American Green and distributed by Jen Hill Construction Materials, Hendersonville, TN, or approved equal

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
 1. Verify no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
 4. Uniformly moisten excessively dry soil which is not workable and is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Construction Manager and replace with new planting soil.

3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
 2. Protect grade stakes until directed to remove them.
- B. Install erosion-control measures to prevent eroding or displacing soil and discharging soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.03 TURF AREA PREPARATION

- A. Limit turf subgrade preparation to areas to be planted.

- B. Newly Graded Subgrades: Loosen subgrade to a 4-inch minimum depth. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose.
1. Spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Add fertilizer and lime per soil test report.
 - c. Mix lime with dry soil before mixing fertilizer.
 - d. For Fescue Seed Mix Only: Add organic matter to provide 2 cubic yards/1,000 square feet uniformly over amended soil. Incorporate into the top 4 to 6 inch soil.
 2. Spread planting soil for all turf areas to a 6-inch minimum depth, 12-inch minimum if over rock, but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
 - a. Spread approximately 1/2 the planting soil thickness over loosened subgrade. Mix thoroughly into top 4-inch subgrade. Spread remainder of planting soil.
 - b. Reduce planting soil elevation to allow for sod's soil thickness.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 2. Loosen surface soil to at least a 6-inch depth. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into soil's top 4-inches. Till soil to a homogeneous, fine texture mixture.
 - a. Apply fertilizer directly to surface soil before loosening.
 3. Remove stones larger than 1-inch in any dimension and sticks, roots, trash, and other extraneous matter.
 4. Legally dispose of waste material including grass, vegetation, and turf off MWS property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within +/-1/2-inch finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Engineer's acceptance of finish grading. Restore planting areas if eroded or otherwise disturbed after finish grading.

3.04 PREPARATION FOR EROSION-CONTROL MATERIALS

- A. Prepare area as specified in "Turf Area Preparation".
- B. For erosion-control blanket or mesh, install from top of slope working downward as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

3.05 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
 1. Do not use wet seed or seed that is moldy or otherwise damaged.
 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
 3. Do not seed when the prepared surface is crusted, the ground is frozen, wet, or otherwise in a non-tillable condition.
- B. Wildflower Mixes
 1. If seeding is not done at a time recommended by the seed distributor, sow seed areas with annual rye or millet cover crop prior to wildflower seeding. Verify with the seed distributor which cover crop to use based on the time of the year. If cover crop is provided, provide ground preparation prior to wildflower seeding in accordance with that noted above.
 2. Recommend seed sowing using double-box Brillion seeder able to simultaneously plant native grasses and wildflower seed. If multi-seeder is not used, seed grasses first, then wildflowers. For ease in obtaining even distribution, thoroughly mix wildflower seed with 50# sand per acre. Provide seeding in an alternate pattern, with a second pass perpendicular to the first.
- C. Moisten prepared seedbed before planting if the soil is dry. Water thoroughly and allow surface moisture to dry before sowing.
- D. Sow using approved mechanical seeders at the specified rate.
- E. Sow by using one-half the seed to cover the entire area, and then sow the other half perpendicular to achieve uniform coverage.
- F. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- G. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets.
- H. Protect seeded areas with slopes not exceeding 1:4 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.

- I. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch or planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16-inch, and roll surface smooth.

3.06 HYDROSEEDING

- A. Hydroseeding shall be in accordance with TDOT Special Provision SP 801A.
- B. Seed: Seed shall meet TDOT Specifications, Section 801. The seed group shall be in accordance with the Drawings.
- C. Tackifier (if used): Tackifier shall be in accordance with TDOT's Special Provision SP801A. The tackifier shall be either emulsified asphalt or a non-toxic, degradable additive that will disperse in cold water to provide a homogenous lump-free solution.
- D. Wood cellulose fiber shall consist of specifically prepared wood cellulose processed into a uniform fibrous physical state.
 1. The wood cellulose fiber shall be in accordance with TDOT Special Provision SP801A.
 2. Wood cellulose fiber shall consist of specifically prepared wood cellulose processed into a uniform fibrous physical state.
- E. Fertilizer: Agricultural lime as required to amend soil and bring soil into conformance with TDOT's Specifications
- F. Coloring Agent: The wood cellulose fiber mulch shall be dyed green or contain a green dye in the package that will provide an appropriate color to facilitate visually inspecting the slurry.
- G. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water using equipment specifically designed for hydroseed application.
 1. Product: Geoskin Straw and Cotton Plant Material Hydromulch. Jen-Hill Construction Materials or approved equal.
 2. Prior to Hydroseeding, trash, debris, and weeds shall be removed.
 3. Install per the manufacturer's direction.

3.07 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Ensure finished grade is uniform. Correct any pockets or divots prior to placing sod to obtain a uniform and smooth surface.
- C. Lay sod to form a solid mass with tightly fitted joints. Butt sod ends and sides; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between sod pieces; remove excess to avoid smothering sod and adjacent grass.
 1. Lay sod across slope angles exceeding 1:3.

2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- D. Saturate sod with fine water spray within two hours of planting. During first week after planting, water daily or more frequently as necessary to maintain moist soil to a minimum 1-1/2-inch depth below sod.

3.08 TURF MAINTENANCE

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
1. Fill in as necessary soil subsidence that may occur due to settling or other processes. Replace materials and turf damaged or lost in subsidence areas.
 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
 3. Apply treatments as required to keep turf and soil free from pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize pesticide use and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a 4-inch depth.
1. Schedule watering to prevent wilting, puddling, erosion, and seed or mulch displacement. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 2. Water turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate until established.
- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 the grass height. Remove no more than 1/3 the grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
1. Mow Fescue to a 2-1/2 to 2-3/4-inch height. Lawns should have one mowing before receiving Substantial Completion.
- D. Turf Post Fertilization: Apply fertilizer after initial mowing and when grass is dry.
1. Use fertilizer that will provide at least 1 pound/1,000 square feet actual nitrogen to turf area.

3.09 SATISFACTORY TURF

- A. Turf installations shall meet the following criteria as determined by Engineer:
1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free from weeds and surface irregularities, with coverage exceeding 90 percent over any 10 square feet and bare spots not exceeding 5 by 5 inches.

2. Satisfactory Sodded Turf: At end of the maintenance period, a healthy, well-rooted, even-colored, viable turf has been established and is free from weeds, open joints, bare areas, and surface irregularities.
 3. Satisfactory Wildflower and Grasses: Acceptance for areas designated to be seeded under this Section will be based on verifying a satisfactory stand of specified grass, legumes, and wildflowers as determined by an on-site observation by Construction Manager. A minimum of 40 seeds per square foot presence shall be considered the basis for acceptance because germination cannot be guaranteed prior to Substantial Completion.
- B. If a satisfactory stand is not established in any area, that area shall be reseeded until a satisfactory stand is established, without additional compensation.
 - C. Use specified materials to reestablish turf that does not comply with requirements continue maintenance until turf is satisfactory.
 - D. A satisfactory stand will be measured in acres or per thousand square feet accepted including ground preparation, seeding, mulch, and erosion control in accordance with Drawings and Specifications.

3.10 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with MWS operations and others in proximity to the work. Notify Construction Manager before each application is performed.
- B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.11 CLEANUP AND PROTECTION

- A. Promptly repair any damage caused by pedestrian or vehicular traffic, erosion, or other causes.
- B. Maintain slope and control runoff.
- C. Promptly remove from paved areas all soil and debris created by turf work. Clean vehicle wheels before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- D. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period remove after plantings have been established.
- E. Remove non-degradable erosion-control measures after grass establishment period.
- F. Should the Contractor fail to take immediate action upon written notice of unacceptable or damaged work, MWS reserves the right to have the work performed by others at the Contractor's expense.

3.12 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 32 93 00

LANDSCAPE PLANTINGS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Replace and repair turf grasses disturbed during the course of the work or install new landscape plantings as indicated on the drawings.
- B. Section includes
 - 1. Plants
 - 2. Planting soils

1.02 RELATED SECTIONS

- A. Section 32 15 00 - Tree Protection and Pruning for protecting existing trees and plantings and for pruning
- B. Section 32 92 00 - Turf and Grasses for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials

1.03 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown. Ball size shall not be less than the size indicated by the "*American Standard for Nursery Stock*," American Association of Nurseryman, Inc.'s latest approved revision. The ball shall be wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the ball surface as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size shall not be less than the size indicated by "*American Standard for Nursery Stock*," American Association of Nurseryman, Inc.'s latest approved revision, ANSI Z-60-1.
- D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required
- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- F. Duff Layer: The native topsoil surface layer composed of mostly decayed leaves, twigs, and detritus

- G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant
- H. Finish Grade: Elevation for finished surface of planting soil
- I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil
- J. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- K. Pests: Living organisms found where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- L. Planting Area: Areas to be planted
- M. Planting Soil: Standardized topsoil, existing native surface topsoil, existing in-place surface soil, imported topsoil, or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth
- N. Plant, Plants, Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- O. Root Flare (also called trunk flare): Area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the transition area between the root system and the stem or trunk
- P. Stem Girdling Roots: Roots encircling tree stems (trunks) below the soil surface
- Q. Subgrade: Subsoil surface or elevation remaining after excavation is complete, or a fill or backfill top surface before planting soil is placed
- R. Subsoil: All soil beneath the soil profile's topsoil layer, typified by the lack of organic matter and soil organisms
- S. Surface Soil: Soil present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.04 SUBMITTALS

- A. Product Data: For each product type indicated including soils
1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
 2. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to the Project.

- B. Material Test Reports: For existing native surface topsoil and for imported or manufactured topsoil and topsoil mix
- C. Maintenance Instructions
 - 1. Recommended procedures to be established by MWS for maintaining plants at a MWS facility during a calendar year.
 - 2. Submit before starting required maintenance periods.
- D. Warranty: Sample of special warranty

1.05 QUALITY ASSURANCE

- A. Installer
 - 1. A landscape installer whose work has resulted in successful plant establishments
 - 2. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
 - 3. Installer's Field Supervision: Require installer to maintain an experienced full-time supervisor on Project site when work is in progress.
 - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the Professional Landcare Network:
 - a. Certified Landscape Technician - Exterior, with installation specialty area(s), designated CLT-Exterior
 - b. Certified Ornamental Landscape Professional, designated COLP
 - 5. Pesticide Applicator: State licensed, commercial
- B. Soil-Testing Laboratory: An independent or university laboratory, recognized by the Tennessee Department of Agriculture, with the experience and capability to conduct the testing indicated and who specializes in types of tests to be performed
- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages for organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content in the soil.
 - 1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
 - 2. The soil-testing laboratory shall oversee soil sampling. Depth, location, and number of samples to be taken shall be per Construction Manager's instructions. Three minimum representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
 - 3. Report suitability of tested soil for plant growth.
 - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1,000 square

foot (92.9 square meters) or volume per cubic yards. (0.76 cubic meters) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

- b. 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.
- D. Provide quality, size, genus, species, and variety for plants indicated, complying with applicable requirements in ANSI Z60.1.
- E. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
- 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches above the root flare for trees up to 4-inch caliper size and 12 inches above the root flare for larger sizes.
 - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- F. Plant Material Observation
- 1. Construction Manager may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality.
 - 2. Construction Manager retains the right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work.
 - 3. Remove rejected trees or shrubs immediately from Project site.
 - 4. Notify Construction Manager about planting material sources 7 days before site delivery.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Bulk Materials
- 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
 - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, soil-bearing water runoff discharge, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
 - 3. Accompany each bulk fertilizer, lime, and soil amendment delivery with appropriate certificates.
- B. Deliver bare-root stock plants freshly dug.
- C. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

- D. Do not prune trees and shrubs before delivery.
- E. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage.
- F. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape.
- G. Protectively cover plants during shipping and delivery.
- H. Do not drop plants during delivery and handling.
- I. Handle planting stock by root ball.
- J. Deliver plants after preparations for planting have been completed and install immediately.
- K. If planting is delayed more than 6 hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
 - 1. Heel-in bare-root stock. Soak roots in a dry condition in water for two hours. Reject dried-out plants.
 - 2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
 - 3. Do not remove container-grown stock from containers before planting time.
 - 4. Water root systems for plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.07 PROJECT CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Coordinate planting periods with maintenance periods to provide required maintenance from Substantial Completion date.
- C. Weather Limitations
 - 1. Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained.
 - 2. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- D. Coordination with Turf Areas (Lawns)
 - 1. Plant trees, shrubs, and other plants after finish grades have been established and before planting turf areas unless otherwise indicated.
 - 2. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas and promptly repair damage caused by planting operations.

1.08 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:
 - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner or MWS, or incidents beyond Contractor's control.
 - b. Structural failures including plantings falling or blowing over.
2. Warranty Period from Substantial Completion date is 12 months.
3. Include the following remedial actions as a minimum:
 - a. Immediately remove dead plants and replace, unless required to plant in the succeeding planting season.
 - b. Replace plants more than 25 percent dead or in an unhealthy condition at end of warranty period.
 - c. A limit of one replacement for each plant will be required, except for losses or replacements due to failure to comply with requirements.
 - d. Provide extended warranty for a period equal to original warranty period for replaced plant material.

1.09 MAINTENANCE SERVICE

- A. Initial Maintenance Service
1. Provide maintenance by skilled employees of landscape installer. Maintain as required in Part 3.
 2. Begin maintenance immediately after plants have been installed and continue until plants are acceptably healthy and well established but for not less than maintenance period below.
 3. Maintenance Period: For 60 days from Substantial Completion date

PART 2 - PRODUCTS

2.01 PLANT MATERIAL

- A. General
1. Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1 and with healthy root systems developed by transplanting or root pruning.

2. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free from disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
 3. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4-inch diameter; or with stem girdling roots will be rejected.
 4. Provide plants the sizes, grades, and ball or container sizes to comply with ANSI Z60.1 for required plant types and forms.
 5. Larger sized plants may be used if acceptable to Construction Manager, with a proportionate increase in root or ball size.
 6. If formal arrangements or consecutive order for plants is shown on Drawings, select stock for uniform height and spread and number the labels to assure symmetry in planting.
- B. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- C. Root-Ball Depth
1. Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1.
 2. Root flare shall be visible before planting.
- D. Labeling
1. Label each plant with the variety, size, and caliper with a securely attached, waterproof tag bearing legible designation with common name and full scientific name, including genus and species.
 2. Include nomenclature for hybrid, variety, or cultivar, if applicable, for the plant as shown on Drawings.

2.02 INORGANIC SOIL AMENDMENTS

- A. Lime
1. ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent
 2. Class: T, with 99 percent minimum passing through No. 8 sieve and 75 percent minimum passing through No. 60 sieve
- B. Perlite: Horticultural perlite, soil amendment grade
- C. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve
- D. Sand: Clean, washed, natural or manufactured, and free from toxic materials

- E. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight
- F. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight

2.03 ORGANIC SOIL AMENDMENTS

A. Compost

1. Well-composted, stable, and weed-free organic matter
2. pH range from 5.5 to 8
3. Moisture content 35 to 55 percent by weight
4. 100 percent passing through 3/4-inch sieve
5. Soluble salt content of 5 to 10 decisiemens/meter
6. Not exceeding 0.5 percent inert contaminants
7. Free from substances toxic to plantings
8. Organic Matter Content: 50 to 60 percent of dry weight
9. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste

B. Sphagnum Peat

1. Partially decomposed sphagnum peat moss
2. Finely divided or granular texture
3. pH range from 3.4 to 4.8

C. Wood Derivatives

1. Decomposed, nitrogen-treated sawdust, ground bark, or wood waste
2. A uniform texture and free from chips, stones, sticks, soil, or toxic materials

D. Manure

1. Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume – straw, sawdust, or other bedding materials
2. Free from toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth

2.04 FERTILIZERS

A. Bone Meal

1. Commercial, raw or steamed, finely ground

2. A minimum of 4 percent nitrogen and 10 percent phosphoric acid

B. Superphosphate

1. Commercial phosphate mixture
2. Soluble
3. A minimum of 20 percent available phosphoric acid

C. Commercial Fertilizer

1. Commercial-grade complete fertilizer with neutral character consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium
2. Composition: 1 pound/1,000 square feet of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
3. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory

D. Slow-Release Fertilizer

1. Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium
2. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight
3. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory

- E. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants and commercial-grade FeDTPA for ornamental grasses and monocots

2.05 PLANTING SOILS

A. Topsoil Characteristics

1. Fertile, friable, naturally occurring topsoil; free from stones, subsoil, clay lumps, hardpan, roots, stumps, branches, sticks, and other debris larger than two inches in any dimension; free from noxious weeds, grasses, seeds, plants, extraneous matter, and any substance harmful to plant growth
2. pH. 5.0 to 7.0
3. Organic matter. 5% to 10%
4. Sand. 30% to 50%
5. Silt. 30% to 50%
6. Clay. 10% to 25%

B. Characteristics for topsoil for Bioretention Areas

1. Fertile, friable, naturally occurring topsoil; free from stones, subsoil, clay lumps, hardpan, roots, stumps, branches, sticks, and other debris larger than two inches in any dimension; free from noxious weeds, grasses, seeds, plants, extraneous matter, and any substance harmful to plant growth
2. pH. 5.0 to 7.0
3. Organic matter. 1.5% to 3%
4. Sand. 30% to 70%
5. Silt. Less than 40%
6. Clay. Less than 25%

C. Planting Soil

1. Existing native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site.
 - a. Verify suitability of native surface topsoil to produce viable planting soil.
 - b. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
2. Mix existing, native surface topsoil with the soil amendments and fertilizers to meet the specifications in 2.05.A Topsoil Characteristics above.

2.06 MULCHES

A. Organic Mulch

1. Free from deleterious materials and suitable as a top dressing for trees and shrubs
2. Type: Shredded hardwood or as indicated on the Drawings
3. Size Range: 3 inches maximum, 1/2 inch minimum
4. Color: Natural

B. Mineral Mulch

1. Hard, durable stone, washed free from loam, sand, clay, and other foreign substances
2. Type: Rounded riverbed gravel or smooth-faced stone
3. Size Range: As indicated on the Drawings
4. Color: Uniform tan-beige color range acceptable to Construction Manager

2.07 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric

1. Polypropylene or polyester fabric
2. 3 ounce/square yard minimum
3. Composed from fibers formed into a stable network so the fibers retain their relative position
4. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.

2.08 PESTICIDES

A. General

1. Pesticides registered and approved by EPA
2. Acceptable to authorities having jurisdiction
3. Of type recommended by manufacturer for each specific problem and as required for Project conditions and application
4. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed germination or growth within planted areas at the soil level directly below the mulch layer

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling growth for already germinated weeds

2.09 MISCELLANEOUS PRODUCTS

A. Antidesiccant

1. Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs
2. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

B. Burlap: Non-synthetic, biodegradable

C. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5,300 spores per pound (0.45 kilograms) of vesicular-arbuscular mycorrhizal fungi and 95,000,000 spores per pound (0.45 kilograms) of ectomycorrhizal fungi - 33 percent hydrogel and a maximum of 5.5 percent inert material.

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.
 - 1. Verify no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
 - 2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
 - 3. Suspend soil spreading, grading, and tilling operations during excessive soil moisture periods until the moisture content reaches acceptable levels to attain the required results.
 - 4. Uniformly moisten excessively dry soil which is not workable and is too dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Construction Manager and replace with new planting soil.

3.02 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent eroding or displacing soils and discharging soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Construction Manager's acceptance for layout before excavating or planting. Make minor adjustments as required.
- D. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
 - 1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- E. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.

3.03 PLANTING AREA ESTABLISHMENT

- A. Loosen planting areas subgrade to a 6- inch minimum depth below ball depth or as indicated on the Drawings. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off MWS property.
 - 1. Thoroughly blend planting soil off-site before spreading.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 - 2. Spread planting soil to a depth as indicated on the Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.
- B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.
- C. Before planting, obtain Construction Manager's acceptance for finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- D. Applying Mycorrhizal Fungi: When directed by the Construction Manager, broadcast dry product uniformly over prepared soil or to bare root material.

3.04 BIOSWALE SEQUENCING

- A. Install sediment control devices as shown on the Drawings.
- B. Grade site to elevations shown on Drawings
 - 1. If applicable, construct curb openings and/or remove and replace existing concrete as specified on the Drawing details.
 - 2. Curb openings shall be blocked or other measures taken to prohibit drainage from entering construction area.
 - 3. At the end of each workday, all excavations shall be protected by construction safety fencing or temporary backfill as needed.
- C. Stabilize grading within the disturbance limit except for bioretention area. The bioretention areas may be used as sediment traps, if the proposed bioretention facility's invert is 1-foot lower than the sediment trap.
- D. Excavate bioretention area to proposed invert depth and scarify the existing soil surfaces, taking care not to compact the in-situ materials.
 - 1. Install underdrain system and observation wells, if specified.
- E. Backfill bioretention area with planting soil as shown on the Drawings. Overfilling is recommended to account for settlement.

- F. Presoak the planting soil prior to planting vegetation to allow for settlement. This can be accomplished by using a water truck or allowing water to enter the pit from a rain event.
- G. Excavate or fill to achieve proper design grade, leaving space for the upper layer of mulch and/or topsoil that will bring the surface to final grade and ready for planting.
- H. Immediately plant the vegetation specified in the planting plan on the Drawings for Bioretention Area.
- I. Mulch and install erosion protection at entrance points. Remove sediment control practices or entrance blocks with Construction Manager's authorization.

3.05 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches

1. Excavate circular planting pits with sides sloping inward at a 45-degree angle consistent with the Drawing details.
2. Excavations with vertical sides are not acceptable.
3. Trim perimeter of bottom, leaving center area of bottom raised slightly to support root ball and assist in drainage away from center.
4. Do not further disturb base.
5. Ensure the root ball will sit on undisturbed base soil to prevent settling.
6. Scarify planting pit sides smeared or smoothed during excavation.
7. Excavate approximately 3 times as wide as ball diameter for balled and burlapped, balled and potted, container-grown or fabric bag-grown stock.
8. Excavate an area wider than root spread and deep enough to accommodate vertical roots for bare-root stock consistent with the Drawing details.
9. Do not excavate deeper than the root ball depth, measured from the root flare to the bottom of the root ball.
10. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
11. Maintain required repose angles for adjacent materials as shown on the Drawings. Do not excavate subgrades for adjacent paving, structures, hardscapes, or other new or existing improvements.
12. If drain tile is shown on Drawings or required under planting areas, excavate to top of porous backfill over tile.

B. Subsoil and topsoil removed from excavations may be used as planting soil if it meets or is amended to meet Topsoil Characteristics in 2.05.A. above.

C. Obstructions: Notify Construction Manager if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

- D. Drainage: Notify Construction Manager if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- E. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

3.06 TREE, SHRUB, AND VINE PLANTING

- A. Before planting, verify the root flare is visible at top of root ball according to ANSI Z60.1.
 - 1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk.
 - 2. After removing soil to expose the root flare, verify the root ball still meets size requirements.
- B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Set balled and burlapped and container grown stock plumb and in center of planting pit or trench with root flare above adjacent finish grades.
 - 1. Use planting soil meeting Topsoil Characteristics from 2.05.A. above for backfill.
 - 2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from root ball tops and sides but do not remove from under root balls.
 - a. Remove pallets, if any, before setting.
 - b. Do not use planting stock if root ball is cracked or broken before or during the planting operation.
 - 3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets.
 - a. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill.
 - b. Repeat watering until no more water is absorbed.
 - 4. Continue backfilling process. Water again after placing and tamping final soil layer.
- D. Set and support bare-root and seedling stock in center of planting pit or trench with root flare above adjacent finish grade.
 - 1. Dip bare root seedlings in mycorrhizae root dip prior to placement.
 - 2. Spread roots without tangling or turning toward surface and carefully work backfill around roots by hand.
 - 3. Puddle with water until backfill layers are completely saturated.
 - 4. Plumb before backfilling and maintain plumb while working backfill around roots and placing layers above roots.

5. Continue backfilling process.
6. Water again after placing and tamping final soil layer.

E. Planting on Slopes

1. Set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil.
2. Apply enough soil to cover the root ball's downhill side.

3.07 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Do not apply pruning paint to wounds.

3.08 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated in even rows with triangular spacing.
- B. Use planting soil meeting Topsoil Characteristics as noted in 2.05.A. above for backfill.
- C. Dig holes large enough to allow roots to spread.
- D. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system, but to a depth not less than 2 nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.09 PLANTING AREA MULCHING

- A. Mulch backfilled planting area surfaces and other areas indicated.
 1. Organic Mulch in Planting Areas: Apply 3-inch average organic mulch thickness over whole planting area surface and finish level with adjacent finish grades.
 2. Mineral Mulch in Planting Areas: Apply to depth and surface area indicated on the Drawings.

3.10 PLANT MAINTENANCE

- A. General
 1. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching.
 2. Restore planting saucers.

3. Adjust and repair tree-stabilization devices.
4. Reset to proper grades or vertical position.
5. Perform other operations, as required, to establish healthy, viable plantings.

B. Soil Subsidence

1. Fill in as necessary soil subsidence that may occur due to settling or other processes.
2. Replace mulch materials damaged or lost in subsidence areas.

C. Treatments

1. Apply sprays or treatments as required to keep plant materials, planted areas, and soils free from pests and pathogens or disease.
2. Use integrated pest management practices whenever possible to minimize pesticide use and reduce hazards.
3. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.11 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations.

1. Coordinate applications with MWS operations and others in proximity to the work.
2. Notify MWS before each application is performed.

B. Pre-emergent Herbicides (Selective and Non-Selective)

1. Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations.
2. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.12 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and other contractor and trade operations.

1. Maintain protection during installation and maintenance periods.
2. Treat, repair, or replace damaged plantings.

- C. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.13 DISPOSAL

- A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them.

3.14 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 33 01 30

POST-REHABILITATION SANITARY SEWER CCTV INSPECTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Perform all sewer line closed circuit television (CCTV) inspection work after the CIPP, rehabilitation or pipe replacement for the mainline and any lateral replacement or relining has been performed.
- B. Perform all CCTV inspection work for new sewer lines after constructing the mainline and any lateral reconnection/replacement has been performed for upgrades.

1.02 REFERENCES

- A. National Association of Sewer Service Companies (NASSCO)
 - 1. Pipeline Assessment and Certification Program (PACP) Reference Manual
 - 2. Recommended Specifications for Sewer Collection System Rehabilitation Standard (2006)

1.03 RELATED WORK

- A. Sewer line cleaning is included in Section 33 35 20.
- B. Pre-rehabilitation CCTV Sewer Inspection is included in Section 33 01 51.
- C. Sewer Flow Control is included 33 01 48.
- D. Sanitary Sewerage Utilities is included in Section 33 30 10.

1.04 DEFINITIONS

- A. Television Inspection: A necessary operation to complete a true-color audio-visual inspection to verify existing internal sewer line conditions. Furnish labor, materials, equipment, tools, and other incidental services for CCTV inspection.
- B. MPEG: MPEG is an acronym for Moving Pictures Expert Group, which is a family of international standards used for coding audio-visual information in a digital compressed format. For this Section, digital audio-visual coding has a 352 pixels (x) by 240 pixels (y) resolution and a 30 frames per second interlaced frame rate. MPEG coding shall be named using “.mpg” as the file extension.
- C. Acceptable media for the video recordings are external hard drive electronic media for data transfer.

1.05 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01 33 00.
- B. Submit a written description for procedures to be used.

- C. Submit the product literature for all digital video equipment, including, but not limited to, cabling, camera, monitor, footage counter, digital video titling device, and recorder.
- D. Submit a written/printed copy of television inspection logs to the Construction Manager. Logs shall record defects according to NASSCO's Pipeline Assessment and Certification Program (PACP) or/and Manhole Assessment and Certification Program (MACP).
- E. Submit 2 copies of visual and audio recording to the Construction Manager in electronic format.
 - 1. The Construction Manager will review the inspections to ensure that the required information is provided and the recording quality is acceptable, but they will not review the inspections for content accuracy.
 - 2. If the Construction Manager determines the recording is defective or not adequate quality, the Contractor shall perform the CCTV inspection again at the Contractor's expense.

1.06 QUALITY ASSURANCE

- A. Comply with requirements in Section 01 43 00.
- B. Comply with all codes, laws, ordinances, and regulations of governmental authorities having jurisdiction over this part of the work.
- C. The television inspection shall be performed one section of line at a time. An individual digital video file and data file shall be developed for each manhole-to-manhole section.
- D. The inspection shall be performed in accordance with NASSCO's Pipeline Assessment and Certification Program (PACP) and/or Manhole Assessment and Certification Program (MACP).
- E. Review all videos and data before they are submitted to the Construction Manager for compliance with the requirements of the Contract.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Furnish the television inspection studio, television camera, audio-visual digital encoding equipment/software, and other necessary equipment, materials, electricity, labor, technicians, as may be needed to perform the television inspection.

2.02 TELEVISION INSPECTION EQUIPMENT

- A. The television inspection equipment shall be able to inspect 1,000 feet minimum sewer line when entry into the sewer can be accessed from the upstream and downstream manholes. When entry is at one end only, the inspection equipment shall be able to inspect 750 feet by a self-propelled unit. The inspection equipment shall be able to clearly televise the interior of 6-inch and larger diameter sewers.
- B. Transport the television equipment in a stable condition through the sewer line to be inspected. Throughout the inspection, position the camera equipment with the camera directed along the sewer's longitudinal axis.

2.03 TELEVISION CAMERA

- A. Use a television camera specifically designed and constructed for sewer pipeline inspection.
 - 1. The camera shall be waterproof and able to operate in any conditions encountered in the inspection environment.
 - 2. Provide a color pan, tilt, and zoom camera to facilitate inspecting service laterals and sewer line to clearly view manhole defects and construction features.
 - 3. The television camera shall be capable of 360-degree rotational scan indicating salient defects.
 - 4. The tilt arc shall not be less than 225 degrees unless otherwise approved by the Construction Manager.
 - 5. The focus and iris adjustment shall provide a minimum 3-inch focal range in front of the camera's lens.
- B. The distance along the sewer in focus from the initial observation point shall be a minimum of twice the sewer's vertical height.
- C. The illumination shall allow an even light shadowing distribution.
 - 1. The view seen by the television camera shall be transmitted to an 11-inch or larger color monitor.
 - 2. The television camera shall be able to receive and transmit a picture having not less than a 352(x) by 240(y) resolution.
 - 3. The television inspection camera travel speed through the sewer shall be uniform and shall not exceed 30 feet per minute maximum speed.
- D. The television inspection equipment shall be a quality to achieve the following:
 - 1. The CCTV monitor display shall incorporate an automatically updated record in feet and tenths of a foot for the distance along the line from the cable calibration point to the camera's or transducer's center point, whichever unit is being used.
 - 2. The relative positions for the two center points should also be noted.
 - 3. Use a metering device that enables the cable length to be accurately measured; this shall be accurate to 6-inches.
 - 4. Demonstrate the tolerance is being achieved by tape measurement between manholes on the surface. This taped measurement must be included on each written and digital television log.
 - 5. The CCTV camera shall be calibrated for accurate length measurements at least once per week with above ground markings every 25 feet for up to 100 feet. The accuracy should be within 0.2 foot for every 100 feet.
 - 6. If the Contractor fails to meet the required accuracy standard, the Construction Manager will instruct the Contractor to provide a new device to measure the footage. The

Construction Manager may instruct the Contractor to resurvey those sewer lengths first inspected with the original measuring device using the new measuring device.

7. Audio-visual recordings and collected data made during the television inspection shall become MWS property. Submit the digital data in MWS software format to the Construction Manager within two weeks from completing the television inspection. MWS will provide project database data to contractor through Construction Manager. Contractor must use project database data to capture CCTV data. No on the fly inspections will be allowed unless approved by Construction Manager.

2.04 TELEVISION STUDIO

- A. The television studio shall be large enough to accommodate four people for viewing the television monitor while the inspection is in progress.
- B. The television studio shall be insulated against noise and temperature extremes and shall have the means to control external and internal light sources to ensure the monitor screen display is in accordance with this Section's requirements.
- C. The Construction Manager shall have access at all times to view the television screen.

PART 3 - EXECUTION

3.01 WASTEWATER FLOW DIVERSION

- A. Sewer Flow Control is presented in Section 33 01 48.

3.02 TELEVISION INSPECTION

- A. Inspect sewer pipelines with pan, tilt and zoom conventional television imagery to record relevant pipeline features and defects. Pipeline inspection shall be carried out in a format reviewed by the Construction Manager. Perform cleaning in accordance with contract document requirements.
- B. CCTV operators shall be NASSCO PACP certified and have a current certification. Prior to beginning work, submit NASSCO's PACP certification for all CCTV operators performing this work on the project. Contractor shall not commence work until such certification is provided.
- C. The Contractor shall provide an external 1 TB portable external hard drive to the Construction Manager in order for the Construction Manager to obtain the MWS project database. The Construction Manager will transmit the hard drive with the MWS database back to the Contractor. The Contractor will add the post-rehabilitation CCTV data and transmit it back to the Construction Manager for the post-rehabilitation CCTV data download into the MWS GIS system of MWS for records and use.
- D. If television inspection for an entire section cannot be successfully performed from one manhole, perform a reverse setup to obtain a complete television inspection.
- E. Perform sewer televising work as necessary, using NASSCO PACP coding to thoroughly document the condition for all sewers, service lateral connections, manhole corbel, barrel, and cone-sections in the study area. To achieve this, the CCTV camera operator shall stop the camera in each manhole invert and shall pan and zoom up the manhole to obtain the best possible image of the manhole, including the cone and corbel section(s).

- F. The quality and coding for all work specified in this Section shall meet or exceed the National Association of Sewer Service Companies (NASSCO) Recommended Specifications for Sewer Collection System Rehabilitation (latest edition) requirements. Applicable Section portions which inadvertently fall below those standards shall be corrected and maintained at the NASSCO standards as a minimum requirement, at no additional cost to MWS.
- G. Document all internal sewer and service lateral inspections via digital video recordings, television logs, digital photos, and a database compatible with the NASSCO PACP coded, CUES's GraniteNet in the most current MWS version, exchange database version 4.6.1 with a Hansen interface or newer, if applicable.
1. If the video is poor quality due to the chosen media, Metro reserves the right to require re-submittal on a different media.
 2. Create separate MPEG 4 H264 files for each sewer line segment.
 3. In a reverse setup, store such inspection in a separate MPEG 4 H264 file.
 4. MPEG 4 H264 files shall be written to an external hard drive for delivery to the Construction Manager.
 5. Each hard drive shall be labeled, at a minimum, with the following information: Metro Water Services, MWS project name, MWS project number, CWNOAP project number, creation date, Prime Contractor's firm name, and TV inspection contractor's firm name.
- H. Digital video shall be defined as ISO-MPEG Level 4 (MPEG 4) --coding with a 352-pixel (x) by 240-pixel (y) (minimum) resolution and a 30 frames per second encoded frame rate.
1. The digital recording shall include audio and video information which accurately reproduces the original video inspection picture and sound.
 2. The digital recording's video portion shall be free from electrical interference and shall produce a clear and stable image.
 3. The audio portion shall produce a clear and discernible oral report, sufficiently free from background and electrical noise.
- I. Separate digital video recordings shall be made for each sewer section and shall be properly identified via continuous on-screen display and voice-over recording with the following:
1. MWS Project number
 2. Upstream MH ID and downstream MH ID
 3. Sewer segment being inspected
 4. Inspection date
 5. Project name
 6. Distance along the reach from the entering manhole
- J. Contractor shall coordinate with Construction Manager prior to commencing work to ensure identification is accomplished in a manner acceptable to MWS. If the video and/or audio recording is poor quality, the Metro has the right to require a re-submittal of the affected sewer

sections. No payment will be made until an acceptable video and audio recording is made and submitted to and accepted by the Construction Manager.

- K. Inspection software to be used shall be CUES's GraniteNet in the most current MWS version, unless otherwise approved by the Construction Manager.
- L. The CCTV equipment/software shall be able to produce digitized images for all sewer line defects, manhole defects, and sewer line service connections in .jpeg format. Plan to take digital still images of each defect, construction features, and service connection to clearly depict it. More images may be necessary depending on the lined pipe condition.
- M. Provide CCTV inspection data via external hard drive. Data shall be recorded and provided in a current version of the NASSCO PACP Exchange format. The data shall specifically include video indexing for all observations. Data to be submitted shall include:
 - 1. NASSCO PACP exchange database file
 - 2. .jpeg files (still photos)
 - 3. MPG 4 H264 files format -(video) for each pipe segment
- N. Provide a complete television inspection for the upstream and downstream manholes. The CCTV operator shall pan and zoom up the manhole from the invert for each manhole and obtain the best possible image of the manhole, including cone and corbel sections. In addition, 3 still digital photos shall be taken for each pipe connection within each manhole. The CCTV operator shall zoom in on each pipe connection so the photos capture each pipe connection's size, location, and approximate elevation.
- O. Whenever prevailing conditions allow, position the camera head to reduce the risk of picture distortion. In circular sewers, position the camera lens centrally (i.e., in prime position) within the sewer. In noncircular sewers, picture orientation shall be taken at mid-height, unless otherwise agreed, and centered horizontally. Direct the camera lens along the sewer's longitudinal axis when in prime position. A +/- 10 percent positioning tolerance of the vertical sewer dimension shall be allowed when the camera is in prime position.
- P. Perform television inspections during low flow conditions. The Construction Manager will reject any television inspection that does not produce an effective sewer pipe survey due to flow conditions or for any other reason. Sewer flow shall be controlled so that the invert of rehabilitated pipe is fully visible.
- Q. Do not pull a cleaning device in front of the television inspection camera while taping the sewer line.

3.03 DIGITAL AUDIO/VISUAL RECORDING

- A. Take continuous digital video recordings of the inspection view as it appears on the television monitor. A digital video recording shall be made for the complete television inspection of the sewer lines constructed as part of this project. The recording shall also be used as a permanent record for defects. The recording shall be MPG 4 H264 file format. The digital video encoding shall include sound and video information that can be reproduced with a video image equal or very close to the original picture quality on the television monitor. The recorded video information replay, when reviewed by Windows Media Player™, shall be free from electrical interference and shall produce a clear, stable image. The composite digital coding's audio portion shall be sufficiently free from electrical interference/background noise to produce an oral report that is clear and completely and easily discernible.

- B. The inspection report's audio portion shall include the section's location or identification, the manhole-to-manhole travel direction, and the distance traveled on the specific run encountered. The inspection camera equipment shall be on the specific run encountered. Continuously connect the inspection camera equipment to the television inspection or monitoring equipment. The recording and monitoring equipment shall have the built-in capability to allow the Construction Manager to instantly review the recording's audio and video quality during the television survey. Playback speed shall be continuously adjustable from 1/3 normal speed for slow-motion viewing to normal playback speed.
- C. Name the MPG 4 H264 files according to the following file specification: Upstream Manhole Number_Downstream Manhole Number_Month_Day_Year.mpg
- D. One final video record shall be submitted for each rehabilitated line segment.

3.04 TELEVISION INSPECTION REPORTS

- A. Prepare a television inspection report covering the television inspection work and the information acquired. Prior to beginning work, submit a sample hardcopy television inspection report to the Construction Manager for review.
- B. Report sewer defects in accordance with the National Association of Sewer Service Companies (NASSCO) program known as Pipeline Assessment and Certification Program (PACP). The Construction Manager reserves the right to refuse any inspection report that does not comply with the PACP program.

3.05 QUALITY CONTROL

- A. Operate a quality control system that will effectively gauge the accuracy of inspection reports produced by the operator.
- B. The Construction Manager shall be entitled to audit the control system and be present when sewer integrity assessments are being determined for rehabilitated or upgraded pipe. When requested, provide sufficient details and information for such audit assessment. Should any report fail to achieve a margin the Construction Manager deems satisfactory, the Contractor, without any additional compensation, shall recode and resubmit any data or reports.

3.06 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 01 40

CURED-IN-PLACE PIPE LINING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section includes furnishing all labor, materials, equipment, and incidentals required to install and test the cured-in-place pipe (CIPP) lining and appurtenances complete as shown on the Drawings or as directed by the Construction Manager including, but not limited to, all services necessary as specified herein for the following:
1. Traffic control
 2. Bypass pumping and/or diverting sewage flows
 3. Cleaning and television inspection of sewers to be lined
 4. Lining installation
 5. Reinstatement and reconnection of service connections
 6. Quality control
 7. Samples for performing required material tests
 8. Final television inspection
 9. Testing the lined pipe system
 10. Warranty work
- B. Sewer cleaning, pre-rehabilitation closed-circuit television (CCTV) inspection, and post-rehabilitation CCTV inspection are required for all pipes to be rehabilitated by CIPP lining methods.
- C. The Contractor shall remove all pipeline obstructions and protruding service connections as required to complete the CIPP rehabilitation.
- D. Neither the CIPP system, nor its installation shall cause adverse effects to any Metro processes or facilities. Product use shall not result in forming or producing any detrimental compounds or by-products in the system or at the wastewater treatment plant. The Contractor shall notify the Construction Manager and identify any by-products produced due to the installation operations and shall test and monitor the levels and comply with any and all local waste discharge requirements.
- E. The Contractor shall cleanup, restore existing surface conditions and structures, and repair any CIPP system determined to be defective. The Contractor shall conduct installation operations and schedule cleanup in a manner to cause the least possible obstruction and inconvenience to traffic, pedestrians, businesses, and property owners or tenants.

1.02 RELATED WORK

- A. Maintaining flow in existing sewers is included in Section 33 01 48.
- B. Pre-CCTV and post-CCTV inspections are included in Section 33 01 51 and Section 33 01 30, respectively.
- C. Sewer line cleaning is included in Section 33 35 20.

1.03 SUBMITTALS

- A. Submit product data, design calculations, installation details, and shop drawings to the Construction Manager in accordance with Section 01 33 00. The Contractor shall provide this information without delay or claim to any confidentiality. Submittals shall include the following:
 - 1. CIPP lining supplier's name and a materials list
 - 2. CIPP lining schedules including field-verified lengths and diameters for all CIPP linings and appurtenances required. Plans should include map(s) showing insertion points for all CIPP installations for pipes 18 inches in diameter and larger.
 - 3. Shop drawings and product data to demonstrate compliance with these specifications and identify construction materials including resins, catalysts, felt, etc., felt manufacturer and facility location, wet-out facility location, etc.
 - 4. Manufacturers' shipping, storage, and handling recommendations for all CIPP system components
 - 5. MSDS sheets for all materials to be furnished for the project
 - 6. Detailed installation procedures including CIPP lining production schedule, acceptable inversion heads and pressures, inversion procedures, curing and cool-down procedures and temperatures, and times for each process stage
 - 7. Prior to each CIPP lining shipment, certified test reports showing the CIPP lining for this Contract was manufactured and tested in accordance with all ASTM Standards specified and referenced herein.
 - 8. An odor control plan that ensures project specific odors will be minimized at the project site and surrounding area. The plan shall address the monitoring of ambient odors such as styrene concentrations, the creation and distribution/availability of public information materials, preventative measures, and methods and means of responses to issues that arise. The plan shall include the furnishing of an on-site, functioning calibrated metering capability to the nearest 0.1 ppm in the event of styrene odor complaints or when requested by the Construction Manager.
 - 9. A detailed public notification plan shall be prepared and submitted including detailed staged notification to residences affected by the CIPP installation. Standard CWNOAP templates for door hangers and excavation notices shall be provided by the Construction Manager.
 - 10. Pre-rehabilitation CCTV main-line and lateral launch inspection data as further defined herein.

11. A complete description for the proposed wet-out procedure for the proposed technology. Wet-outs “over-the-hole” for large CIPP diameters/lengths shall be identified for the segment(s) and include full details of the procedure including environmental conditions control, resin temperature control, quality assurance procedures, etc.
12. Wet-out forms with detailed information including, but not limited to resin volumes and/or weights, CIPP liner length, roller gap settings, start times, finish times, gel times, resin injection locations, and any other pertinent data documenting the wet-out for each CIPP liner section manufactured.
13. Design data and specification data sheets listing all parameters used in the CIPP liner design and thickness calculations based on ASTM F1216. All calculations shall be prepared under and stamped by a Tennessee registered professional engineer.
14. A list with all service laterals abandoned or reconnected as part of the work as further defined herein
15. Manufacturer’s recommended cure method for each CIPP liner diameter and thickness to be installed including detailed curing procedures describing the curing medium and the application method
16. CIPP lining curing reports documenting the liner installation for all sewer segments. The CIPP lining reports shall document all lining installation details including manhole numbers, street names/sewer location, project number, date, time, temperature, curing temperature, curing time, CIPP liner thickness, etc. A sample report shall be submitted to the Construction Manager for approval prior to installing any CIPP lining.
17. Post-rehabilitation CCTV mainline and trenchless lateral launch inspection data as further defined herein.
18. Ten reports from projects within the past 2 years from independent testing laboratory for liner materials analysis showing the elasticity modulus as determined by appropriate ASTM standard and flexural stress as determined by appropriate ASTM standard. The lining must be the same resin system and felt tube materials as proposed for this project.
19. Installed liner(s) samples for testing to be performed by an ASTM-certified independent testing laboratory, as described further herein
20. Data on the maximum allowable stresses and elongation of the tube during installation and the means the Contractor will use to monitor stress and elongation
21. A detailed summary about the proposed quality controls to be performed by the Contractor including:
 - a. Proposed procedures for quality control
 - b. Product sampling and testing method and frequency for product sampling and testing in raw material form and cured product form
 - c. Inspection forms and guidelines for quality control inspections

- B. Submit the name and experience for lead personnel including verifiable references, as described in the Qualifications subsection below.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D543 – Standard and Practice for Evaluating the Resistance of Plastics to Chemical Reagents
2. ASTM D638 – Standard Test Method for Tensile Properties of Plastics
3. ASTM D790 – Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
4. ASTM D792 – Standard Test Methods for Density and Specific Gravity of Plastics by Displacement
5. ASTM D2412 – Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
6. ASTM F1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
7. ASTM F1743 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)
8. ASTM D638 – Standard Test Method for Tensile Properties of Plastics
9. ASTM D5813 – Standard Specification for Cured-in-Place Thermosetting Resin Sewer Piping Systems
10. ASTM D2990 – Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics

B. National Association of Sewer Service Companies (NASSCO)

1. Recommended Specifications for Sewer Collection System Rehabilitation

C. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

1.05 EXPERIENCE AND CERTIFICATIONS

A. The Contractor performing the CIPP lining work shall be experienced and equipped to complete this work expeditiously and in a satisfactory manner and shall be certified and/or licensed as an installer by the CIPP lining manufacturer.

B. The lead personnel including the supervisor, the foreman, and the lead crew personnel for the CCTV inspection, factory and “over-the-hole” resin wet-out, the CIPP lining installation, lining curing and the robotic service reconnections each must have a 3-year and/or 250,000 feet minimum total continuous experience with the CIPP technology proposed for this Contract and must have demonstrated competency and experience to perform the scope of work contained in this Contract.

1.06 GUARANTEE

- A. All placed CIPP linings shall be guaranteed by the Contractor and manufacturer for a 3-year period from the final acceptance date. During this period, the Contractor shall remove and replace any and all serious defects discovered in the CIPP lining, as determined by Metro, which may materially affect the pipe's integrity, strength, function, and/or operation in a satisfactory manner to Metro at no cost to Metro. Defects replaced during this 3-year period shall be fully warranted by the Contractor and manufacturer for a period of two years from date the defect was repaired. At Metro's own expense, Metro may conduct an independent CCTV inspection of the CIPP lining work prior to completing the guarantee period.
- B. CIPP tube manufacturer shall warrant the tube and resin materials to be free from any defects for a 10-year minimum from the manufacture date.

1.07 QUALITY ASSURANCE

- A. All CIPP linings shall be from a single manufacturer. The suppliers shall be responsible for providing all test requirements specified herein as applicable. In addition, all CIPP linings to be installed under this Contract may be inspected at the plant for compliance with these specifications by an independent testing laboratory provided by Metro or Construction Manager. The Contractor shall require the manufacturer's cooperation with these inspections. The cost for CIPP lining plant inspection approved for this Contract will be MWS or the Construction Manager's responsibility.
- B. The Construction Manager or Metro may inspect CIPP lining after delivery. The CIPP lining shall be subject to rejection at any time if it fails to meet any requirements specified, even though sample CIPP lining may have been accepted as satisfactory at the manufacturer. CIPP lining rejected after delivery shall be marked for identification and removed from the job site.
- C. In the event that an installation is rejected based on a review of the post-rehabilitation CCTV inspection data, the Contractor shall repair the sewer segment to the satisfaction of Metro at no additional cost to Metro.

1.08 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in shipping, handling, and laying to avoid damaging the CIPP liner. Any CIPP liner damaged in shipment shall be replaced as directed by the Construction Manager.
- B. Any CIPP lining showing a split or tear or which has received a blow that may have caused damage, even though no such damage can be seen, shall be marked as rejected and removed at once from the work.
- C. While stored, CIPP shall be adequately supported and protected in the manner recommended by the manufacturer.
- D. The CIPP lining shall be maintained at a proper temperature in refrigerated facilities at all times prior to installation to prevent premature curing. The CIPP lining shall be protected from UV light. Any CIPP lining showing evidence of premature curing shall be rejected for use and immediately removed from the site.

1.09 WATER

- A. Water for all construction operations shall be available from identified Metro fire hydrants at normal commercial rates. Water usage shall be in accordance with Metro backflow and metering policies.

1.10 AVAILABLE SEWER VIDEOS

- A. The existing sewer lines scheduled for rehabilitation were inspected to the degree possible for pipe conditions by a cleaning and CCTV services contractor for Metro. Electronic files with the video inspections only of the main and connection area will be provided to the Contractor FOR INFORMATION ONLY.

1.11 SEWER CHECK VALVES

- A. If the existing sewer service includes a check valve, then that check valve should remain in place or be replaced with a new check valve during construction.
- B. Removal of an existing check valve shall only occur for the hours of explicit construction for service lateral lining or replacement.
- C. Notify the Construction Manager immediately of the presence of a service line check valve and maintain the sewage backup prevention aspect of the valve.

PART 2 - PRODUCTS

2.01 CIPP FELT LINER AND RESIN

- A. CIPP lining shall be Inliner CIPP by Inliner Solutions, LLC; Insituform by Insituform Technologies, Inc.; MooreLiner by Moore Construction Co.; Pipenology Liner by SAK Construction, LLC; CIPP Corporation liner by American Infrastructures Technologies; or pre-bid approved equal.
- B. The CIPP liner shall have tubing material with one or more layers of a flexible non-woven polyester felt with or without additives such as woven fiberglass or other fibers and shall meet ASTM F1216, ASTM F1743, ASTM D5813, and ASTM D2990 requirements. The CIPP liner's felt content shall be determined by the Contractor, but shall not exceed 15 percent of the total impregnated liner volume. The fabric tube shall be able to absorb and carry resins, be constructed to withstand installation pressures and curing temperatures, and have sufficient strength to bridge missing pipe segments and stretch to fit irregular pipe sections.
- C. The CIPP liner tube may be single or multiple layer construction with any layer not less than 1.5 mm thick. The wet-out fabric tube shall have a uniform thickness and excess resin distribution which, when compressed at installation pressures, will meet or exceed the design thickness after cure.
- D. Prior to being inverted, the tube's outside layer shall be coated with an impermeable material compatible with the resin and fabric.
- E. The manufactured tube's exterior shall have distance markings along its length at regular intervals not to exceed 5 feet. Use these marks as a gauge to measure elongation during insertion. Should a reach's overall elongation exceed 5 percent, the liner tube shall be rejected and replaced.
- F. The tube shall be homogenous across the entire wall thickness, containing no intermediate or encapsulated layers. No material shall be included in the tube that may cause delamination in the cured CIPP. No dry or unsaturated layers shown by the color contrast between the felt fabric and the activated resin containing a colorant shall be visible upon inspection.

- G. Seams in the tube shall be stronger than the non-seamed felt material and shall meet the requirements of ASTM D5813.
- H. The CIPP's interior wall color after installation shall be a relatively light reflective color so that a clear detailed examination with CCTV equipment may be made. The hue of the color shall be dark enough to distinguish between fully resin saturated felt fabric and dry or resin lean areas.
- I. Resin: The resin shall be a corrosion resistant polyester or vinyl ester resin and catalyst system or epoxy and hardener system that, when properly cured within the tube composite, meets the requirements of ASTM F1216, ASTM F1743 or ASTM F2019, the physical properties herein, and those which are to be utilized in the design of CIPP for this project. Resin shall produce CIPP which will comply with or exceed structural and chemical resistance requirements. Liner material and resin shall be completely compatible. Generally, resin shall not contain fillers, except those required for viscosity control, fire retardance, or increased strength, or with applications for which inert fillers would facilitate better heat transfer and retention during installation. The liner contractor may add up to 5 percent by mass of a thixotropic agent for viscosity control, which will not interfere with visual inspection.
- J. The felt tubing shall be vacuum impregnated with a thermosetting polyester resin and catalyst; vinyl ester resin and catalyst; or epoxy resin, inhibitors and hardener.
- K. The resins may contain pigments, dyes, or colorants which shall not interfere with visually inspecting cured lining. The resin quantity used for tube impregnation shall be sufficient to fill the volume of air voids in the tube with additional allowances for polymerization shrinkage and the resin loss through cracks and irregularities in the original pipe wall. Use a serial vacuum impregnation process (or equal) to provide maximum resin impregnation throughout the tube.
- L. The Contractor shall identify the wet-out facility where all CIPP linings under this Contract will be manufactured. All CIPP linings shall be manufactured from this designated wet-out facility throughout the entire Contract, unless specifically approved otherwise in writing by the Construction Manager. Multiple wet-out facilities shall not be allowed except where identified and approved for "over-the-hole" on-site wet-out facilities for large diameter CIPP.
- M. Metro or its representatives may inspect the CIPP lining during manufacturing and wet-out. The Metro and its representatives must be given an opportunity to witness the manufacturing for all CIPP linings for this project. If the Metro decides to inspect the CIPP lining manufacturing, the Contractor shall provide full access to witness the wet-out process and any and all information related to the manufacturing as requested without delay and without claims about confidentiality or product privacy. Metro is responsible for costs associated with witnessing the CIPP lining manufacturing.
- N. Applying resin to the felt tubing (wet-out) shall be conducted under factory or controlled on-site conditions using vacuum impregnation, and the materials shall be fully protected against UV light, excessive heat, and contamination at all times.
- O. Liners that are impregnated at the factory and transported to the project site in refrigerated trucks shall be installed as soon as possible and within no more than ten (10) days after the date of impregnation at the factory.
- P. When cured, the CIPP lining shall form a continuous, hard, impermeable lining which is chemically resistant to any chemicals normally found in domestic sewage per Table x2.1 in ASTM F1216. The CIPP lining shall be chemically resistant to trace amounts of gasoline and

other oil products commonly found in municipal sewerage and soils adjacent to the sewer pipe to be lined. The CIPP lining shall provide the maximum available abrasion resistance.

- Q. The Contractor shall measure the existing pipelines in the field prior to ordering lining. The CIPP lining's length shall be as deemed necessary by the Contractor to effectively carry out inserting and sealing the CIPP lining at the outlet and inlet manholes.
1. The CIPP lining tube shall be manufactured or fabricated to a size that will tightly fit the internal circumference of the sewer being rehabilitated after being installed and cured.
 2. The CIPP lining shall be able to fit into irregularly shaped pipe sections and through bends (up to 45 degrees) and dips within the pipeline.
 3. Allowance for longitudinal and circumferential expansion shall be taken into account when sizing and installing the CIPP lining.
 4. The tube shall be properly sized to the existing pipe's diameter and the length to be rehabilitated and be able to stretch to fit irregular pipe sections and negotiate bends.
 5. The Contractor shall verify the lengths in the field prior to ordering and prior to the impregnation of tube with resin to ensure that the tube will have sufficient length to extend entire length of the run, which is defined as the length of the existing host pipe measured from the interior walls of the manholes and/or from the ends of the pipe when/if the pipe extends into the manholes. The Contractor shall also measure the inside diameter and circumference of the existing pipelines at the face of each manhole in the field prior to ordering the liner so that liner can be installed in a tight-fitted condition with little or no wrinkling.
- R. The Contractor shall verify the proposed CIPP lining thicknesses and submit the associated calculations. The CIPP lining for 8-inch through 10-inch diameter host pipe shall be designed in accordance with the applicable ASTM F1216 provisions for "fully deteriorated gravity pipe conditions." The CIPP lining for other pipe sizes may be designed in accordance with the applicable ASTM F1216 provisions for "partially deteriorated gravity pipe conditions," unless it is noted on the Drawings that "fully deteriorated gravity pipe conditions" shall apply based on reviewing the CCTV video. For sewers where previous CCTV inspection data was not available, the Contractor should submit the completed inspection to determine if "partially deteriorated" or "fully deteriorated" apply. The CIPP lining shall meet the following minimum design conditions, unless Metro agrees to their change or as noted on the Drawings:
1. AASHTO H-20 Live Load with two trucks passing
 2. Constrained soil modulus of native soil in the pipe zone = 1,000 psi
 3. Soil weight with 120 pounds per cubic foot and a coefficient of friction of $Ku' = 0.130r$ shall be used for the installed depths.
 4. The long-term flexural modulus used in the design calculations shall be estimated by multiplying the lowest short-term flexural modulus specified in the ASTM standards by a long-term retention of mechanical properties factor equal to 50 percent.
 5. Design safety factor = 2.0
 6. Typical groundwater levels shall be estimated at 1/2 the distance between the pipe's invert and the ground surface. If actual groundwater depth information is available from USGS or other sources, it may be used in the calculations. If the sewer is within 50 feet

of a creek or other water body or if the pipe diameter is larger than 15-inches or if indicated on the Drawings, the groundwater depth used in the calculations should be the maximum depth from the ground surface to the pipe crown.

7. Service temperature range shall be 40 °F to 100 °F.
8. Maximum long-term deflection shall be 5 percent.
9. Minimum pipe ovality shall be 2 percent.
10. The CIPP lining thickness to be used shall be the largest thickness as determined by calculations for deflection, bending, buckling, and minimum stiffness.
11. The CIPP shall be designed to withstand all imposed loads including live loads and, if applicable, hydrostatic pressure. The liner shall have sufficient wall thickness to withstand all anticipated external pressures and loads that may be imposed after installation.
12. Submit to the Construction Manager for approval the structural design for other size sewers and depths or “fully deteriorated” gravity sewers when conditions apply.
13. The minimum lining thickness after installation and curing shall be as follows:

Minimum Lining Thickness Following Installation and Curing* ** ***			
Pipe Diameter (in)	Depth of Sewer to Top of Pipe (ft)	Fully Deteriorated Pipes Minimum Liner Thickness (mm)	Partially Deteriorated Pipes Minimum Liner Thickness (mm)
8-inch	3 to 20	6	N/A
10-inch	3 to 15	6	N/A
10-inch	15 to 20	7.5	N/A
12-inch	3 to 9	6	6
12-inch	9 to 17	7.5	6
12-inch	17 to 20	9	6
15-inch	3 to 9	7.5	6
15-inch	9 to 15	9	6
15-inch	15 to 20	10.5	7.5
18-inch	3 to 8	9	6
18-inch	10 to 14	10.5	7.5
18-inch	14 to 18	12	7.5
18-inch	18 to 20	12	9
21-inch	0-10	12	9
21-inch	10-15	15	12
21-inch	15-20	16.5	12.5

*Chart assumes normal groundwater condition (1/2 distance between pipe invert and ground surface).
 **Contractor shall submit calculations for liner thickness in alternate pipe sizes, depths not listed, or if sewer is within 50 feet of a creek or body of water.
 ***8-inch and 10-inch diameter pipes are always assumed to be Fully Deteriorated.

- S. The CIPP lining shall be watertight.

- T. The CIPP lining shall provide a 50-year service life and shall have the following minimum initial and long-term properties:

Property	Test Method	Initial (psi)	Long-term (psi)
Flexural Strength	ASTM D790	4,500	2,250
Flexural Modulus of Elasticity	ASTM D790	300,000	150,000

- U. Enhanced strength polyester resins may be used for sewers larger than 18 inches in diameter to reduce wall thickness. Submit to Construction Manager for specific approval.
- V. Enhanced strength resins and composite CIPP systems may be used for sewers greater than 33 inches in diameter to reduce wall thickness and be more cost-effective. These systems must be submitted to Purchasing for pre-bid concept approval and to the Construction Manager for specific approval.

2.02 END SEALS

- A. End seals shall be composed of hydrophilic rubber and molded or formed as a one-piece cylinder which, when installed, will form a 360 degree seal between the host pipe and the newly installed liner. Use of caulking in lieu of an end seal will not be allowed. Acceptable end seals are Insignia™ End Seals by LMK Enterprises, Hydrotite by Greenstreak, or approved equal.

PART 3 - EXECUTION

3.01 PRE-INSTALLATION

- A. The Contractor shall notify all property owners who discharge sewage directly to the sewer being lined that their service will be temporarily discontinued during the CIPP lining installation. The Contractor shall notify individual property owners at least 72 hours in advance, giving the date, start time, and estimated completion time for the work being conducted. The notification method and the text included in the notification shall be approved by Metro and use standard CWNOAP templates for notifications.
- B. The Contractor shall clean each pipe length to be lined and shall dispose of any resulting material offsite as specified in Section 33 35 20.
- C. The Contractor shall conduct a pre-rehabilitation CCTV inspection including lateral launches of services for all sewers to be rehabilitated by CIPP lining methods in accordance with Section 33 01 51. The inspection shall be to verify the segment for rehabilitation, identify pipe defects, to document all service lateral connection locations, and to confirm additional needed point repair locations other than those indicated on the Drawings. The Contractor's project manager and/or superintendent shall review the pre-rehabilitation inspection videos to confirm the quality of the videos, locations of lateral connections, and locations of point repairs to be performed. Only after the contractor has confirmed that the quality of the videos is adequate for a clear review of the pipeline, shall they be submitted to Metro. The Construction Manager will review pre-rehabilitation inspection videos to verify the segment for rehabilitation, determine the method of service lateral renewal by replacement or trenchless lining, and confirm point repair locations to be performed by the Contractor. The Contractor may not proceed with CIPP lining installation until the Construction Manager has reviewed and approved the Contractor's pre-rehabilitation CCTV inspection data. A minimum of 5 working days shall be provided to review each pre-rehabilitation CCTV and

lateral inspection data submittal. If the contractor submits CCTV and lateral data in groups of 25 or more segments, the review time for data will be a maximum of 10 working days.

- D. The Drawings may provide the Contractor the location for known laterals; however, this list shall not be interpreted as all-inclusive. The Contractor shall be responsible for verifying active customer service connections prior to rehabilitation. If the Contractor discovers an error or addition to the list provided, the Contractor shall immediately notify the Construction Manager. Upon completing the rehabilitation work, a list with all service laterals abandoned or reconnected as part of the work shall be submitted to the Construction Manager. The compiled list shall include the following information:
1. Location for each service lateral based on the CCTV inspection logs, which shall include an accurate distance measured from the starting manhole centerline and a notation (by clock-reference) stating where on the pipe circumference the service lateral connects.
 2. Status (Active or Inactive)
 3. The address for each customer and associated active lateral location
- E. During the pre-rehabilitation CCTV inspection and prior to installing the CIPP lining, all protruding service lateral connections greater than or equal to ½ inch for less than 18-inch diameter pipe and ¾ inch for 18-inch and larger diameter pipe shall be internally cut or ground down flush with the pipe wall using a robotic cutter specifically designed for this purpose. The internal cutter shall be able to cut cast iron, PVC, vitrified clay pipe, concrete pipe, ductile iron pipe, and Orangeburg pipe. All materials/cuttings shall be removed from the sewer and properly disposed.
- F. The Contractor shall provide sewage flow bypass pumping in accordance with Section 33 01 48. Service connection effluent may be plugged only after proper notification to the affected residence and may not remain plugged overnight or longer than 10 hours without the Construction Manager's approval of alternate measures. Lining installation shall not begin until the Contractor has installed the required plugs or a sewage by-pass system and until all pumping facilities have been installed and tested under full operating conditions including bypassing mainline, side sewer flows, and services addressed. Once the lining process has begun, existing sewage flows shall be maintained until the resin/felt tube composite has been fully cured, cooled down, fully televised, and the CIPP ends finished.
- G. The Contractor shall furnish and install the CIPP lining in the sewer's full length as shown on the Drawings. The CIPP lining installation shall be in complete accordance with applicable ASTM F1216 provisions and the manufacturer's recommendations.
- H. If the CIPP lining manufacturer believes the infiltration rate in the sewer segment is high enough to risk washing out the resin, the Contractor shall perform required measures to minimize infiltration prior to installation. If any infiltration runners or gushers as defined by NASSCO PACP are observed during the pre-CCTV inspection, the Contractor shall submit in writing for approval by the Construction Manager the methods and materials for mitigating any adverse impacts from the infiltration. Infiltration runners or gushers that are observed may be stopped by injecting a chemical hydrophilic grouting using a remote packer as an acceptable and preferred method or short cured-in-place internal repairs. If the pipe is larger than 33 inches in diameter, man-entry with hand-applied epoxy application can be performed to stop the infiltration.
- I. The Contractor shall evaluate CIPP liner installations for the potential of adverse odor issues such as from styrene and implement measures including, but not limited to, supplemental ventilation, service plugging, and monitoring in accordance with the *Odor Control Plan* and

pertinent state and federal rules and regulations. The evaluations shall include issues that may occur from long duration installations, extended curing times, close proximity to buildings, and/or resident's sensitivities, impairments, or known health conditions relative to respiratory issues.

- J. Throughout the construction and installation, the Construction Manager may elect to conduct independent odor monitorings, such as styrene concentration readings. The Contractor shall cooperate with the Construction Manager and the Construction Manager's representatives and allow full access to the project lining site and equipment.

3.02 INSTALLATION

- A. The CIPP lining for 6-inch through 18-inch diameter sewers without sags greater than 30% may be installed via inversion using hydrostatic head or air pressure or pull-in methods in accordance with ASTM F1216 and manufacturer's recommendations.
- B. The CIPP lining for greater than 18-inch diameter sewers or with sags greater than 30% shall be installed via inversion using hydrostatic head in accordance with ASTM F1216 and manufacturer's recommendations.
- C. The Contractor shall install a hydrophilic seal at each manhole face prior to inverting or pulling in the uncured CIPP lining.
- D. If the CIPP lining does not fit tightly against the original pipe at its termination points, at no additional cost to Metro, the full circumference of the CIPP lining exiting the host pipe shall be filled with a resin mixture compatible with the CIPP and approved by the CIPP manufacturer. There shall be no groundwater leakage between the existing pipe and the CIPP lining at the manhole connection or service lateral connections. Any leakage found shall be eliminated by the Contractor at no additional cost to Metro.
- E. The installed CIPP lining shall be cured using circulating heated water or steam in accordance with ASTM F1216 and manufacturer's recommendations for sewers 18 inches in diameter and smaller with temperature monitoring at manholes and service openings if available. For sewers larger than 18 inches in diameter, the installed CIPP lining shall only be cured using circulating heated water in accordance with ASTM F1216 and manufacturer's recommendations.
- F. The resin-impregnated flexible felt tube lining shall be processed to affect the desired cure throughout the tube's length, extending full length from manhole to manhole(s). The resin shall be cured into a hard impermeable pipe of the minimum specified thickness, providing a structurally sound, uniformly smooth interior and tight-fitting lining within the existing pipe.
- G. Cool-down procedures shall be in accordance with ASTM F1216 and manufacturer's recommendations.
- H. UV cured CIPP will not be permitted without written approval from Metro and after reviewing the documentation to ensure the lining is compatible with all specifications and other related work including any lateral lining systems.
- I. The Contractor may install CIPP lining in multiple sewer segments at one time where possible. When installing CIPP lining in multiple sewer segments at one time, remove the top 1/2 of the CIPP lining in the intermediate manhole and fill the void between the CIPP lining and existing channel with non-shrink grout. The manhole bench shall be reconstructed as required to provide a smooth transition to the new CIPP lining.

- J. Temperature monitoring systems shall be required for all 18-inch or larger diameter sewers, any sized sewer that crosses a stream, creek, or other body of water, or as noted on the Drawings. This system shall be installed at the pipe invert per the manufacturer's recommended procedures. The temperature sensors shall be placed at intervals as recommended by the sensor manufacturer. Additional sensors shall be placed where significant heat sinks are likely or anticipated. The sensors, if installed, shall be monitored by a computer using a tamper proof database which can record temperatures at the lining interface and the host pipe. The Contractor shall provide the Construction Manager with access to the longitudinal temperature monitoring system data during the installation via digital data, web-based or other approved methodology, and printed reports. Temperature monitoring systems shall be Zia Systems or Vericure by Pipeline Renewal Technologies.
- K. If cool-down is to be accomplished by introducing cool water into an inversion standpipe to replace the water being drained from a small hole made in the downstream end, cool the hardened pipe to a temperature below 100 °F (38 °C) before relieving static head in the inversion standpipe. When releasing static head, ensure a vacuum will not be produced that could damage the newly installed CIPP lining.
- L. Vent and/or exhaust noxious fumes or odors generated during and remaining after the curing process has been completed. This process shall remain in place at all manholes, laterals, etc., until noxious odors have dissipated to an acceptable level in accordance with OSHA requirements for the materials used and there is no potential health hazard left to the general public or the construction workers.
- M. Identify and submit for approval to the Construction Manager the points to where curing water will be discharged if other than the downstream sanitary sewer system at acceptable discharge rates. NO discharge to storm sewers or drainage systems shall be allowed.
- N. Provide piping, pumps, valves, and other equipment to discharge curing water.
- O. All cutting and sealing of CIPP liner at manhole connections and/or walls shall provide watertight pipe and manhole seals. All cut edges of cured liner shall be thoroughly sealed with the same resin used in the liner. If a catalyst or hardener is used, it shall be compatible with the resin/catalyst used in liner previously. However, it shall not require an external heat source to begin exothermic reaction (curing). There shall be no leakage of groundwater into the manhole between the CIPP liner and the existing sewer pipe or between the existing sewer pipe and the manhole wall.
- P. The installed CIPP lining shall be continuous over the sewer line section's entire length and be free from visual defects such as foreign inclusions, dry spots, pinholes, fins, major wrinkles, and delamination. The lined invert and lower third of the pipe in normal wastewater flow depth shall be of particular concern to defect avoidance. The CIPP lining shall be impervious and free from any pipe leakage to the surrounding ground or from the ground to inside the lined pipe.

3.03 REINSTATING SERVICES

- A. After the new CIPP lining has been cured and completely cooled down, the Contractor shall reconnect the existing active service laterals as designated by the pre-installation CCTV report generated by the Contractor. This shall be done without excavation from the pipeline's interior using a television camera and a remote cutting device that reestablishes the service connection to not less than 90 percent of the original diameter. All connections between the CIPP lining and the service connection shall be watertight. All openings shall be clean and neatly cut, and the cut shall be buffed with a wire brush to remove rough edges and provide a

smooth finish. The bottom of the openings shall be flush with the bottom of the lateral pipe with no protruding material able to hinder flow or catch debris.

- B. For service renewals by excavation methods, InsertaTees may be used for solid wall pipes having a 0.36-inch or greater wall thickness. InsertaTees shall be "Fatboy" type with hub manufactured of SDR 26 PVC material incorporating a 360-degree integral stop on the hub surface and exceeding ASTM F1336 Section 10.3 Pipe Stop Load Support Test, or approved equal. Romac type saddles shall be used for pipes having a wall thickness thinner than 0.36 inches. Other services will be renewed by trenchless lateral lining as specified in Section 33 01 88.
- C. Inactive service laterals will be abandoned by not reopening the service connection after installing the CIPP lining.
- D. Provide a fully operational backup device for reinstating service laterals. If for any reason the remote cutting device fails during a service lateral's reinstatement, immediately deploy the standby device to complete the reinstatement. The backup device shall be fully functional without needing to remove parts from the primary device. The backup equipment shall be on site throughout the reinstatement process.

3.04 FIELD TESTING AND ACCEPTANCE

- A. The Contractor shall perform a 4 psi air test on each CIPP lining segment in the Construction Manager's presence after curing the CIPP and prior to internally re-instating laterals on all 18-inch and smaller diameter sewers. The CIPP shall be able to hold a 4-psi pressure for a 5-minute minimum duration after a 2-minute stabilization period. Larger diameter sewers will be visually inspected only by CCTV for leaks during a period of high groundwater with a required outcome of no visible leaks. Any lining not able to meet this testing requirement shall be repaired and retested at no additional cost to Metro.
- B. Field acceptance for the CIPP lining shall be based on the Construction Manager's evaluation of the installation including reviewing the CIPP lining curing data, the post-rehabilitation CCTV inspection data, the certified test data for the installed CIPP lining, and CIPP air testing results. All CIPP sample testing and repairs to the installed CIPP as applicable shall be completed and documented in written form before final acceptance.
- C. For every 1,000 linear feet of CIPP lining installed, the Contractor shall perform sampling and testing to determine the installed CIPP lining's flexural properties and thickness. After 10,000 feet of acceptable test results have been received, Metro may reduce the test sample frequency to one sample every 2,000 feet from the same wet-out batch, as long as samples continue to meet all minimum standards and sampling results are received in a timely manner. The testing frequency may be increased by Metro and performed by the Contractor at no additional cost to Metro when the required tests show the installed CIPP lining does not meet the specifications.
- D. Tests shall be performed by an independent testing laboratory certified by the American Association for Laboratory Accreditation (A2LA). The Contractor shall submit to the Construction Manager the name and location for the independent testing laboratory, a certified statement from the laboratory indicating they are independent from and not associated with the Contractor in any way, and the ASTM certification for the independent testing laboratory.
- E. All expenses for sampling and testing the installed lining shall be paid by the Contractor. The cost for all manufacturers' testing to qualify products furnished to the project site shall be the Contractor's responsibility.

F. Sampling and testing for the installed CIPP lining shall conform to the following requirements.

1. Remove one restrained sample of the installed CIPP lining at least 18 inches in length. The sample shall be captured by installing the CIPP lining through a section of PVC or similar cylindrical tube (same diameter as the existing sewer diameter) within the installation's most downstream manhole and at all intermediate manholes if multiple sewer segments are lined at the same time. The Contractor may elect to cut the sample longitudinally and take 1/2 the sample for direct shipping to the laboratory and keep the other sample 1/2 for additional testing if necessary.
2. For sewers 18 inches in diameter and larger, a minimum of two plate samples formulated out of the same felt blend and resin mixture as the installed liner shall be prepared and cured in the downtube of the installation column.
3. The CIPP lining thickness shall be measured in accordance with ASTM D5813. Flexural properties shall be determined in accordance with ASTM D790. The Contractor shall label and date all samples for shipping to the independent testing laboratory. The Construction Manager shall be copied on all transmittals to the independent testing laboratory. Testing results shall be submitted to the Construction Manager within 30 days after installing the CIPP lining, or payment will be withheld.
4. Any CIPP lining not meeting the specified installed strength and/or thickness requirements, regardless of the amount below the specified requirements, shall not be approved for payment until the deficiency has been corrected by the Contractor in a manner approved by the Construction Manager at no additional cost to Metro. Options considered for correcting deficient CIPP lining installations include the following.
 - a. Remove the existing CIPP lining and re-line the sewer.
 - b. Provide open-cut sewer replacement from manhole to manhole.
 - c. Re-line the sewer with the existing CIPP lining in place. Note that this will not be accepted if Metro determines that the sewer section has capacity concerns.
 - d. Accept the following penalties depending on the structural and thickness test results.
 - 1) If the tests are within 90 percent of the specification, the payment reduction shall be 10 percent of the bid price per item.
 - 2) If the tests are between 75 percent and 89 percent of the specification, then 75 percent of the bid price shall be paid.
 - 3) If the tests are below 75 percent, the Contractor must reline or replace the segment.

G. The Contractor shall perform a post-rehabilitation CCTV inspection for all sewers rehabilitated using CIPP lining methods in accordance with Section 33 01 30. The post-rehabilitation CCTV inspection shall be performed following the CIPP lining installation and reinstating all active service laterals. The Contractor's project manager and/or superintendent shall review the post-rehabilitation inspection videos to confirm the quality of the videos and of the installed CIPP. Only after the Contractor has confirmed that the video is of good quality shall the videos be submitted to the Construction Manager. If it is determined that any repairs are needed at any segment, a new CCTV inspection of the entire segment(s) shall be performed after the repairs have been completed.

1. The Construction Manager shall review and approve payment based on the Contractor having satisfactorily completed a lining free from significant defects. The finished lining shall be continuous between manholes and shall be free from visual defects such as foreign inclusions, reverse curvatures, splits, flats, cracks, lifts, kinks, wrinkles, flats, dry spots, pinholes, shrinkage, crazing, leaks, and delamination. The maximum allowable size for wrinkle or bulge as shown in the inspection shall not exceed 3 percent of equivalent pipe diameter or 1 inch by visual measurement, whichever is smaller. No wrinkles will be allowed in the invert of the pipe between the 4:00 and 8:00 o'clock positions.
 - a. The Contractor will be responsible for removing and repairing, at Contractor's expense, all such defects in a manner that is satisfactory to the Construction Manager.
 - b. Shrinkage of the CIPP liner's length of more than one (1) inch for pipe diameters less than 18 inches and of more than two (2) inches for pipe diameters greater than or equal to 18 inches from the face of the manhole shall be repaired with a fiberglass reinforced CIPP spot repair at no cost to Metro.
- H. The cured CIPP lining and all pipe-to-manhole connections shall be watertight and free from infiltration.
- I. Following rehabilitation or replacement of the service laterals, the Contractor shall perform an air test in the Construction Manager's presence for each 18-inch and smaller diameter segment lined in accordance with Section 33 30 10, or may test each lateral and connection area individually in lieu of the full segment air test.

3.05 MEASUREMENT AND PAYMENT

A. Payment

1. Payment for CIPP lining shall be made at the contract unit price per linear foot for each size as stated in the Bid, complete in place in accordance with the Drawings and specifications. Payment will be based on the actual number of feet installed, as measured by the Construction Manager. The pipe will be measured horizontally on the surface from center-to-center of manholes to the nearest 0.1 foot.
2. The price paid per linear foot for pipe lining shall include full compensation for furnishing labor, materials, tools, equipment, and incidentals necessary to furnish, install, and test the CIPP lining plus traffic control, sewage bypassing, water control, service lateral reinstatement, manhole connections, cleaning, sewer cleaning materials disposal, final inspection, protecting existing utilities and adjacent property, and all required surface restoration work and traffic control, complete in place, as shown on the Drawings and specified herein.

3.06 CLEANUP

- A. Upon the installation work and testing acceptance, restore the project area affected by the operations to a condition at least equal to what existed prior to the work.

3.07 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 33 01 44

MANHOLE REHABILITATION AND LINING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Furnish all labor, materials, equipment, and incidentals required to rehabilitate manholes as noted on the Drawings or directed by the Construction Manager.
- B. Where noted in the Drawings or directed by the Construction Manager, rebuild invert and benching, reset or replace manhole frame and cover assemblies, and locate and/or raise manhole frame and cover assemblies.
- C. Install the monolithic cementitious epoxy, Polyurea or urethane resin, or composite manhole lining system and appurtenances as specified herein. The monolithic lining shall be used to rehabilitate the interior for all designated existing sewer manholes as shown on the Drawings or as directed by the Construction Manager.
- D. Accurately field measure and size each individual manhole. Each existing sewer manhole designated to receive the monolithic lining may have a different configuration and varying field dimensions. All field measurements shall conform to the monolithic lining manufacturer's requirements.
- E. The manhole lining shall not be installed until all main sewer lining and other manhole rehabilitation work is complete.
- F. Each manhole to be rehabilitated shall be thoroughly cleaned and then inspected for loose or missing bricks, loose mortar, holes, etc. All leaks shall be plugged prior to manhole lining.
- G. The presence or absence of leakage through manhole walls noted on the manhole inspection reports and as seen in the Contractor's independent manhole inspections prior to bidding or construction depend on the groundwater levels and conditions at the time of the inspections. High groundwater levels in the project area typically occur in the dormant season (December through May), but will vary with rainfall in any given year and sewer location. Be advised the groundwater currently entering the leaking sewer mains and laterals may migrate to the manholes after the sewer mains and laterals are rehabilitated or replaced. Reflect assumptions and judgments on leakage through manhole walls based on this information in the unit prices bid for lining manholes. All leakage shall be stopped prior to lining manholes. No additional payment will be made for repairing leaks not visible prior to bidding or sewer rehabilitation.
- H. Maintain sewer flows and/or perform diversion pumping as specified in Section 33 01 48.

1.02 RELATED WORK

- A. Sewer line cleaning is included in Section 33 35 20.
- B. Testing and testing laboratory services are included in Section 01 45 23.
- C. Maintaining flow in existing sewers is included in Section 33 01 48.

1.03 SUBMITTALS

- A. Submit in accordance with Section 01 33 00, shop drawings and product data for all manhole rehabilitation materials specified in this Section for each manhole to be rehabilitated.
- B. Submit in accordance with Section 01 33 00, shop drawings, working drawings showing actual field dimensions, schedules for all monolithic cementitious, epoxy, or urethane resin, or composite manhole lining systems and appurtenances required product data, specific installation procedures, etc. Submit design data and specification data sheets listing all parameters used in the monolithic manhole lining design based on applicable ASTM provisions. Submit from a Tennessee registered professional engineer a certification for all design data.
- C. Submit within 30 days from the Notice-to-Proceed, the supplier's name and a "to be furnished" materials list, and submit the subcontractor's name (if subcontracted) and experience with the specified product (total years installing the product, total manholes lined with the product, references list, and any other pertinent information).
- D. Prior to each material shipment, submit certified test reports stating the materials for this project were manufactured and tested in accordance with the ASTM Standards specified herein.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 - 1. ASTM C78: Standard Test Method for Flexural Strength of Concrete
 - 2. ASTM C94: Standard Test for Ready Mix Concrete
 - 3. ASTM C109: Standard Test Method for Compressive Strength of Hydraulic Cement Mortars
 - 4. ASTM C234: Standard Test Method for Comparing Concretes on the Basis of the Bond Developed with Reinforcing Steel
 - 5. ASTM C267: Standard Test Method for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing
 - 6. ASTM C321: Standard Test Method for Bond Strength of Chemical-Resistant Mortars
 - 7. ASTM C496: Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens
 - 8. ASTM C596: Standard Test Method for Drying Shrinkage of Mortar Containing Portland Cement
 - 9. ASTM C666: Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
 - 10. ASTM C827: Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
 - 11. ASTM C952: Standard Test Method for Bond Strength of Mortar to Masonry Units

12. ASTM C1244: Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
13. ASTM D2240-97e1: Standard Test Method for Rubber Property Durometer Hardness
14. ASTM D638-98: Standard Test Method for Tensile Properties of Plastics
15. ASTM D790-98: Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
16. ASTM D695-96: Standard Test Method for Compressive Properties of Rigid Plastics

- B. Where reference is made to one of the above standards, the revision in effect at the bid opening shall apply.

1.05 EXPERIENCE AND CERTIFICATIONS

- A. The entity performing the work shall be experienced, equipped to complete this work expeditiously and in a satisfactory manner, and an approved installer for the proposed lining system as certified and licensed by the manufacturer. Submit the following information for review and approval before any work is performed.
 1. Manufacturer's and supplier's name for this work
 2. The entity shall submit a certified statement from the manufacturer stating the entity is a certified and/or licensed liner installer.
- B. The entity shall also be able to provide crews as needed to complete this work without undue delay.

1.06 GUARANTEE

- A. All monolithic lining installed shall be guaranteed for a 3-year period from the final acceptance date. During this period, all defects discovered in the monolithic lining as determined by Metro or the Construction Manager shall be repaired or replaced in a satisfactory manner at no cost to Metro.

1.07 QUALITY ASSURANCE

- A. The supplier and/or manufacturer shall be responsible for providing all test requirements specified in the above referenced ASTM Standards as applicable.
- B. The Construction Manager or Metro may inspect the lining products and materials after delivery. The lining products and materials shall be subject to rejection at any time due to failure to meet any Specification requirements, even though samples may have been accepted as satisfactory at the manufacturer. Lining materials rejected after delivery shall be marked for identification and shall be removed from the job at once.
- C. The Contractor shall furnish the services of the cementitious, epoxy or urethane resin, or composite manhole liner manufacturer's field service technician, who has complete knowledge about manhole rehabilitation, to advise and assist the lining installation and provide instruction for rehabilitating the first 10 manholes. A second 1-day review will be conducted after 100 manholes have been completed for the project. The field service technician shall be experienced in manhole rehabilitation work. Manufacturer's sales and marketing personnel will not be accepted as field service technicians.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in shipping, handling, and placing to avoid damaging the lining products. Extra care may be necessary during cold weather construction. Any lining product or material damaged in shipment shall be replaced as directed by the Construction Manager.
- B. Any lining product showing deterioration, or which has been exposed to any other adverse storage condition that may have caused damage, even though no such damage can be seen, shall be marked as rejected and removed at once from the work.
- C. While stored, the lining products shall be adequately packaged and protected. The lining products shall be stored in a manner recommended by the manufacturer.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Stopping minor active leaks in concrete and masonry manholes (< 0.5 gpm)
 - 1. A rapid setting cementitious product specifically formulated for leak control shall be used to stop minor water infiltration, shall be applied according to manufacturers' recommendations, and shall have the following minimum requirements:

Minimum Requirements		
Compressive Strength	ASTM C109	>1,000 psi, 1 hr. >2,500 psi, 24 hrs.
Sulfate Resistance	ASTM C267	No weight loss after 15 cycles @ 2,000 ppm
Freeze/Thaw	ASTM C666 "Method A"	100 cycles
Pull Out Strength	ASTM C234	14,000 lbs.
Set Time	---	<1.0 minute

- 2. A silicate-based liquid accelerator field mixed with Portland neat cement shall be used. The set time shall be approximately 1 minute.

B. Patching, re-pointing, filling, and repairing non-leaking holes, cracks, and spalls in concrete and masonry manholes

1. A quick-setting fiber reinforced calcium aluminate cementitious material shall be used as a patching material, is to be mixed and applied according to manufacturer's recommendations, and shall have the following minimum requirements:

Minimum Requirements		
Compressive Strength	ASTM C109	>800 psi, 1 hrs. >1,800 psi, 24 hrs.
Bond	ASTM C882	>1,600 psi, 28 days
Calcium Aluminate Cement		Sulfate resistant
Applied Density		105 lbs pcf \pm 5 lbs
Shrinkage	ASTM C596	0% at 90% R.H.
Placement Time		5 to 10 minutes
Set Time		15 to 30 minutes

2. The patching product is to be formulated with calcium aluminate cement, specially selected chemical additives, and alkaline resistant fibers. Water used to mix product shall be clean and potable. No material (other than water) shall be used with or added to the patching product without prior approval or recommendation from manufacturer.

C. Frame and Covers

1. Manhole frames and covers shall be made from cast iron conforming to the details shown on the Drawings and meeting ASTM A48, Class 30 requirements.
2. All manhole frame and cover castings shall be made accurately to the required dimensions and shall be sound, smooth, clean, and free from blisters and other defects. Defective castings which have been plugged or otherwise treated to remedy defects shall be rejected. Frames and covers contact surfaces shall be machined so the covers rest securely in the frames with no rocking and so the entire cover perimeter is in contact with the frame.
3. Standard Casting: Similar to JBS 1150
4. Water-Tight Casting: Similar to JBS 1123

D. Invert/Bench Replacement

1. Manhole invert and bench shall be formed with 3,000 psi concrete. An epoxy bonding adhesive shall be applied to the existing concrete per manufacturer's instructions.

E. Exterior Chemical Curtain Grouting and/or for Major Active Leaks (>0.5 gpm)

1. Exterior chemical curtain grouting shall be used to stop significant infiltration sources. Chemical curtain grouting shall be solvent-free, hydrophilic resin designed to seal leaks in concrete and masonry structures. When it contacts water, chemical grout shall expand exponentially and form a tough, flexible foam seal that cannot be penetrated by water. Chemical curtain grouting shall be manufactured by Avanti International, DeNeef Construction Chemicals, or approved equal.

- F. Exterior chemical curtain grouting shall be applied according to manufacturer's recommendations and shall have the following minimum requirements:

Minimum Requirements		
Bond Strength	ASTM C882	60 psi
Tensile Strength	ASTM D3574	310 psi
	ASTM D1623, free rinse	54 psi
Elongation	ASTM D3574	280%
	ASTM D1623, free rinse	64%
Shrinkage	ASTM D1042/D756	< 2%
Internal Linear Shrinkage		5%
Tear Resistance	ASTM D3574	20 lbs/in
Density	ASTM D3574	30.8 lbs/ft ³

- G. Cured properties will vary depending on job conditions. Cured properties above (ASTM D3574) are derived from 10-15 pcf foam. Free rise properties are derived from 3-5 pcf foam.
- H. Exterior chemical curtain grouting shall be suitable for the intended purpose and shall be compatible with the monolithic lining as certified by the manufacturer.

2.02 CEMENTITIOUS, EPOXY, POLYUREA OR URETHANE RESIN, OR COMPOSITE MANHOLE LINING - WALLS AND BENCHES

- A. All lining materials shall be approved by U.S. EPA for sewer system rehabilitation and shall conform to the applicable provisions and classifications described in EPA Handbook entitled *Sewer System Infrastructure Analysis and Rehabilitation* dated October 1991.
- B. The manhole lining system shall be a cementitious, epoxy or urethane resin, or composite system suitable for use as a trowel- or spray-applied monolithic surfacing in sewer manholes. All monolithic lining shall provide a minimum 25-year service life. The cementitious, epoxy or urethane resin, or composite lining system shall be:
1. Portland-based Cementitious Liner
 - a. Strong MS-2A
 - b. Quadex QM-1s
 - c. Standard Cement Re-liner MSP
 - d. Permacast MS-10,000
 - e. Mainstay ML-72
 - f. Or approved equal

2. The Portland-based cementitious liner product shall be used to form a structural monolithic liner covering all interior substrate surfaces and shall have the following minimum requirements:

Minimum Requirements			
Compressive Strength	ASTM C109	28 days	>9,000 psi
Tensile Strength	ASTM C496	28 days	>800 psi
Flexural Strength	ASTM C293	28 days	>1,200 psi
Shrinkage @90% R.H.	ASTM C596	28 days	0%
Bond	ASTM C882	28 days	>2,000 psi
Density, When Applied	-		134 ± 5 lbs/ft ³
Freeze/Thaw	ASTM C666	N/A	300 cycles no visible damage

3. The Portland-based liner shall be made with Type I Portland Cement and shall be used according to manufacturer's recommendations in applications where there are no sulfide conditions (pH 3.0 or higher substrate surface). The liner product shall be reinforced with alkaline resistant fiberglass rods or other similar fibers not less than 1/2 inch in length. The material should meet or exceed industry standards and shall not have any basic ingredient that exceeds EPA maximum allowable limits for any heavy metals.
4. Epoxy, Polyurea or Urethane Based Resin Liner
- Warren Environmental S-301
 - Sprayroq SprayWall
 - SpectraShield Liner
 - Or equal
5. The material spray or trowel applied onto the manhole surface shall be an epoxy resin (similar to Warren Environmental Systems S-301), polyurea (similar to SpectraShield) or a urethane (similar to Sprayroq SprayWall) system formulated for application within a sanitary sewer environment. The resin will exhibit suitable corrosion resistance and enhance the existing manhole's structural integrity.
6. The cured epoxy or urethane resin system shall conform to the following minimum structural standards:

Minimum Requirements			
Cured Product	Test Method	Urethane Results	Epoxy Results
Compressive Strength	ASTM D695	10,500 psi	12,000 psi
Tensile Strength	ASTM D638	7,000	7,000 psi
Flexural Strength	ASTM D790	12,000 psi	11,000 psi
Flexural Modulus	ASTM D790	550,000 psi	500,000 psi
Shore D Hardness	ASTM D2240	90	83 - 85
Adhesion to Concrete	ASTM D4541	Substrate failure	Substrate failure

7. Composite
 - a. Base Coating
 - b. Strong Profile Plus Mix
 - c. Or equal
8. Top Coating
 - a. Warren Environmental S-301
 - b. Sprayroq SprayWall
 - c. Or equal
9. The base coating should be a calcium aluminate, acid resistant cementitious profiling product used for building back deteriorated substrates to original dimensions, providing structural restoration, corrosion protection, eliminating infiltration, and providing a smooth surface for applying an epoxy or urethane coating and shall have the following minimum requirements:

Minimum Requirements			
Compressive Strength	ASTM C109	28 days	>8,000 psi
Tensile Strength	ASTM C496	28 days	>800 psi
Flexural Strength	ASTM C293	28 days	>1,200 psi
Shrinkage @90% R.H.	ASTM C490	28 days	0%
Bond	ASTM C882	28 days	>2,000 psi
Density, When Applied	-	N/A	135±5 lbs/ft3
Freeze/Thaw	ASTM C666	N/A	100 cycles no visible damage

10. The final coating shall be an epoxy resin (similar to Warren Environmental Systems S-301) or urethane (similar to Sprayroq SprayWall) system formulated for application within a sanitary sewer environment. The resin will exhibit suitable corrosion resistance and enhance the existing manhole's structural integrity. The cured urethane or epoxy resin system shall conform to the following minimum structural standards:

Minimum Requirements			
Cured Product	Test Method	Urethane Results	Epoxy Results
Compressive Strength	ASTM D695	10,500 psi	12,000 psi
Tensile Strength	ASTM D638	7,000	7,000 psi
Flexural Strength	ASTM D790	12,000 psi	11,000 psi
Flexural Modulus	ASTM D790	550,000 psi	500,000 psi
Shore D Hardness	ASTM D2240	90	83 - 85
Adhesion to Concrete	ASTM D4541	Substrate failure	Substrate failure

- C. When cured, the monolithic cementitious, epoxy or urethane resin, or composite lining shall form a continuous, tight-fitting, hard, impermeable surfacing which is suitable for sewer

system service and chemically resistant to any chemicals or vapors normally found in domestic sewage.

- D. The lining shall be compatible with the thermal condition of the existing sewer manhole surfaces. Surface temperatures will range from 20°F to 100°F. Provide test data on shrinkage for the cementitious lining based on ASTM C596.

2.03 INVERT CHANNEL COATING

- A. All invert channels shall be coated with cementitious, epoxy or urethane resin, or composite lining systems to build up the invert channel to the new sewer main pipes invert elevations; to fill all voids, cracks, holes, etc.; and to form a smooth flow channel. The entire channel shall be coated. The coating shall be applied in accordance with manufacturer's installation instructions.
- B. The cementitious, epoxy or urethane resin, or composite lining system used for the invert channel shall be suitable for the intended purpose and shall be compatible with the materials used for the cementitious, epoxy or urethane resin, or composite manhole lining system. The cementitious, epoxy or urethane resin, or composite lining for the invert channel shall be as manufactured by the cementitious, epoxy or urethane resin liner manufacturer.

PART 3 - EXECUTION

3.01 GENERAL

- A. Each manhole to be rehabilitated shall be thoroughly cleaned and then inspected for loose or missing bricks, loose mortar, holes, etc. Prepare each manhole to receive the manhole lining system as necessary by reshaping and repairing benches, inverts, cone, walls, and corbelling where required. Plug all leaks prior to manhole lining.
- B. Materials associated with manhole surface preparation, chemical curtain grouting, monolithic lining installation, or other manhole rehabilitation activities shall not be allowed to be carried downstream.

3.02 SURFACE PREPARATION

- A. Remove all loose mortar and rubble from existing corbelling, cone, walls, benches, and inverts.
- B. Clean each sewer manhole to be surfaced and dispose of any resulting material as specified in Section 33 35 20.
 - 1. Use a high power jet wash at 3,500 psi water pressure minimum. Remove all dust, biological growths, grease, oil, paint or any other surface contaminants or prior coatings. This includes removing bitumastic coatings.
 - 2. Coatings that cannot be removed shall be sanded with coarse sand paper to sufficiently roughen the surface to obtain and ensure adequate bonding of the cementitious, epoxy or urethane resin, or composite lining system.
 - 3. Debris resulting from cleaning shall be removed from the manhole and not allowed to be carried downstream.

- C. Remove existing manhole ladder rungs/steps unless noted on the Drawings or directed by the Construction Manager. Following removal, patch any voids prior to manhole lining.
- D. Prior to placing the lining, the Contractor shall visually inspect each manhole after it is cleaned and shall properly prepare surface for liner installation per the manufacturer's instructions. All cracks and other voids must be repaired and filled with suitable non-shrinking cements, sealants, or grouts including all voids between the existing sewer pipes and manhole walls. All patches shall be smooth and even with the manhole wall. Proper substrate preparation is critical to a well bonded lining. Ensure proper installation conditions including temperature, flow diversion, and moisture. All interior surfaces shall be prepared as recommended by the lining manufacturer.

3.03 SEALING LEAKS IN INVERTS, BENCHES, WALLS, CONE, AND CORBELLING

- A. All active hydrostatic infiltration leaks shall be plugged or sealed with an appropriate grout compatible with the lining.
- B. A rapid setting cementitious product specifically formulated for leak control shall be used to stop minor water infiltration and shall be applied according to manufacturer's recommendations.
- C. Exterior chemical curtain grouting shall be used to seal significant active leaks in the manhole invert, bench, wall, cone, or corbelling.
 - 1. From the manhole's interior, drill injection port holes through the manhole wall at locations recommended by the manufacturer.
 - 2. Starting with the lowest injection port holes, inject grout through the holes at a minimum 250 psi pressure. Injection pressure shall not cause damage to the manhole structure or surrounding features. Any damage caused shall be repaired by the Contractor at no additional cost to Metro.
 - 3. Continue injecting grout until grout is observed from defects or adjacent injection port holes. Provide additional injection port holes as necessary to ensure grout travel across the exterior manhole surface.
 - 4. Repeat this process until the entire area identified for curtain grouting has been completed.
 - 5. After installing the curtain grouting, clean injection port holes and patch with a quick-setting, fiber-reinforced cementitious material to be flush with the adjacent surface.
 - 6. The curtain grouting installation shall adhere to all manufacturer's guidelines

3.04 INVERT CHANNEL COATING

- A. All invert channels shall be coated with cementitious mortar or polymer resins to prevent infiltration and to build up the invert channel to the new sewer main invert elevations; to fill all voids, cracks, holes, etc.; and to form a smooth flow channel. The entire channel shall be coated. The coating shall be a minimum 1/4- to 1/2-inch thick if cementitious or 125 mils if epoxy or urethane resin system.

3.05 INVERT AND BENCHING REPLACEMENT

- A. Where noted on Drawings or directed by the Construction Manager, rebuild and/or replace the invert and benching.
- B. Manhole inverts shall be constructed to conform to flow-through sewers sizes and shapes. At changes in directions, the inverts shall be laid out in curves of the longest possible radii tangent to the sewer pipes' centerline. Benches shall be constructed to the highest pipe crown elevation and sloped to drain toward the flow-through channel.
- C. Mix mortar only in such quantity as may be required for immediate use. Use mortar before initial set has taken place. Mortar shall be used within 1-1/2 hours and shall be constantly worked with hoe or shovel until used. Anti-freeze mixtures shall not be included in the mortar. Install masonry when the outside temperature is above 40 °F unless provisions are made to protect the mortar, bricks, and finished work from frost by heating and enclosing the work with tarpaulins or other suitable material. Construction Manager's decision regarding the adequacy of protection against freezing shall be final.
- D. The manhole bench's sloped surface for epoxy and urethanes shall be made non-skid by broadcasting aluminum oxide or sand into the surface prior to gelatin/set.

3.06 LOCATING, RAISING, RESETTING, AND/OR REPLACING MANHOLE FRAME AND COVER ASSEMBLIES

- A. Where noted on the Drawings or directed by the Construction Manager, locate and uncover buried manhole frame and covers, remove existing manhole frame and covers, dispose of existing manhole frame and covers if they are not being reused, raise manhole frame and covers, and/or install new or reused manhole frame and covers. The Contractor shall repair any damage to the manhole chimney or corbelling caused by removing the existing manhole frame at no additional cost to Metro.
- B. Existing frames and covers to be reused shall be thoroughly cleaned before re-installing.
- C. Install new or reused frames so the cover tops are at grade with the surrounding area unless noted otherwise on the Drawings or directed by the Construction Manager. Utilize bricks or precast concrete grade rings to set the manhole frame and cover to the finished grade. Precast concrete grade rings shall be set in a butyl mastic sealant bed. Bricks shall be set in a full mortar bed. The inside ring faces shall be wiped with a non-shrink grout to fill the voids and leave a smooth transition between the frame casting and the chimney.

3.07 LINING INSTALLATION - GENERAL

- A. Complete other manhole rehabilitation aspects prior to lining including surface preparation, patching voids, sealing leaks, coating invert channel, and other required manhole rehabilitation work.
- B. Notify all property owners who discharge sewage directly to the manhole being surfaced that their service will be discontinued while the lining is being placed, cured, and active pipe and service connections reopened. The Contractor shall notify individual property owners at least 72 hours in advance, giving the date, start time and estimated completion time for the work being conducted. This notification shall be coordinated with the door hanger distribution.
- C. The monolithic lining shall cover the complete interior of the existing sewer manhole including the benches (shelves) and inverts. The lining shall effectively seal the interior sewer manhole surfaces and prevent any groundwater infiltration, penetration, or leakage. The

manhole bench's sloped surface for epoxies and urethanes coatings shall be made non-skid by broadcasting aluminum oxide or sand into the surface prior to gelatin/set.

- D. The lining shall be installed to 3 inches above the bottom of the manhole frame.
- E. The Contractor shall provide any necessary sewage flow bypass pumping where and when the rehabilitation work is being performed, as specified in Section 33 01 48.
- F. The Contractor shall reopen all the existing active pipe connections in each sewer manhole following manhole rehabilitation.
- G. Temperature limitations must be handled as appropriate and as approved by the manufacturer. The cured monolithic lining shall be continuously bonded to all the brick, mortar, concrete, chemical sealant, grout, pipe, and other surfaces inside the sewer manhole.

3.08 INSTALLATION – PORTLAND-BASED CEMENTITIOUS LINERS

- A. Furnish and place Portland-based cementitious lining in each manhole as noted in the Drawings or where directed by the Construction Manager. The lining installation shall be in complete accordance with the applicable ASTM provisions and the manufacturer's specifications.
- B. The cementitious lining system shall be a pumpable Portland based cement. The lining shall be installed via low-pressure application only. The materials shall be suitable for all the specified design conditions.
- C. The materials used in the cementitious lining systems shall be mixed on site in accordance with the manufacturer's recommendations. Water shall only be added to the materials during the mixing process and prior to material pumping or spray application. No water shall be added at the nozzle.
- D. All bottom and horizontal surfaces including the benches shall have the lining applied to the required thickness as shown on the Drawings or as directed by the Construction Manager. For concrete manholes in good structural condition and showing no evidence of infiltration, the lining shall be installed to a minimum 1/2-inch thickness. For all other concrete manholes and for all brick manholes, the lining shall be installed to a minimum 1-inch thickness. All cementitious lining shall be installed by gradually thickening in accordance with the manufacturer's recommendations to withstand groundwater pressure. Spray applied cementitious linings shall be troweled smooth after application. Troweled cements should then be lightly brushed to remove any sharp edges. The cured surfacing thickness shall be smooth and continuous with proper sealing connections to all unsurfaced areas.

3.09 INSTALLATION – EPOXY, POLYUREA OR URETHANE RESIN LINERS

- A. Furnish and place epoxy, polyurea, or urethane-based lining in each manhole as noted in the Drawings or where directed by the Construction Manager. The lining installation shall be in complete accordance with the applicable ASTM provisions and the manufacturer's specifications.
 - 1. The epoxy, polyurea or urethane resin system shall be sprayed onto the manhole walls, benches, and invert surfaces to produce a smooth coating and yield the required structural integrity and corrosion resistance.
 - 2. The spray equipment shall be specially designed to accurately ratio and apply the specified materials.

3. The epoxy or urethane resin system shall be applied to a minimum 125-mil thickness on precast surfaces and 250 mils on brick surfaces at the top of the manhole and gradually thickened in accordance with the manufacturer's recommendations to withstand groundwater pressure. The cured surfacing shall be monolithic, properly sealing connections to all unsurfaced areas and shall be placed and cured in one to two applications, depending on existing manhole conditions.
4. The modified polyurea resin multi-component system shall be applied to a minimum 500-mil total thickness on precast surfaces and 750 mils on brick surfaces at the top of the manhole and gradually thickened in accordance with the manufacturer's recommendations to withstand groundwater pressure. The cured surfacing shall be monolithic, properly sealing connections to all unsurfaced areas and shall be placed and cured in one to two applications, depending on existing manhole conditions.

3.10 INSTALLATION – COMPOSITE LINERS

- A. With the Engineer's approval, the Contractor may furnish and place composite lining in lieu of epoxy or urethane-based lining. The lining installation shall be in complete accordance with the applicable ASTM provisions and the manufacturer's specifications.
 1. The lining shall be installed via low-pressure application only.
 2. The materials used in the cementitious base coating shall be mixed on site in accordance with the manufacturer's recommendations. Water shall only be added to the materials during the mixing process and prior to material pumping or spray application. No water shall be added at the nozzle.
 3. All bottom and horizontal surfaces including the benches shall have the lining applied to the required 1/2-inch thickness by spray on methods. Spray applied cementitious base coatings shall be troweled smooth after application. Troweled cements should be lightly brushed to remove any sharp edges. The cured surfacing thickness shall be smooth and continuous with proper sealing connections to all unsurfaced areas.
 4. It is mandatory for the applicator to wait 28-days minimum following the cementitious base coating installation before placing the epoxy or urethane top coat.
 5. Prior to placing the top coating, the Contractor shall properly prepare surface for liner installation per the manufacturer's instructions. Proper substrate preparation is critical to a well bonded lining. The Contractor is responsible for ensuring proper installation conditions including temperature and moisture.
 6. The epoxy or urethane resin top coating shall be sprayed onto the manhole walls, benches, and invert surfaces to produce a smooth coating and yield the required structural integrity and corrosion resistance.
 7. The spray equipment shall be specially designed to accurately ratio and apply the specified materials.
 8. The epoxy or urethane resin top coating shall be applied to a minimum 75-mil thickness at the top of the manhole and gradually thickened in accordance with the manufacturer's recommendations to withstand groundwater pressure. The cured surfacing shall be monolithic, properly sealing connections to all unsurfaced areas and shall be placed and cured in one to two applications, depending on existing manhole conditions.

3.11 FIELD TESTING AND ACCEPTANCE

- A. Field acceptance for monolithic manhole linings shall be based on the Construction Manager's evaluation of the proper manhole monolithic surfacing per field inspections. Acceptance shall also be based on the Construction Manager's evaluation of the appropriate installation and curing test data.
- B. The cementitious, epoxy, polyurea or urethane resin, or composite lining shall provide a continuous monolithic surfacing with uniform thickness throughout the manhole interior.
 - 1. Work with the Construction Manager to develop an easy method for measuring the liner thickness. This method should be so the Construction Manager does not have to enter the manhole to measure the thickness. Possible methods include:
 - a. Measuring material usage (i.e. log the number of bags of product used per manhole)
 - b. Performing a wet gauge depth check
 - 2. The costs associated with measuring the liner thickness shall be included in the unit bid price.
 - 3. If the lining thickness is not uniform or is less than specified, it shall be repaired or replaced at no additional cost to Metro.
- C. The Construction Manager and/or Metro may enter the manholes to inspect the benching, invert channels, manhole wall/pipe connections, surface preparation, and other parts of the work. Provide, forced air ventilation, gas monitors and detectors, harnesses, lights, personnel for opening/closing manholes and operating equipment, etc. for the Construction Manager and/or Metro to enter the manhole and perform the inspection in complete accordance with OSHA requirements at no additional cost to Metro.
- D. Vacuum testing shall be performed on all manholes after all manhole rehabilitation work has been completed in accordance with ASTM C1244. Vacuum testing shall test the manhole lining including the connection between the manhole frame and chimney. The testing shall be included in the bid price for manhole lining. The Construction Manager shall be notified 48 hours prior to testing and shall be present for all testing. Submit the test reports which include the project name, manhole tested, data on testing (vacuum pressure, test duration, etc.), and whether the manholes passed or failed the test. Any manhole that fails the vacuum test shall be repaired and retested at no additional cost to Metro.
- E. There shall be no groundwater infiltration or other leakage through the manhole wall after it has been lined. If leakage is found, it shall be eliminated with an appropriate method as recommended by the liner manufacturer and approved by the Construction Manager at no additional cost to Metro.
- F. All pipe connections shall be open and clear and be smoothly transitioned with lining material or epoxy as necessary.
- G. There shall be no cracks, voids, pinholes, uncured spots, dry spots, lifts, delaminations, or other type defects in the lining.
- H. If any defective lining is discovered after it has been installed, it shall be repaired or replaced in a satisfactory manner within 7 days and at no additional cost to Metro. This requirement shall apply for the entire guarantee period.

3.12 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 33 01 48

FLOW CONTROL OF SEWER LINES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This Section includes all materials, labor, and equipment required to provide bypass flow control for sanitary sewer lines construction, upgrade, or rehabilitation.
- B. Also, furnish all power, maintenance, etc. to implement the bypass flow control and diversion pumping to divert the existing flow around the work area for the work's duration. If the duration of the work coincides with conditions that have a potential to cause higher flows than the minimum, the contractor shall be at risk for containing all flows.
- C. The design, installation, and operation for the temporary bypass pumping system shall be solely the Contractor's responsibility. The Contractor is to plan and perform his construction work for the supporting diversion pumping operations to reduce risk, avert overflows, minimize exposure durations and address variable season and event sewer flow rates.
- D. Bypass Pumping Operation Checklist

1.02 PERFORMANCE AND PENALTIES

- A. The Contractor shall ensure:
 - 1. All temporary sewer bypass pumping activities for the work are completed in full compliance with the Metro Stormwater Management Regulations, and no water quality or quantity compliance issues are encountered.
 - 2. No illicit pollutant discharges to (or to a location that would create contaminated water runoff to) a storm sewer, a stormwater conveyance, or a water body within Metro Nashville Davidson County shall occur per Metro Ordinance §15.64.205 Non-stormwater Discharges.
 - 3. All temporary sewer bypass pumping activities for the work are completed in full compliance with the Tennessee Department of Environment and Conservation and the U.S. EPA regulations, and no water quality or quantity compliance issues are encountered.
- B. No discharge of sewage or debris shall be released to the environment. Should the Contractor's actions cause a sewage or debris overflow or bypass to the environment, site cleanup will be the Contractor's responsibility consistent with the *Metro Spill and Overflow Response Plan* and regulators directions. All overflow or bypass environmental cleanup activities shall be immediately commenced and prosecuted continuously by the Contractor. Any associated fines or penalties enacted by the Tennessee Department of Environment and Conservation, the U.S. EPA, and/or any other regulatory groups or programs will be borne solely by the Contractor.

1.03 SUBMITTALS

- A. At least 4 weeks prior to commencing work including plugging any line, bypass pumping, or similar actions, the Contractor shall submit to the Construction Manager a detailed *Bypass*

Sewage Pumping Plan (Plan), as further described in these specifications, for review and approval. Any Plan approval does not relieve the Contractor from any responsibility for the Plan's adequacy or proper execution. The Contractor is responsible for conducting his work in a manner which will not cause overflows or system backups that could damage private and/or public property.

B. Submit the following in accordance with Section 01 33 00.

1. *Bypass Sewage Pumping Plan*. Plan shall contain, at minimum, the following:
 - a. Staging areas for pumps
 - b. Sewer plugging method and plug types
 - c. Size and location for manholes or access points for suction and discharge hose or piping
 - d. Size for pipeline or conveyance system to be bypassed
 - e. Number, size, material, location, and method for installing suction piping
 - f. Number, size, material, location, and method for installing discharge piping
 - g. Provide bypass pump sizes, capacity, number of each size to be on site, and power requirements. Pump sizing shall clearly indicate compliance with requirements in this Section.
 - h. Calculations for static lift, friction losses, and flow velocity (pump curves showing pump operating range)
 - i. Standby power generator size, location, and spill prevention and control measures
 - j. Downstream discharge plan
 - k. Method to protect discharge manholes or structures from erosion and damage
 - l. Thrust and restraint block sizes and locations
 - m. Sections showing suction and discharge pipe depth, embedment, select fill, and special backfill
 - n. Noise control method for each pump and/or generator
 - o. Any temporary pipe supports and anchoring required
 - p. Design plans and computations for access to bypass pumping locations indicated on the Drawings
 - q. Calculations for selecting bypass pumping pipe size
 - r. Schedule for installing and maintaining bypass pumping lines
 - s. Plan indicating selection for bypass pumping line locations
 - t. Plan indicating monitoring location selections

- u. All items related to testing, inspection, maintenance, and monitoring as described in this Section
- v. All other incidental items necessary and/or required to ensure facilities are properly protected including protecting the access and bypass pumping locations from damage due to the discharge flows and compliance with the requirements and permit conditions specified in the Contract Documents
- w. For sewer rehabilitation by lining methods, generic plans may be developed for typical situations and various sizes to be implemented.

PART 2 - PRODUCTS

2.01 BYPASS EQUIPMENT

- A. All equipment used for bypass pumping shall be specifically designed for that intended purpose. All piping, pumps, etc. in contact with sanitary sewage shall be manufactured with materials designed for use in a sewage environment.
- B. All pumps used shall be fully automatic self-priming units which do not require foot valves or vacuum pumps in the priming system.
- C. The pumps shall be electric, hydraulic, or diesel powered.
- D. All pumps used shall be constructed to allow dry running for long periods of time in order to accommodate effluent flows' cyclical nature.
- E. Above-ground pumps and/or power units shall be located inside a temporary portable berm to contain any fuel or sewage that may spill during the normal course of operation.
- F. Hard discharge piping shall be butt-welded HDPE with a minimum pressure rating of 2.5 times the total dynamic pump head.
- G. Under no circumstances will irrigation type piping or glued PVC pipe be allowed.
- H. A discharge hose may be allowed on rehabilitation projects for short-term setups (less than or equal to 48 hours) on short sections with approval from the Construction Manager. Hoses shall have no leaks, and all couplings shall be quick connecting with gaskets.
- I. The multiple pump header system shall have check valves to facilitate pump removal, service, and/or replacement while the system remains operational.
- J. All above ground pumps and/or power units shall be equipped with sound attenuation measures which reduce noise levels to 75-decibels maximum at a 30-foot distance from the equipment during all operation periods. If equipment is operated between 8:00 PM and 6:00 AM, this equipment shall also be provided with a sound attenuation 3-sided enclosure including a roof constructed of 2 x 4 lumber frame with ½-inch plywood sheathing and 2-inch extruded polystyrene foam panels attached to the inside of the entire enclosure. The enclosure shall be portable to allow the enclosure to be moved when bypass pumping equipment is moved.
- K. The discharge location (the point where the bypass main reenters the gravity sewer system) shall be constructed with adequate sealant materials to minimize sewer gas and odor release to the maximum extent possible.

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Provide bypass sewage pumping, as required, around the section in which work is to be performed. Bypass pumping shall be the Contractor's full responsibility. The bypass system shall be of sufficient capacity to handle a minimum of 2.0 times the dry weather daily peak flow, as provided by Metro for trunk lines, of the pipeline section being bypassed. Peak flows and pipe capacities at key locations may be provided in a Table on the Drawings. Performance of extended pumping durations in or immediately following precipitation events and/or with precipitation events in the forecast will require greater pumping system capacities to accommodate the potential higher flows. As listed in the table, these flows are significantly higher than the minimum of 2.0 times the dry weather daily peak flow. Bypass pumping systems sized for smaller flows than are listed in the full flow capacity for wet weather conditions may be entertained if, at the discretion of the Construction Manager, sufficient evidence and planning is provided to show that the full capacity is not necessary and that a plan can be implemented in time to accommodate all flows if actual or forecasted conditions change.
- B. At least 4 weeks prior to the desired start date of construction requiring bypass pumping, submit a detailed description of the method proposed for bypass pumping to the Construction Manager for review and approval. The description shall include capacity calculations, operational conditions, conditions of performance relative to precipitation and antecedent conditions, all materials and equipment to be used, personnel, spare equipment, and sketches showing proposed pump-around setups. No work shall commence until the Construction Manager approves.
- C. Bypass pumping equipment shall include pumps, conduits, engines, and related equipment necessary to divert sewage flow around the section in which work is to be performed. Backup pumps shall be online and isolated from the primary system by valves. Include 100% mechanical redundancy installed online with a float or ultrasonic type system to switch to the standby system automatically if the primary system fails.
- D. Piping redundancy may be required for relatively long bypass piping lengths or large diameter bypass pipes as deemed necessary by the Construction Manager. Special design considerations shall be made for pump suction lifts greater than 23 feet.
- E. Make all arrangements for bypass pumping when the main is shut down for any reason. The system shall overcome any existing force main pressure on discharge.
- F. Suction and discharge points shall only be located at manholes.
- G. If at any time the Contractor is unable to properly bypass pump the sewage, construction will be stopped until the Contractor can continue work in an acceptable manner. Additional contract time for delays caused by improper equipment, labor, or breakdowns will not be considered.
- H. Service shall be maintained at all times. Surcharges due to plugging the sewer line for bypass pumping shall be maintained to prevent service backups and overflows anywhere in the system.
- I. For rehabilitation projects and only with the Construction Manager's approval, a hose may be used for 48 hours or less. If the anticipated bypass time exceeds 48 hours, use hard piping only. If using a hose when the bypass time reaches 48 hours, the Contractor may either install hard piping to accomplish the bypass or restore flow until an approved bypass method can be

employed. No modifications to the bypass system shall be made without Construction Managers' approval.

- J. The bypass or diversion pumping system shall be able to pump all of the sewage in the existing line regardless of the performance period's weather and seasonal conditions. All pumping equipment to be used shall be submitted to the Construction Manager for review and approval.
- K. Bypass pumping systems are required to be operated and continuously monitored 24-hours per day for flow diversion.
- L. The bypass pumping must be initiated at one manhole upstream and continue to one manhole downstream of the line being rehabilitated in order to use flow-through plugs at the insertion and end points. The liner bag may not be used as part of the bypass pumping system or as a plug in the line.
- M. For bypass or diversion pumping in overnight operations greater than 2 days, portable lighting systems must be provided and maintained as needed for monitoring and operation activities at the bypass pumping site(s).
- N. The temporary diversion pumping system shall be placed in operation prior to the commencement of work in the areas being bypassed. Minimum times of operation prior to the commencement of work are 1 hour for small diameter CIPP lining and 4 hours for any other major system work such as trunk sewer diversion, large diameter sewer lining, or pumping station work.
- O. Protect the bypass lines from damage in the areas of backhoe and excavation operations.
- P. Provide the necessary stop/start controls and a visual alarm indicating a pump malfunction for each pump. Each pump shall have a 0-30 inch Hg vacuum gauge on the inlet and a 0-60 psi pressure gauge on the outlet.

3.02 PERFORMANCE REQUIREMENTS

- A. It is essential for the operation of the existing system being bypassed that no interruptions in the flow occur throughout the project's duration. Provide, maintain, and operate all temporary facilities such as dams, plugs, pumping equipment (primary and backup units as required), conduits, all necessary power, and all other labor and equipment necessary to intercept the incoming flow before it reaches the point where it would interfere with the work, carry it past the work area, and return it to the existing system downstream of the work.
- B. The temporary pumping system's design, installation, and operation shall be the Contractor's responsibility. The bypass system shall meet all codes and requirements for regulatory agencies having jurisdiction.
- C. The temporary pumping system's design, installation, and operation shall address system flow variations for diurnal peaks and low flows during the pumping period.
- D. Provide all necessary means to safely convey the sewage past the work area. The Contractor will not be permitted to stop or impede the sewer main flows under any circumstances.
- E. No flow diversion around the work area shall be performed in a manner that will cause damage to or the surcharging of Metro system. The diversion shall protect public and private property from damage and flooding.

- F. Protect water resources, wetlands, and other natural resources.

3.03 FIELD QUALITY CONTROL AND MAINTENANCE

- A. Testing: Prior to actual operation, test the bypass pumping discharge hard piping system for leaks and pressure using clean water. Bypass hard piping shall be hydrostatically tested following each setup and prior to flow diversion or bypass to a minimum pressure 2.5 times the pump(s) total dynamic head. The Construction Manager shall be given a 24-hour notice prior to testing.
- B. Inspection: Inspect the bypass pumping system on a continuous basis to ensure the system is working properly. A daily checklist for physically inspecting the piping shall be required. The checklist shall contain all bypass pumping system components and shall be specifically developed to address aspects for the individual project. The daily checklist shall be submitted to and approved by the Construction Manager. The completed daily checklists will be maintained, available for review, and on-site for the project's duration. A sample checklist is included in this Section.
- C. Maintenance Service: Ensure that the temporary bypass pumping system is properly maintained and that a responsible operator shall be readily available at all times when pumps are operating.
- D. Monitoring
 - 1. During bypass pumping, continuously monitor all bypass pumping system components.
 - 2. A telemetry system or designated personnel to maintain 24-hour onsite monitoring shall be required to alert the Contractor to system malfunctions or high liquid levels in manholes.
 - 3. If bypass pumping activities are conducted near state waters or in other situations where the potential exists for a sewage release to potentially enter state waters by other than direct means, an in-line stream monitoring system shall be used to measure real-time conductivity and dissolved oxygen (DO) concentrations in 30-minute intervals at a minimum. The system shall be mounted in the receiving stream in the immediate downstream area(s) adjacent to the location(s) of the bypass piping system discharge to the gravity conveyance system. The system shall have web-portal capabilities with alarm functions for conductivity and DO. The alarm function shall be equipped with battery power and solar charging provisions and shall be able to send e-mail and text messaging alarms to at least five devices.
- E. Additional Materials
 - 1. Spare parts for pumps and piping shall be kept on site as required.
 - 2. Adequate hoisting equipment for each pump and accessories shall be maintained on site.
 - 3. Keep an HDPE fusion machine on site for the duration of bypass pumping to facilitate immediate repairs to hard piping.
- F. Preparations and Precautions
 - 1. Locate any existing utilities in the area selected for the bypass pipelines. Locate the bypass pipelines to minimize any disturbance to existing utilities and obtain approval for

the pipeline locations. Pay all costs associated with relocating utilities and obtaining all approvals.

2. During all bypass pumping operations, protect the Metro system (pumping station, conveyance system, etc.) as applicable from damage inflicted by any equipment. The Contractor is responsible for all physical damage to the system caused by human or mechanical failure.

G. Installation and Removal

1. Remove manhole sections or make connections to the existing conveyance system. Construct temporary bypass pumping structures only at the access location(s) indicated on the Drawings and as may be required with Construction Manager's approval to provide adequate suction conduit.
2. Plugging or blocking flows shall incorporate a primary or secondary plugging device. When plugging or blocking is no longer needed for work performance and acceptance, it is to be removed in a manner that permits the sewage flow to slowly return to normal without surge flows to prevent surcharging or causing other major disturbances downstream.
3. When working inside manholes, sewers, or force mains, exercise caution and comply with all applicable OSHA requirements.
4. Bypass pipeline installation is prohibited in all wetland areas. The pipeline shall be located, if possible, off streets and sidewalks and on road shoulders. If in easements, the bypass pipeline shall be within the easement area acquired for the project.
5. When the bypass pipeline crosses local streets and private driveways, place the bypass pipelines in trenches and cover with temporary pavement. Obtain any property owner approvals for placing the temporary pipeline.

3.04 CLEANUP

- A. Upon acceptance of the installation work and testing, restore the project area affected by the operations to a condition at least equal to that existing prior to the work.

3.05 MEASUREMENT AND BASIS OF PAYMENT

- A. Temporary bypass sewage pumping will be considered incidental to the work with which it is associated and will not be measured for payment as a separate pay item.

3.06 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

PART 4 - FORMS

1. Bypass Pumping Operation Daily Checklist



Bypass Pumping Operation Daily Checklist

Project No.: _____ **Inspection Date:** _____
Project Name: _____ **Inspection Time:** _____ am/pm
Superintendents: _____ **Inspector Name:** _____
Project Mgr/Adm: _____ **Inspector Signature:** _____

Number of Pumps Running During Inspection:

Bypass Pumps/Floats

	Yes	No	N/A	Comments
All suction hoses removed and impellers cleaned today	_____	_____	_____	_____
All pumps fueled up today	_____	_____	_____	_____
Floats tied off to vertical pole	_____	_____	_____	_____
Pumps on level ground for fuel intake	_____	_____	_____	_____
Pump suction and discharge gauges working properly	_____	_____	_____	_____

Bypass Plugs

	Yes	No	N/A	Comments
Bypass pressure checked at suction manhole	_____	_____	_____	PSI: _____
Bypass pressure checked at discharge manhole	_____	_____	_____	PSI: _____
Bypass plug cables tied off and secure	_____	_____	_____	_____
Air hose routed through and tied off to steps	_____	_____	_____	_____

Bypass Line

	Yes	No	N/A	Comments
Visually checked all suction lines	_____	_____	_____	_____
Visually checked manifold	_____	_____	_____	_____
Visually checked discharge lines	_____	_____	_____	_____
Visually checked HDPE discharge line	_____	_____	_____	_____
Visually checked discharge manhole	_____	_____	_____	_____

Other

	Yes	No	N/A	Comments
Visually checked 1 st upstream manhole for normal liquid level	_____	_____	_____	_____
	_____	_____	_____	_____

ADDITIONAL COMMENTS:

END OF SECTION



SECTION 33 01 51

PRE-REHABILITATION SANITARY SEWER CCTV INSPECTION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. When preparing each sewer segment to be relined or replaced, furnish all necessary labor, materials, equipment, services, and incidentals required to visually inspect designated sewer line sections and service laterals, including, but not limited to, recording and playback equipment, materials and supplies required for closed-circuit television (CCTV).
- B. Perform the inspection on one sewer line section at a time (i.e., manhole-to-manhole) to complete the following:
 1. Document the sewer's and service lateral's general condition
 2. Confirm the cleaning is sufficient for relining
 3. Determine accurate service lateral locations
 4. Determine any other significant pipe conditions that may be necessary to repair to properly and successfully install the cured-in-place pipe (CIPP) liner and other lining materials
 5. Determine any other significant service lateral pipe conditions such as transitions, defects, and fittings that may be necessary to repair or adjust renewal methods to properly and successfully install the cured-in-place pipe (CIPP) service lateral liner or replacement pipe for laterals under roadway, crossing major utilities and adjacent to or crossing waterways. The Construction Manager may waive the requirement for laterals to be launched when renewed by replacement methods outside of roadway.
- C. Make digital CCTV video recordings of the inspections. Supply recordings and printed inspection log copies to the Construction Manager. Pre-rehabilitation CCTV inspection for all sewer segments and service laterals is required.
- D. Contractor may have to perform cleaning, point repairs, and obstruction removal or remove protruding service connections to complete pre-rehabilitation CCTV inspection.

1.02 RELATED WORK

- A. Sewer line cleaning is included in Section 33 35 20.
- B. Sewer flow control maintenance in existing sewers is included in Section 33 01 48.
- C. CIPP lining is specified in Section 33 01 40.
- D. CIPP Service Lateral Lining is specified in Section 33 01 88.

PART 2 - PRODUCTS

2.01 EQUIPMENT

- A. The television camera(s) used for the inspection shall be specifically designed and constructed for such inspections.
- B. Camera lighting shall be suitable to allow a clear picture for the pipe's entire periphery.
- C. The camera shall be operative in 100 percent humidity conditions.
- D. The camera, television monitor, and other video system components shall be able to produce a minimum 500-line resolution video picture.
- E. Picture quality and definition shall be to the Construction Manager's satisfaction. If the quality is unsatisfactory, the inspection shall be performed again with the appropriate Construction Manager designated changes made at no additional cost to Metro.
- F. The television inspection equipment shall have an accurate footage counter that shall display on the monitor the camera's exact distance from the starting manhole's centerline or the connection with sewer main.

PART 3 - EXECUTION

3.01 TELEVISION INSPECTION

- A. Inspect sewer pipelines with pan, tilt, and zoom conventional television imagery to record relevant pipeline and service lateral features and defects. Pipeline and service lateral inspection shall be carried out in a format reviewed by the Construction Manager prior to the commencement of the inspection. Perform cleaning in accordance with Contract Document requirements.
- B. CCTV operators shall be NASSCO PACP certified and have a current certification. Prior to beginning work, the Contractor shall submit the NASSCO PACP certifications for all CCTV operators performing this work. The Contractor shall not commence work until such certification has been provided.
- C. The Contractor shall provide an external 1 TB portable external hard drive to the Construction Manager in order for the Construction Manager to obtain the MWS project database. The Construction Manager will transmit the hard drive with the MWS database back to the Contractor so that the Contractor can add the pre-rehabilitation CCTV data.
- D. If television inspection for an entire section cannot be successfully performed from one manhole, perform a reverse setup to obtain a complete television inspection.
- E. Perform sewer televising work as necessary using NASSCO PACP coding to thoroughly document the condition for all sewers, service lateral connections, service lateral conditions, manhole corbel, barrel, and cone-sections in the study area. To achieve this, the CCTV camera operator shall stop the camera in each manhole invert and shall pan and zoom up the manhole to obtain the best possible image of the manhole, including the cone and corbel section(s).
- F. The quality and coding for all work specified in this Section shall meet or exceed the National Association of Sewer Service Companies (NASSCO) Recommended Specifications for Sewer

Collection System Rehabilitation (latest edition) requirements. Applicable Section portions which inadvertently fall below those standards shall be corrected and maintained at the NASSCO standards as a minimum requirement, at no additional cost to MWS.

- G. Document all internal sewer and service lateral inspections via digital video recordings, television logs, digital photos, and a database compatible with the NASSCO PACP coded, CUES's GraniteNet in the most current MWS version, exchange database version 4.6.1 with a Hansen interface or newer, if applicable.
1. If the video is poor quality due to the chosen media, Metro reserves the right to require re-submittal on a different media.
 2. Create separate MPEG 4 H264 files for each sewer line segment.
 3. In a reverse setup, store such inspection in a separate MPEG 4 H264 file.
 4. MPEG 4 H264 files shall be written to an external hard drive for delivery to the Construction Manager.
 5. Each hard drive shall be labeled, at a minimum, with the following information: owner's name, project name, MWS project number, creation date, prime contractor's firm name, and TV inspection contractor's firm name.
- H. Digital video shall be defined as ISO-MPEG Level 4 (MPEG-4) coding with a 352-pixel (x) by 240-pixel (y) (minimum) resolution and a 30 frames per second encoded frame rate.
1. The digital recording shall include audio and video information which accurately reproduces the original video inspection picture and sound.
 2. The digital recording's video portion shall be free from electrical interference and shall produce a clear and stable image.
 3. The audio portion shall produce a clear and discernible oral report, sufficiently free from background and electrical noise.
- I. Separate digital video recordings shall be made for each sewer section and shall be properly identified via continuous on-screen display and voice-over recording with the following:
1. MWS Project number
 2. Upstream MH ID and downstream MH ID
 3. Sewer segment being inspected
 4. Inspection date
 5. Project name
 6. Distance along the reach from the entering manhole
- J. Contractor shall coordinate with Construction Manager prior to commencing work to ensure identification is accomplished in a manner acceptable to MWS. If the video and/or audio recording is poor quality, the Metro has the right to require a re-submittal of the affected sewer sections and service laterals. No payment will be made until an acceptable video and audio recording is made and submitted to and accepted by the Construction Manager.

- K. Inspection software to be used shall be CUES's GraniteNet in the most current MWS version unless otherwise approved by the Construction Manager. If software other than CUES's GraniteNet is used, compile all video recordings, digital photos, and databases in CUES's GraniteNet software before submitting to the Construction Manager.
- L. The CCTV equipment/software shall be able to produce digitized images for all sewer line defects, manhole defects, sewer line service connections, and service laterals in .jpeg format. Plan to take digital still images of each defect, construction features, and service connection to clearly depict it. More images may be necessary depending on the lined pipe condition.
- M. Provide CCTV inspection data via external hard drive. Data shall be recorded and provided in a current version of the NASSCO PACP Exchange format. The data shall specifically include video indexing for all observations. Data to be submitted shall include:
1. NASSCO PACP exchange database file
 2. .jpeg files (still photos)
 3. MPG 4 H264 -files (video) for each pipe segment
- N. Provide a complete television inspection for the upstream and downstream manholes. The CCTV operator shall pan and zoom up the manhole from the invert for each manhole and obtain the best possible image of the manhole, including cone and corbel sections. In addition, 3 still digital photos shall be taken for each pipe connection within each manhole. The CCTV operator shall zoom in on each pipe connection so the photos capture each pipe connection's size, location, and approximate elevation.
- O. Whenever prevailing conditions allow, position the camera head to reduce the risk of picture distortion. In circular sewers, position the camera lens centrally (i.e., in prime position) within the sewer. In noncircular sewers, picture orientation shall be taken at mid-height, unless otherwise agreed, and centered horizontally. Direct the camera lens along the sewer's longitudinal axis when in prime position. A +/- 10 percent positioning tolerance of the vertical sewer dimension shall be allowed when the camera is in prime position.
- P. Perform television inspections during low flow conditions. The Construction Manager will reject any television inspection that does not produce an effective sewer pipe or service lateral survey due to flow conditions or for any other reason. Sewer flow shall be controlled so that the invert of pipe is fully visible.

3.02 PROCEDURE

- A. The camera shall be moved through the line in either direction at a uniform rate, stopping when necessary to ensure it properly documents the sewer's or service lateral's condition.
1. At no time shall the television camera travel at a speed greater than 30 feet per minute.
 2. To move the camera through the sewer line, use manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera's view or interfere with proper sewer condition documentation.
 3. If the television camera will not pass through the entire main sewer line section during the inspection operation, the equipment shall be removed and repositioned so the inspection can be performed from the opposite manhole.
 4. All set-up costs for the inspection shall be included in the unit prices bid.

- B. The measurement must be accurate to within 0.2 foot for the length of the sewer or service lateral line section being inspected.
1. Significant defect locations that may require internal remediation or excavation or that may prohibit the use of CIPP lining shall be measured and marked above ground using an appropriate measurement device. These defects and markings must be noted on the drawings as they are being marked in the field. The Construction Manager must be notified about the drawings, and a copy of these drawings must be submitted to the Construction Manager within 5 working days after the notes are added to the drawings. The Construction Manager may choose to accompany the Contractor during the marking activity.
 2. Marking on cable or the like, which would require interpolation for manhole depth, shall not be allowed.
 3. Accuracy for the measurement meters shall be checked daily using a walking meter, roll-a-tape, or other suitable device. The accuracy shall be satisfactory to the Construction Manager.
- C. The camera height shall be adjusted so the camera lens is always centered (12-inch inside diameter or larger) in the pipe being televised. Control flow so the flow depth shall not exceed 20 percent of pipe's diameter.
- D. Lighting system shall be adequate for quality video.
- E. At the direction of the Construction Manager, the Contractor shall inspect segments by push camera CCTV inspection from existing cleanouts to the service lateral if a lateral launch from the main is unsuccessful or if the main is excessive in length and requires both views.

3.03 RECORDING FIELD OBSERVATIONS

- A. Television Inspection logs
1. Electronic location records shall be kept which shall clearly show the location, in relation to adjacent manholes, for each discovered infiltration source.
 2. Keep other significant data, including building and house service connection locations, estimated infiltration from such services, transitions, bends, and any significant structural defects or construction features that could pose an issue for the installation, cause any lining defects, or determine the service lateral renewal method and cleanout placement. A copy of such records in a summary spreadsheet format shall be supplied to the Construction Manager prior to initiating work on each segment.
- B. Digital CCTV Video
1. Digital CCTV video shall supply a visual and audio record of the sewer service connections, an estimate for infiltration from such services, and any significant structural defects or construction features that could be an issue for the installation or cause any lining defects or service lateral renewal methodology adjustments.
 2. The Contractor shall provide a digital copy of this video in CUES's GraniteNet format for each pipe segment.
 3. These videos are essential for payment.

4. The Contractor shall keep a copy of the video for 30 days minimum after completing the project.

END OF SECTION

FOR INFORMATION ONLY

SECTION 33 01 53

PIPE BURSTING SEWER LINING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Furnish all labor, materials, equipment, and incidentals required to install and test new high density polyethylene (HDPE) sewer pipe and appurtenances using pipe bursting.
 - 1. Connect new pipe to existing manholes.
 - 2. Modify existing manhole bases as needed.
 - 3. Reconnect existing sewer lateral connections.
 - 4. Perform pre- and post-rehabilitation television inspection
 - 5. Perform all other work as shown on the Drawings.

1.02 DEFINITIONS

- A. Pipe Bursting is a method for replacing existing buried piping by installing a replacement pipe material into an existing host conduit. The actual pipe bursting shall be accomplished by inserting a tool/head with a greater outside diameter than the maximum inside diameter of the existing host conduit which, when advanced pneumatically or mechanically, fragments the existing host conduit and pushes the fragments into the surrounding soil.
- B. Host Conduit is defined as the existing sewer pipeline to be replaced by bursting.
- C. Replacement Pipe is defined as the new inserted diameter SDR 17, ASTM F 714-05, IPS system, HDPE pipe to be installed behind the pipe bursting tool/head to replace the host conduit.

1.03 RELATED WORK

- A. Sewer Line Testing is included in Section 33 30 00.
- B. Sewer Line Cleaning is included in Section 33 35 20.
- C. Television Inspection for pipelines is included in Section 33 01 30.
- D. Maintenance for Sewage Flows and Temporary Bypass Pumping Systems is included in Section 33 01 48.

1.04 SUBMITTALS

- A. Submit in accordance with Section 01 33 00, shop drawings and schedules for all installation equipment, pipe, and appurtenances required. Submit design data and specification data sheets listing all parameters used in the pipe design and thickness calculations based on HDPE. Additional calculations shall include the anticipated pulling forces, equipment pull capability, maximum pulling forces that can be applied to the pipe, and stresses and strains at

manhole connections. All pipe design calculations shall be sealed and signed by a Tennessee registered professional engineer.

- B. Submit the detailed construction method procedures for installing the pipe including a detail for the proposed pipe-to-manhole connection method.
- C. Prior to starting work, submit the following
 - 1. A drawing and layout plans showing the size and location for all proposed pits and excavations required to complete the work. All access pits must be within the easement limits defined on the Drawings. It is assumed the excavations will occur primarily at or near existing manhole locations.
 - 2. A written plan for maintaining sewage service flows for review and approval
 - 3. One copy of the Contractor's record of the pre-bursting condition survey including video and written documentation
 - 4. Qualifications for personnel trained in using butt-fusion equipment and their training in the proper methods for handling and installing the HDPE pipe
 - 5. Project specific Contingency Plan that accounts for obstructions, heave and/or settlement, damage to laterals and other utilities, loss of line and grade, and loss of bursting head
 - 6. Submit the following information for review and approval of the pipe bursting contractor, personnel and manufacturer
 - a. Equipment manufacturer and supplier name for this work. The pipe bursting contractor shall be experienced with the manufacturer's equipment and systems and shall be trained by the pipe bursting manufacturer. Training verification shall be submitted.
 - b. The name for the pipe bursting supervisor who will provide constant full-time direction over all pipe bursting operations

1.05 QUALIFICATIONS

- A. Manufacturer
 - 1. The pipe bursting system manufacturer shall have previously demonstrated its ability to successfully install 1 million feet of pipe minimum via pipe bursting.
 - 2. Pipe bursting system manufacturers shall be TT Technologies, Inc., Aurora, Illinois; TRS Trenchless Replacement Service, LTD, Calgary, Alberta, Canada; Miller Pipeline Corp., Indianapolis, Indiana or approved equal.
- B. Be able to provide equipment and crews as needed to complete the work without delay. The pipe bursting contractor crews shall perform all work associated with the pipe bursting operations.
- C. HDPE pipe jointing shall be performed by personnel trained in using butt-fusion equipment and the required joint procedures for butt-fusion joining the product pipe being used. Qualification for the product pipe size(s) and type(s) shall be submitted and shall be current at the time of the project and when performing pipe jointing. Personnel directly involved with installing the new pipe shall receive training in the proper methods for handling and installing

the product pipe. Such training shall be conducted by a qualified fusion equipment manufacturer or pipe supplier representative.

1.06 AVAILABLE SEWER VIDEOS

- A. The existing sewer lines scheduled for rehabilitation were inspected to the degree possible for pipe conditions by a cleaning and closed circuit television (CCTV) services contractor for Metro.
- B. The electronic files of the CCTV data will be provided FOR INFORMATION ONLY to the awarded bidder.

1.07 QUALITY ASSURANCE

- A. Quality assurance is the workers' sole responsibility during the project's duration. Be responsible for any costs associated with corrective measures required to replace or repair items not meeting the quality standards.
- B. No pipe bursting restoration shall be accepted that has created a sag in the restored line (not previously inherent to the existing line). Correct any sags in the line created by this operation.

1.08 WARRANTY

- A. All pipe bursting shall be fully warranted for a 3-year period from the acceptance date.
- B. During this period, all serious defects impacting flow, structural, or watertight pipe integrity shall be removed and replaced in a satisfactory manner at no cost to Metro.

1.09 WATER

- A. Water for all construction operations shall be available from identified Metro fire hydrants at normal commercial rates.
- B. Water usage shall be in accordance with Metro backflow and metering policies.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Select appropriate pipes and pipe joints to safely carry the loads, including jacking forces, imposed during construction. Pipe joints shall be flush with the outside pipe face when the pipes are assembled. Pipe material shall be ASTM F714-05, light-colored HDPE pipe, IPS system, SDR 17.
- B. Pipe couplings and/or fittings shall be ASTM D3261 HDPE.
- C. Use round pipe with a smooth, even outer surface, which has joints that allow for easy connections between pipes. Pipe ends shall be designed so the bursting loads are evenly distributed around the entire pipe joint and so point loads will not occur when the pipe is installed. Pipe used for pipe bursting shall be able to withstand all forces that will be imposed by the installation process and the final in-place loading conditions.

- D. The pipe bursting equipment may include a bentonite or polymer slurry lubrication system in accordance with the pipe bursting equipment manufacturer's recommendations to reduce friction developed on the replacement pipe surface during insertion.
- E. Electrofusion couplings shall be manufactured by Central, Friale by Friatec or approved equal.

2.02 EQUIPMENT

- A. The pipe bursting contractor shall confirm proper pipe bursting equipment selection which, based on past experience, has proven to be satisfactory in similar geologic conditions for pipe bursting the existing diameter(s) and material(s) of existing pipe(s) with a new HDPE pipe while maintaining accurate line and grade control. Equipment shall generally include a full bodied tool with rear expander and constant tension winch or other method to monitor correct cable tension.
- B. Sound emissions from the pipe bursting replacement process shall be limited to 80 decibels (dB) at 100 feet from the exhaust point of the pipe to be installed during the installation process. The Contractor shall measure noise and shall provide silencers or other devices to reduce equipment and work noise to meet these requirements.
- C. Pipe jacking equipment shall include the following features:
 - 1. Main jacks mounted in a jacking frame located in the starting pit
 - 2. Jacking frame which successively pushes a string of connected pipes towards a receiving pit
 - 3. Sufficient jacking capacity to push the string of pipe through the ground; incorporate intermediate jacking stations, if required
 - 4. At least 20 percent greater capacity than the calculated maximum jacking load
 - 5. Uniformly distributes jacking forces on the pipe's end by using spreader rings and packing, measured by operating gauges
 - 6. Jack Thrust Reactions: Use reactions for pipe jacking that are adequate to counteract the jacking pressure developed by the main jacking system. Special care shall be taken when setting the pipe guide rails in the jacking pit to ensure correct alignment, grade, and stability.

PART 3 - EXECUTION

3.01 MAINTAINING FLOW

- A. Provide for sewage flow diversion and/or bypass pumping during pipe bursting operations as specified in Section 33 01 48.
- B. Be solely responsible for cleanup, repair, property damage costs, and claims resulting from a diversion and/or bypass pumping system failure.

3.02 PREPARATION FOR PIPE BURSTING OPERATIONS

A. Notifying Residents

1. Notify the owners and residents of any homes or businesses whose service lateral will be affected by the lining work.
2. In addition, deliver written notification to each such resident or business 3 days prior to such lining work, further advising of the work.
3. Include in the notifications any restrictions on using the sewage system facilities.
4. Describe exact days and hours when the sewer system cannot be used.

B. Service Connections and Other Existing Utilities

1. Prior to the actual pipe bursting operation, identify and locate active customer service connections by dye testing, CCTV inspection, or other means. Prior to pipe bursting, locate, excavate, expose, and completely disconnect all active service connections. Exercise due diligence when excavating to sufficiently allow the existing pipe to uniformly circumferentially expand through the service connection pit.
2. All buried utilities adjacent to the pipe bursting operation shall be reviewed. Where necessary, utilities shall be excavated to relieve transient loading during the pipe bursting operation. If the Contractor considers any utilities to be too close to the pipe to be burst, excavate a pit at the location to check clearance. If adequate clearance does not exist between the existing sewer line and the subject utility, employ substitute means to rehabilitate the existing sewer line. For utilities crossing near the existing sewer line to be burst, soil shall be excavated and removed to relieve loading during the pipe bursting operation.
3. Be responsible for all costs resulting from damage to utilities during pipe bursting operations.

C. Point Repairs

1. Determine if point repair(s) are required to complete the pipe bursting operations.
2. Inform the Construction Manager with a 24-hour minimum notice prior to each and every point repair.
3. Perform any excavation and repair to prepare the sewer segment for pipe bursting. This includes repairing significant segments of sunken sewer main which would not be corrected during the pipe bursting process, if specified on the Drawings or directed by the Construction Manager.

D. Existing Manholes

1. Connections at existing manholes shall be enlarged before the bursting operation if the new pipe is planned to traverse through the manhole during bursting.
2. The manholes shall be replaced if traversed through to adjacent segments.

E. Concrete Encasements

1. Any concrete encasement shall be excavated and removed prior to the bursting operation to allow pipe bursting head to have a steady and free passage.
2. All in-line valves and fittings shall be removed prior to the pipe bursting operation.

F. Access Pit Locations

1. Excavation, trenching, dewatering, sheeting, shoring, and bracing shall comply with all applicable OSHA, local, and state standards and specifications.
2. Locate and protect existing utilities as required during construction and/or as required by utility companies, Metro, and/or Construction Manager.
3. Sedimentation tubes and silt fence shall be installed at each excavation to prevent damage to wetlands and buffer zones.
4. The size, location, and number for pits shall be determined to facilitate the pipe bursting insertion, minimize excavation and traffic disruption, and shall be submitted prior to construction. All access pits and excavation shall be within the limits defined on the Drawings. Provide the minimum number of pits necessary to satisfactorily complete the work. Pits shall be a sufficient size to allow equipment access and new pipeline installation. Pits shall be centered over the existing sewer and are generally anticipated to occur at each existing manhole location, at manhole construction points, at service connections, or at points where spot repairs need to be performed.
5. Submit any pit relocations and reasons for pit relocation for review. Include any appropriate sketches deemed necessary by the Construction Manager. The Contractor shall be responsible for obtaining all necessary permits as they relate to the relocation should they be approved by Metro.
6. Access pits shall be excavated and constructed as required to allow adequate access width for workers, sheeting and shoring installation, and to provide clearance necessary to avoid damage to the pipe during insertion.
7. Keep all open excavations maintained and secured at all times using barricades, lights, signs, construction tape, or fencing, etc. and/or by other means necessary or as directed by the Construction Manager.

G. Cleaning/Television Inspection

1. Perform the cleaning in accordance with Section 33 35 20 prior to commencing pipe bursting operations.
2. The cleaning shall be to the extent necessary to conduct pipe bursting operations and to televise and identify potential obstructions or other concerns.
3. No additional compensation will be made if additional work is required because the conduit was not sufficiently cleaned.
4. The television inspection work, unless otherwise herein specified, shall be done in accordance with Section 33 01 30.

H. Line Obstructions

1. If pre-installation video (CCTV) inspection reveals an obstruction in the existing sewer (heavy solids, dropped joints, protruding service laterals, protruding utility lines, or collapsed pipe) which cannot be removed by conventional sewer cleaning equipment and will prevent completing the pipe bursting process, the Contractor shall remove the obstruction with the Construction Manager's approval.
2. Obstruction removal shall be performed by digging an obstruction elimination pit and removing by point repair. Collapsed pipe shall be replaced by pipe replacement or by other measures as approved by the Construction Manager.

I. Sags in Line

1. If pre-installation video (CCTV) inspection reveals a sag in the existing sewer that is greater than 1/4 the existing pipe's diameter or causes the CCTV camera lens to be underwater and is not identified on the Drawings, the Construction Manager should be notified to determine if the sag is acceptable or if repair is required.
2. When a sag repair is necessary prior to pipe bursting, the Contractor shall take the necessary measures to eliminate these sags by pipe replacement, by digging a sag elimination pit and bringing the bottom of the pipe trench to a uniform grade in line with the existing pipe invert, or by other measures as approved by the Construction Manager.

3.03 PIPE BURSTING OPERATIONS

A. General

1. Though the installation process may be licensed or proprietary in nature, no change to any material, thickness, design, values, or procedural matters stated in the submittals shall be allowed without the Metro's prior knowledge and approval.
2. Pipe bursting operations, including instances where pipe upsizing is required, shall not cause excessive disruption or heaving to the above ground terrain or improvements.
3. Upon commencing the bursting process, pipe insertion shall be continuous and without interruption from one entry point to another, except as approved by the Construction Manager.
4. If pipe spans between manholes are fused ahead of bursting operations, transport the pipe to the site by using rollers and/or other means that will not damage the pipe's exterior. Contractor shall not drag the pipe to the insertion pit locations.
5. Protect the pipe and joints driving ends against damage.
6. Install pulleys, rollers, bumpers, alignment control devices, and any other equipment required to protect existing manholes and to protect the pipe from damage during installation. Lubrication may be used as recommended by the manufacturer. Under no circumstances shall the pipe be stressed beyond its elastic limit.

B. Pre-bursting Condition Survey

1. Prior to starting pipe bursting, conduct a pre-bursting condition video survey of all existing structures and existing conditions on or within 100 feet of the site. The survey shall include wetland areas, trees and vegetation, existing buildings and homes, roads,

cart paths, and all other significant features. Coordinate activities, issue notices, obtain clearance, and provide whatever assistance is necessary to accomplish the preconstruction video survey.

2. Record observations while surveying each structure's existing conditions.
3. The pre-bursting condition survey record shall include written documentation and photographs for the conditions identified, with appropriate audio description for conditions and defects.
4. Upon completing all pipe bursting, examine any properties, structures, and conditions where damage complaints have been received or damage claims have been filed. Notify all interested parties so they may be present during the final examination.

C. Installing Pipe Bursting Machine and Replacement Pipe

1. The specific type of replacement pipe material described above for HDPE shall be installed in the locations as shown on the Drawings and delineated in these specifications.
2. All sharp edges shall be removed from the exposed pipe opening.
3. The pipe bursting tool shall be pneumatically advanced without interruption through the host conduit from access pit/manhole to access pit/manhole. The replacement pipe shall be advanced pushed, pulled, or both directly behind the tool to fill the void left by the shattered host conduit.
4. In areas where construction site access is limited, existing sewers are deep, or where restrictions on streets are limited and/or lane blockage is prohibited, the Contractor may consider sectional pipe installation (i.e., cartridge style) methods.
5. The bursting head shall be sized so the maximum diameter of the temporary void created by the bursting operation shall not exceed the replacement pipe's maximum outside diameter by greater than 20 percent. The new sewer shall be installed straight along the existing pipeline centerline following the same line and grade.
6. Due to the presence of existing utilities adjacent to the sewer to be replaced, the pipe bursting method shall limit vibrations transmitted to the surrounding soils. The peak particle velocity for ground vibrations resulting from pipe bursting operations shall be limited to 0.5 inches per second.
7. If bentonite or polymer slurry is used, maintain an envelope around the pipe's exterior during the pipe bursting operation to reduce the exterior friction and the possibility of the pipe seizing in place.
8. If the pipe reaches the rejection point (seizes in place) and it is elected to construct a recovery access pit, obtain Construction Manager's approval, then coordinate property access, traffic control measures, and utility adjustments as necessary prior to commencing work. Excavations within delineated wetlands shall be avoided when possible.
9. If a pipe section is damaged during the bursting operation or joint failure occurs as evidenced by inspection, visible groundwater infiltration or other observations, submit methods for repairing or replacing the pipe to the Construction Manager for approval. Repairing pipe sections damaged during bursting operations shall be made at no additional cost to Metro.

10. Allow the new HDPE pipe to return to its original length and shape in the unstressed state and then trim the excess pipe in the manholes. The liner pipe manufacturer's recommendations shall be followed regarding relieving and normalizing stress and strain due to temporary stretching and elongation after pulling operations have been completed. Time allowed for stress and strain relief shall not be less than 24 hours.

D. Work in Existing Manholes

1. After the pipe has been inserted into the entire sewer section length, anchor the pipe at existing manholes. The pipe shall protrude in manholes for enough distance to allow sealing and trimming.
2. After the pipe has been inserted into the entire sewer section length, install new precast manholes as needed or as directed by Construction Manager and as shown on the Drawings.
3. If a new manhole is not shown on the Drawings, restore manhole bottom and invert and repair damage caused by the insertion process. If the Construction Manager deems the damage caused by insertion process not repairable, replace the manhole at no cost to Metro.
4. When the replacement pipe passes through or terminates at an existing manhole, the channel and portion of the base shall be removed as the Contractor deems necessary for the bursting tool to be able to maintain a constant line and grade upstream and downstream of the manhole. The pipe within the existing manhole shall be neatly and completely saw-cut off and not broken or sheared off, to protrude at least 4 inches away from the manhole walls. If the new pipe passes through the manhole, the pipe's top half within the manhole shall be neatly cut off and not broken or sheared off, at least 4 inches away from the manhole walls. The channel in the manhole shall be rebuilt with new concrete and mortar, shall be a smooth continuation of the pipe(s), and shall be merged with other lines or channels, if any. Channel cross section shall be U-shaped with a minimum height to the pipe's crown. The channel sides shall be built up with mortar/concrete to provide benches at a 1 in 12 pitch maximum towards the channel.
5. All cutting and sealing for the new pipe at manhole connections shall provide watertight pipe and manhole trough seals. Connections to manholes will not be made any earlier than 24 hours following the bursting operations. This 24-hour "relaxation period" is intended to allow the pipe temperature to reach equilibrium with the surrounding soil and for the pipe to release stresses imparted during bursting operations. The time period shall be extended based on manufacturer's and/or supplier's recommendations, if required.
6. To seal the pipe at the manhole, provide a flexible gasket connector in the manhole wall at the pipe's end, centered in the existing manhole wall. Grout the flexible connector in the manhole wall filling all voids for the full thickness.
7. The replacement pipe in the manhole shall be locked down and sealed as specified above before proceeding to the next pipe bursting section. All manholes shall be individually inspected by the Construction Manager for replacement pipe cutoffs, benches, and sealing works prior to any additional manhole rehabilitation activities.

E. Service Connections

1. After the replacement pipe has been completely installed and tested, all existing active service laterals shall be reconnected after the liner has been pulled in place, but not permanently before the pipe has been allowed to relax for 24 hours minimum.

2. Connections to the existing service lateral pipe shall be made using reinforced flexible couplings that conform to ASTM C425, such as Fernco Inc. or equal. Joint deflection limits and lateral connections shall meet the maximums indicated in ASTM C12 and C425. The slope for the existing lateral toward the newly installed sewer main shall be maintained at the existing percent.
 3. Sewer connections shall be attached to polyethylene replacement pipe by heat fusion saddles or InsertTees. InsertTees or approved equal may be used for pipes having a 0.36-inch or greater wall thickness. InsertTees shall be "Fatboy" type with hub manufactured of SDR 26 PVC material incorporating a 360 degree integral stop on the hub surface and exceeding ASTM F1336 Section 10.3 Pipe Stop Load Support Test or approved equal. Fusion saddles shall be as manufactured by Central Plastics, Phillips Driscopipe, or equal. Once the saddle is secured in place, drill hole in pipe equal to the saddle outlet's full inside diameter. Connection to PVC or ductile iron pipe replacement pipe shall be accomplished using a compression fit service connection and per pipe manufacturer's and/or supplier's guidance.
 4. Sewer laterals from the connection shall be replaced by excavation to the easement or property line if in rights-of-way with a cleanout installed. For reconstructed laterals, a minimum 2 percent slope is required.
- F. Post-bursting Condition Survey and Television Inspection
1. Following the pipe bursting operations, including work associated with manhole and service connections, conduct final videotaped color television inspection in accordance with Section 33 01 30 for the completed work.
 2. The replacement pipe shall be continuous over the sewer's entire length between 2 manholes and shall be free from visual defects. Defects the Construction Manager determines may affect the pipe's integrity or strength shall be repaired or replaced.

3.04 FIELD TESTING AND ACCEPTANCE

- A. Field acceptance for the new pipeline shall be based on the Construction Manager's evaluation of the installation, including CCTV videos, inspecting the manhole connection, and all pipe and manhole testing results.
- B. Testing shall be required after the replacement pipe has been installed. The replacement pipe shall be tested before it has been sealed in-place at the manholes and before any service reconnections have been made. This test checks the integrity of the joints that have been made and verifies the replacement pipe has not been damaged by inserting it through the host conduit.
- C. Groundwater infiltration into the new pipe, including at the manhole and service connections, shall be zero.
- D. Refer to Section 33 30 10 for air testing requirements for segments replaced through pipe bursting.
- E. All service connections shall be open, clear, and watertight.

3.05 CLEANING AND RESTORATION

A. Cleaning the New Sewer Main Line

1. After evaluating the CCTV videotapes, if the Construction Manager determines the new sewer mainline needs to be cleaned, Contractor shall re-clean the line at no additional cost to Metro.
2. The cleaning shall be done in accordance with Section 33 35 20.

B. Disturbed Areas

1. Upon completing the pipe bursting operation, restore all areas disturbed by these operations including streets, yards, cross country easements, and wetland areas to a condition as good as or better than what existed prior to initiating construction activities.

3.06 CLOSEOUT ACTIVITIES

- #### A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 01 88

SEWER SERVICE LATERAL LINING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Furnish all labor, materials, equipment, and incidentals required to install cured-in-place pipe (CIPP) lining to rehabilitate existing active service laterals as shown on the Drawings or as directed by the Construction Manager. Service laterals shall be lined from the connection with the main sewer to the property line or easement edge, unless otherwise noted or approved by the Construction Manager. A full-wrap style lining shall be used to address the connection between the main sewer and the service lateral.
- B. Furnish all labor, materials, equipment, and incidentals required to conduct air testing, post-rehabilitation CCTV inspections, and other requirements described herein for final service lateral lining acceptance.
- C. This specification shall also apply to installing CIPP lining for service laterals discharging directly into manholes, if the pipe diameter is 6 inches or less.
- D. Service laterals may be a combination of tees, wyes, or break-in taps of varying sizes (4-inch to 8-inch) with angles generally ranging up to 90 degrees. In most cases, a cleanout will be installed at the property line or easement edge.
- E. If any active service laterals are identified as defective and the Contractor is unable to line the lateral from the main sewer to the property line or easement edge, the Contractor shall inform the Construction Manager about the service lateral's condition and shall propose a rehabilitation method that maximizes the service lateral's rehabilitated length while minimizing the extent of surface disruption. The Construction Manager will direct the Contractor as to the acceptable approach for rehabilitating or replacing the service lateral in question.

1.02 RELATED WORK

- A. Sewer line cleaning is included in Section 33 35 20.
- B. Pre-Rehabilitation CCTV sewer inspection is included in Section 33 01 51.
- C. Post-Rehabilitation CCTV sewer inspection is included in Section 33 01 30.
- D. Sewer flow control is included in Section 33 01 48.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:
 - 1. Shop drawings and schedules for all service lateral lining and appurtenances required
 - 2. Design data and specification data sheets listing all parameters used in the lining design

3. Thickness calculations based on ASTM F1216-09, Appendix XI.1.2 for fully deteriorated pipe
 - a. All service lateral lining design calculations shall be sealed and signed by a Tennessee registered professional engineer.
4. Detailed procedure for installing the service lateral lining
5. The service lateral lining manufacturer's name and the facility location where the service lateral lining will be manufactured
6. A licensed and certified trainer and representative from the lining system manufacturer shall be on-site to assist in the work for a minimum of 2 weeks.
7. The Contractor shall be an approved installer as certified and/or licensed by the lining manufacturer.
8. Material Certifications. Written certification is required from the manufacturer stating all materials used in the work were manufactured and tested in accordance with ASTM F1216 and is being used or installed in conformance with the manufacturer's recommendations.
9. Customer Notifications. Submit a copy of the initial customer notification as described in Section 1.08.
10. Storage and Delivery Procedures. Provide the lining manufacturer's recommended storage and delivery procedures. This shall include storage and delivery temperatures, maximum time from wet-out to installation, and other pertinent information.
11. Material Safety Data Sheets. Submit Material Safety Data Sheets (MSDS) for each component of the service lateral lining system.
12. Test Results. Prior to using any materials, furnish the proposed material's test results from an independent laboratory in conformance with these specifications. All submitted test data shall have been performed on field installed samples within the last 12 months. Testing by an independent laboratory shall verify the products to be used meet all minimum strength standards as set forth in ASTM F1216, Table 1. Testing shall also verify any product to be used on the project meets the minimum chemical resistance requirements as established in ASTM F1743, Table 2, where the testing is in accordance with Section 7.2.1 of ASTM F1743.
13. Pipe Cleaning Narrative. Submit a narrative describing in sufficient detail the proposed methods for root cutting and cleaning the existing service laterals. Prepare such narrative to include the degree of cleaning as recommended by the lining manufacturer. Such narrative shall indicate the lining manufacturer's technical representative's approval for the proposed cleaning methods.
14. Lining Thickness Calculations. Perform lining thickness calculations for each set of service laterals for each manhole-to-manhole section and furnish them to the Construction Manager with supporting assumptions. Calculations shall be done after cleaning, televising, and other field inspections have been accomplished. Design parameters shall be used in calculations.

15. Curing Cycle and Cooling Rate. If the service lateral lining is heat-cured, submit the resin manufacturer's recommended curing cycle and the recommended cooling rate. Submit a copy of the cure logs for each service lateral installation.
16. Detrimental Lateral Lining Pipe Conditions. Submit reports to the Construction Manager identifying detrimental conditions or physical pipe configurations that may interfere with or prohibit CIPP lateral lining from the main or maintenance, in compliance with the pre-rehabilitation CCTV tasks as delineated in the Contract Documents.
17. Post-lining Inspection Data. Submit the final television inspection in CUES's GraniteNet in the most current MWS version that shows the rehabilitated service lateral per Section 33 01 30.

1.04 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM)
 1. ASTM D790 – Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
 2. ASTM F1216 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
 3. ASTM F2561 – Standard Practice for Rehabilitation of a Sewer Service Lateral and its Connection to the Main Using a One Piece Main and Lateral Cured-in-Place Liner
 4. ASTM F1743 – Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)
 5. ASTM D2990 – Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
- B. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. The Contractor performing the service lateral lining work shall be experienced and equipped to complete this work expeditiously and in a satisfactory manner.
- B. Be able to provide crews as needed to complete the work without undue delay and within the contract time allotted.
- C. The service lateral lining shall be provided by a single manufacturer. The supplier shall be responsible for providing all test requirements specified herein as applicable.
- D. The Construction Manager may inspect the service lateral lining after delivery. The service lateral lining shall be subject to rejection at any time if it fails to meet any requirements specified, even though sample lining may have been accepted as satisfactory at the manufacturer. Lining rejected after delivery shall be marked for identification and removed from the job site at once.
- E. Final Installed Lining Thickness. The final installed lining thickness shall not be less than or more than 10 percent greater than the required thickness. The final installed lining thickness measurement shall be determined from lining sample coupons retrieved from the sewer, plate

samples or as deemed necessary by the Engineer. It shall be the Contractor's responsibility to consider site conditions and their installation process to determine the proper lining thickness to install.

- F. Non-Compliance. If the flat plate samples do not meet the required 4,500 psi flexural strength and 250,000 psi flexural elasticity modulus as outlined, actual installed samples must be taken. The installed samples shall be taken as directed by the Construction Manager and in accordance with all applicable ASTM requirements. From these samples, the installed thickness shall be determined by taking an average of at least 10 thickness measurements. Installed samples shall then be prepared for re-testing in accordance with these specifications.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Care shall be taken in shipping, handling, and storing to avoid damaging the service lateral lining. Extra care shall be taken during cold weather construction. Any lining damaged in shipment shall be replaced as directed by the Construction Manager.
- B. Any lining showing a split or tear, or which has received a blow that may have caused damage, even though damage may not be visible, shall be marked as rejected and removed at once from the job site.
- C. At all times, the lining materials, including the wet-out lining, shall be maintained at a proper temperature, such as in refrigerated facilities, to prevent premature curing prior to installation. The lining shall be protected from UV light prior to installation. Any lining showing evidence of premature curing will be rejected for use and will be removed from the site immediately.

1.07 PUBLIC NOTIFICATION

- A. Notify the owners and residents of any homes or businesses whose service lateral will be affected by the lining work. Also, deliver written notification to each such resident or business 3 days prior to such lining work, further advising of the work. Include in the notifications any restrictions on using the sewage system facilities. Describe exact days and hours when the sewer system cannot be used. Standard CWNOAP templates for door hangers and excavation notices shall be provided by the Construction Manager. **CONTACT ANY HOME OR BUSINESS THAT CANNOT BE RECONNECTED WITHIN TIME STATED IN THE WRITTEN NOTICE.**
- B. **THE MAXIMUM TIME ANY HOME OR BUSINESS SHALL BE WITHOUT SANITARY SEWER SERVICE IS 10 HOURS and NOT BETWEEN 6:00 PM AND 8:00 A.M. ANY SERVICE OUT LONGER THAN 10 HOURS WILL HAVE SERVICE RESTORED AT CONTRACTOR'S EXPENSE OR TEMPORARY MEASURES TAKEN.**

1.08 GUARANTEE

- A. All lining work shall be fully guaranteed by the Contractor and manufacturer for 3 years from the acceptance date. A written warranty shall be submitted. During this period, all serious defects, including failure of the seal between the service lateral lining and the main sewer, discovered by Metro shall be removed and replaced by the Contractor in a satisfactory manner at no additional cost to Metro. At their own expense, Metro may conduct an independent television inspection of the lining work prior to the guarantee period's completion. Any defects replaced at that time shall be fully guaranteed by the Contractor and manufacturer for one year from the date the defect was repaired. Wrinkles, blisters, dry spots in resin, or other defects in the finished service lateral, which in the Construction Manager's opinion, negatively affect the service lateral's integrity or strength or the pipe's flow capacity or performance of solids passage are unacceptable. Contractor will be responsible to remove and

repair, at Contractor's expense, all such defects in a manner satisfactory to the Construction Manager. Defects also include but are not limited to the following:

1. Leakage through the lining or between lining and pipe
 2. More than 10 percent reduction in the lining thickness
 3. Lining separating from the pipe
 4. Excessive wrinkles inhibiting flow
- B. The lining shall be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The lining shall have a smooth surface free from leaks, cracks, and crazing. Some minor waviness that, in the Construction Manager's opinion, will not appreciably decrease the flow cross-section or affect the flow characteristics shall be permissible.

1.09 WATER

- A. Water for all construction operations shall be available from identified Metro fire hydrants at normal commercial rates.
- B. Water usage shall be in accordance with Metro backflow and metering policies.

1.10 AVAILABLE SEWER VIDEOS

- A. The existing sewer main lines scheduled for rehabilitation were inspected to the degree possible for pipe conditions by a cleaning and CCTV services contractor for Metro.
- B. Electronic files with the video inspections only of the main and connection area FOR INFORMATION ONLY will be provided to the Contractor.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. The service lateral lining shall be a seamless, corrosion-resistant, cured-in-place pipe lining product that seals the service lateral pipe and the junction between the service lateral pipe and main sewer. The portion of the service lateral lining system that connects to the main/lateral interface shall be a full-wrap connection type for pipe sizes 18 inches in diameter and smaller.
- B. The service lateral lining shall be 1) a resin-impregnated, flexible polyester felt, non-woven textile tube, needle punched felt, circular knit or circular braid, glass fiber reinforced plastic, or 2) equivalent material tube which is cured -in-place by an acceptable curing method. The tube shall be able to conform to bends, offset joints, bells, and disfigured pipe sections.
- C. The service lateral shall provide a 50-year service life and shall have the minimum structural properties listed below:

Minimum Structural Properties	
Physical Properties	Minimum Standard
Flexural Strength (ASTM D790)	4,500 psi
Flexural Modulus of Elasticity (ASTM D790)	250,000 psi

- D. The service lateral shall be designed, fabricated, and installed for the actual conditions encountered for this application including the host pipe material, in accordance with the applicable ASTM F1216, ASTM D2990 provisions, and shall meet the following minimum design conditions:
1. AASHTO H-20 live load with two trucks passing
 2. Soil Weight 120 pounds per cubic foot
 3. Friction coefficient $Ku'=0.130$
 4. Estimated maximum groundwater level at ground surface
 5. Fully deteriorated pipe with 2 percent (min.) ovality. If existing pipe's ovality is found to be worse, use actual percent up to 5 percent (max.).
 6. Soil Modulus 1,000 psi
 7. Safety factor = 2
 8. Soil Depth: The cover depth will be determined by field measurements.
- E. The finished lining shall have a 3 mm minimum thickness for 4-inch diameter service laterals and 4.5 mm for 6-inch diameter service laterals.
- F. The service lateral lining shall have sufficient wall thickness to withstand all anticipated external pressures and loads that may be imposed after installation. The design shall be performed and certified by a Tennessee registered professional engineer.
- G. The service lateral lining shall be manufactured and installed by T-Liner by LMK Technologies; SCS+L by BLD Services, LLC; epros DrainMtH System by Trelleborg Pipe Seals Milford, Inc.; or approved equal.
- H. When cured, the service lateral lining shall extend from the mainline into the service lateral connection in a continuous tight fitting, watertight pipe-within-a-pipe to eliminate any visible groundwater leakage and future root growth at the service lateral to mainline connection and along the service lateral. The service lateral product system shall be compatible with the mainline and/or service lateral pipe or lining. The lining portion within the mainline pipe may be a full-wrap connection or style.
- I. When cured, the finished service lateral product shall be chemically resistant to domestic sewage over the rehabilitated pipe's expected lifetime. The lining material and resin shall be completely compatible.
- J. The service lateral lining shall extend 6-inches minimum from the service lateral connection in either direction along the entire circumference of the main sewer.
- K. A leak-free seal must be created to form a sealing bond between the service lateral product and the host service lateral and mainline pipe walls. The Contractor should use either a hydrophilic material or an epoxy-sealing component at each lining tube end to provide a leak-free seal.
- L. When cured, the lining shall form a hard, impermeable lining which is chemically resistant to chemicals found in domestic sewage.

2.02 RESIN

- A. The resin system shall meet the requirements of ASTM F1216, Section 5.2. The resin installed service lateral lining system shall produce a service lateral that will comply with the structural requirements specified herein and shall provide chemical resistance for the flow media in the gravity pipe. The resin shall be compatible with the rehabilitation process, shall be able to cure in water's presence or absence and shall have an initiation temperature for cure as recommended by the resin manufacturer. Unless otherwise specified, provide a general purpose or enhanced strength unsaturated, thermosetting, polyester, vinyl ester, epoxy or silicate resin and a catalyst system compatible with the installation process. The resin shall be vacuum impregnated into the lining.
- B. Submit documentation from the resin manufacturer specifically describing the resin system's chemical characteristics including allowable mixing, impregnation, and handling time, transportation, and storage time, and recommended curing cycle including temperatures, pressures, and times. The resin manufacturer's documentation must also include maximum allowable time for handling the impregnated tube prior to insertion and the maximum allowable elapsed time from insertion to exotherm. If remedial measures are available to extend either of the maximum allowable times indicated above, without affecting the resin's physical properties, the resin manufacturer should describe these measures and the time limits beyond which even these measures will not prevent altering the resin's physical properties.

PART 3 - EXECUTION

3.01 PRE-INSTALLATION

- A. A digital CCTV video inspection must be done on the mainline pipe with a pan and tilt camera and the service lateral to confirm the proposed repair falls within the limitation parameters set by the manufacturer on the following aspects:
 1. The location and clock reference of the service lateral junctions to be lined
 2. Any offsets, any intrusions from the service lateral into the main
 3. Angle at which the connection comes in
 4. Any changes in the service lateral's approach angle for the repair length
 5. Potential flows coming throughout the service lateral pipe
 6. Potential flows going through the main pipe
 7. Diametric connection size for the lining length
 8. Main pipe's size at the service lateral point
 9. Service lateral's condition including the presence of debris, turns, bends, changes in diameter, or other observations
 10. Active infiltration present within the work area vicinity
 11. Any defects noted in the mainline pipe or service lateral should be documented using NASSCO PACP/LACP Standards.

- B. Inform the Construction Manager about service laterals in which a service lateral lining cannot be installed from the main sewer to the cleanout established at the property line or easement line. The Contractor shall identify these service laterals and provide the Construction Manager with documentation about the conditions encountered including the CCTV inspection. If a full-length service lateral lining cannot be installed or a point repair on the service cannot be performed, the Construction Manager may direct the Contractor to install a transition liner or a short service lateral lining with no cleanout required extending up the service lateral from the main. The length is to be field determined to the maximum length possible, but should extend 3 feet minimum up the service lateral from the main.
- C. Inform the Construction Manager about service laterals in which a short length service lateral product cannot be installed. The Contractor shall identify, document, and video record these services and inform the Construction Manager about the conditions encountered. If a short length service lateral lining cannot be installed, the service connection will be “cut and buffed” to restore a 95% minimum service opening.

3.02 LINE PREPARATION

- A. Prior to installing the service lateral product, the area around the service lateral sealing surface in the main and the service lateral shall be inspected. Waste product build-up, hard scale, roots, service lateral cutting debris, or resin slugs must be removed using high-pressure water jetting or in-line cutters. All service laterals to be lined shall be cleaned as required prior to lining. The term “cleaned” shall mean removing all sand, dirt, roots, grease, and other solids or semisolid materials from the interior face of the sewer mainlines and the service laterals.
- B. Built-up deposits on the main and service lateral pipe walls shall be removed. The removal shall reach at least 1 foot beyond the scheduled service lateral installation length to allow the bladder to inflate tightly against the pipe walls ensuring a smooth transition from service lateral product to the existing pipe wall.
- C. Televiser the service lateral to provide a detailed record of existing conditions and service lateral connections. Have a copy of the pre-lining inspections in the field. Immediately prior to lining insertion, the camera shall traverse the service lateral to inspect for debris which may have entered the line after the existing condition inspection.
- D. Where active infiltration is present and when it is recommended by the service lateral lining manufacturer, the infiltration must be stopped in advance by grouting.
- E. Additional precautions need to be taken when applying the sleeve to a main pipe lined with a CIPP lining with a polyolefin coating. The coating is to be lightly scarified, scraping off the coating in the main CIPP in the service lateral lining’s vicinity, and verified by the Construction Manager. This scuffing is mandated for service lateral linings required to adhere to the pipe wall. Service lateral linings with hydrophilic material are not required to have the existing lining scarified.
- F. The Contractor shall be responsible, if needed, for bypassing sewage while installing the service lateral lining product. In cases where the temporary sewage backup is accepted as a replacement for bypassing, the Contractor shall be responsible for all damage caused by sewage backing up into properties or sanitary sewer overflows.

3.03 INSTALLATION

- A. The service lateral lining shall be vacuum-impregnated with resin (wet-out) under controlled conditions. The resin volume used shall be sufficient to fill all voids in the textile lining material at nominal thickness and diameter. The volume shall be adjusted by adding 5% to

10% excess resin for the change in resin volume due to polymerization and to allow for any resin migration into the cracks and joints in the original pipe. All resin shall be contained within the translucent bladder during vacuum impregnations. No dry or unsaturated area in the service lateral tube shall be acceptable upon visual inspection.

- B. The service lateral product shall be loaded on the applicator apparatus, attached to a robotic manipulator device, and positioned at the cleanout or pipe opening of the service connection that is to be rehabilitated. For service lateral full-wrap style linings with compression gaskets, the mainline lining and bladder shall be wrapped around the "T" launching device and held firmly by placing 4 hydrophilic material bands around the main lining. For service lateral full-wrap linings that do not use hydrophilic material, a 300 ml volume adhesive sealant shall be applied to the main/service lateral interface and shall be applied as a 2-inch wide band on the main lining. The robotic device with a television camera shall be used to align the repair product with the service connection opening. The insertion pressure shall be adjusted to fully deploy the service lateral product into the service lateral connection and hold the service lateral product tight to the main and service lateral pipe walls.
- C. The pressure apparatus shall include a bladder with sufficient length in the main and service lateral lines so the inflated bladder extends beyond the ends of the service lateral product's service lateral tube and main line tube, pressing the end edges flat against the internal pipe wall, thus forming a smooth transition from service lateral product to pipe diameters without a step, ridge, or gap between the service lateral product and the service lateral and mainline pipes' inner diameters.
- D. For service lateral linings with hydrophilic materials, the main bladder shall be inflated causing the main sheet to unwrap and expand, embedding the hydrophilic material between the main lining and the main pipe as the main lining is pressed tight against the main pipe.
- E. After insertion is completed, recommended pressure must be maintained on the impregnated service lateral product according to ASTM F1216-09, Sections 7.4.2 and 7.4.3, pressing the lining firmly against the inner pipe wall during the entire curing process. The lining shall be cured at ambient temperatures or by a suitable heat source. In no instance will sewage be used to invert or cure linings or calibration tubes.
- F. The finished service lateral lining shall be free from dry spots, lifts, and delamination. The installed service lateral lining should not inhibit the CCTV post installation video inspection for the mainline and service lateral pipes or future pipe cleaning operations. For service lateral linings with compression gaskets, the CIPP shall taper at each end providing a smooth transition to accommodate video equipment and maintain proper flow in the mainline. In all cases, the finished product must provide an airtight/watertight verifiable non-leaking connection between the main sewer and sewer service lateral. During the warranty period, any defects with the service lateral that affect the service lateral connection's performance, cleaning, or water tightness shall be repaired at the Contractor's expense in a manner acceptable to Metro.
- G. Following the lining installation, provide the Construction Manager with an electronic picture and recorded data identifying the location and showing the completed work and restored condition for all the rehabilitated service laterals from the sewer main to the service reconnection point. The Contractor shall televise the rehabilitated service lateral to provide a detailed record of finished conditions using NASCCO PACP/LACP guidelines. When complete, the Contractor shall submit the rehabilitated service lateral inspections in CUES's GraniteNet in the most current MWS version and the accompanying logs on an external USB hard drive.

3.04 FIELD TESTING AND ACCEPTANCE

- A. The lining's field acceptance shall be based on the Construction Manager's evaluation of the installation including post-lined digital CCTV inspection and reviewing certified test data for the installed pipe samples. The CCTV inspection for each service lateral shall extend 10 feet minimum past the end of the rehabilitation work on the service lateral. For service laterals where a cleanout was installed, the CCTV inspection shall include the cleanout and the connection to the existing, undisturbed service lateral.
- B. The lining shall have zero groundwater infiltration, and each service lateral must pass a 2-minute 4 psi air test conducted by the Contractor as described in Section 33 01 40. Service laterals with a pipe size transition in the run of the service lateral or done as a "blind shot" with no cleanout are not required to be air tested for the service lateral length. The connection area with the main shall be air tested.
- C. A flat plate sample shall be collected at the direction of the Construction Manager for approximately every 50 service lateral installations, and the sample shall be submitted to a third party testing laboratory to confirm strength properties (flexural strength and flexural modulus) in accordance with ASTM F1216. The test results must meet or exceed the design strengths and thickness, or the Contractor must provide a 10% credit for up to 50 of the service laterals the sample represents.
- D. All service connections shall be open, clear, and watertight.
- E. The lining shall have no evidence of splits, cracks, breaks, lifts, kinks, delaminations, or crazing.
- F. If any defective lining is discovered after it has been installed, it shall be removed and replaced by the Contractor with a new lining, a new pipe, or other measures with the Construction Manager's approval at no additional cost to Metro. Any lining installation not meeting specified strengths or thickness shall provide other acceptable remediation measures or credit as approved by the Construction Manager. The re-inspection requirements as listed above shall apply to this re-installed section of line.

3.05 CLEANUP

- A. After the installation work and testing have been accepted, restore the project area affected by the operations to a condition at least equal to what existed prior to the work.

3.06 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 01 89

INTERNAL POINT REPAIRS

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Furnish all labor, materials, equipment, and incidentals required to install internal point repairs to rehabilitate existing sewers with limited defects as shown on the Drawings or as directed by the Construction Manager. The internal point repair shall include either short segments of cured-in-place pipe (CIPP) lining or mechanical stainless steel repair grouting sleeves and shall be installed without excavation or surface disturbance from adjacent manholes. These repairs are intended to address specific, local defects such as fractures, separated/open joints, holes, voids, sheared pipe, infiltration sources, etc., from closed circuit television (CCTV) inspection generally of a singular structural nature and not requiring rehabilitation for the entire manhole-to-manhole length.
- B. Furnish all labor, materials, equipment, and incidentals required to conduct post-rehabilitation CCTV inspections and other requirements described herein for final internal point repair acceptance.

1.02 RELATED WORK

- A. Sewer line cleaning is included in Section 33 35 20.
- B. Pre-Rehabilitation CCTV sewer inspection is included in Section 33 01 51.
- C. Post-Rehabilitation CCTV sewer inspection is included in Section 33 01 30.
- D. Sewer flow control is included in Section 33 01 48.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:
 - 1. Shop drawings and schedules for all internal point repairs required
 - 2. Design data and specification data sheets listing all parameters used in the design
 - 3. Detailed procedure for installing the internal point repair
 - 4. The internal point repair manufacturer's name and the facility location where the internal point repair will be manufactured
 - 5. A licensed and certified trainer from the internal point repair's manufacturer shall be onsite to assist in the work for 2 weeks minimum.
 - 6. The Contractor shall be an approved installer as certified and/or licensed by the manufacturer.
 - 7. Material Certifications. Written certification is required from the manufacturer stating all materials used in the work were manufactured and tested in accordance with applicable

ASTM or AWWA specifications and is being used or installed in conformance with the manufacturer's recommendations.

8. Customer Notifications. Submit a copy of the initial customer notification as described in Section 1.07.
9. Storage and Delivery Procedures. Provide the manufacturer's recommended storage and delivery procedures include storage and delivery temperatures, maximum time from wet-out or grout impregnation to installation, and other pertinent information.
10. Material Safety Data Sheets (MSDS). Submit MSDS for each internal point repair system component.
11. Pipe Cleaning Narrative. Submit a narrative describing in sufficient detail the proposed methods for root cutting and cleaning the existing mains. Prepare such narrative to include the degree of cleaning as recommended by the manufacturer. Such narrative shall indicate the manufacturer's technical representative's approval for the proposed cleaning methods.
12. CIPP Lining Thickness Calculations. When CIPP internal point repairs are to be used, perform lining thickness calculations for each CIPP type internal point repair location according to ASTM F1216 and furnish them to the Construction Manager with supporting assumptions. Calculations shall be done after cleaning, televising, and other field inspections have been accomplished. Design parameters stated herein shall be used in calculations. All CIPP internal point repair design calculations shall be sealed and signed by a Tennessee registered professional engineer.
13. CIPP Curing Cycle and Cooling Rate. If the internal point repair is heat-cured, submit the resin manufacturer's recommended curing cycle and the recommended cooling rate. Submit a copy of the cure logs for each internal point repair installation.
14. Post-Internal Point Repair Inspection Data. Submit the final television inspection in CUES's GraniteNet in the most current MWS version and show the installed internal point repair and adjacent host sewer per Section 33 01 30 and this specification.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM D790: Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
2. ASTM F1216: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by the Inversion and Curing of a Resin-Impregnated Tube
3. ASTM F1743: Standard Practice for Rehabilitation of Existing Pipelines and Conduits by Pulled-in-Place Installation of Cured-in-Place Thermosetting Resin Pipe (CIPP)
4. ASTM D2990: Standard Test Methods for Tensile, Compressive, and Flexural Creep and Creep-Rupture of Plastics
5. AWWA Manual M11: Standard for Flexible Tunnel Liners

B. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. The Contractor performing the internal point repair work shall be experienced and equipped to complete this work expeditiously and in a satisfactory manner.
- B. Be able to provide crews as needed to complete the work without undue delay and within the contract time allotted.
- C. The internal point repair for each type – CIPP Liner or Stainless Steel Sleeves – shall be provided by a single manufacturer.
- D. The final installed CIPP thickness shall be within +/- 10 percent of the required thickness. It shall be the Contractor's responsibility to consider site conditions and their installation process to determine the proper lining or gauge thickness to install.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in shipping, handling, and storing to avoid damaging the internal point repair. Extra care shall be taken during cold and extreme hot weather construction. Any internal point repair damaged in shipment shall be replaced as directed by the Construction Manager.
- B. Any internal point repair showing a split or tear, or which has received a blow that may have caused damage, even though damage may not be visible, shall be marked as rejected and removed at once from the job site.
- C. At all times, the lining materials used for CIPP internal point repairs, including the wet-out lining, shall be maintained at a proper temperature, such as in refrigerated facilities, to prevent premature curing prior to installation. The lining shall be protected from UV light prior to installation. Any lining showing evidence of premature curing will be rejected for use and will be removed from the site immediately.

1.07 PUBLIC NOTIFICATION

- A. Three (3) days prior to beginning the Work, provide written notification to the owners and residents of any homes or businesses whose service will be affected by the Work. Include in the notifications the description of the work being done and any restrictions about using the sewage system facilities specifying the exact days and hours the sewer system may not be used.
- B. Provide copies of the delivered notices to the Construction Manager.
- C. THE MAXIMUM TIME ANY HOME OR BUSINESS SHALL BE WITHOUT SANITARY SEWER SERVICE IS 10 HOURS BETWEEN 8:00 A.M. AND 6:00 P.M. ANY SERVICE OUT LONGER THAN 10 HOURS SHALL HAVE MEASURES TAKEN TO PROVIDE TEMPORARY SERVICE AT CONTRACTOR'S EXPENSE.

1.08 GUARANTEE

- A. All internal point repair work shall be fully guaranteed by the Contractor and manufacturer for 3 years from the acceptance date. A written warranty shall be submitted. During this period, all serious defects including seal failure between the internal point repair and the main sewer shall be removed and replaced by the Contractor in a satisfactory manner at no additional cost to Metro. At its own expense, Metro may conduct an independent television inspection of the internal point repair work prior to the guarantee period's completion. Any defects replaced at

that time shall be fully guaranteed by the Contractor and manufacturer for 1 year from the date the defect was repaired. Wrinkles, blisters, dry spots in resin, unexpanded tabs or other defects in the finished internal point repair, which in the Construction Manager's opinion negatively affect the pipe's integrity, strength, flow capacity, or solids passage performance are unacceptable. The Contractor will be responsible for removing and repairing, at the Contractor's expense, all such defects in a manner satisfactory to the Construction Manager. Defects also include but are not limited to the following:

1. Leakage through the internal point repair or between internal point repair and pipe
 2. Internal point repair separating from the pipe
 3. Collapsed mechanical type sleeves or liners
 4. Non-expanded sleeves or liners with poor end transitions
 5. Excessive wrinkles or other obstructions inhibiting flow through the sewer
- B. The lining for CIPP internal point repairs shall be as free as commercially practicable from visual defects such as foreign inclusions, dry spots, pinholes, and delamination. The CIPP lining shall have a smooth surface free from leaks, cracks, and crazing. Some minor waviness that, in the Construction Manager's opinion, will not appreciably decrease the flow cross section or affect the flow characteristics shall be permissible.
- C. The stainless steel internal point repairs shall be as free as commercially practicable from visual defects. The stainless steel point repair shall have a smooth surface free from leaks, cracks, and transition to the host pipe. Some minor variances that, in the Construction Manager's opinion, will not appreciably decrease the flow cross section or affect the flow characteristics shall be permissible.

1.09 WATER

- A. Water for all construction operations shall be available from identified Metro fire hydrants at normal commercial rates. Water usage shall be in accordance with Metro backflow and metering policies.

1.10 AVAILABLE SEWER VIDEOS

- A. The existing sewer main lines scheduled for rehabilitation were inspected to the degree possible for pipe conditions by a cleaning and CCTV services contractor for Metro. Electronic files including the CCTV inspections only of the main will be provided to the awarded contractor FOR INFORMATION ONLY.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. General
1. The internal point repair shall be designed, fabricated, and installed for the actual conditions encountered for this application including the host pipe material, in

accordance with the applicable ASTM F1216, ASTM D2990 provisions, or AWWA Manual 11 and shall meet the following minimum design conditions:

- a. AASHTO H-20 live load with two trucks passing
 - b. Soil Weight 120 pounds per cubic foot
 - c. Friction coefficient $Ku'=0.130$
 - d. Estimated maximum groundwater level at ground surface or minimum 5 psi external water pressure
 - e. Fully deteriorated pipe with 5 percent (minimum) ovality. If existing pipe's ovality is found to be worse, use actual percent up to 7 percent (maximum). If greater than 7 percent, advise the Construction Manager before proceeding.
 - f. Soil Modulus 1,000 psi
 - g. Safety Factor = 2.5
 - h. Soil Depth: The cover depth will be determined by field measurements.
2. Product shall provide a 50-year service life, and CIPP liners shall have the minimum structural properties listed below:

Physical Properties	Minimum Standard
Flexural Strength (ASTM D790)	4,500 psi
Flexural Modulus of Elasticity (ASTM D790)	300,000 psi

3. The design shall be performed and certified by a Tennessee registered professional engineer and shall have sufficient wall thickness to withstand all anticipated external pressures and loads that may be imposed after installation.
4. The internal point repair shall be installed so a continuous overlap is at the internal point repair and extends 8-inches minimum (12-inches for CIPP) from the defect outer planes along the entire pipe circumference.
5. A leak-free seal must be created to form a sealing bond between the internal point repair product and the mainline pipe walls. The Contractor should use either a hydrophilic material or an epoxy-sealing component to provide a leak-free seal.
6. When cured, the internal point repair shall form a hard, impermeable tight-fitting lining which is chemically resistant to chemicals found in domestic sewage.

B. CIPP

1. The internal point repair by CIPP methods shall be a seamless, corrosion-resistant, CIPP lining product that seals the main sewer as manufactured by LMK – Performance Liner, Steven's Technology – New Life, BLD Services, LLC – CIPP Spot Repair, or approved equal.
2. The CIPP internal point repair shall be a resin-impregnated, flexible polyester felt, non-woven textile tube, needle punched felt, circular knit or circular braid, glass fiber reinforced plastic or equivalent material tube which is cured-in-place by an acceptable

curing method. The tube shall be able to conform to shears, voids, cracks, offset joints, bells, and disfigured pipe sections with allowance for circumferential stretching during installation and bridge missing pipe.

3. The finished CIPP lining shall have a minimum 6 mm thickness and a minimum 30-inch length.
4. When cured, the CIPP internal point repair shall form a continuous tight fitting, watertight pipe-within-a-pipe to eliminate any visible groundwater leakage and future root growth.
5. When cured, the finished CIPP internal point repair product shall be chemically resistant to domestic sewage over the rehabilitated pipe's expected lifetime. The lining material and resin shall be completely compatible.
6. The CIPP resin system shall meet ASTM F1216, Section 5.2 requirements. The resin installed as part of the internal point repair system shall produce an internal point repair that will comply with the structural requirements specified herein and shall provide chemical resistance for the flow media in the gravity pipe. The resin shall be compatible with the rehabilitation process, be able to cure in water's presence or absence, and have an initiation temperature for cure as recommended by the resin manufacturer. Unless otherwise specified, provide a general purpose or enhanced strength unsaturated, thermosetting epoxy, or silicate resin and a catalyst system compatible with the installation process. The resin shall be vacuum impregnated into the lining.
7. Submit documentation from the resin manufacturer specifically describing the resin system's chemical characteristics including allowable mixing, impregnation, and handling time; transportation and storage time; and recommended curing cycle including temperatures, pressures, and times. The resin manufacturer's documentation must also include maximum allowable time for handling the impregnated tube prior to insertion and the maximum allowable elapsed time from insertion to exotherm. If remedial measures are available to extend either of the maximum allowable times indicated above without affecting the resin's physical properties, the resin manufacturer should describe these measures and the time limits beyond which even these measures will not prevent altering the resin's physical properties.

C. Stainless Steel Sleeves

1. The alternative internal point repair by stainless steel sleeve methods shall be a fabricated SST-316 tabbed flare, locking body, corrosion-resistant, pipe lining product with foam grout infiltration carrier and grout that seals the main sewer. Up to 3 sleeve sections, to a maximum 6-foot length, may be used to address a single pipe defect, if installed according to the manufacturer's instructions and will be considered one unit.
2. The stainless steel liner shall be minimum 24-gauge and a minimum 16-inch length.
3. The stainless steel sleeve type internal point repair shall be manufactured by Link-Pipe, Inc. – Sewer Sealer Sleeve, or approved equal.

PART 3 - EXECUTION

3.01 PRE-INSTALLATION

- A. A digital CCTV video inspection must be performed on the mainline pipe with a pan and tilt camera to confirm the proposed repair falls within the limitation parameters set by the manufacturer, including, but not limited to, the following:
 1. Any offsets or intrusions into the main
 2. Potential flows going through the main pipe
 3. Main pipe's size at the internal point repair location
 4. Condition including the presence of debris, changes in diameter, or other observations
 5. Active infiltration present within the work area vicinity
 6. Any defects noted in the mainline pipe should be documented using NASSCO PACP/LACP Standards.
- B. Inform the Construction Manager about defects or other pipe conditions which would prevent an internal point repair from being installed. The Contractor shall identify these locations and provide the Construction Manager with documentation about the conditions encountered including the CCTV inspection.

3.02 LINE PREPARATION

- A. Prior to installing the internal point repair product, the area around the sealing surface in the main shall be inspected. Waste product build-up, hard scale, roots, and debris must be removed using high-pressure water jetting or in-line cutters. All defects to be internally repaired shall be cleaned as required prior to installation. The term "cleaned" shall mean removing all sand, dirt, roots, grease, and other solids or semisolid materials from the interior face of the sewer mainlines in the identified defect's vicinity.
- B. Built-up deposits on the main pipe walls shall be removed. The removal shall reach at least 2 feet beyond the scheduled internal point repair installation length to allow the bladder to inflate tightly against the pipe walls ensuring a smooth transition from internal point repair product to the existing pipe wall.
- C. Where active infiltration is present and when it is recommended by the internal point repair manufacturer, the infiltration must be stopped in advance by internal injection grouting.
- D. The Contractor shall be responsible for controlling sewer flows in accordance with Section 33 01 48 while installing the internal point repair product. The Contractor shall be solely responsible for cleanup, repair, property damage costs, and claims resulting from their operations.

3.03 INSTALLATION

- A. The CIPP internal point repair shall be vacuum-impregnated with resin (wet-out) under controlled conditions. The resin volume used shall be sufficient to fill all voids in the textile lining material at nominal thickness and diameter. The volume shall be adjusted by adding 5 percent to 10 percent excess resin for the change in resin volume due to polymerization and to allow for any resin migration into the cracks and joints in the original pipe. All resin shall

be contained within the translucent bladder during vacuum impregnations. No dry or unsaturated area in the lateral tube shall be acceptable upon visual inspection.

- B. The internal point repair product shall be loaded on the applicator apparatus, attached to a robotic manipulator device, and positioned at the defect to be rehabilitated. The robotic device with a television camera shall be used to longitudinally align the repair product with the defect. The insertion pressure shall be adjusted to fully deploy the internal point repair product and hold the internal point repair product tight to the host main pipe walls.
- C. The pressure apparatus shall include a bladder with sufficient length in the main so the inflated bladder extends beyond the ends of the internal point repair product's main line tube, pressing the end edges flat against the internal pipe wall, thus forming a smooth transition from internal point repair product to pipe diameters without a step, ridge, or gap between the internal point repair product and the mainline pipe inner diameter.
- D. For internal point repairs with hydrophilic materials, the main bladder shall be inflated causing the main sheet to unwrap and expand, embedding the hydrophilic material between the main lining and the main pipe as the main lining is pressed tight against the main pipe.
- E. After insertion is completed, recommended pressure must be maintained on the impregnated internal point repair product, pressing the lining firmly against the inner pipe wall during the entire curing process. The CIPP lining shall be cured at ambient temperatures or by a suitable heat source. In no instance will sewage be used to invert or cure linings or calibration tubes.
- F. The finished internal point repair shall be free from dry spots, lifts, sharp edges, intruding defects, and delamination. The installed internal point repair should not inhibit the CCTV post installation video inspection for the mainline or future pipe cleaning operations. Internal point repairs shall taper at each end providing a smooth transition to accommodate video equipment and maintain proper flow in the mainline. In all cases, the finished product must provide an airtight/watertight verifiable non-leaking connection for the main sewer. During the warranty period, any defects with the internal point repair that affect the performance, cleaning, or water tightness shall be repaired at the Contractor's expense in a manner acceptable to Metro.
- G. Following the internal point repair installation, the Contractor shall televise the rehabilitated main beginning 10 feet upstream from the start of the internal point repair location and extending to the downstream manhole. CCTV inspection shall be completed according to NASSCO PACP guidelines. When complete, the Contractor shall submit the CCTV inspection data in CUES's GraniteNet in the most current MWS version on DVDs or an external USB hard drive.

3.04 FIELD TESTING AND ACCEPTANCE

- A. The internal point repair field acceptance shall be based on the Construction Manager's evaluation of the post-installation digital CCTV inspection.
- B. The internal point repair shall have zero groundwater infiltration.
- C. All service connections in the point repair or immediately adjacent area shall be open, clear, and watertight.
- D. The internal point repair shall have no evidence of defects, which in the Construction Manager's opinion negatively affect the pipe's integrity, strength, flow capacity, or solids passage performance.

- E. If any defective internal point repair is discovered after it has been installed, it shall be removed and replaced by the Contractor with a new internal point repair, a new pipe, or other measures with the Construction Manager's approval at no additional cost to Metro. The re-inspection requirements as listed above shall apply to this re-installed section of line.

3.05 CLEANUP

- A. After the installation work and testing have been accepted, restore the project area affected by the operations to a condition at least equal to what existed prior to the work.

3.06 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 01 90

INTERNAL POINT REPAIRS (LARGE DIAMETER PIPE > 18-INCHES)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Furnish all labor, materials, equipment, and incidentals required to install internal point repairs to rehabilitate existing large diameter sewers with limited defects as shown on the Drawings or as directed by the Construction Manager. Large diameter sewers are defined as having a nominal diameter greater than 18-inches. The internal point repair shall include a flexible rubber membrane with stainless steel retaining bands and shall be installed without excavation or surface disturbance from adjacent manholes. These repairs are intended to address specific, local defects such as abandoned lateral connections, holes, voids, infiltration sources, etc., from closed circuit television (CCTV) inspection and not requiring rehabilitation for the entire manhole-to-manhole length.
- B. Furnish all labor, materials, equipment, and incidentals required to conduct pre- and post-rehabilitation CCTV inspections and other requirements described herein for final internal point repair acceptance.

1.02 RELATED WORK

- A. Sewer line cleaning is included in Section 33 35 20.
- B. Pre-Rehabilitation CCTV sewer inspection is included in Section 33 01 51.
- C. Post-Rehabilitation CCTV sewer inspection is included in Section 33 01 30.
- D. Sewer flow control is included in Section 33 01 48.
- E. Internal point repair of small diameter pipe is included in Section 33 01 89.

1.03 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:
 - 1. Shop drawings and schedules for all internal point repairs required
 - 2. Design data and specification data sheets listing all parameters used in the design
 - 3. Detailed procedure for installing the internal point repair
 - 4. The internal point repair manufacturer's name and the facility location where the internal point repair will be manufactured
 - 5. A licensed and certified trainer from the internal point repair's manufacturer shall be onsite to assist in the work for 2 weeks minimum.
 - 6. The Contractor shall be an approved installer as certified and/or licensed by the manufacturer.

7. Material Certifications. Written certification is required from the manufacturer stating all materials used in the work were manufactured and tested in accordance with applicable ASTM or AWWA specifications and is being used or installed in conformance with the manufacturer's recommendations.
8. Customer Notifications. Submit a copy of the initial customer notification as described in Section 1.07.
9. Storage and Delivery Procedures. Provide the manufacturer's recommended storage and delivery procedures include storage and delivery temperatures, maximum time from wet-out or grout impregnation to installation, and other pertinent information.
10. Material Safety Data Sheets (MSDS). Submit MSDS for each internal point repair system component.
11. Pipe Cleaning Narrative. Submit a narrative describing in sufficient detail the proposed methods for root cutting and cleaning the existing mains. Prepare such narrative to include the degree of cleaning as recommended by the manufacturer. Such narrative shall indicate the manufacturer's technical representative's approval for the proposed cleaning methods.
12. Post-Internal Point Repair inspection data. Submit the final television inspection in a Granite XP compatible database that shows the installed internal point repair and adjacent host sewer per Section 33 01 30 and this specification.

1.04 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM)

1. ASTM A240: Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
2. ASTM C150: Standard Specification for Portland Cement
3. ASTM D1171: Standard Test Method for Rubber Deterioration—Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens)
4. ASTM D2000: Standard Classification System for Rubber Products in Automotive Applications
5. ASTM D2240: Standard Test Method for Rubber Property – Durometer Hardness
6. ASTM D3568: Standard Test Methods for Rubber – Evaluation of EPDM (Ethylene Propylene Diene Terpolymers) Including Mixtures With Oil
7. ASTM D3900: Standard Test Methods for Rubber-Determination of Ethylene Units in Ethylene-Propylene Copolymers (EPM) and in Ethylene-Propylene-Diene Terpolymers (EPDM) by Infrared Spectrometry
8. ASTM D395: Standard Test Methods for Rubber Property—Compression Set
9. ASTM D412: Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension

10. ASTM D562: Standard Test Method for Consistency of Paints Measuring Krebs Unit (KU) Viscosity Using a Stormer-Type Viscometer
11. ASTM D573: Standard Test Method for Rubber—Deterioration in an Air Oven

B. American Welding Society (AWS)

1. AWS A5.14: Specification for Nickel and Nickel-Alloy Bare Welding Electrodes and Rods
2. AWS A5.22: Specification for Stainless Steel Electrodes for Flux Cored Arc welding and Stainless Steel Flux Cored Rods for Gas Tungsten Arc Welding

- C. Where reference is made to one of the above standards, the revision in effect at the time of the bid opening shall apply.

1.05 QUALITY ASSURANCE

- A. The Contractor performing the internal point repair work shall be experienced and equipped to complete this work expeditiously and in a satisfactory manner.
- B. Be able to provide crews as needed to complete the work without undue delay and within the contract time allotted.
- C. The internal point repair shall be provided by a single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Care shall be taken in shipping, handling, and storing to avoid damaging the internal point repair. Extra care shall be taken during cold and extreme hot weather construction. Any internal point repair damaged in shipment shall be replaced as directed by the Construction Manager.
- B. Any internal point repair showing a split or tear, or which has received a blow that may have caused damage, even though damage may not be visible, shall be marked as rejected and removed at once from the job site.

1.07 PUBLIC NOTIFICATION

- A. Three (3) days prior to beginning the Work, provide written notification to the owners and residents of any homes or businesses whose service will be affected by the Work. Include in the notifications the description of the work being done and any restrictions about using the sewage system facilities specifying the exact days and hours the sewer system may not be used.
- B. Provide copies of the delivered notices to the Construction Manager.
- C. THE MAXIMUM TIME ANY HOME OR BUSINESS SHALL BE WITHOUT SANITARY SEWER SERVICE IS 10 HOURS BETWEEN 8:00 A.M. AND 6:00 P.M. ANY SERVICE OUT LONGER THAN 10 HOURS SHALL HAVE MEASURES TAKEN TO PROVIDE TEMPORARY SERVICE AT CONTRACTOR'S EXPENSE.

1.08 GUARANTEE

- A. All internal point repair work shall be fully guaranteed by the Contractor and manufacturer for 3 years from the acceptance date. A written warranty shall be submitted. During this period, all serious defects including seal failure between the internal point repair and the main sewer shall be removed and replaced by the Contractor in a satisfactory manner at no additional cost to Metro. At its own expense, Metro may conduct an independent television inspection of the internal point repair work prior to the guarantee period's completion. Any defects replaced at that time shall be fully guaranteed by the Contractor and manufacturer for 1 year from the date the defect was repaired. Wrinkles, blisters, dry spots in resin, unexpanded tabs or other defects in the finished internal point repair, which in the Construction Manager's opinion negatively affect the pipe's integrity, strength, flow capacity, or solids passage performance are unacceptable. The Contractor will be responsible for removing and repairing, at the Contractor's expense, all such defects in a manner satisfactory to the Construction Manager. Defects also include but are not limited to the following:
1. Leakage through the internal point repair or between internal point repair and pipe
 2. Internal point repair separating from the pipe
 3. Collapsed rubber membrane / retaining band
 4. Non-expanded retaining band with poor end transitions
 5. Obstructions inhibiting flow through the sewer
- B. The internal point repairs shall be as free as commercially practicable from visual defects. The point repair shall have a smooth surface free from leaks, cracks, and transition to the host pipe. Some minor variances that, in the Construction Manager's opinion, will not appreciably decrease the flow cross section or affect the flow characteristics shall be permissible

1.09 WATER

- A. Water for all construction operations shall be available from identified Metro fire hydrants at normal commercial rates. Water usage shall be in accordance with Metro backflow and metering policies. Metro water usage costs shall be compensated at no markup from the water usage allowance item established in the contract.

1.10 AVAILABLE SEWER VIDEOS

- A. The existing sewer main lines scheduled for rehabilitation were inspected to the degree possible for pipe conditions by a cleaning and CCTV services contractor for Metro. Electronic files including the CCTV inspections only of the main will be provided to the awarded contractor FOR INFORMATION ONLY.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General

1. The internal point repair shall be Weko Seal[®] manufactured by Miller Pipeline Corporation, or approved equal.

2. The internal point repair shall be designed, fabricated, and installed for the actual conditions encountered for this application including the host pipe material.
3. The internal point repair shall be installed so a continuous overlap is at the internal point repair and extends 8-inches minimum from the defect outer planes along the entire pipe circumference.
4. A leak-free seal must be created to form a sealing bond between the internal point repair product and the mainline pipe walls. The Contractor should use an epoxy-sealing component to provide a leak-free seal, as recommended by manufacturer.
5. The internal point repair shall be chemically resistant to chemicals found in domestic sewage.

B. Manufacturing Process

1. Extrusion process used for belt material.
2. All joints to be transfer molded.
3. Vulcanization shall occur at 330°F with 2000-psi pressure.
4. Manufactured to Miller Pipeline drawing numbers, 3600 0000 0149, 3600 0000 0248, and 3600 0000 0347.
5. All material specifications must be certified.
6. Material Safety Data Sheet (MSDS) must be provided.

C. Flexible Rubber Membrane

1. The flexible rubber membrane shall be manufactured in compliance with ASTM D3900 and D3568 and shall have designation of M4AA710A13B13C12Z1Z2Z3 in accordance with ASTM D2000, where Z1, Z2, and Z3 are defined as follows:
 - a. Suffix Z1: The material shall be an EPDM polymer where all ingredients are listed in FDA Title 21 Code of Federal Regulations Section 177.2600 Rubber Articles Intended for Repeated Use with the final material not supporting microbiological growth when used in potable water or sea water or in humid aerobic conditions.
 - b. Suffix Z2: The volume change of the rubber shall not exceed 3% after immersion in fresh or seawater at 100°C for 70 hours.
 - c. Suffix Z3: The stress relaxation shall not exceed 12% when tested from the time of 30 minutes to 24 hours in accordance with British Standard Method of Testing Vulcanized Rubber Part A42 determination of stress relaxation
2. The EPDM material shall have the following properties:

<u>Physical Properties</u>	<u>Specification</u>	<u>Typical Results</u>
Durometer (pts) ASTM D-2240	70 ± 5	72
Tensile (psi) ASTM D-412	1,450 min.	1,700
Elongation (%) ASTM D-412	250 min.	400

Suffix A13 (ASTM D-573): Heat Aged 70h 70°C

<u>Physical Properties</u>	<u>Specification</u>	<u>Typical Results</u>
Durometer (pts)	± 15	± 6
Tensile change, (%)	± 30	± 4
Elongation change, (%)	- 50 max.	- 22

Suffix B13 (ASTM D-395B): Compression Set, 22h 70°C

<u>Physical Properties</u>	<u>Specification</u>	<u>Typical Results</u>
(%) Permanent set	25 max.	13

Suffix C12 (ASTM D-1171)

<u>Physical Properties</u>	<u>Specification</u>	<u>Typical Results</u>
(%) Ozone resistance	85 min.	100

Suffix Z1

<u>Physical Properties</u>	<u>Specification</u>	<u>Typical Results</u>
EPDM/FED REG. 177.26	Listed	Listed

Suffix Z2 (FLUID AGING D471): 70 hrs. @ 100°C

<u>Physical Properties</u>	<u>Specification</u>	<u>Typical Results</u>
(%) Volume swell in water	3 max.	1

Suffix Z3

<u>Physical Properties</u>	<u>Specification</u>	<u>Typical Results</u>
Stress relaxation, 100% Elongation 10-min., 10 min. Rest, (%)		+4

- The flexible banded rubber internal membrane shall be classified ANSI/NSF Standard 61 “Drinking Water System Components Health Effects.”

D. Stainless Steel Retaining Band

- All bands, wedges, shims, and set screws for securing rubber membrane across piping joints shall be UNS S30400 (Type 304), UNS S31600 (Type 316), UNS S31603 (Type 316L), or UNS N08367 (AL-6XN) and shall conform to ASTM A240 Standard Specifications for heat-resisting chromium and chromium-nickel stainless steel plate, sheet, and strip for pressure vessels. The weld wire ER316, ER316L shall conform to AWS A5.22 and Alloy 625 (ERNiCrMo-3) shall conform to AWS A5.14.
- All material such as push tabs, shims, and wedges shall be made compatible with the base metal selected.
- Welding wire used for selected base metal:

Retaining Band	Weld Wire
UNS S30400 (Type 304)	ER316
UNS S31600 (Type 316)	ER316
UNS S31603 (Type 316L)	ER316L
UNS N08367 (AL-6XN)	ERNiCrMo-3

4. The retaining band shall be rolled to the radius of the pipe that being repaired. The radius shall be obtained from measurement data acquired from the inspection report. Each band to be checked on a fixed radius gauge.
5. The cleated ends shall be manufactured from the same lot number as the band. Certified welders shall make all shop and field welds with a minimum of 2 years' experience on this alloy (T-304). The welds shall be made with a stick or wire of T-316 alloy, as mentioned in the above table.
6. Welding shall be accomplished in using either gas metal arc welding or shielded metal arc welding.
7. All material specifications shall be certified.
8. All material sourcing and manufacturing is performed in the U.S.A.
9. All shims to be manufactured to the radius of the pipe and shall be 16-22 gauge x 2" x 6" composed of the same alloy selection as band material. All edges shall be deburred.
10. All retaining bands to be manufactured from stainless steel materials with the following minimum physical properties:

Physical Properties	Type 304	Type 316	Type 316L	Type AL-6XN
UNS Designation	S30400	S31600	S31603	N08367
Tensile Strength (min.)	75,000 psi	75,000 psi	70,000 psi	100,000 psi
Yield Strength (min.)	30,000 psi	30,000 psi	25,000 psi	45,000 psi
Elongation in 2in (min.)	40%	40%	40%	30%
Brinell Hardness (max.)	202	217	217	233
Weld Wire Tensile Strength (min.)	80,000 psi	70,000 psi	70,000 psi	110,000 psi

11. The retaining bands shall be made from the material selection above or designed from a material that will meet the customer's requirement. Typical selection is Type 304 for potable water, Type 316/316L for wastewater conditions, and AL-6XN for seawater environments. These materials have been selected for their exceptional physical properties as well as their ability to resist corrosion when subject to said environment.

E. Cement Mortar

1. Cement Mortar for pipe joint sealing and preparation shall be the fast setting type suitable for sea water, wet/dry conditions. Cement mortar shall be as specified in ASTM-C150.

F. Liquid Joint Lubrication

1. Liquid joint lubricant to assist in installation of the flexible banded rubber internal membrane and retaining bands shall be a non-toxic vegetable based lubricating gel with the following required properties:
 - a. Will not deteriorate or decompose while in storage for a minimum of two years.
 - b. A soft pasty consistency suitable for use intended from 0°F to 120°F.
 - c. Does not have any deteriorating effect on natural or synthetic rubber gaskets.

- d. Will not impart taste or odor to water.
- e. Has no objectionable odor.
- f. Is non-toxic and does not support the growth of bacteria.
- g. PH – 9.6 minimum – 11 maximum (pH Meter)
- h. Method of test, Modified ASTM-D562-55
- i. Does not contain any petroleum based oils or grease.
- j. Does not contain any material considered toxic.

G. Thread Sealing Compound

- 1. Thread sealing compound shall be a non-toxic Paste Type with “Teflon”.
- 2. Teflon Components Required Properties:

Physical Data	
Flash Point	410 degrees F closed cup
Density	1.4 – 1.42
Viscosity	200,000 – 275,000 centipoises
Temperature Range	-50 degrees F to 500 degrees F
Pressure Application	Maximum 10,000 psi

PART 3 - EXECUTION

3.01 PRE-INSTALLATION

- A. A digital CCTV video inspection must be performed on the mainline pipe with a pan and tilt camera to confirm the proposed repair falls within the limitation parameters set by the manufacturer, including, but not limited to, the following:
 - 1. Any offsets or intrusions into the main
 - 2. Location and size of existing lateral connections to be abandoned
 - 3. Potential flows going through the main pipe and/or abandoned lateral connection
 - 4. Main pipe’s size at the internal point repair location
 - 5. Condition including the presence of debris, changes in diameter, or other observations
 - 6. Active infiltration present within the work area vicinity
 - 7. Any defects noted in the mainline pipe should be documented using NASSCO PACP/LACP Standards.
- B. Inform the Construction Manager about defects or other pipe conditions which would prevent an internal point repair from being installed. The Contractor shall identify these locations and provide the Construction Manager with documentation about the conditions encountered including the CCTV inspection.

3.02 LINE PREPARATION

- A. Prior to installing the internal point repair product, the area around the sealing surface in the main shall be inspected. Waste product build-up, hard scale, roots, and debris must be removed using high-pressure water jetting or in-line cutters. All defects to be internally repaired shall be cleaned as required prior to installation. The term “cleaned” shall mean removing all sand, dirt, roots, grease, and other solids or semisolid materials from the interior face of the sewer mainlines in the identified defect’s vicinity.
- B. Built-up deposits on the main pipe walls shall be removed. The removal shall reach at least 2 feet (or more if recommended by the manufacturer) beyond the scheduled internal point repair installation length to ensure a smooth transition from internal point repair product to the existing pipe wall.
- C. Where active infiltration is present and when it is recommended by the internal point repair manufacturer, the infiltration must be stopped in advance by internal injection grouting.
- D. The Contractor shall be responsible for controlling sewer flows in accordance with Section 33 01 48 while installing the internal point repair product. The Contractor shall be solely responsible for cleanup, repair, property damage costs, and claims resulting from his operations.

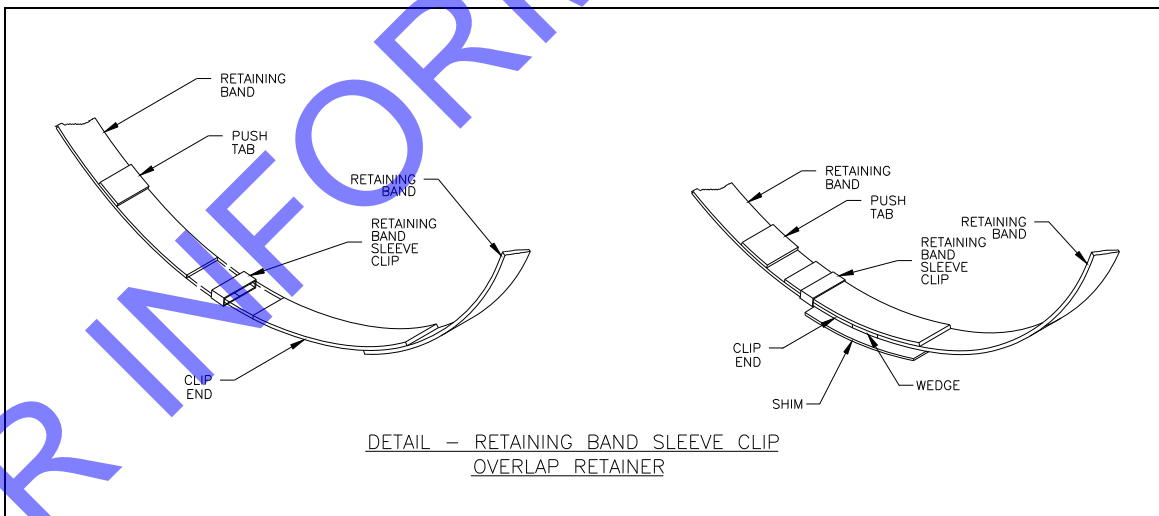
3.03 INSTALLATION

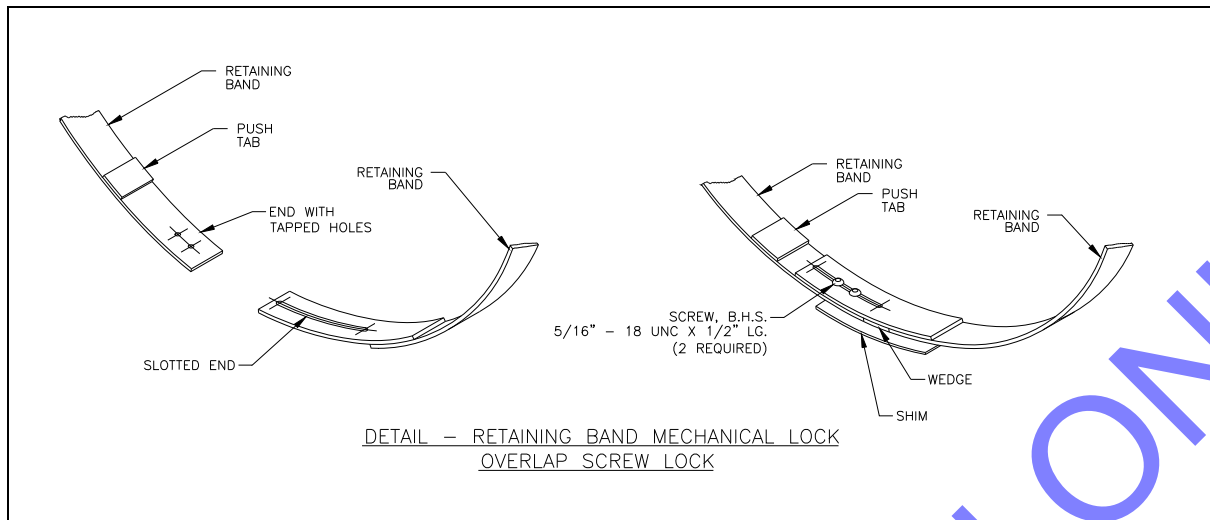
- A. Manufacturer’s preparation and installation guidelines shall be followed at all times.
- B. Fill joint(s) to the full depth of the gap with a quick-setting cement mortar and render flush with the surrounding joint surface. All surplus material spillage shall be removed from the joint area. Surface preparation, mixing, placement, and curing of the quick-setting cement mortar shall be performed in accordance with the manufacturer’s placement guidelines.
- C. All high/low surface imperfections running axially through or part way through the sealing surface must be removed before installation of the seals. Any joint gaps, low areas, or deep imperfections must be properly filled with approved non-toxic joint filler and rendered smooth to suite the prepared surface of the joint area. When the pipe is concrete or reinforced concrete, it may be necessary to apply a thin layer of quick-setting cement mortar to the preparation area where the seal will be placed. This cement will control pipe porosity and irregularities to provide an effective leak test on the completed seal.
- D. Verify that the sealing surface surrounding the joint area and the area where the “lip seals” are to be seated is free of debris and smooth.
- E. Mark the locations of the lip seals on the pipe ID to clearly define the seal installation position.
- F. Lubricate prepared seal area with “Ease-On Pipe Lubricant.” The lubricant shall be hand applied (using a brush) over the prepared area. Care must be taken not to acquire debris from the surrounding unprepared surfaces into the lubricant and thereby reintroducing debris to the prepared surface. The lubricant functions as an aid in fitting the seal and is not credited with pressure retention. “Ease-On Pipe Lubricant” is a brand name typically used by Miller Pipeline; however, other approved lubricant of equivalent composition is acceptable.
- G. Position the flexible banded rubber internal membrane parallel to the joint gap with the pressure test valve located at approximately 3 o’clock or 9 o’clock position. The seal must be

positioned accurately on the joint areas guided by the marks established in Paragraph 3.03E above.

- H. Install a metal radiused shim underneath the wedge area in the seal grooves for each retaining band before placement of the stainless steel bands on the seal. These shims enable radial loads to be transmitted evenly to the seal as the bands are expanded.
- I. Install the upstream and downstream stainless steel retaining bands into position by placing in designated seal grooves. If additional bands are required per manufacturer's recommendations, placement of additional retaining bands shall be placed according to Paragraph 3.03.R. Since retaining bands can be of one-piece, two-piece, or three-piece construction depending on pipe diameter, a retainer clip is to be used to restrain band movement during expansion. In certain design applications as recommended by manufacturer, a special mechanical locking device shall be used to temporarily lock the bands before expansion. See reference drawing details in Paragraph 3.03.V.
- J. Position the hydraulic expander device in line with the retaining bands while ensuring that the retaining bands remain in position and do not become moved or dislodged. Care must be taken to ensure that the expander is positioned correctly on the bands.
- K. Expand the stainless steel retaining bands using the hydraulic expander, holding pressure for at least two minutes. Expansion pressure range should be known before performing this operation and is available via expansion pressure chart for the designated seal size. Extreme caution should be taken to ensure that recommended expansion pressures are not exceeded, resulting in pipe and/or seal damage.
- L. Install a radiused-locking piece (wedge) in the exposed gap between the expanded band ends. The wedge size shall be selected to provide interference fit. Tap the wedge into position, locking in the compression of the seal. Release the pressure from the hydraulic expander after wedge is secure.
- M. Perform a second expansion for each of the retaining bands a minimum of 30 minutes after the first expansion using the same pressure range as the first expansion. This allows for any seal relaxation that may occur. If required, replace wedge piece with a larger size to provide interference fit.
- N. Torque the mechanical locking device to 15 inch-pounds, if required by manufacturer as noted in Paragraph 3.03.I.
- O. Perform a pressure test on the seal sections after a minimum of 30 minutes has elapsed after final fitting of the seal to be tested. A restraining device called a "test band" is to be utilized when needed for standard and extra-wide seal sizes to prevent excessive ballooning.
 - 1. Pressurize seal to 10 psig through the seal test valve. Apply an approved soap and water solution to the seal ends and inspect for leakage.
 - 2. If the pressure test indicates leakage, determine cause and repeat steps outlined in Paragraphs 3.03.A through 3.03.D.
- P. Perform a second pressure test at a lower pressure with the test band removed.
 - 1. Pressurize to 5 psig through the test valve. Apply an approved soap test solution to the entire surface of the seal. This lower pressure leak test is primarily used to check for seal defects such as seal punctures.

2. Inspect for leakage. If the pressure test indicates leakage, remove seal, replace with new seal and follow steps outlined in Paragraphs 3.03.A through 3.03.D.
- Q. Depressurize seal and isolate test port. Seal the “test valve” with a countersunk hex head completion screw using an approved thread sealing compound. Remove all installation hardware, and pressure gauges.
- R. If installation of a middle-retaining band is required per manufacturer’s recommendations, between the upstream and downstream bands, install the middle-retaining band in accordance with steps outlined in Paragraphs 3.03.H through 3.03.M. NOTE that the seals do not have a designated positioning groove for the middle-retaining band. Install the middle-retaining band upstream of the test port. Pressure testing is not required after performing this step.
- S. The finished internal point repair shall be free from sharp edges and intruding defects. The installed internal point repair should not inhibit the CCTV post installation video inspection for the mainline or future pipe cleaning operations. Internal point repairs shall taper at each end providing a smooth transition to accommodate video equipment and maintain proper flow in the mainline. In all cases, the finished product must provide an airtight/watertight verifiable non-leaking connection for the main sewer. During the warranty period, any defects with the internal point repair that affect the performance, cleaning, or water tightness shall be repaired at the Contractor’s expense in a manner acceptable to Metro.
- T. Following the internal point repair installation, the Contractor shall televise the rehabilitated main beginning 10 feet upstream from the start of the internal point repair location and extending to the downstream manhole. CCTV inspection shall be completed according to NASSCO PACP guidelines. When complete, the Contractor shall submit the CCTV inspection data in a Granite XP-compatible database on DVDs or an external USB hard drive.
- U. REFERENCE DRAWING DETAILS





3.04 FIELD TESTING AND ACCEPTANCE

- A. The internal point repair field acceptance shall be based on the Construction Manager's evaluation of the post-installation digital CCTV inspection.
- B. The internal point repair shall have zero groundwater infiltration.
- C. All service connections in the immediately adjacent area of the point repair shall be open, clear, and watertight.
- D. The internal point repair shall have no evidence of defects, which in the Construction Manager's opinion negatively affect the pipe's integrity, strength, flow capacity, or solids passage performance.
- E. If any defective internal point repair is discovered after it has been installed, it shall be removed and replaced by the Contractor with a new internal point repair, a new pipe, or other measures with the Construction Manager's approval at no additional cost to Metro. The re-inspection requirements as listed above shall apply to this re-installed section of line.

3.05 CLEANUP

- A. After the installation work and testing have been accepted, restore the project area affected by the operations to a condition at least equal to what existed prior to the work.

3.06 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 05 16.17

VALVE BOXES, METER BOXES, AND VAULTS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope (1.02)
- C. Submittals (1.03)
- D. Measurement and Payment (1.04)

1.02 SCOPE

- A. Precast valve boxes, meter boxes, sewer cleanout boxes, and vaults.
- B. This Section does not include Metro Public Works and Tennessee Department of Transportation (TDOT) structures.

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittals.
- B. Submit manufacturer's product data for proposed valve boxes, meter boxes, cleanout boxes, and vaults for approval.
- C. Furnish shop drawings and notarized certificates of inspection stating that the valve boxes, meter boxes, sewer cleanout boxes and/or vaults were constructed and satisfactorily tested for the conditions present on-site regarding loadings and are in full compliance with these Specifications.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Furnish valve boxes, sewer cleanout boxes, and meter boxes in accordance with MWS' published Approved Materials List.
- B. Provide a minimum 4000 psi, 28-day compressive strength precast concrete sections of the sizes and configurations indicated on the Drawings, complete with reinforcement to support an AASHTO H-20 vehicle loading for valve boxes, meter boxes, and vaults.
- C. For valve boxes, sewer cleanout boxes, and meter boxes, provide precast concrete footing blocks of the size, configuration, and quantity indicated on the Drawings and provide Portland cement in conformance with the latest revision of ASTM C-150 Type 1 for use in establishing a full mortar bed to set the casting..

- D. Provide sound, smooth, blemish free cast iron castings in conformance with the latest revision of ASTM A48, Class 30, with support of an AASHTO H-20 loading for vehicles and of the sizes and configurations indicated on the Drawings.
- E. Provide sound, smooth, blemish free HDPE small size sewer cleanout boxes and solid green co-polymer cover boxes, Carson #1015 or approved equal, of the sizes and configurations indicated on the Drawings.
- F. Provide hand ground contact surfaces for the cast iron covers and frames so that the cover rests securely on the frame without movement and is in contact with the frame for the entire perimeter of the contact surface.
- G. Provide casting covers with the required identification indicated on the Drawings.
- H. Provide vaults and vault lids as indicated on the Drawings.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install valve boxes, meter boxes, sewer cleanout boxes, and vaults plumb and flush with the existing ground surface unless otherwise indicated on the Drawings.
- B. For vaults, remove unstable soil at the base, if discovered, and refill area with appropriate material. Notify and receive approval from the Construction Manager for the refill material to be used and prior to undercutting and removing undesirable material at the base.

END OF SECTION

SECTION 33 11 00.11

POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope
- C. Submittals
- D. Measurement and Payment

1.02 SCOPE

- A. Polyvinyl chloride (PVC) pipe and fittings
- B. PVC pipe, joints, and fittings for low pressure sanitary sewers and gravity sewer mains
- C. PVC pipe and joints for sewer force mains

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittals.
- B. Submit manufacturer's product data for proposed PVC pipe, joints, and fittings for approval.
- C. Furnish shop drawings and a statement from the factory inspector stating that the pipe was constructed and satisfactorily tested in full compliance with these specifications.
- D. Furnish shop drawings and a statement from the factory inspector stating that the joints, joint materials, specials, and fittings were constructed and satisfactorily tested in full compliance with these specifications.
- E. Provide the Construction Manager with access to observe all testing, if requested, and submit certified copies of all test results prior to requesting the shipment of pipe and fittings shipment.
- F. Submit certification from the manufacturer verifying conformance with the latest revision of the applicable ASTM Standards.

1.04 MEASUREMENT AND PAYMENT

- A. Compensation for PVC pipe and fittings is not addressed in this section; refer to gravity sewer mains and/or low pressure sanitary sewers specification sections.
- B. Consider all requirements in this section to be incidental to the Work with no separate payment allowed.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide PVC pipe laying nominal lengths of 14 or 20 feet for gravity sewer mains and 20 feet for low pressure sanitary sewers and force mains.
- B. Provide PVC pipe with Styrene Butadiene Rubber (SBR) gaskets in conformance with the latest revision of ASTM F477.
- C. Provide Cell Classification 12454 A or 12454 B PVC manufactured in conformance with the latest revision of ASTM D1784.
- D. Provide piping marked with diameter, manufacture's name, or trademark, pressure pipe type, grade and class to be clearly visible.
- E. Provide Green Type P solvent cement conforming to the latest revision of ASTM D2564.

2.02 GRAVITY SEWER MAINS

- A. Furnish PVC pipe, fittings, and accessory materials for gravity sewer mains in accordance with MWS' published Approved Materials List.
- B. Provide SDR 35 or SDR 26 PVC pipe and fittings as indicated on the Drawings.
- C. For pipe 15 inches and smaller, provide pipe and fittings in conformance with the latest revision of ASTM D3034 with a pipe stiffness in conformance with the latest revision of ASTM D 3412 and a pipe joint in conformance with the latest revision of ASTM D3212.
- D. For pipe 18 inches and larger, provide pipe and fittings in conformance with the latest revision of ASTM F679 with a pipe stiffness in conformance with the latest revision of ASTM D3412 and a pipe joint in conformance with the latest revision of ASTM D3212 for 18-inch and larger.
- E. Provide SDR 35 or SDR 26 PVC full body injection molded or factory fabricated fittings and double wye cleanout assemblies.

2.03 LOW PRESSURE SANITARY SEWERS FOR SIZES EQUAL TO OR LESS THAN 1 ¼"

- A. Provide PVC Solvent Weld Pressure SDR 21 pipe manufactured in strict accordance with the latest revision of ASTM D2241 for physical dimensions and tolerances.
- B. Provide fittings with the same pressure rating required for the pipe.
- C. Provide certifications of each production run of pipe manufactured stating that the pipe meets or exceeds the ASTM test requirements for materials, workmanship, burst pressure, impact resistance, flattening, and extrusion quality conforming to the latest revision of ASTM D2241.
- D. Provide belled end pipe with tapered sockets to create an interference type fit meeting dimensional requirements and the minimum socket length for pressure-type belled sockets conforming to the latest revision of ASTM D2672.
- E. Provide piping with a #12 AWG, high strength copper clad steel conductor with HDPE insulation rated for direct burial. Provide wire to be brought up into the valve box at 1,000 feet maximum intervals and taped to the top of the force main at minimum 10-foot intervals.

2.04 LOW PRESSURE SANITARY SEWER FOR SIZES GREATER THAN 1 ¼” AND LESS THAN 4”

- A. Provide Type 1, Grade 1 or 2 PVC SDR 21 pipe manufactured in strict accordance with the latest revision of ASTM D2241 for physical dimensions and tolerances and joints in accordance with the latest revision of ASTM-D3139.
- B. Provide fittings with the same pressure rating required for the pipe.
- C. Provide certification of each production run of pipe manufactured stating that the pipe meets or exceeds the ASTM test requirements for materials, workmanship, burst pressure, impact resistance, flattening, and extrusion quality conforming to the latest revision of ASTM D2241.
- D. Provide pipe in nominal lengths of 20 feet.
- E. Provide single rubber gasket push-on (bell and spigot) joints designed so that the pipe and fittings may be connected without the use of solvent cement or any special equipment.
- F. Provide solvent welded type joints for clean out assemblies.
- G. Provide piping with a #12 AWG, high strength copper clad steel conductor with HDPE insulation rated for direct burial. Provide wire to be brought up into the valve box at 1,000 feet maximum intervals and taped to the top of the force main at minimum 10-foot intervals.

2.05 SEWER FORCE MAIN 4” AND LARGER

- A. PVC Pipe up to 24 Inches in Diameter: ASTM C900/C905. Bell and spigot ends shall conform to ASTM D3139 with flexible elastomeric seals seated in internal groove.
- B. Fittings to conform to requirements specified for epoxy lined ductile iron pipe fittings.
- C. Provide C900 PVC force mains with minimum DR 18 (PC150psi) and C905 minimum DR 26(PR 160psi)
- D. Provide fittings with the same pressure rating required for the pipe.
- E. Provide certifications for each production run of pipe manufactured stating that the pipe meets or exceed the ASTM test requirements for materials, workmanship, burst pressure, impact resistance, flattening, and extrusion quality conforming to the most recent revision of ASTM C900/C905.
- F. Provide single rubber gasket push-on (bell and spigot) joints designed so that the pipe and fittings may be connected without the use of solvent cement or any special equipment.
- G. Provide piping with a #12 AWG, high strength copper clad steel conductor with HDPE insulation rated for direct burial. Provide wire to be brought up into a valve box at 1,000 feet maximum intervals and taped to the top of the force main at minimum 10-foot intervals.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 33 11 13.13

DUCTILE IRON PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope
- C. Submittals
- D. Measurement and Payment

1.02 SCOPE

- A. Ductile Iron Pipe (DIP), Joints and Fittings
- B. Ductile iron pipe, joints and fittings for water mains, sewer force mains, and gravity sewer mains

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittals.
- B. Submit manufacturer's product data for proposed pipe, joints, joint materials, specials, coatings, paint for exterior piping, and fittings for approval.
- C. Furnish shop drawings and a notarized statement from the factory inspector, stating that the pipe was constructed and satisfactorily tested in full compliance with these specifications.
- D. Furnish shop drawings and a notarized statement from the factory inspector, stating that the joints, joint materials, specials, and fittings were constructed and satisfactorily tested in full compliance with these specifications.
- E. Provide the Construction Manager with access to observe all testing, if requested, and submit certified copies of all test results prior to requesting the shipment of pipe and fittings.
- F. Submit a certificate of inspection stating that the pipes were hydrostatically tested to a minimum of 500 psi for a minimum of 5 seconds in conformance with the most recent revision of AWWA Standard C151.
- G. For pipes 30 inches and larger submit a certificate of inspection stating that the pipes were subjected to a pressure equal to 75% of the 42,000 psi minimum yield strength for ductile iron pipe.
- H. Submit certification from the manufacturer verifying conformance with the most recent revision of the applicable AWWA Standards.

1.04 MEASUREMENT AND PAYMENT

- A. Compensation for ductile iron pipe and fittings is not addressed in this section; refer to water mains, gravity sewer mains, and/or sewer force mains specification sections.
- B. Consider all requirements in this section to be incidental to the Work with no separate payment allowed.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide ductile iron pipe, fittings, and accessory materials that meet the requirements of NSF 61, Drinking Water System Components – Health Effects.
- B. Provide ductile iron pipe laying nominal lengths of 18 or 20 feet.
- C. Furnish ductile iron pipe and fittings from manufacturers in accordance with MWS' published Approved Materials List.
- D. Provide gasket lubricant in accordance with the manufacturer's instructions, NSF 61, and in conformance with the most recent revision of AWWA Standard C111.
- E. Gray iron fittings are not allowed.

2.02 DUCTILE IRON PIPE AND FITTINGS FOR WATER MAINS

- A. Provide Pressure Class 350 ductile iron pipe for all pipe sizes in conformance with the most recent revision of AWWA Standard C151.
- B. Provide an interior cement mortar lining with asphaltic seal coating for all pipe, joints, and fittings in conformance with the most recent revision of AWWA Standard C104.
- C. For buried pipe, provide an exterior asphaltic coated surface, joints, and fittings in accordance with the most recent revision of AWWA Standard C151.
- D. For non-buried pipe, provide an exterior protective coating in accordance with the most recent revisions of AWWA Standard C151 with the following:
 - 1. Clean, dry, remove all existing paint and black coating, and sandblast with non-silica media for surface preparation in accordance with NAPF 500-3 Standard.
 - 2. Apply TNEMEC N69(F) - Hi-Build Epoxoline II or approved equal at 4.0-6.0 mils for 1st coat.
 - 3. Apply TNEMEC N69 - Color Hi-Build Epoxoline II or approved equal at 4.0-6.0 mils for intermediate coat.
 - 4. Apply TNEMEC 1074/1075 Endura Shield Dark Blue or approved equal at 2.0-3.0 mils for finished coat.
 - 5. Do not coat nameplates, brass, or stainless steel surfaces.

- E. For sizes 24 inches in diameter and smaller, provide restrained joints and fittings with a minimum pressure rating of 350 psi in conformance with the most recent revisions of AWWA Standard C110, AWWA Standard C111, and AWWA Standard C153.
1. Provide Fast-Grip® joints, Field Flex-Ring® joints, Field LOK 350® joints, or approved equal for buried pipe in sizes 4” to 24”.
 2. Provide Fast-Grip® fittings, Field Flex-Ring® fittings, Field LOK 350® fittings or mechanical joint fittings with Mega-Lug® or approved equal restraint for buried pipe in sizes 4” to 24”.
 3. For fittings at fire hydrants and valves provide mechanical joint fittings with Mega-Lug® or approved equal restraint.
 4. Provide flanged joints and fittings in above ground or vault applications.
- F. For sizes greater than 24 inches in diameter, provide restrained joints and fittings with a minimum pressure rating of 250 psi in conformance with the most recent revisions of AWWA Standard C110, AWWA Standard C111 and AWWA Standard C153.
1. Provide HP LOK® joints, TR Flex® joints, Flex-ring® joints, LOK-Ring® joints or approved equal for buried pipe in sizes greater than 24”.
 2. Provide HP LOK® fittings, TR Flex® fittings, Flex-ring® fittings, LOK-Ring® fittings or mechanical joint fittings with Mega-Lug® or approved equal restraint for buried pipe in sizes greater than 24”.
 3. For fittings at fire hydrants and valves, provide mechanical joint fittings with Mega-Lug® or approved equal restraint.
 4. Provide flanged joints and fittings in above ground or vault applications.

2.03 DUCTILE IRON PIPE AND FITTINGS FOR GRAVITY SEWERS

- A. Provide minimum Pressure Class 150 ductile iron pipe for all pipe sizes in conformance with the most recent revision of AWWA Standard C150 and AWWA Standard C151.
- B. Provide interior 40 mil dry film thickness Protecto 401 Ceramic Epoxy, Perma Shield 431 PL or approved equal for all pipe and fitting sizes in conformance with the most recent revision of ASTM E 96 Method A; ASTM B 117; ASTM G 95, ASTM G 8; NACE TM 0174; ASTM G 210; an abrasion resistance test using European Standard EN 598: 2007+ A1:2009; and a thickness test using SSPC-PA2.
- C. Provide an exterior asphaltic coated surface on all buried pipe and fittings in accordance with the most recent revision of AWWA Standard C151.
- D. For sizes 24” and below, provide push-on type single joints with styrene butadiene rubber (SBR) gaskets with a minimum pressure rating of 150 psi in conformance with the most recent revision of AWWA Standard C110, AWWA Standard C111, AWWA Standard C150, AWWA Standard C151, and AWWA Standard C153.
- E. For sizes greater than 24 inches in diameter, provide push-on type single joints with styrene butadiene rubber (SBR) gaskets with a minimum pressure rating of 150 psi in conformance with the most recent revision of AWWA Standard C110, AWWA Standard C111, AWWA Standard C150, AWWA Standard C151, and AWWA Standard C153.

- F. Within casing pipe, for sizes 24 inches in diameter and smaller, provide Fast-Grip® joints, Field Flex-Ring® joints, Field LOK 350® joints, or approved equal restrained joints with a minimum pressure rating of 150 psi in conformance with the most recent revisions of AWWA Standard C110, AWWA Standard C111, and AWWA Standard C153.
- G. Within casing pipe, for sizes greater than 24 inches in diameter, provide HP LOK® joints, TR Flex® joints, Flex-ring® joints, LOK-Ring® joints or approved equal restrained joint with a minimum pressure rating of 150 psi in conformance with the most recent revisions of AWWA Standard C110, AWWA Standard C111, and AWWA Standard C153.

2.04 DUCTILE IRON PIPE FOR WASTEWATER FORCE MAINS

- A. Provide a minimum Pressure Class 150 ductile iron pipe for all pipe sizes in conformance with the most recent revision of AWWA Standard C151.
- B. Provide interior 40 mil dry film thickness Protecto 401 Ceramic Epoxy, Perma Shield 431 PL, or approved equal for all pipe and fitting sizes in conformance with the most recent revision of ASTM E 96 Method A; ASTM B 117; ASTM G 95, ASTM G 8; NACE TM 0174; ASTM G 210; an abrasion resistance test using European Standard EN 598: 2007+ A1:2009; and a thickness test using SSPC-PA2.
- C. For buried pipe, provide an exterior asphaltic coated surface, joints, and fittings in accordance with the most recent revision of AWWA Standard C151.
- D. For non-buried pipe, provide an exterior protective coating in accordance with the most recent revisions of AWWA Standard C151 with the following:
 - 1. Clean, dry, remove all existing paint and black coating, and sandblast with non-silica media for surface preparation in accordance with NAPF 500-3 Standard.
 - 2. Apply TNEMEC N69(F) Hi-Build Epoxoline II or approved equal at 4.0-6.0 mils for 1st coat.
 - 3. Apply TNEMEC N69 Color Hi-Build Epoxoline II or approved equal at 4.0-6.0 mils for intermediate coat.
 - 4. Apply TNEMEC 1074/1075 Endura Shield Dark Blue or approved equal at 2.0-3.0 mils for finished coat.
 - 5. Do not coat nameplates, brass, or stainless steel surfaces.
- E. For sizes 24 inches in diameter and smaller if designated on the Drawings, provide restrained joints and fittings with a minimum pressure rating of 150 psi in conformance with the most recent revisions of AWWA Standard C110, AWWA Standard C111, and AWWA Standard C153.
 - 1. Provide Fast-Grip® Joints, Field Flex-Ring® Joints, Field LOK 350® Joints, or approved equal for buried pipe in sizes 4" to 24".
 - 2. Provide Fast-Grip® Fittings, Field Flex-Ring® Fittings, Field LOK 350® Fittings, or Mechanical Joint Fittings with Mega-Lug® or approved equal restraint for buried pipe in sizes 4" to 24".
 - 3. Provide flanged joints and fittings or disassembly couplings in above ground or vault applications as shown on the Drawings.

F. For sizes greater than 24 inches in diameter if designated on the drawings, provide restrained joints and fittings with a minimum pressure rating of 150 psi in conformance with the most recent revisions of AWWA Standard C110, AWWA Standard C111 and AWWA Standard C153.

1. Provide HP LOK® Joints, TR Flex® Joints, Flex-ring® Joints, Lok-Ring® Joints, or approved equal for buried pipe in sizes greater than 24”.
2. Provide HP LOK® Fittings, TR Flex® Fittings, Flex-ring® Fittings, Lok-Ring® Fittings, or Mechanical Joint Fittings with Mega-Lug® or approved equal restraint for buried pipe in sizes greater than 24”.
3. Provide flanged joints and fittings or disassembly couplings in above ground or vault applications as shown on the Drawings.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 33 12 16.19

AIR RELEASE AND VACUUM RELIEF VALVES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope (1.02)
- C. Submittals (1.03)
- D. Measurement and Payment (1.04)

1.02 SCOPE

- A. Air release valves, vacuum relief valves, and combination air valves for water and wastewater piping systems.

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittals.
- B. Submit manufacturer's product data for proposed valves for approval.
- C. Furnish shop drawings and notarized certificates of inspection, stating that the valves were constructed and satisfactorily tested in full compliance with these specifications.
- D. Submit valve start up report after installation.
- E. Submit a detailed schedule of valves for more complex installations.

1.04 MEASUREMENT AND PAYMENT

- A. MWS will compensate for furnishing and installing air release, vacuum relief valves, or combination air valves, manholes and vaults at the contract unit price per each for the unit installed complete and ready for operation if a unit price bid item is established. If there is not such a bid item, merge all costs, and no separate payment will be made.
- B. Include costs for piping, isolation valves, connections to main, materials, equipment, labor, excavation, backfill, manhole or valve box, casting, hatches, fittings, rodding, testing, service, and all incidentals necessary for a complete and operable installation.

PART 2 - PRODUCTS

2.01 AIR RELEASE AND VACUUM RELIEF VALVES

- A. Provide combination air release and vacuum relief valves in conformance with the most recent revision of AWWA Standard C512.

- B. Provide valves in conformance with the Safe Water Drinking Act, ANSI/NSF 61 Drinking Water System Components – Health Effects.
- C. Furnish combination air release and vacuum relief valves from A. R. I. Model D-020, DeZurik/APCO Model 300.00 or manufacturers in accordance with MWS’ published Approved Materials List.
- D. Provide bodies and covers made of 316 stainless steel.
- E. Use Pressure Class 150.
- F. For valve sizes 2 inches and smaller, provide connections to the valve conforming to the requirements for tapered pipe threads for general use per ASME B1.20.1.
- G. For valve sizes greater than 2 inches, provide flanged connections to the valve per ASME B16.42.
- H. Furnish 316 stainless steel cover bolts, nuts, float balls, and guides.
- I. Provide properly sized orifices for the required service conditions.
- J. Provide air release valves with a port to allow reverse direction capability.
- K. Provide internal and external coatings per MWS’ or manufacturer’s recommendations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install the type and size air release, vacuum relief, and/or combination valves with orifice sizes and isolation valves as indicated on the Drawings with the actual location subject to field verification and adjustment.
- B. Provide the services of the manufacturer’s field representative during installation to ensure that the valve is installed, tested, and brought into operation properly.

END OF SECTION

SECTION 33 30 10

SANITARY SEWERAGE UTILITIES – SMALL DIAMETER (< 36-INCHES)

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Work under this Section includes providing all labor, material, equipment, tools, and services required to furnish, install, construct, test, and/or abandon sanitary gravity sewers, pressure pipelines, and/or appurtenances.

1.02 RELATED SECTIONS

- A. Section 01 14 14 – Control of Work
- B. Section 01 25 00 - Substitution Procedures
- C. Section 01 29 01 - Measurement and Payment (Unit Prices)
- D. Section 01 29 02 – Measurement and Payment (Lump Sum Projects)
- E. Section 01 43 00 – Quality Requirements

1.03 REFERENCES

- A. Where materials and methods are indicated in these specifications as being in conformance with a standard specification, it shall refer to the latest edition of the specifications and shall include all interim revisions. Listing a standard specification without further reference indicates the particular material or method shall conform to such listed specification.
 - 1. American Water Works Association (AWWA)
 - a. C-210: Ductile Iron Coal-Tar Epoxy Coating
 - b. C-500: Gate Valves 3" through 48" for Water and Sewerage Systems
 - c. C-600: Installation of Ductile-Iron Water Mains
 - 2. American National Standards Institute (ANSI)
 - a. A-21.4: Cement Mortar Lining for Ductile Iron and Gray Iron Pipe and Fittings for Water
 - b. A-21.10: Ductile-Iron and Gray Iron Fittings, 3"-48" for Water and Other Liquids
 - c. A-21.11: Rubber Gasket Joints for Ductile Iron and Gray Iron Pressure Pipe Fittings
 - d. A-21.51: Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-lined Molds, for Water or Other Liquids
 - 3. ASTM International
 - a. A-48: Ductile Iron Castings

- b. C-33: Standard specification for concrete aggregates
- c. C-39: Compressive Strength of Cylindrical Concrete Specimens
- d. C-172: Concrete Testing
- e. C-478: Precast Reinforced Concrete Manhole Sections
- f. C-923: Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes
- g. C-1619: Specifications for Rubber Gaskets
- h. D-3034: Type PSM Polyvinyl chloride (PVC) Sewer Pipe and Fittings
- i. D-3212: Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
- j. D-2412: Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
- k. D-638: Test Method for Tensile Properties of Plastics
- l. D-695: Standard Test Method for Compressive Properties of Rigid Plastics
- m. F-477: Specification for Elastomeric Seals (Gaskets) for joining Plastic Pipe

1.04 SUBMITTALS

- A. Submit the following in accordance with Section 01 33 00:
 - 1. Pipe materials
 - 2. Precast manholes
 - 3. Manhole frame and covers
 - 4. Pipe fittings
 - 5. Pipe couplings
 - 6. Pipe thrust restraint
 - 7. Valves
 - 8. Accessories
 - 9. Appurtenances
- B. Manufacturer's Certificate: Certify the products meet or exceed specified requirements.
- C. Instructions: Provide manufacturer's installation instructions.
- D. Factory Test Reports: Provide results from all testing performed as indicated in Subparagraph – Factory Testing.

- E. Material Test Reports: Provide results from all testing performed as indicated in Subparagraph – Material Testing.
- F. Construction Test Reports: Provide results from all testing performed as indicated in Subparagraph – Construction Testing.
- G. Project Record Documents: Provide marked-up drawing set showing actual locations for piping, manholes/structures, valves, connections, thrust restraints, and invert elevations. Identify and describe unexpected variations to subsoil conditions or discovered uncharted utilities.

1.05 MATERIAL TESTING

- A. Required tests shall be done by an independent testing laboratory selected by the Contractor and approved by the Construction Manager. All tests shall be at the Contractor's expense, and no separate payment shall be allowed.
- B. Where the total quantity of sanitary sewer pipe including all pipe sizes is less than 1,000 feet, the pipe shall be visually inspected by the Construction Manager at the site for conformance to the specifications.
- C. Where the total pipe quantity, including all sizes exceeds 1,000 feet, tests shall be performed by an independent laboratory for conformance with the specifications. Tests shall be conducted on 0.5 percent of the number for each pipe size, but in no case less than two specimens for each size. Mill certification shall be required.
- D. The number and manner of sewer pipe joint tests for conformance to the specifications shall be the same as required for the sewer pipe.
- E. All materials to be incorporated in the sanitary sewers and appurtenances construction shall be subject to inspections and tests.

1.06 FACTORY TESTING

- A. Manufacturer shall perform pressure testing on every pipe section for sizes greater than or equal to 18-inches in accordance with the applicable AWWA/ANSI/ASTM standards. Results shall be submitted to Construction Manager prior to pipe installation.
- B. Acceptance for all pipes, joints, fittings and other materials shall in part be based on receiving a written certification. This certification shall include a copy of the manufacturer's test report or a statement by the seller, accompanied by a copy of the test results, stating the material has been sampled, tested, and inspected in accordance with applicable provisions in AWWA/ANSI/ASTM standards. Each certification furnished shall be signed by the seller's authorized agent or manufacturer and be submitted to the Construction Manager.

PART 2 - PRODUCTS

2.01 GRAVITY SANITARY SEWER PIPE

A. Polyvinyl Chloride (PVC) Pipe

1. The PVC pipe shall be:
 - a. 6-inch through 15-inch diameters
 - 1) Solid wall SDR35 in conformance with the latest ASTM D3034 revisions
 - b. 18-inch through 30-inch diameters
 - 1) Solid wall SDR35 in conformance with the latest ASTM F-679 revisions
 - c. Laying lengths shall be regular commercial lengths not to exceed 13-feet.
2. PVC sewer pipe delivered to the project shall bear the mark of an approved testing laboratory showing such pipe was tested and approved at the manufacturing plant. PVC pipe testing shall conform to ASTM D3034, and certified test reports shall be furnished to the Construction Manager.
3. Joint Material for PVC Sewer Pipe
 - a. PVC joint material shall be elastomeric flexible type with push-on joints conforming to ASTM D-3212 requirements and shall be assembled in accordance with manufacturer recommendations.
 - b. Furnish technical and construction data for PVC jointing material for review in accordance with Section 01 33 00 prior to incorporating the jointing material into the work.

B. Ductile Iron Pipe (DIP)

1. Ductile iron pipe and fittings shall conform to ANSI 21.51/AWWA C-151 and ANSI A21.10/AWWA C-110 requirements. Pipe Pressure Class shall be minimum 150, unless otherwise indicated on the Drawings. Pipe shall have bituminous coating exterior with Induron Protecto 401 or Tnemec Perma Shield 431 PL ceramic epoxy coating on the interior.
2. Joints for the ductile iron pipe shall be the slip-type single gasket joints conforming to ANSI A21.11 and AWWA C-111 requirements. Ductile iron joints shall be rated for minimum 150 psi operating pressure.
3. Fittings for ductile iron pipe shall be equal to Bell-Tite, Fast-Tite, or Tyton fittings. Mechanical type fittings may be used on short sections of ductile iron gravity sewers if approved by Metro or specified on the Drawings. Fittings shall not weigh less than the accompanying pipe and shall be assembled in accordance with the manufacturer's recommendations.
4. Interior Coating for Ductile Iron Pipe – Ceramic Epoxy Lining
 - a. The quality standard for modified polyamine cured novalac epoxy is Induron Protecto 401 or Tnemec Perma Shield 431 PL Ceramic Epoxy. The material shall

contain at least 20 percent by volume of ceramic quartz pigment or quartz microspheres.

- b. Requests for substitutions shall be accompanied by a successful history of lining pipe and fittings for sewer service and a certified test report verifying the following properties:
- 1) A 0.00 permeability rating when tested according to ASTM E-96 Procedure A, Method A with a 30-day test duration
 - 2) The following tests must be conducted on coupons from factory lined ductile iron pipe:
 - a) ASTM B-117 salt spray (scribed panel): Results shall equal 0.0 undercutting after 2 years.
 - b) ASTM G-95 cathodic disbondment: 1.5 volts at 77°F with no more than 0.5 mm undercutting after 30 days
 - c) Immersion test rated using ASTM D-714
 - (1) 20 percent sulfuric acid: No effect after 2 years.
 - (2) 25 percent sodium hydroxide at 140°F: No effect after 2 years
 - (3) 160°F distilled water: No effect after 2 years
 - (4) 120°F tap water (scribed panel) 0.0 undercutting: No effect after 2 years
 - d) An abrasion resistance of no more than 3 mils (0.075 mm) loss after one million cycles using European Standard EN 598: 2007 + A1:2009 Section 7.8 Abrasion Resistance
 - 3) Lining Thickness: Lining shall be 40 mils nominal dry film thickness with the number of lining material coats as recommended by the lining manufacturer.
 - 4) Surface Preparation: Prior to abrasive rotary blasting, the entire area to receive the protecting compound shall be inspected for oil, grease, etc. Areas with oil, grease, or substances removable by solvent shall be solvent cleaned using the guidelines outlined in DIPRA - 1 Solvent Cleaning. After the surface has been cleaned, areas to receive the protective compounds shall be abrasive blasted using compressed air nozzles with angular sand or grit abrasive media. The entire surface to be lined shall be stuck with the blast media so all rust, loose oxides, etc., are removed from the surface. Only slight stains and tightly adhering annealing oxide may be left on the surface in accordance with NAPF Standard 500-03. Any area where rust reappears before lining must be blasted again.
 - 5) Application
 - a) Applicator: The lining shall be applied by a competent firm with a successful history of applying linings to the interior of ductile iron pipe and fittings.

- b) Lining: Within 8 hours of surface preparation, the pipe interior shall receive 40 mils nominal dry film thickness of Induron Protecto 401 or Tnemec Perma Shield 431 PL or approved equal. No lining shall take place when the substrate or ambient temperature is below 40°F. The surface also must be dry and dust free. If flange pipe or fittings are included in the project, the lining shall not be used on the flange face.
- c) Coating Bell Sockets and Spigot Ends: The gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum Induron Protecto 401 or Tnemec Perma Shield 431 PL joint compound or preapproved equal joint compound. The joint compound shall be applied by brush to ensure coverage. The joint compound shall be smooth without excess buildup in the gasket seat or on the spigot ends. Coating the gasket seat and spigot ends shall be performed after the lining application.
- d) Number of Coats: The applied number of lining material coats shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer. The maximum or minimum time between coats shall be the time recommended by the lining material manufacturer. No material shall be used for lining that is not indefinitely recoatable with the same material without roughening the surface.
- 6) Inspection and Certification
- a) The lining thickness for ductile iron pipe and fittings shall be verified using a magnetic film thickness gauge. The thickness testing shall be performed using the method outlined in SSPC-PA-2 Film Thickness Rating.
- b) The interior lining for all pipes and fittings shall be tested for pinholes with a nondestructive 4,000-volt test. Any pinholes found shall be repaired prior to shipment at no additional cost to Metro.
- c) Pipe joints and fittings shall be marked with the lining system's application date and the application's numerical sequence. Records shall be maintained by the applicator.
- d) The pipe or fitting manufacturer must supply a certificate attesting the applicator met requirements in this specification and lining manufacturer's recommendations for preparation with the material specified.

5. Exterior Corrosion Protection

- a. Where specified on the Drawings, exterior corrosion protection shall be a high-density polywrap. The polywrap shall be cross-laminated high-density polyethylene film complying with ANSI/AWWA C105/A21.5-10.

2.02 FORCE MAIN (PRESSURE) SANITARY SEWER PIPE MATERIALS

A. Force Main (Pressure) Sewer Pipe 4 Inches in Diameter and Larger

1. Ductile Iron Pipe: AWWA C151/A21.51, minimum Pressure Class 150; restrained push-on joints conforming to AWWA C111/A21.11 with Induron Protecto 401 or Tnemec Perma Shield 431 PL Ceramic Epoxy lining.
2. Ductile Iron Restrained Mechanical Joint or restrained Push-on Joint Fittings
 - a. AWWA C110 and 153
 - b. Induron Protecto 401 or Tnemec Perma Shield 431 PL Ceramic epoxy lining
 - c. 4-inch through 24-inch: Pressure class 350
 - d. 30-inch: Pressure class 250
3. PVC pipe up to but less than 36-inch diameter: C900/905 minimum pressure class 150, push-on joint ends. Fittings shall conform to requirements specified for ductile iron pipe fittings.

2.03 PRECAST CONCRETE MANHOLES

A. Standard Manhole Sidewall

1. Standard manhole sidewall shall be constructed with the following concrete types:
 - a. Precast concrete rings
 - b. Precast concrete manhole sidewalls with base
 - c. Precast concrete monolithic manhole sidewall
 - d. Precast concrete monolithic manhole with base
 - e. Poured-in-place concrete monolithic manhole sidewall
2. Concrete for precast or poured-in-place concrete manhole sidewall shall be Class C, as specified in Section 03 30 00. All precast concrete manhole sidewalls shall conform to ASTM C-478 requirements.

B. Concrete Manhole Bases and Fillets: Concrete manhole bases and fillets may be precast with the manhole sidewall or poured-in-place conforming to the following requirements:

1. Precast manhole bases and fillets: Reinforced precast concrete in accordance with ASTM C478/C478M
2. Poured-in-place manhole bases and fillets: Concrete for poured-in-place plain concrete base and fillets shall be 4,500 psi in accordance with Section 03 30 00 and conform to P.C.A. Specifications for Plain and Reinforced Concrete requirements.

2.04 MANHOLE FRAME AND COVERS

- A. Manhole frames and covers shall be made from cast iron conforming to the details shown on the Drawings and meeting ASTM A-48, Class 30 requirements.
- B. All casting shall be made accurately to the required dimensions and shall be sound, smooth, clean, and free from blisters and other defects. Defective castings that have been plugged or otherwise treated to remedy defects shall be rejected. Contact surfaces for frames and covers shall be machined so the covers rest securely in the frames with no rocking and with the covers in contact with the frames for the entire contact surface perimeter.

2.05 MANHOLE DROP PIPE ASSEMBLY

- A. All drop pipe assemblies must be submitted and accepted in accordance with Section 01 33 00.
- B. Pipe, specials, and fittings used to construct the manhole drop assembly shall conform to the Drawings.
- C. The support for outside drop assemblies shall be concrete and conform to the Drawings.
- D. Concrete for the base and drop assembly support shall be 4,500 psi, as specified in Section 03 30 00.
- E. Standard drop pipe assemblies shall be external to the manhole unless approved by the Construction Manager. Upon approval, inside drop assemblies shall be constructed and supported as detailed in the Drawings.

2.06 PIPE RESILIENT CONNECTORS TO MANHOLES

- A. Resilient connectors between manholes and pipes such as Kor-N-Seal or A-Lok shall be installed in the precast or cored opening manhole wall. The resilient connector shall meet ASTM C-923 requirements. For Kor-N-Seal type connectors, an external band made entirely of corrosion resistant stainless steel shall be used to seal around the pipe.

2.07 SEALANT AND WATERPROOFING/CORROSION PROTECTION

- A. Sealant to be used in joints shall be an approved flexible plastic gasket similar to Ram-Nek or a rubber gasket joint conforming to ASTM C443.
- B. Manhole waterproofing/basic corrosion protection shall be XYPEX C1000 (dye) or equal concrete waterproofing/basic corrosion inhibiting admixture and shall be added to concrete during the batching operation. Colorant (dye) shall be added at the factory to verify the XYPEX admix is added to the concrete.
- C. Spray applied urethane or epoxy resin system manhole lining (extended corrosion protection)
 - 1. The material sprayed onto the manhole surface shall be a urethane (similar to Sprayroq) or epoxy resin (similar to Raven 405) system formulated for application within a sanitary sewer environment. The resin will exhibit suitable corrosion resistance and enhance the structural integrity of the existing manhole.

2. The cured urethane or epoxy resin system shall conform to the following minimum structural standards:

TEST	METHOD	RESULTS
Tensile Stress	ASTM D-638	5,000 psi
Flexural Stress	ASTM D-790	10,000 psi
Flexural Modulus	ASTM D-790	550,000 psi

2.08 STUBOUTS

- A. Stubouts shall be the bell or hub end of a pipe joint conforming to sewer main pipe requirements.

2.09 MANHOLE STEPS

- A. Manhole steps shall be inserted and securely embedded in the manhole sidewall with either plastic coated steel or aluminum alloy material non-skid design.
- B. Aluminum alloy manhole steps shall be Alcoa aluminum-magnesium silicide type alloy conforming to Federal Specifications QQ-A-200/8 or approved equal.
- C. Plastic coated steel manhole steps shall be constructed with 1/2-inch steel reinforcing rods encapsulated in polypropylene plastic.

2.10 VENT PIPE ASSEMBLIES

- A. The pipe and fittings shall be Schedule 40 steel pipe or Class 150 ductile cast iron pipe, with Protecto 401 ceramic epoxy interior lining. Pipe and fittings exterior shall be commercial blast cleaned (SSPC-SP6) for steel and NAPF-500-03 for ductile iron. Apply one coat of TNEMEC series N69 HiBuild Epoxoline (4 to 6 mils dry film thickness) and one coat of TNEMEC 1074 Endura Shield (2 to 3 mils dry film thickness) to exterior surfaces. Follow manufacturer's recommendations for recoat based on time and temperature. The paint's top coat shall be dark green.

2.11 VALVES

A. Gate Valves

1. 3 inches and over: 100 psi working pressure. AWWA C509, iron body, bronze trim, non-rising stem with square nut, single wedge, resilient seat, mechanical joint ends, control rod, and extension box.

B. Air Relief Valve

1. AWWA C512 automatic air release valve flanged type. ____psi ____ working pressure.
2. Orifice Size: 2 inches.
3. Upon venting air, valve shall close to prevent liquid from escaping.
4. Provide valve rated for 100 psi, with cast-iron body, float, and stainless steel internal levers.

C. Combination Air-Vacuum Valve

1. AWWA C512: _____ psi working pressure. Factory-test to _____ psi hydraulic pressure. Air-intake: Air-release flanged type for preventing vacuum and for venting air
2. Incorporate two stainless steel floats connected by stainless steel float guide to maintain air gap between bottom and top shutoff float. Air gap shall retard waste solids from fouling or clogging top shutoff float. Make internals easily removable through top cover without removing valve. Furnish valve with inlet ball valve, blowoff valve, and shutoff valve with quick-disconnect coupling for flushing.
3. Valve size: _____ inches
4. Air release valve orifice size: _____ inches
5. Heavy-duty, cast-iron body, stainless steel float, guided

2.12 VALVE VAULTS

- A. Reinforced precast concrete structure meeting ASTM C913, designed to withstand an AASHTO HS20-44 live loading in accordance with ASTM C890.
- B. Access Cover: Aluminum, watertight with provision for drain connection. Channel frame 1/4-inch aluminum with anchor flange around perimeter and 1-1/2 inch-diameter drainage coupling, double leaf
 1. Door Leaf: 1/4-inch aluminum diamond pattern reinforced to withstand a 300-psf live load. Equip door with heavy forged brass or bronze hinges, stainless steel pins, spring operation for easy operation, and automatic hold-open arm with release handle. Provide inside snap lock with outside removable handle.
 2. Hardware: Cadmium-plated
 3. Factory Finish: Mill finish with bituminous coating applied to frame exterior.

2.13 SIX-INCH TEE CONNECTIONS FOR SERVICES

- A. Pipe construction, installation and material containing tee openings and the joint materials for the same shall conform to specifications requirements for PVC or DIP sewer where installed. All tees on concrete pipe shall be manufactured by coring the reinforced concrete pipe and cement epoxying a PVC hub on the pipe for the pipe wall's full depth using a Kor-N-Tee resilient compressive fitting.
- B. New service and/or existing service reconnections on less than 24-inch diameter pipe are to be accomplished with manufactured standard tees unless otherwise noted. New service connections and/or existing service reconnections on greater than or equal to 24-inch diameter pipe are to be accomplished with Romac or equivalent saddles.
- C. InsertaTees may be used for solid wall pipes having a 0.36-inch or greater wall thickness. InsertaTees shall be "Fatboy" type with hub manufactured of SDR 26 PVC material incorporating a 360-degree integral stop on the hub surface and exceeding ASTM F1336 Section 10.3 Pipe Stop Load Support Test, or approved equal.

2.14 6-INCH SERVICES

- A. Furnishing, constructing and installing all materials and/or methods used to construct 6-inch sewer services shall be as specified in this Section and as shown on Drawings. Pipe Material shall be PVC or DIP. Where the sewer main is DIP, use DIP service pipe.

2.15 SERVICE RECONNECTIONS

- A. Furnishing, constructing and installing all materials and/or methods used to construct connecting new or reconnecting live sanitary services shall be as specified in this Section and as shown on Drawings.

2.16 PVC SEWER DOUBLE SWEEP CLEANOUT ASSEMBLIES

- A. PVC sewer pipe and fittings furnished and installed on this project for double sweep cleanout assemblies shall conform to this Section using flexible joints if replaced from the main. If a cleanout assembly is inserted into an existing lateral, the PVC pipe and fittings shall conform to ASTM D1785, Schedule 40 PVC1120 with gasket or D2466 solvent welded fittings per Metropolitan Plumbing Code.

2.17 CONCRETE ENCASEMENT

- A. Concrete for concrete encasement and/or cradle shall be 3,000 psi as specified in Section 03 30 00.

2.18 GROUTING ABANDONED SEWERS

- A. The concrete shall be in accordance with Section 03 30 00. Contractor may use concrete with a slump up to 12 inches and an aggregate of 3/8-inch stone to facilitate pouring the concrete. Concrete shall have a minimum 28-day strength of 300 lbs. per square inch.

2.19 BEDDING AND COVER MATERIALS

- A. As specified in Section 31 23 33

2.20 THRUST RESTRAINT

- A. Mechanical Joint Restraint: Wedge action restrained joint retainer gland devices; mechanical joint restraint incorporated into the follower gland design
- B. Push-On Restrained Joint Pipe: Provide joint restraint and conforming joint to AWWA C111/21.11, fabricated to be easily disassembled. Provide assembly and disassembly kits.

2.21 ACCESSORIES

- A. Flexible Couplings: Sleeve type elastomeric PVC held firmly to pipe ends by screw-tightened bands. Bands and screws shall be Type 304 stainless steel.

2.22 TRACER WIRE

- A. Tracer wire shall be included on all PVC pressure pipe installations. Wire shall be a #12 AWG HS-CCS high-strength copper clad steel conductor (HS-CCS); insulated with a 30 mil, high-density, high molecular weight polyethylene (HDPE) insulation; and rated for direct burial use at 30 volts. HS-CCS conductor must be a 21% conductivity for locating purposes with a minimum break load of 380 pounds. HDPE insulation shall be RoHS compliant and

utilize virgin grade material. Insulation color shall be green. Provide sufficient excess tracer wire at termini (6 feet minimum) to facilitate use. Excess wire to be installed in a standard sewer cleanout box.

2.23 APPURTENANCES

- A. Provide all necessary appurtenances for a full and complete piping system suitable for operation and in conformance with Project Documents.

2.24 MISCELLANEOUS MATERIALS

- A. All material used on this project shall be visually inspected by the Construction Manager at the site for conformance to the specifications.
- B. When the Construction Manager has a reasonable doubt about the material meeting specifications, the Construction Manager may require certified mill test, samples and/or test by an independent laboratory, or other suitable verification stating the material meets specification requirements.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Sanitary Sewer

1. Perform a preconstruction surface video inspection of the system route to document existing conditions. Video shall be submitted to the Construction Manager prior to commencing construction activities.
2. Perform a preconstruction internal video inspection of adjacent existing parallel sewers within 50-feet of the proposed conveyance system to document existing conditions. The video is to be submitted to the Construction Manager in CUES's GraniteNet in the most current MWS version prior to commencing construction activities.
3. Set grade stakes, lines, and levels. Prepare cut sheets. Provide level, level rod, and tripod on the job site at all times for checking grades, as deemed necessary by the Construction Manager.
4. A Tennessee registered land surveyor shall set all grade and alignment stakes for construction and bear associated costs. The requirement for this work to be performed by a registered land surveyor may be waived by the Construction Manager if the Contractor desires to use their own personnel who are qualified to set the grade and alignment stakes. Contractor shall have a Tennessee registered land surveyor perform quality oversight/audit of the work periodically in accordance with the project quality plan. Assume all responsibility for the accuracy of the grade and alignment stakes.
5. Use batter boards or a properly calibrated beam device. No claim for extra work will be allowed for alleged inaccuracy of the laser beam device. Grade hubs for laser beams shall not exceed 100 feet apart, with centerline hubs every 50 feet to check laser and grade between manholes. Perform a daily survey check of lines and grades.
6. If the Contractor elects to use batter boards, the Contractor shall provide and maintain on the work at all times. Use a gauge rod of sufficient length to reach from the invert of the sewer pipe being laid to the top line strung on the three batter boards. The gauge rod

shall be graduated and numbered each foot of its entire length. The gauge rod shall be equipped with either a plumb line or two spirit levels to ensure a truly vertical gauge rod at the time a reading is taken and pipe is being set.

7. Two weeks prior to commencing trench excavation, prepare and submit to the Construction Manager for review 4 copies of detailed cut sheets showing:
 - a. Beginning and ending manholes
 - b. Distance between manholes
 - c. Line grade, size and type
 - d. Cut depth
 - e. Etc.
8. Provide the cut sheet form. All expenses incurred to prepare cut sheets shall be borne and be included in the unit price bid per foot of pipe.
9. Cut sheets must be reviewed by the Construction Manager and approved in writing before trenching operations may be permitted. Prepare cut sheets 2 weeks before anticipated trench excavation schedule.
10. The junction of two or more sewers shall be made in strict conformance with the Drawings. The cost for all connections shall be included in the Contract price for the new sewers, unless specifically provided in the Contract.
11. New sewer connections with existing sewers shall be made within a manhole. Where an existing manhole is the connection point for new a sewer, it shall be repointed. Any loose bricks or blocks in the walls of the old existing manhole shall be re-laid. Reconstruct fillet (invert) of the manhole to accommodate the new connection. The cost for such work shall be included in the Contract price for new main sewer, unless other payments are specifically provided for in these specifications.
12. Outside manhole drop assemblies shall be used to connect a new sewer to an existing manhole.
13. Where no manhole exists at the connection point, a new manhole shall be constructed in the size and type shown on the Drawings. Payment for such additional manholes will be made at the unit price in the Contract for new manholes, which includes all work necessary to make the connection.
14. Connections for new sewers to existing sewers when encountered in construction and not shown on the Drawings shall be made when ordered by the Construction Manager. Such connections shall be made within a manhole, except for house sewer and drain connections. When such sewer connections are made within an existing manhole, any added work involved will be paid in accordance with the procedure outlined in the Contract. If the Construction Manager orders such connections be made in a new manhole, the new manhole will be paid at the prices established in the Contract, with the price including all work necessary to make the connections.
15. When connections are made with live sewers, no portion of the work shall be conducted under water. A flume or dam must be installed and pumping maintained if necessary to keep the new work in the dry until completed and concrete or mortar has set up.

16. Junctions for future sewer connections indicated on the Drawings on precast concrete manholes shall be provided with a 2-foot long stubout connected to the manhole with a pipe resilient connector. The stubout shall be sealed using an approved end plug.
17. Pipe Laying
- a. Pipe installation shall conform to ASTM D-2321 and these Specifications. If a conflict occurs between these specifications and ASTM D-2321, the more stringent requirements shall apply. Each pipe shall be laid on an even, firm bed, so no uneven strain will come to any pipe part. Pipes shall not bear on the sockets. Bell holes for bell and spigot pipe shall be dug at each point. Each pipe shall be laid in the Construction Manager's presence. The pipe's bell end shall be laid upgrade.
 - b. The foundation within the sewer pipe trench shall conform to these specifications.
 - c. The sewer interiors shall be clean from all dirt, jointing material, and superfluous materials.
 - d. Proper and suitable tools and equipment shall be used to safely and conveniently handle and lay the pipes and fittings.
 - e. Pipes joints shall be completely seated.
18. Pipe Installation in Tunnel
- a. Prior to installing the sewer pipe, verify the primary liner has been constructed so the sewer pipe may be placed in conformance with specified tolerances.
 - b. Tolerances from lines and grades shown on the Drawings for the sewer pipe installed in the tunnel are +/-2 inches in horizontal alignment and +/-1/4-inch in elevation.
 - c. Handle and transport pipe into the tunnel in a manner that prevents damage to the pipe, joints, gaskets, and plastic liner.
 - d. Provide adequate support to establish final pipe grade. Each pipe end shall be supported so the weight for each pipe length is self-supported. Support may include screened concrete, steel beam, or other methods as designed by the Contractor's engineer. Secure the pipe support to the pipe or primary liner. If concrete is used for pipe support, cure it 12 hours minimum prior to setting pipe.
 - e. Joint pipe segments to properly compress the gaskets and allow for the pipe's correct final positioning for line and grade. Closely align pipes by bringing them loosely together using hydraulic jacks, locomotives, pipe mobiles, or winches. Once pipes have been loosely joined, completely seat them using a hydraulic device or other similar method suitably protecting pipe and joints against damage. Impact jointing such as ramming with locomotives or other mechanical equipment is not permitted.
 - f. Install pipe-blocking systems and secure blocking rigidly in place so it cannot be dislodged during pipe placement and grouting operations.
 - g. Lubricate pipe joints evenly around the gaskets and steel end rings. Lubricant shall not be allowed to dry prior to joining pipe. Excess lubricant shall be cleaned from each joint prior to grouting joint.

- h. Pipe damaged during installation shall be repaired or removed, based on the extent of damage and the Construction Manager's requirements. The Construction Manager's decision shall be final.
- i. Joints shall be made watertight, with particular care taken to prevent misalignment or damage to the joint to be installed in the tunnel.
- j. If the joint deflection exceeds the manufacturer's recommendations for deflection on long radius curves, provide beveled pipe, radius pipe, or shorter pipe lengths per manufacturer's recommendations.

B. Manholes and Appurtenances

1. This item shall include furnishing all materials and doing all work necessary to completely construct standard and/or special manholes of the types, sizes, shapes, dimensions, and at the locations shown on the Drawings.
2. Manhole Bases and Fillets
 - a. Precast Manhole Bases
 - 1) Install the precast concrete manhole base on a minimum 6-inch thick crushed stone (No. 67, 57, or approved equal) bed. This bed shall be brought to the required grade. Ensure the bed is level and even so, when the precast unit is set in place, the manhole sidewall will be installed plumb, and the concrete manhole base is in full contact with the gravel base.
 - 2) The precast manhole base shall be a 6-inch thick minimum for 48-inch diameter manholes and 8-inch for 60-inch and 72-inch diameter manholes. For units requiring the fillets to be poured-in-place, 2 inches minimum shall be allowed from the inside of the base to the downstream pipe invert for constructing the fillet.
 - 3) Backfilling operations may begin after completing the precast manhole sidewall with base installation. After completing the backfilling operations, traffic may be allowed on the structure.
 - b. Poured-In-Place Manhole Bases and Fillets
 - 1) Concrete shall be adequately protected from injurious sun action sun by wetting, covering with water-saturated cover, or other methods approved by the Construction Manager.
 - 2) In cold weather, concrete shall be mixed and placed only when the ambient temperature is at 40°F or above and rising, unless specifically authorized by the Construction Manager, in which event all materials shall be heated in a manner approved by the Construction Manager. In freezing weather, suitable means shall be provided for maintaining the concrete at a temperature of at least 50°F for a period not less than 72-hours after placing. Salt, chemicals, or other foreign materials shall not be mixed with the concrete to preventing freezing, unless approved by the Construction Manager.
 - 3) Poured-in-place manhole bases shall be allowed to set 24 hours minimum before installing the manhole sidewall.

- 4) The monolithic concrete or the lower section of the precast ring sidewall shall be installed on the manhole base with a cement mortar bond.
- 5) The bond shall be prepared by placing a minimum 3-inch thick cement mortar bead on the manhole base and lowering the sidewall unit onto the mortar. The mortar forced from beneath the sidewall shall not be removed, but shall be worked into the manhole sidewall to form a fillet or chamfer around the sidewall base.
- 6) Ensure that the manhole sidewall is installed plumb and truly vertical and the concrete manhole base is finished to a horizontal surface.
- 7) When approved by the Construction Manager, the manhole sidewall may be set on concrete block supports and the required base poured up to and around the manhole sidewall. The base shall then be allowed to set for 24 hours. Prevent concrete being poured up to or around the resilient pipeline connector.

c. Fillets

- 1) Except as otherwise specified, fillets in manholes shall be tapered uniformly between the inlet pipe and the outlet pipe inverts. Fillets in junction manholes shall be constructed with curved channels for side streams to minimize turbulence as shown on Drawings. Fillets in end manholes shall be shaped to drain to the discharge pipe.
- 2) In cases where the inlet pipe invert is 6 inches or more above the outlet pipe invert, the fillet flow line at the inlet side shall not be greater than 6 inches above the outlet pipe invert to provide clearance for maintenance or testing equipment.
- 3) Fillets shall be neatly and uniformly shaped, have a brushed finish, and be constructed from concrete. Cement mortar shall not be used to obtain the required shape and finish.
- 4) The cost for manhole fillets shall be included in the unit manhole price with no separate payment allowed.
- 5) The area on the manhole interior around the sidewall and the fillet juncture shall be waterproofed as specified in these specifications.

3. Manhole Sidewall

a. Precast manhole sidewall

- 1) Order the precast manhole sidewall to meet the required field conditions. The unit's height in place shall allow the adjusting rings to be placed on top of the manhole transition section prior to setting the casting. A 2-inch minimum and/a 10-inch maximum precast concrete adjustment ring will be allowed. The maximum distance from top of casting to the start of corbell section shall be 18 inches. Precast concrete or composite adjusting rings shall be used.
- 2) The manhole sidewall's corbell section shall be cast in a concentric cone shape.
- 3) At precast manhole sidewall joints, apply an approved flexible, plastic gasket material similar to Ram-Nek or rubber gasket conforming to ASTM C443 to

the joint surface prior to placing the next manhole section. Sufficient gasket material shall be used to fill the void in the joint.

- 4) Ensure the backfill material is simultaneously placed around the manhole sidewalls in equal levels.
- 5) Use resilient connectors to make pipeline connections to the manhole sidewall.

b. Poured-in-Place concrete monolithic sidewall

- 1) Place the forms so the manhole casting is set to match the finished grade of the adjacent street and/or ground line with allowance of a 2-inch adjustment ring.
- 2) The manhole sidewall's corbell section shall be cast in a concentric cone shape.
- 3) Obtain and have tested concrete cylinders for compliance with ASTM C-173, ASTM C-31 and ASTM C-39 at an approved testing laboratory. Instruct the testing laboratory to forward copies of the test reports to the Construction Manager.
- 4) The maximum manhole depth shall not exceed 20 feet. The minimum wall thickness for 48-inch inside diameter manholes shall be 6 inches. The minimum wall thickness for 60-inch and 72-inch inside diameter manholes shall be 8 inches.
- 5) The base shall be 4,500 psi concrete, vibrated on a firm suitable crushed stone bedding subgrade foundation. The base diameter shall be minimum 8-inches greater than the manhole's outside diameter and a minimum 8-inch thickness.
- 6) The first base concrete placement shall include approximately 1/2 cubic yards of concrete deposited evenly around the walls and vibrated until a minimum 60-degree slope is developed from the bottom of the forms to the bearing surface both inside and outside the manhole. Additional concrete must be deposited in evenly distributed 18-inch layers, with each layer vibrated to bond to the preceding layer. As the concrete placements are made, the wall spacers must be raised within the area from which the spacer is withdrawn while being concurrently vibrated.
- 7) If cold joints are necessary, a formed groove and reinforcing dowels (#5 bars, 36 inches long on 12-inch centers) shall be required in the top of the first placement for shear protection. Immediately before the second placement is made, the cold joint surface shall be thoroughly cleaned and wetted with a mortar layer placed on the surface.
- 8) The forms may be removed 24 hours after placement.
- 9) The monolithic manholes shall be simultaneously backfilled to same level. The manholes shall not be backfilled until they reach 75 percent of the specified design strength. An Construction Manager approved gravel backfill material shall be placed adjacent to the manholes in areas where swelling clays exist.
- 10) A resilient connector shall be used to connect pipe to manhole sidewall.

4. Manhole frames and covers: The manhole frame for the cover shall be set on the manhole sidewall in a full cement mortar bed at the required elevation. Where manholes

are constructed in paved areas or fill slopes, the frame and cover surface shall be tilted to conform to the existing surface's slope, crown, or grade. Vertical adjustments to new and existing manhole frames and covers shall be made exclusively with concrete or composite adjustment rings in available heights or mortar, when adjustments less than 2 inches are required.

5. Manhole Drop Pipe Assembly

- a. Where the difference in invert elevations for an entering sewer and a discharging sewer intercepting in the same manhole is 2-feet or more, a drop manhole assembly shall be constructed on the entering sewer.
- b. The cost to furnish, construct, and install manhole bases, fillets, sidewalls, castings, and all other work necessary for a complete creek bottom manhole installed as shown in the Drawing shall be included in the unit price for Creek Bottom Manholes, with no separate payment allowed.

6. Pipe Resilient Connectors to Manholes

- a. Pipe connections to manhole sidewalls shall be made with resilient connectors. Openings in the manhole sidewall for the pipe shall be precast or cored to provide required size and location. The hole shall be manufactured to allow for lateral and vertical movement and angular adjustments through a 20-degree range. A resilient connector between the manhole and pipes such as Kor-N-Seal or A-Lok and seals shall be installed in the precast or cored openings. The resilient connector shall meet the ASTM C-923 requirements. The insulator ring provided by the manhole supplier must be used to prevent cosmetic dressing mortar from setting inside the resilient connector creating an adverse rigid connection. For Kor-N-Seal type boots, an external band made entirely from corrosion resistant stainless steel shall be used to seal around the pipe. A torque wrench, as specified by the manhole supplier, must be used to seat the resilient connector to pipe.
- b. The void between the pipe and the connector shall be filled with an approved flexible gasket material.
- c. Resilient connectors shall be considered an integral part of the manhole sidewall with no separate payment allowed.

7. Sealing

- a. Sealing the joints in the manhole sidewall and manhole inverts shall conform to specifications for waterproofing and sealing. Safety regulations and precautions set by the paint manufacturer and OSHA shall be strictly observed.
- b. All joints between the precast manhole sidewall sections shall be sealed with an approved flexible plastic gasket similar to Ram-Nek or a rubber gasket conforming to ASTM C443 and applied to the joint surface prior to placing the next manhole section. Sufficient gaskets shall be used to fill the void in the joint.
- c. For manholes installed on a poured-in-place base, after completing the manhole fillet, the area where the inside manhole sidewall joins the manhole fillet shall be waterproofed by applying a sealant. This will not be required on manholes where the base is precast or poured-in-place monolithically with the manhole sidewall.

- d. The area to be waterproofed shall extend up the manhole sidewall and into the manhole fillet 6 inches from the sidewall and the fillet juncture.
- e. Manhole waterproofing/basic corrosion protection shall be XYPEX C1000 (dye) or preapproved equal concrete waterproofing admixture and shall be added to concrete during the batching operation. Colorant (dye) shall be added to verify the XYPEX admix is added to the concrete. Admix should meet the U.S. Army Corps of Engineers CRD-C48 Permeability of Concrete at 7-bars (224 feet water head).
- f. Manhole extended corrosion protection as indicated on the Drawings shall be as follows:
- 1) Spray Applied Urethane Resin System
 - a) The urethane shall be sprayed onto the manhole walls, benches, and invert surfaces to produce a smooth coating and yield the required structural integrity and corrosion resistance. A depth gauge shall be used at various locations during application to verify the required thickness.
 - b) In accordance with manufacturer's recommendations, the urethane resin shall be applied to a minimum 0.25-inch thickness at the top of the manhole and gradually thickened to withstand groundwater pressures.
 - c) The manhole bench's sloped surface shall be made non-skid by broadcasting aluminum oxide or sand into the surface prior to gelatin/set.
 - 2) Sprayed Applied Epoxy Resin System
 - a) The epoxy resin shall be sprayed onto the manhole walls, benches, and invert surfaces to produce a smooth coating and yield the required structural integrity and corrosion resistance. A depth gauge shall be used at various locations during application to verify the required thickness.
 - b) In accordance with manufacturer's recommendations, the epoxy resin shall be applied to a minimum 0.125-inch thickness at the top of the manhole and gradually thickened to withstand groundwater pressures. The application shall have a 3-hour minimum cure time before being subjected to active flow.
 - c) The manhole bench's sloped surface shall be made non-skid by broadcasting aluminum oxide or sand into the surface prior to gelatin/set.
- g. Sealing shall be considered an integral part of the manhole sidewall, and no separate payment will be allowed.
8. Stubouts: Provide provisions for future sewers by installing a 24-inch long stubout to the size, line, and grade indicated. Stubouts shall be the bell or hub end of a pipe joint pipe that conforms to the main sewer requirements. The bell or hub shall be plugged with a disk plug of the same material and sealed with the same joints as specified for the main sewer. All costs involved to place stubouts shall be included in the unit price for manhole sidewall, and no separate payment will be allowed.
9. Manhole Steps: Manhole steps shall be inserted and securely embedded in the manhole sidewall. Manhole steps shall be considered as an integral part of the manhole sidewall, and no separate payment will be allowed.

10. Vent Pipe Assemblies

- a. The vent pipe shall be located out of a travel way, in back of a curb or sidewalk, or as shown on the Drawings. The top of the vent pipe shall not be less than 9 feet above the existing ground line or set to the elevation as indicated on the Drawings.
- b. Concrete foundations for manhole vent pipe assemblies shall be 4,500 psi concrete, per these Specifications. Forms will not be required, unless the foundation is located in backfill materials.

3.02 VALVE INSTALLATION

- A. Set valves on solid bearing.
- B. Install valves according to applicable AWWA Standard.

3.03 6-INCH TEE CONNECTION

- A. This item shall include furnishing and installing 6-inch tee connections at locations shown on the Drawings or as specified by the Construction Manager during construction.
- B. Pipe construction, installation, and material containing tee openings and joint materials shall conform to specification requirements for that portion of the main sewer. Where provided for future house sewer service connections and as directed by the Construction Manager, the sewer service line shall be extended 4 feet minimum and capped as specified in these specifications.

3.04 6-INCH SEWER SERVICES

- A. This item shall include furnishing and installing 6-inch house sewer service sanitary sewers at the locations shown on the Drawings or as directed by the Construction Manager during construction. It shall also include bends, caps, and joint material.
- B. Furnishing, constructing, and installing materials and/or methods used to construct 6-inch house sewer services shall be as specified in these specifications and as shown on Drawings.
- C. The location for all 6-inch house sewer services shall be as directed by the Construction Manager during construction. The slope shall not be less than 1/8-inch per foot.
- D. The pipe material and jointing method shall be the same as specified for the main sewer.
- E. Where directed by the Construction Manager for future house sewer services, saw off the bell on the last 6-inch sewer pipe joint laid on each service line and cap each service line end with a Quik Cap flexible (PVC) cap (Fernco or approved equal) with an external band made entirely from corrosion-resistant stainless steel to seal around the pipe. No additional payment will be allowed for cutting and capping the service pipe.

3.05 RECONNECTING LIVE SANITARY SERVICES

- A. General: This item shall include furnishing all materials and performing all work to reconnect each live sanitary sewer service to the new sanitary sewer collector lines. Determine if a service is live. No payment will be made for reconnecting a dead service. Metro reserves the right to sample and test storm water discharges. If tests reveal fecal coliform, which would indicate a sanitary sewer connection(s) on the storm sewer, the onus is on the Contractor to

show all live sanitary reconnections have been made regardless of the level of effort necessary to so prove.

- B. Double Sweep Cleanout Assembly: Each reconnected service shall be provided with a 6-inch double sweep cleanout assembly as shown on the Drawings. Cleanouts shall be complete as shown on the Drawings.
- C. Reconnection: Dissimilar pipe reconnections shall be made with a corrosion resistant reinforced coupling with stainless steel hose clamps (Fernco or approved equal). Reconnection shall be as shown on the Drawings.

3.06 CONCRETE ENCASEMENT

- A. Concrete for concrete encasement and/or cradle shall be 3,000 psi conforming to P.C.A. Specifications for Plain and Reinforced Concrete.
- B. All concrete shall be adequately protected with methods satisfactory to the Construction Manager.
- C. Concrete shall be mixed and placed only when the ambient temperature is 40°F or above and rising, unless specifically authorized by the Construction Manager. During freezing weather, suitable means shall be provided for maintaining the concrete at a temperature of at least 50°F for a period not less than 72-hours after placing. Salt, chemicals, or other foreign materials shall not be mixed with the concrete to prevent freezing, unless approved by the Construction Manager.
- D. Concrete shall be placed before initial set has occurred and, in no event, after it has contained its water content for more than 30 minutes.
- E. Concrete shall not be placed on soft or dry soil.
- F. Freshly placed concrete shall be protected from heavy rain, flowing water, mud deposits, and other injurious conditions.
- G. When placing concrete cradles or encasements, ensure the sewer pipe is not moved from its proper grade and alignment.
- H. Imperfect or damaged work, or any material damage before final acceptance, shall be satisfactorily replaced. Concrete removal and/or replacement work shall be done in a manner that will not impair its strength.

3.07 CONSTRUCTION TESTING

- A. These specifications' intent is to secure pipelines with no leakage. All gravity pipelines shall be tested for infiltration and exfiltration. All leakage testing shall be observed by the Construction Manager.

1. Testing Gravity Sewers

a. Visual Tests

- 1) After completing construction or earlier if the Construction Manager deems advisable, the Construction Manager will visually inspect the sewer and construction site. Immediately repair all leaks and defects found by such inspection.

- 2) In addition to general cleanup and leakage, the following standards shall be used to determine project failures or defects.
- a) Sewers must be built to remain true to line and grade. The inclining grade for the bottom of the sewer after completion shall be such that after flooding the flood water will drain so no remaining water puddle will be deeper than 1/4 inch on 36-inch internal diameter or smaller pipe and 1/2 inch on pipe with a larger than 36-inch in internal diameter. Any pipe section not complying with the specifications at any time prior to the final acceptance of the work shall be replaced or re-laid.
 - b) All parts of the work shall bear the backfill load. If longitudinal and or transverse cracks develop within 1 year from the work's acceptance date, the Contractor will be required to address as follows:
 - (1) Longitudinal and or transverse cracks with a width less than 0.01-inch are considered hairline and minor and no remediation or repair is required.
 - (2) Seal cracks greater than 0.01 inches wide and less than 0.10 inch wide, if there is no displacement across the crack.
 - (3) Contractor shall replace or remediate pipes having longitudinal and transverse cracks that exhibit displacement across the crack greater than 0.10 inch wide and/or a crack is greater than 0.10 inch wide.

b. Survey Line and Grade Check

- 1) On 30-inch internal diameter and larger pipe, perform a survey line and grade check of the first 100 linear feet and at every manhole thereafter. The survey shall be performed by an independent surveyor other than daily grade crew, and the results shall be submitted to the Construction Manager for review concurrent with payment requests for the work.

c. Low Pressure Air Tests

1) Positive Pressure Test

- a) After completing construction or earlier if the Construction Manager deems advisable, provide the necessary equipment and labor to perform low positive pressure air tests in accordance with ASTM C 924, ASTM C1103, or ASTM F-1217 provisions as appropriate for size and material type.
- b) This test shall be performed in the Construction Manager's presence and on all gravity sewer pipe material types. This test shall also include sewer services to the cleanout assembly and service lines from manholes. It is imperative the plugs be installed and braced to prevent blowouts. A 6 psi pressure relief device must be used. No one shall be allowed in or near the manholes during pressurization, testing, or depressurization.

2) Negative Pressure Manhole Test

- a) After completing construction or earlier if the Construction Manager deems advisable, provide the necessary equipment and labor to perform

low negative pressure air tests for manholes in accordance with ASTM C1214. This test shall be performed in the Construction Manager's presence and on all manholes for all gravity sewer pipe material types 18-inch diameter and smaller. This test shall also include the house sewer services to the cleanout assembly and service lines from manholes. It is imperative the plugs be installed and braced to prevent blowouts. A 6 psi pressure relief device must be used. No one shall be allowed in or near the manholes during pressurization, testing, or depressurization.

- 3) Individual Joint Testing: For pipes larger than 18-inch diameter, individual joints may be pressure tested with a portable tester to 5 psi maximum with air or water in lieu of line air testing.

d. Infiltration

- 1) All leakage testing shall be observed by the Construction Manager.
- 2) Leak testing shall be visually inspected after dewatering operations have been discontinued for a minimum of 48-hours, or until groundwater has been allowed sufficient time to reach its natural elevation. Any visible leakage or dampness found during this operation shall be corrected.
- 3) Adequate bulkheads or plugs shall be installed at each end of the sewer in preparation for testing. Submit the bulkhead or plug type to be used to the Construction Manager for review. After testing, the bulkheads or plugs shall remain in place until the sewer section is to be placed in service. At that time, remove the bulkheads or plugs.
- 4) All leak testing shall be performed prior to grouting joints.
- 5) No measurable leakage will be acceptable with any approved pipe materials.
- 6) No measurable infiltration will be acceptable with any approved pipe materials.

- e. Internal TV Inspection: Perform a post-construction internal video inspection of the completed gravity system prior to acceptance. The video is to be submitted in CUES's GraniteNet in the most current MWS version format to the Construction Manager. Correct all deficiencies discovered by this inspection at no additional cost to Metro.

f. Deflection Tests

- 1) No pipe will be accepted deflected more than 3 percent.
- 2) PVC and ductile iron sewer pipe shall pass a go/no go mandrel inspection or laser video deflectometer inspection. The test shall be conducted after the pipe is in place and not less than 30 days after the pipe has been completely backfilled. The sewer line shall be thoroughly cleaned before testing. Any section that fails to pass shall be repaired by rebedding or replacing the pipe and retested to Construction Manager's satisfaction. Metro will provide the mandrel, or the Contractor may provide a mandrel approved by the Construction Manager. The mandrel shall be freely pulled by hand through the sewer pipe from manhole to manhole. The mandrel shall be sized appropriately for each pipe material.

2. Service connections and 6-inch sewer service lines shall be included and must satisfy tests specified for the main sewer.
3. Manhole Vacuum Test
 - a. Subject manholes to at least a 10-inches Hg vacuum test prior to Metro acceptance. The test shall be conducted to include the manhole frame and will be considered acceptable if the vacuum remains at 10-inches Hg or drops to no less than 9-inches Hg within 1 minute. If the manhole fails the initial test, locate the leak and make appropriate repairs acceptable to the Construction Manager. If the manhole being tested is subject to existing water table elevation above the lowest pipe opening invert, the vacuum pressure should be reduced by the amount of external pressure being exhibited on the pipe connection to avoid compromising the pipe to manhole connection system.
 - b. Furnish equipment necessary for manhole vacuum tests including the manhole sealing apparatus, gauges, pumps, plugs, and operating personnel.
 - c. The cost for this work shall be merged into the unit price bid for manholes, and no additional payment shall be allowed.

3.08 MAINTENANCE

- A. After completing each individual sewer line or 1,500-foot segment, begin cleanup and property restoration prior to installing another line, unless written permission is obtained from Metro and/or Construction Manager. This permission will only be given if the following conditions and situations exist:
 1. Maintain a sufficient cleanup crew on the project at all times, weather permitting. The cleanup progress shall be at least equal to the pipe laying progress on the project.
 2. The cleanup must be maintained not more than one line or 1,500 feet, whichever is less, behind the pipe laying crew.
 3. This shall be subject to weather and ground conditions.
- B. Conditions permitting, cleanup and property restoration shall begin and be prosecuted to completion on a timely basis. Failure to prosecute and complete property cleanup and restoration on a timely basis will result in withholding 15-percent from the payment due for that part of the completed pipe sewer for which cleanup and property restoration has not been accomplished. This 15-percent withholding constitutes payment for work not completed. This amount shall be in addition to the retained percentage for work completed. This 15-percent withholding will continue on subsequent payment estimates until cleanup and property restoration is in compliance.
- C. Cleaning up and restoring areas and facilities disturbed by construction operations shall be considered an integral part of the excavation work, and no separate payment will be allowed.

3.09 REPAIR/RESTORATION

- A. Repair any existing utilities, structures, or features damaged while installing sanitary sewerage utilities to a condition as good as or better than existing prior to construction start and to Metro satisfaction. This shall be done at no cost to Metro.

3.10 FIELD PAINTING/COATINGS

- A. Repair any shop painting/coatings damaged during storage or installation to Metro satisfaction.

3.11 PROTECTION

- A. Protect sanitary sewerage utilities from damage throughout storage, installation, testing, and final acceptance.

3.12 MEASUREMENT AND BASIS OF PAYMENT

- A. Sanitary Sewer: No separate measurement or direct payment will be made for work under this Section. Costs associated with this work shall be included in the price bid for the item to which it pertains.
 - 1. The payment measurement for sanitary sewer inside and outside roadways shall be made horizontally along the centerline of the sewer in-place from the center of the manhole and/or where construction begins to the center of the manhole and/or where construction ends, and no deductions in length will be made for manholes.
 - 2. Plugging abandoned lines, manholes, and filling with lean concrete shall be considered incidental to new sewer construction, and no separate payment shall be allowed.
 - 3. The unit price bid for sewers shall include the cost to excavate and the proper backfill necessary to completely install the sewer and appurtenances, and no separate payment shall be allowed. The unit price bid for sewers shall not include removing and disposing of unstable materials and crushed stone refill beyond the limits of typical excavation necessary to establish satisfactory foundations. The unit price bid for sewers shall not include tee branches, manhole bases, manhole sidewalls, frames and covers, and other items specifically set out in the contract documents. These items shall be paid separately under specific items listed.
- B. Manholes up to 6 feet deep with base: Payment for manholes up to 6 feet deep with base for manholes shall be made at the unit price bid per each manhole installed. Separate items may be listed in the bid schedule for each different manhole diameter size. The cost for manhole bases shall be merged into the unit price bid for each manhole up to 6 feet deep. The unit price bid shall include excavation, backfill, manhole fillet (invert), manhole steps, pipe resilient connectors, stubouts, plugs, sealing, and items needed for a complete installation.
- C. Additional Manhole Sidewalls: Payment for additional manhole sidewalls shall be made at the unit price bid per vertical foot that exceeds the 6-foot manhole depth for various manhole sizes as set in the bid schedule. Measurement for additional manhole sidewall shall be made vertically in place from the outlet sewer pipe invert to the bottom side of the frames and cover in place excluding the initial 6 feet.
- D. Excavation of Material/Undercutting and Refill
 - 1. All excavations shall be unclassified with no distinction made between rock and soil.
 - 2. If a grade change is required during construction or other special conditions exist and with the Construction Manager's written approval, additional items may be needed including:
 - a. Bid Item – Unclassified excavation 0 foot to 10 feet deep

- b. Bid Item – Unclassified excavation 10 feet to 20 feet deep
 - c. Bid Item – Unclassified excavation 20 feet deep and over
3. For these special items, payment width will be $4/3$ outside diameter plus 24 inches for pipe and outside diameter plus 36 inches for manholes. No additional excavation shall be allowed for payment where the grade change is 1 foot or less. Where the grade is raised more than 1 foot, the Contractor will compute 85 percent of the resultant reduction in excavation for credit to Metro.
 4. Payment for furnishing and installing additional backfill material for inside or outside roadway shall be considered an integral part of these special bid items, and no separate payment will be allowed unless directed in writing by the Construction Manager. If crushed stone refill is required by the Construction Manager for backfilling undercut areas, payment will be made for cubic yards of material installed at allowable dimensions under the special item Crushed Stone Refill. No payment will be allowed for material installed at the Contractor's discretion.

3.13 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 31 00

GRAVITY SEWER MAINS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope
- C. Submittals
- D. Measurement and Payment
- E. General

1.02 SCOPE

- A. Gravity sewer mains, connections, abandonments, and excavation and backfill

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittals.
- B. Submit manufacturer's product data for proposed gravity sewer main pipe, joints, joint materials, specials, interior coatings, and fittings for approval.
- C. Submit crushed stone bedding and envelope material sieve analysis and compaction methods.
- D. Submit abandonment plan, bypass pumping requirements, proposed grouting sequence, and plugging, if any, and other information pertinent to completion of the Work.
- E. Submit an installation plan for gravity sewer main taps and connections to be performed on existing gravity sewer mains.
- F. Submit cut sheets for each individual sewer line segment indicating the following information: beginning and ending structures with stationing conforming to the Drawings, distance, gradient between structures of the segment, size and type of pipe material, the location of service connections, the depths of cut of the segment, alignment, deflection angle, and other pertinent information. Cut sheets require Construction Manager review and approval prior to commencing excavation.
- G. Submit asphaltic binder information certifying that the material is in conformance with the most recent revision of Metro Public Works' standard specification Section 02575 if gravity sewer mains or service lines are to be installed within a Metro Public Works roadway or with the most recent revision of the applicable TDOT asphaltic binder specification if gravity sewer mains or service lines are to be installed within a TDOT roadway.
- H. Submit flowable fill information certifying that the material is in conformance with the most recent revision of Metro Public Works standard specification Section 02225 if gravity sewer mains or service lines are to be installed within a Metro Public Works roadway or with the

most recent revision of the applicable TDOT flowable specification if gravity sewer mains or service lines are to be installed within a TDOT roadway.

- I. Submit outside roadway backfill material source if imported materials are proposed, quality information, and compaction methods.
- J. Submit Proctor Density Test results in accordance with the most recent revision of ASTM D698 or ASTM D1557 when required by MWS.
- K. Submit compaction field testing results in accordance with the most recent revision of ASTM D6938 or other approved method when required by MWS.

1.04 MEASUREMENT AND PAYMENT

- A. MWS will compensate for Work only if unit price items are set forth in the Bid documents and allow NO separate payment to be made otherwise.
- B. MWS will compensate for furnishing and installing gravity sewer mains or service lines at the contract unit price per linear foot for the gravity sewer main or service lines installed complete and ready for operation. Measure the gravity sewer main or service lines horizontally along the centerline of the pipe in place from centerline of structure to centerline of structure, including fittings such as tees or tee wyes and cleanouts.
- C. Include cost in the unit price for gravity sewer mains or service lines for labor, equipment, material, cutting, laying to grade and alignment, joints, bypass pumping, standby time and delay in MWS locating and gaining access to existing gravity sewer mains or service lines, hydrostatic testing and other testing required, and all incidentals necessary for a complete and operable installation.
- D. Include cost in the unit price for gravity sewer mains or service lines for fittings such as tees, tee wyes, and/or cleanouts whether indicated on the Drawings or not.
- E. Include cost in the unit price for gravity sewer mains or service lines for excavation. Excavation is unclassified with no distinction made between rock and/or dirt excavation.
- F. Include cost in the unit price for gravity sewer mains or service lines for crushed stone bedding, crushed stone envelope, and additional crushed stone used as backfill material between the top of the crushed stone pipe envelope and the bottom of the flowable fill.
- G. Include cost in the unit price for gravity sewer mains or service lines for outside of roadway backfill material.
- H. Include cost in the unit price for gravity sewer mains or service lines for dewatering operations, including, but not limited, to water filtration systems for groundwater, obtaining permits with appropriate agencies on dewatering activities, and appropriately filtering and properly disposing of groundwater in accordance with permits.
- I. Include cost in the unit price of gravity sewer mains or service lines for grade and alignment survey staking operations performed by a Tennessee registered land surveyor.
- J. Undercutting of undesirable material at the trench base and approved refill material to be paid with "Unforeseen Work Elements" allowance bid item.
- K. C. MWS will compensate for furnishing and installing taps and connections at the contract unit price per each for each tap and connection complete and ready for operation.

- L. Include all cost in the unit price for taps and connections for labor, equipment, excavation, material, backfilling, and all incidentals necessary for a complete and operable installation.
- M. D. MWS will compensate for cutting and plugging in order to abandon a gravity sewer main or service line at the contract unit price per each.
- N. Incorporating all cutting and plugging costs in the unit price including labor, equipment, materials, bypass pumping, permanent solid gravity sewer main plug, and all incidentals necessary for a complete gravity sewer main abandonment operation.
- O. Include all costs in the unit price for pipe grout, labor, and all incidentals necessary for a complete abandonment.
- P. E. MWS will compensate for furnishing and installing flowable fill in pipe trenches at the contract unit price per theoretical cubic yard calculated utilizing the specified trench width per gravity sewer main or service line size, the length, and the specified flowable fill depth but not for the actual amount of flowable fill if more material is installed.
- Q. Include all costs in the unit price for flowable fill for excavation, material, labor, and all incidentals necessary for a complete installation.
- R. F. MWS will compensate for furnishing and installing asphalt binder at the contract unit price per theoretical cubic yard calculated utilizing the specified trench width per gravity sewer main or service line size, the length, and the specified binder depth but not for the actual amount of binder if more material is installed.
- S. Include all costs in the unit price for asphalt binder for excavation, material, labor, and all incidentals necessary for a complete installation.
- T. MWS will compensate for furnishing and installing miscellaneous concrete at the contract unit price per cubic yard for concrete installed between a proposed gravity sewer main or service line traversing perpendicular and above an existing water main.
- U. Include all costs in the unit price for miscellaneous concrete for excavation, materials, labor, and all incidentals necessary for a complete installation.

1.05 GENERAL

- A. Calculate Bid Schedule payment items of flowable fill and asphalt binder by the following table. If a wider than indicated trench width is utilized during construction, payment will only be compensated based on the trench width limits detailed in the following table.

Maximum Trench Width Limits in Feet for Compensation for Binder and Flowable Fill Items per Pipe Size in Inches and Depth in Feet			
Pipe Size (inches)	Trench Depth (feet)		
	Up to 5	Greater Than 5 to 10	Greater Than 10
4	2.5	3.0	4.0
6	3.0	3.5	4.5
8	3.0	3.5	4.5
10	3.5	4.0	5.0
12	3.5	4.0	5.0
15	4.0	4.5	5.5

Maximum Trench Width Limits in Feet for Compensation for Binder and Flowable Fill Items per Pipe Size in Inches and Depth in Feet			
Pipe Size (inches)	Trench Depth (feet)		
	Up to 5	Greater Than 5 to 10	Greater Than 10
16	4.0	4.5	5.5
18	4.0	4.5	5.5
20	4.5	5.0	6.0
21	4.5	5.0	6.0
24	5.0	5.5	6.5
30	-	6.0	7.0
36	-	6.5	7.5
42	-	7.5	8.5
48	-	8.0	9.0
54	-	8.5	9.5
60	-	9.5	10.5
64	-	10.0	11.0
66	-	10.0	11.0

- B. Bury gravity sewer mains and service lines in roadways to the slope and alignment requirements indicated on the Drawings. Utilize crushed stone material compacted in maximum 8-inch lifts at the proper moisture content as the supplementary trench backfill material between the crushed stone envelope and the flowable fill.
- C. Bury gravity sewer mains and service lines outside of roadways to the slope and alignment requirements indicated on the Drawings. Utilize suitable native backfill material compacted in 12-inch lifts.
- D. Maintain existing gravity sewer services during the Work.
- E. Do not plug manholes or structures on the existing system and/or new gravity sewer mains placed in service without a written bypass plan.
- F. MWS will make every reasonable effort to locate and uncover all manholes and/or structures to divert wastewater when required for the Work. Circumstances may prevent timely location and access due to such items as weather conditions, lack of access to a location, high wastewater flows, and/or a lack of forces due to higher priority situations. Consider standby time due to these types of delays to be incidental to the Work with no separate payment allowed.
- G. Perform Proctor Density Test in accordance with the most recent revision of ASTM D698 or ASTM D1557 when required by the Construction Manager. Test to be performed by an independent approved materials testing firm. Pay for test if Work is found to be noncompliant.
- H. Perform compaction field testing results in accordance with the most recent revision of ASTM D6938 or other approved method when required by the Construction Manager. Compaction tests to be performed by an independent approved materials testing firm. Pay for test if Work is found to be noncompliant.

- I. Abandon gravity sewer mains smaller than 12 inches in internal diameter with a permanent concrete cap/plug and fill with grout for a distance of approximately 20 linear feet into the main.
- J. Abandon gravity sewer mains 12 inches in internal diameter and larger with a permanent concrete cap/plug and fill with grout for the full distance of the abandoned main.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide gravity sewer main products and accessories from manufacturers in accordance with MWS' Approved Material List.
- B. Provide pipe material for gravity sewer mains and service lines as indicated on the Drawings.
- C. Provide TDOT No. 57 or No. 67 crushed stone for pipe bedding, pipe envelope, and for locations where additional pipeline depth is required within roadways prior to excavatable flowable fill placement and/or to avoid existing utilities.
- D. Provide asphaltic binder in conformance with the most recent revision of Metro Public Works standard specification Section 02575 when the gravity sewer main or service line is to be installed within a Metro Public Works roadway and provide asphaltic binder in conformance with the most recent revisions of the applicable TDOT specification when the gravity sewer main or service line is to be installed within a TDOT roadway.
- E. Provide excavatable flowable fill in conformance the most recent revision of Metro Public Works standard specification Section 02225 when a gravity sewer main or new extended service line is to be installed within a Metro Public Works roadway and provide excavatable flowable fill in conformance with the most recent revisions of the applicable TDOT specification when the gravity sewer main or service line is to be installed within a TDOT roadway.
- F. Provide Grade B or Grade C cement based dry pack grout for abandonment of gravity sewer mains in conformance with the most recent revision of ASTM C1107.

PART 3 - EXECUTION

3.01 GENERAL

- A. Provide the services of a Tennessee registered land surveyor for grade and alignment survey operations.
- B. Set grade stakes, lines, bench marks and elevations, and provide proper equipment to verify alignment and/or grade. Provide grade hubs no more than 100 feet apart with center line hubs no more than 50 feet apart to check laser equipment and grade between manholes. Provide offset stakes at each manhole, junction structure, or change in alignment location. Preserve survey staking, check staking, and reset missing, disturbed, or damaged staking, and/or property boundaries.
- C. Deliver gravity sewer main products and accessories to job site free of damages and/or defects. If damages or defects are discovered, provide new material at no cost to MWS.

- D. Store materials on site in enclosures or under protective above ground coverings.
- E. Keep interiors of gravity sewer main products free of dirt and debris.
- F. Install gravity sewer main, joints, gaskets and fittings in accordance with the most recent revision of ASTM D2321 and manufacturer's recommendations
- G. Install gravity sewer mains and service lines to the gradient and alignment indicated on the Drawings.
- H. Install gravity sewer mains and service lines in crushed stone gravel bedding in the dry.
- I. Install dewatering systems, if necessary, for excavation and gravity sewer main installation. Provide water filtration systems for groundwater. Obtain permits with appropriate agencies for dewatering activities. Appropriately filter and properly dispose of groundwater in accordance with permits.
- J. Clean the inside of the bell and the outside of the spigot of the pipe. Grind or smooth rough edges of the spigot of the pipe and wipe clean as recommended by the pipe manufacturer prior to insertion of the gasket and final joints and/or fittings assembly.
- K. Maintain a minimum of 10 feet horizontal separation when installing a gravity sewer main or service line that shares a parallel alignment with a water main or water service line.
- L. If the new gravity sewer main or service line is installed over an existing water main or existing water service pipe, maintain a minimum vertical separation of 24 inches from the bottom of the gravity sewer main or service line to the top of the water main. Attempt to place the crossing at a point to keep the water main joints at equal distances and as far as possible from the gravity sewer main or service line. Install concrete material between the existing water main and gravity sewer main crossing for the entire width of the distance between the utilities and for a length of at least 6 feet centered at the point of crossing.

3.02 PREPARATION OF THE SITE

- A. Before starting construction, remove from the work site all vegetative growth (except as hereinafter excluded), debris, and/or other objectionable matter as well as any buildings and/or other structures that the Drawings and/or the Construction Manager specifically indicate are to be removed. Dispose of this refuse material in a manner that complies with all applicable laws and regulations.
- B. In certain areas, it may be desirable for existing trees, shrubs, or other vegetation on the site to be preserved for the permanent landscape. Such vegetation may be shown on the Drawings, specifically listed in the specifications, marked on the site, or identified by the Construction Manager. Do not damage or remove such growth without written permission from the Construction Manager.
- C. If the area to be excavated is occupied by trees, brush, or other vegetative growth, clear such growth, grub the excavated area, and remove all large roots to a depth of not less than 2 feet below the bottom of the proposed construction. Dispose of the growth removed in compliance with all applicable laws and regulations. With suitable material, fill all holes or cavities created during this work that extend below the subgrade elevation and compact to the same density as the surrounding material.
- D. Trees, cultivated shrubs, etc., that are situated within public rights-of-way and/or construction easements through private property but not directly within the excavation area shall remain

undisturbed unless it is necessary to remove them so that the work can be performed safely and unless their removal is specifically ordered by the Construction Manager. Take special precautions to protect and preserve such growth throughout all stages of the construction.

- E. If excavation is to be completed under any pavement or concrete, the pavement and/or concrete must be cut or sawed to straight, clean lines before excavation begins.
- F. Preparation of the site shall be considered an integral part of the excavation and one for which no separate payment shall be allowed.

3.03 EXCAVATION

- A. The Construction Manager may limit blasting and require alternate rock breakage methods if conditions warrant such as trenching within areas having high concentrations of utilities or major transmission level utility lines, or proximity to structures and to comply with permit conditions.
- B. The Construction Manager may limit the method of excavation if conditions warrant such as trenching within areas of high concentration of utilities.
- C. Contact Tennessee One Call Center (1-800-351-1111) for the locations of buried facilities pursuant to TCA 65-31-101 through TCA 65-31-133; however, take sole responsibility for the locations of all affected underground utilities.
- D. Locate and preserve existing utilities. The types and locations of known existing utilities as indicated on the Drawings are approximate. Repair or replace damaged utilities in accordance with utility owner protocols, whether shown on the Drawings or not, at no cost to MWS.
- E. Notify the Construction Manager immediately, stop the Work, secure the safety of the site, and wait for the Construction Manager's direction before resuming the Work if solvents, petroleum products, or any unknown chemical substance is discovered during excavation.
- F. Do not remove any structures unless the structure is indicated to be removed on the Drawings or written approval is provided by Construction Manager.
- G. Consider all excavation material to be unclassified.
- H. Saw cut pavement to trench width limits when excavation is within a roadway.
- I. Excavate trench width to permit a minimum of 6 inches between the edge of the trench and the outside of the gravity sewer main and/or service line.
- J. Excavate to allow for a minimum of 6 inches of crushed stone bedding below the bottom of the gravity sewer main and/or service line.
- K. Remove unstable soil at the trench bottom if discovered and refill area with appropriate material. Notify and receive approval from the Construction Manager prior to undercutting and removing undesirable material at the trench base and to receive approval for the refill material.
- L. Remove all loose material from the trench bottom. Do not lay gravity sewer mains directly on rock.
- M. Excavate in accordance with Trench Safety Systems, TOSHA and OSHA regulations, and permits.

- N. Do not place excavated material on roadway surfaces.

3.04 UNSUITABLE MATERIALS / TRENCH STABILIZATION

- A. Wherever muck, quicksand, soft clay, swampy ground, or other material unsuitable for foundations, subgrade, or backfilling is encountered beneath the level of the lines, grades, and/or cross sections on the Drawings, remove it and continue excavation until suitable material is encountered or as directed by the Construction Manager.
- B. The material removed shall be disposed of in the manner described in paragraph 3.06 of this Section.
- C. Refill the areas excavated for this reason with TDOT No. 57 or No 67 crushed stone or other crushed stone material approved by the Construction Manager up to the level of the lines, grades, and/or cross-sections shown on the Drawings. The material shall be placed over the full width of the trench or excavated area in 6-inch lifts and mechanically compacted prior to placing succeeding lifts.
- D. The Construction Manager may require TDOT No. 357 crushed stone or larger base rock for stabilizing the trench bottom below the top 6 inches of the refill.

3.05 ROCKS AND BOULDERS

- A. Any material that is encountered within the limits of the required excavation that cannot be removed except by drilling and/or blasting, including rock, boulders, masonry, hard pan, chert, shale, street and sidewalk pavements, and/or similar materials, shall be considered as unclassified excavation, and no separate payment will be made.
- B. Should rock be encountered in the excavation, remove it by blasting or otherwise. Where blasts are made, cover the excavation with enough excavation material and/or timber, rubber, or steel matting to prevent danger to life and property. Secure all permits required by law for blasting operations and the additional hazard insurance required. Observe all applicable laws and ordinances pertaining to blasting operations. Perform a mandatory pre-blast survey prior to commencing any blasting activities.
- C. Excavate rock over the horizontal limits of excavation and to a depth of not less than 6 inches below the outside bottom of pipe up to 30 inches in diameter and not less than 8 inches below the outside bottom of larger pipes if rock extends to such depth. Then backfill the space below grade with No. 57 crushed stone or other approved material, mechanically compact to the proper grade, and make the area ready for construction.

3.06 DISPOSAL OF MATERIALS

- A. Whenever practicable, all materials removed by excavation that are suitable for backfilling pipe trenches or for other purposes shown on the Drawings or directed by the Construction Manager shall be used for these purposes. Any surplus materials not so used shall be managed as either consisting solely of earth, rock, concrete, and/or asphalt paving materials (“clean spoil”) or, if determined to be something other than clean spoil, as waste materials.
- B. Clean spoil may be deposited off site in spoil areas at site locations in accordance with local regulations. For all such areas, provide certification that proper material handling was in compliance with all applicable laws and regulations.
- C. Dispose of surplus excavated material at a Metro approved permitted site.

- D. Unless otherwise provided in the Contract Documents, waste materials must be properly classified by Contractor and lawfully transported to and disposed of in an appropriate permitted landfill. Provide proof of each such transport and disposal to the Construction Manager within 24 hours after such disposal.
- E. Once any part of the Work is completed, properly remove all surplus clean spoil and lawfully dispose of all waste materials left within the construction limits of that Work. Upon completion of the Work, all plants, rubbish, unused materials, concrete forms, and other like material shall be removed from the job site.
- F. The site shall be left in a state of order and cleanliness.
- G. The depositing of clean spoil and the disposal of waste materials in the manner described above shall be considered an integral part of the excavation work and one for which no separate payment shall be made.

3.07 TRENCH PROTECTION

- A. During working hours, the maximum amount of exposed pipe trench shall be 100 feet.
- B. During nonworking hours inside roadway, use one of the following methods of trench protection:
 1. Steel plate, minimum ¾-inch thick over entire trench or excavation overlapping each pavement edge by 1 foot minimum
 2. Concrete jersey type barriers placed around entire trench or excavation
 3. Cones, barrels, illumination markers and orange safety fencing/posts
- C. During nonworking hours outside roadway, use one of the following methods of trench protection:
 1. Concrete barriers and/or equipment placed around entire trench or excavation
 2. Cones, barrels, and/or orange safety fencing/posts

3.08 EXCAVATION FOR TRENCHES, FACILITIES AND STRUCTURES

- A. Unclassified excavation for pipelines shall consist of the excavation necessary for the construction of all piping and their appurtenances (including manholes, inlets, outlets, headwalls, collars, concrete saddles, and pipe protection) that are called for by the Drawings. It shall include clearing and grubbing, where necessary, backfilling, tamping, and compacting pipe trenches and around structures and disposing of waste materials all of which shall conform to the applicable provisions set forth elsewhere in these specifications.
- B. Contractor may, if he chooses, use a motor powered trenching machine. If he does, however, he shall be fully responsible for the preservation or repair of existing utility service connections and the adequate compaction of backfill material.
- C. Unless the construction of lines by tunneling, jacking, or boring is called for by the Drawings or specifically authorized by Construction Manager, make excavation for pipelines in open cut trenches true to the lines and grades shown on the Drawings or established by the Construction Manager on the ground. Cut the banks of trenches between vertical parallel planes equidistant from the pipe centerline. The horizontal distance between the vertical

planes (or, if sheeting is used, between the inside faces of that sheeting) shall vary with the size of the pipe to be installed as shown in the standard details of the Drawings. When approved in writing by the Construction Manager, the banks of trenches from the ground surface down to a depth not closer than 1 foot above the top of the pipe may be excavated to non-vertical and nonparallel planes, provided the excavation below that depth is made with vertical and parallel sides equidistant from the pipe centerline. If a motor powered trenching machine is approved by the Construction Manager, the trench width will conform to the standard details of the Drawings. Trench width for trenching machines will require a minimum spacing of 12 inches between the pipe wall and vertical rock surfaces and 6 inches between the pipe wall and horizontal rock surface. Contractor shall comply with all backfill compaction requirements regardless of the trenching method that is approved by the Construction Manager.

- D. Perform all work so as to cause the least possible inconvenience to the public. Construct temporary bridges or crossings when and where the Construction Manager deems necessary to maintain vehicular or pedestrian traffic.
- E. In all cases where materials are deposited along open trenches, place them so that, in the event of rain or surcharge, loading from such deposits will result in no damage to the work and/or to adjacent property.

3.09 PIPE ZONE

- A. Pipe zone for pipe used on sewer installations shall consist of an envelope of No. 57 (TDOT) crushed stone from 6 inches below pipe bell to 8 inches above pipe crown for full trench width. No. 7 (TDOT) crushed stone may be used for pipe 12-inches and smaller in diameter in lieu of No. 57 for the pipe envelope to aid consolidation by the contractor.
- B. Hand grade and mechanically consolidate each lift to provide a firm, unyielding surface.
- C. Check grade and correct irregularities in bedding material. Loosen the top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe.
- D. The bedding material shall be shaped for bell and spigot pipe at proper intervals to provide uniform bearing under the entire length of the pipe.
- E. Install to form continuous and uniform support except at bell holes, if applicable, or when there are minor disturbances resulting from removal of lifting tackle.
- F. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joints and to provide uniform bearing along barrel of pipe or conduit.
- G. Restrain pipe as necessary to prevent movement during backfill operations.
- H. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes installed in same trench.
- I. Pipe 10 inches and smaller in diameter: The first lift shall be less than or equal to ½ of the pipe diameter.
- J. Pipe greater than 10 inches in Diameter: Maximum lift height is 8 inches.

- K. Thoroughly consolidate each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under pipe haunches with a rod to ensure that voids are completely filled before placing each succeeding lift.
- L. Where a trench box is used with flexible pipe installation, lift the box to relocate for further pipe installation operations to above the pipe exterior crown and compact each pipe zone lift of bedding material.
- M. After the full depth of the pipe bedding material has been placed as specified, mechanically compact the material over the area between the sides of the pipe and the trench walls.
- N. Do not use power-driven impact compactors to compact pipe bedding material.
- O. On 30-inch internal diameter and larger pipe, perform a survey line and grade check of the first 100 linear feet and at every manhole thereafter. The survey shall be performed by an independent surveyor other than the daily grade crew, and the results shall be submitted to the Construction Manager for review concurrent with payment requests for the work.

3.10 GENERAL BACKFILLING METHODS

- A. Backfilling operations shall be performed so as not to disturb or injure any pipe and/or structure against which the backfill is being placed. If any pipe or structure is damaged and/or displaced during backfilling, open up the backfill and make whatever repairs are necessary. This work shall be done at no cost to MWS.
- B. Backfilling and cleanup operations shall closely follow pipe laying. Pipe laying operations may advance a maximum of 100 linear feet ahead of backfilling operations and 1,000 linear feet ahead of excess spoil removal and cleanup operations. Upon completion of each individual sewer line or 1,500-foot segment, begin cleanup and property restoration prior to installation of another line unless written permission is obtained from the Construction Manager.
- C. Backfilling operations around facilities and structures shall be conducted in the same manner as specified for pipelines except that even greater care is necessary to prevent damage to the utility structures.
- D. Consolidating by flooding will not be permitted under or adjacent to paved or unpaved traffic areas. If tests for in-place density consistently fail to meet the requirements, the Construction Manager may require the contractor to change his method of compaction.

3.11 BACKFILL WITHIN ROADWAY

- A. Take precautions not to damage the gravity sewer main and accessories during backfill operations. Replace damaged items at no cost to MWS.
- B. Install specified backfill material for the full width of the excavated trench and to specified depths.
- C. Install No. 57 or No. 67 crushed stone compacted to 95% Standard Proctor Density in 8-inch lifts for pipe bedding and pipe envelope. Place crushed stone bedding 6 inches below the bottom of the gravity sewer main and/or service line. Place a crushed stone envelope to a height of 8 inches above the top of the gravity sewer main and/or service line. Utilize crushed stone material compacted in maximum 8-inch lifts at the proper moisture content as the supplementary trench backfill material between the crushed stone envelope and the flowable fill.

- D. Install flowable fill above crushed stone envelope at a minimum thickness of 14 inches for MPW roadways and 23 inches for TDOT roadways.
- E. Install an asphalt binder above the flowable fill at a minimum thickness of 8 inches for Metro Public Works' roadways and at a minimum thickness of 11 inches for TDOT roadways. All must be compacted flush with the roadway surface elevation. Maintain a smooth driving surface until final paving is complete.
- F. Remove the indicated thickness of the asphalt binder as part of the milling operations when preparing to pave the roadway.
- G. Install the indicated thickness of the asphaltic surface mix as part of the paving operations in accordance with Metro Public Works or TDOT specifications.
- H. Remediate any settlement of backfill material for a period of one year after final completion and final acceptance of the Work by MWS.

3.12 BACKFILL OUTSIDE OF ROADWAY

- A. Take precautions not to damage the gravity sewer main and accessories during backfill operations. Replace damaged items at no cost to MWS.
- B. Install specified backfill material for the full width of the excavated trench.
- C. Install No. 57 or No. 67 crushed stone compacted to 95% Standard Proctor Density in 8-inch lifts for pipe bedding and pipe envelope. Place crushed stone bedding 6 inches below the bottom of the gravity sewer main and/or service line. Place a crushed stone envelope to a height of 8 inches above the top of the gravity sewer main and/or service line.
- D. Install native soil compacted to 90% maximum Proctor Density in 12-inch lifts above the crushed stone envelope to finished grade. Do not utilize rock greater than 8 inches as backfill.
- E. Remediate any settlement of backfill material for a period of one year after final completion and final acceptance of the Work by MWS.
- F. Seed and straw the disturbed area to reestablish growth. Replace trees and vegetation removed during clearing and excavation with trees and vegetation as shown on the Drawings' revegetation plan.

3.13 MAINTENANCE

- A. Restore and maintain in good condition all excavated areas, trenches, fills, embankments, and channels until final acceptance by the Construction Manager.
- B. Maintain trench backfill at the approximate level of the original ground surface by periodically adding backfill material wherever necessary and whenever directed to do so by the Construction Manager. Continue such maintenance until final acceptance of the project or until the Construction Manager issues a written release.

END OF SECTION

SECTION 33 31 13.17

REINFORCED CONCRETE PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope (1.02)
- C. Submittals (1.03)
- D. Measurement and Payment (1.04)

1.02 SCOPE

- A. Reinforced Concrete Pipe and fittings for gravity sanitary sewers.

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittals.
- B. Submit descriptive information and shop drawings covering complete details of pipe and manufacture, including concrete design mix, reinforcement, lining material, joints, joint materials, fittings, and special pieces.
- C. Submit a Certification of Inspection stating the quantity of pipe, including joints, and pipe length in the shipment, that the pipe was fabricated in accordance with American Concrete Pipe Association QCast Quality Assurance Program requirements, including reinforcement and wall thickness, the dates and results of inspections, the dates and results of concrete cylinders and cores compressive tests (3-edge bearing test for 0.01-inch crack strength), pipe piece numbers, laying schedule, number in line, and that the materials were subjected to and shipped in conformance with the most recent revision of ASTM C76 and ASTM C443.
- D. Submit a Certification of Inspection stating that the coarse aggregate utilized is in conformance with the most recent revision of ASTM C33, that the Portland cement utilized is Type I/II, that the water to cement ratio is no more than 0.43 by weight, that all reinforcement is in conformance with the most recent revision of ASTM A82, A185, A496, or A497, that a corrosion protection additive was utilized, and if indicated which lining system was utilized, and that all joints are manufactured in conformance with the most recent revision of ASTM C443.
- E. Submit, prior to fabrication and shipment, a laying schedule of all pipes including all fittings, adapters, and specials, stationing, pipe class, class coding, stationing for all gradient changes, and the transition stations for the various pipe classes and the limits of each.

1.04 MEASUREMENT AND PAYMENT

- A. Compensation for reinforced concrete pipe and fittings is not addressed in this section; refer to the gravity sewer mains specification section.

- B. Consider all requirements in this section to be incidental to the Work with no separate payment allowed.

PART 2 - PRODUCTS

2.01 REINFORCED CONCRETE PIPE AND FITTINGS

- A. Provide 4000 psi concrete strength, Wall B or Wall C, Class IV, or Class V pipe indicated on the Drawings in conformance with the most recent revision of ASTM C76.
- B. Provide pipe reinforcement with steel areas and clearances for the entire pipe length in conformance with the most recent revisions of ASTM C76 and the following:
 - 1. For plain steel wire in conformance with ASTM A82
 - 2. For plain steel welded wire in conformance with ASTM A185
 - 3. For fabricated deformed steel mats in conformance with ASTM C496 or ASTM C497
- C. Provide two full circular steel cages of reinforcement for pipe 42 inches and larger in diameter and do not use elliptical or quadrant steel cages.
- D. Provide steel end ring type joints in conformance with ASTM C361 with extruded or molded and cured rubber gaskets in conformance with ASTM C443.
- E. Provide Xypex C1000 or approved equal corrosion resistant additive in an amount per manufacturer's recommendation.
- F. If indicated on the Drawings, provide a mechanically cast lining material system, either a minimum 0.065-inch thick PVC or HDPE or a minimum 80 mils dry film thickness factory applied epoxy lining similar to Tnemec Protecto 401. Provide locking studs that penetrate the concrete when the pipe or fittings are cast and a flap or Type P-1 joint for welding by a certified welder to each adjacent liner section into the pipe wall.
- G. Provide standard pipe lengths of 12 feet or 16 feet for pipes larger than 24 inches in diameter.
- H. Provide pipe without lifting holes in the walls.
- I. Transport, handle, and store pipe and/or fittings as recommended by the manufacturer.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install pipe and fittings in accordance with the laying schedule provided by the manufacturer.
- B. Install pipe and fittings in conformance with the American Concrete Pipe Association requirements.

- C. Repair the interior lining/coating of pipe and/or fittings as recommended by the lining/coating manufacturer utilizing a certified manufacturer's representative or their designee.

END OF SECTION

FOR INFORMATION ONLY

SECTION 33 31 13.18

FIBERGLASS REINFORCED POLYMER MORTAR PIPE AND FITTINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope
- C. Submittals
- D. Measurement and Payment

1.02 SCOPE

- A. Fiberglass Reinforced Polymer Mortar Pipe (FRPMP) and fittings for large diameter gravity sanitary sewers

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittals.
- B. Submit descriptive information and shop drawings covering complete details of pipe and manufacture, including resin, design mix, fiberglass reinforcement, lining material, joints, joint materials, fittings, and special pieces.
- C. Submit a Certification of Inspection stating: the quantity of pipe, including joints and pipe length in the shipment; that the pipe was fabricated in accordance with ASTM Quality Assurance Program requirements, including reinforcement and wall thickness; dates and results of inspections; dates and results of cylinders and cores compressive tests laying schedule; and that the materials are compliant with and were shipped in conformance with the latest revision of ASTM D2412 or ASTM D3262.
- D. Submit a Certification of Inspection stating that the fine aggregate utilized is in conformance and 98 percent silica with maximum 0.2 percent moisture content in manufacturing and that all joints are manufactured in conformance with the latest revision of ASTM D4161 performance requirements.
- E. Submit, prior to fabrication and shipment, a laying schedule of all pipes, including all fittings, adapters, specials, stationing, pipe class, class coding, stationing for all gradient changes, and the transition stations for the various pipe classes and the limits of each.

1.04 MEASUREMENT AND PAYMENT

- A. Compensation for fiberglass reinforced polymer mortar pipe and fittings is not addressed in this section; refer to gravity sewer mains specification section.
- B. Consider all requirements in this section to be incidental to the Work with no separate payment allowed.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Pipe Design. ASTM D3262 pipe should be designed to handle all loading conditions in accordance with AWWA M45 Manual – Fiberglass Pipe Design. Load conditions should include loading from earth, hydrostatic, and live loads.
- B. Resin Systems. The manufacturer shall use polyester resin systems with a proven performance history in this particular application. The historical data shall have been acquired from a composite material of similar construction and composition as the proposed product.
- C. Glass Reinforcements. The reinforcing glass fibers used to manufacture the components shall be the highest quality commercial grade E-glass filaments with binder and sizing compatible with impregnating resins. Pipes for conveying sanitary sewage shall use E-glass CR (corrosion resistant) glass.
- D. Internal Liner. The internal liner shall be a glass-reinforced thermoset liner suitable for service in a sewer pipe and shall be highly resistant to corrosion when exposed to sulfuric acid as produced by biological activity from hydrogen sulfide gases. Pipe shall meet or exceed ASTM D3681 requirements.
- E. Silica Sand. Sand shall be minimum 98 percent silica with 0.2 percent maximum moisture content.
- F. Additives. Resin additives such as curing agents, pigment, dyes, fillers, thixotropic agents, etc., when used, shall not detrimentally affect the product's performance.
- G. Elastomeric Gaskets shall be supplied by approved gasket manufactures and be suitable for the service intended.
- H. Fittings. Flanges, elbows, reducers, tees, wyes, laterals, and other fittings shall be able to withstand all operating conditions when installed. They may be contact molded or manufactured from mitered pipe sections joined by glass-fiber-reinforced overlays. Properly protected standard ductile iron, fusion-bonded epoxy coated steel, and stainless steel fittings may also be used.
- I. Diameters. The actual pipe outside diameters (OD) (36-inch to 48-inch) shall be in accordance with ASTM D3262. For other diameters, ODs shall be per manufacturer's literature.
- J. Lengths. Pipe shall be supplied in 20-foot nominal lengths. Actual laying length shall be nominal +1, -4 inches. At least 90 percent of the total footage for each pipe size and class, excluding special order lengths, shall be furnished in nominal length sections. Special short lengths may be used where surface geography or installation conditions require shorter lengths.
- K. Wall Thickness. The pipe's average wall thickness shall not be less than the nominal wall thickness published in the manufacturer's literature, and the minimum wall thickness at any

point shall not be less than 87.5 percent of the nominal wall thickness. The minimum wall thickness shall be as follows:

Nominal Pipe Diameter (inches)	Minimum Wall Thickness (inches)	
	Minimum Pipe Stiffness 46 (psi)	Minimum Pipe Stiffness 72 (psi)
36	0.72	0.83
42	0.83	0.95
45	0.89	1.02
48	0.94	1.08
51	1.00	1.15
54	1.05	1.21
57	1.10	1.27
60	1.15	1.33
63	1.21	1.39
66	1.27	1.46
69	1.32	1.53
72	1.38	1.59
78	1.48	1.71
84	1.58	1.82
90	1.71	1.97
96	1.80	2.08
104	1.95	2.25
110	2.06	2.38

- L. Stiffness. Minimum pipe stiffness in accordance with ASTM D2412 shall normally be 46 psi or as required per the Drawings. Submit full engineering calculations sealed by a Tennessee registered professional engineer for approval prior to authorizing manufacturing of the pipe in order to confirm the pipe class suitability.
- M. End Squareness. All points around each pipe unit's end shall fall within $\pm 1/4$ inch or ± 0.5 percent of the pipe's nominal diameter, whichever is greater, to a plane perpendicular to the pipe's longitudinal axis.
- N. Pipes. Pipes shall be manufactured and tested in accordance with ASTM D3262. Submit the strain corrosion test results from products made in the same manufacturing facility.
- O. Joints. Coupling joints shall meet ASTM D4161 requirements.
- P. Strain Corrosion. Pipes shall be manufactured and tested in accordance with ASTM D3262 and ASTM 3681 (strain corrosion test). Submit a valid copy of full test report by an outside third party independent lab, demonstrating a 50-year extrapolated strain corrosion value of 0.90% in a normal sulfuric acid environment typical of conditions found in sanitary sewers. No short-term validation test results will be accepted in lieu of above referenced full test report.
- Q. Metro or the Construction Manager shall be entitled to inspect pipes or witness the pipe manufacturing.
- R. Manufacturer's Notification to MWS. Should Metro request to see specific pipes during any manufacturing process phase, the manufacturer must provide the Construction Manager with adequate advance notice about when and where the specific pipe production will take place.

- S. The pipe and fittings manufacturer shall have employed manufacturing methods and material formulations used to manufacture glass-fiber-reinforced polymer mortar pipe for 15 years minimum.
- T. Submit a project reference list with project name, owner, and engineer contact and phone numbers for 10 sanitary sewer projects with sizes furnished under the projects and larger pipe supplied and installed in U.S. with a 2,000 feet minimum per project.
- U. Packaging, Handling and Shipping. Packaging, handling, and shipping shall be performed in accordance with the manufacturer's instructions.

2.02 CENTRIFUGALLY CAST FIBERGLASS REINFORCED POLYMER MORTAR PIPE

- A. Pipe. Manufacture pipe by the centrifugal casting process to result in a dense, non-porous, corrosion-resistant, consistent composite structure. The interior surface of the pipe exposed to sewer flow shall be manufactured using a resin with a 50 percent elongation (minimum) when tested in accordance with ASTM D638. The interior surface shall provide crack and abrasion resistance. Include certification from the resin supplier in the submittals. The pipe's exterior surface shall be comprised of a sand and resin layer. The layer shall provide UV protection to the pipe exterior.
- B. Joints. Unless otherwise specified, the pipe shall be field connected with fiberglass sleeve couplings that use elastomeric sealing gaskets made from EPDM rubber compound as the sole means to maintain joint water tightness. The joints must meet ASTM D4161 performance requirements. Joints at tie-ins, when needed, may use stainless steel gasket-sealed closure couplings. As a supplement to ASTM D4161 - Sect 7.4 testing requirements, the proposed pipe joints shall be able to withstand a 100 psi external pressure test in straight alignment and angularly deflected. A test report certified by an independent testing lab is required with submittals for acceptance.

2.03 FILAMENT WOUND FIBERGLASS REINFORCED POLYMER MORTAR PIPE

- A. Pipe. The Pipe shall be manufactured using a filament-wound, continuously advancing mandrel process using continuous glass fiber reinforcements in the circumferential direction. Both continuous glass fiber roving and chopped roving will be incorporated for high hoop strength and axial reinforcement. A sand fortifier shall be used to provide increased stiffness with placement near the neutral axis in the core. The pipe shall meet the following cell limits—Type 1, glass-fiber-reinforced thermosetting polyester resin mortar (RPMP polyester), Liner 1, and Grade 1. Pipes shall be manufactured and tested in accordance with ASTM D3262 and ASTM 3681 (strain corrosion test).
- B. Joints. The filament-wound fiberglass pipe shall use filament-wound Reka Couplings. The Reka Coupling shall use 2 gaskets with 4 to 6 sealing fins (depending on diameter) and shall be located in a recessed groove approximately 1.5 inches from each edge. The sealing gaskets will be the sole means to maintain joint water tightness. An elastomeric pipe stop will be located in a groove in the middle of the Reka Coupling between the sealing gaskets. The joints shall use elastomeric gaskets meeting ASTM D4161 performance requirements. The couplings shall be manufactured using the same process as the pipe. For project installation depths more than 50 feet over the top of pipe, the proposed pipe joints shall be able to withstand a 100 psi external pressure test in straight alignment and angularly deflected. A test report, certified by an independent testing lab, is required with submittals for approval.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install pipe and fittings in accordance with the laying schedule provided by the manufacturer.
- B. Install pipe and fittings in conformance with the manufacturer's requirements.
- C. Repair the interior lining/coating of pipe and/or fittings as recommended by the lining/coating manufacturer utilizing a certified manufacturer's representative or their designee.

END OF SECTION

SECTION 33 31 61

ACCEPTANCE TESTING FOR SANITARY SEWERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope
- C. Submittals
- D. Measurement and Payment
- E. Performance Requirements
- F. Testing Requirements
- G. Observations
- H. Remediation

1.02 SCOPE

- A. Acceptance testing for gravity sewer mains, sanitary sewer force mains, low pressure sanitary sewer mains, and sewer manholes.

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittal.
- B. Submit a test plan in accordance with these specifications.
- C. Submit signed test reports for all sanitary sewer testing required.

1.04 MEASUREMENT AND PAYMENT

- A. Consider expenses for acceptance testing of sanitary sewers incidental to the Work with no separate payment allowed.
- B. Provide labor, equipment, or any other devices necessary for proper testing at no additional cost to MWS.

1.05 PERFORMANCE REQUIREMENTS

- A. Supply pipe materials, manholes, and other sanitary sewer appurtenances that will meet performance requirements.
- B. Ensure sewer service connections and service lines meet performance requirements.
- C. Install gravity flow sanitary sewers with straight alignments and uniform grades between manholes.

- D. Install flexible sewer pipe with no more than 5 percent barrel deflection.
- E. Provide installed sewer pipes with no visual seal, longitudinal, and/or transverse cracks.
- F. Provide installed sewer pipes with no measurable or visual leakage and/or infiltration.

1.06 TESTING REQUIREMENTS

- A. Perform Mandrel Test, Low Pressure Air Test, and internal video observations for newly installed gravity sanitary sewers.
- B. Perform Hydrostatic Pressure Test for newly installed sanitary force mains.
- C. Perform Vacuum Test for newly installed sanitary sewer manholes.
- D. Perform Infiltration Test, Exfiltration Test, and/or Smoke Test at the direction of the Construction Manager.

1.07 OBSERVATION

- A. Perform testing in the presence of the Construction Manager.
- B. Observable leakage, infiltration, grade defects, excessive deflection, and/or cracks will not be accepted.

1.08 REMEDIATION

- A. Repair, correct, and retest manholes or sections of pipe that fail to meet specified requirements when tested.
- B. Repair deficiencies in sanitary sewer pipe by re-bedding pipe, re-laying pipe, and/or removing and replacing pipe that does not conform to the Drawings and Specifications at no additional cost to MWS.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 MANDREL TEST

- A. Perform testing no sooner than 30 days after backfilling of line segment.
- B. Construct or furnish mandrel with a minimum diameter of 95 percent of the inside diameter of the pipe being tested.
- C. Construct or furnish mandrel with metal or rigid plastic material that can withstand 200 psi without being deformed.
- D. Construct or furnish mandrel to have nine or more nonadjustable or noncollapsible runners or legs.

- E. Construct or furnish the barrel section of the mandrel with a diameter of 75 percent of the inside diameter of the pipe being tested.
- F. Pull approved mandrel by hand through sewer sections. Replace any section of sewer not passing the mandrel.
- G. Retest repaired or replaced sewer sections.

3.02 LOW PRESSURE AIR TEST

- A. Perform low pressure air test on gravity sanitary sewer mains less than a 36-inch inside diameter in accordance with the latest version of ASTM C 828, ASTM C 924, as ASTM F1417 as applicable.
- B. Use testing pneumatic plugs that can remain in place when pressurized to 25 psig without external aids.
- C. For pipes 36 inches inside diameter and larger, test pipe at each joint, provided the barrel of the pipe has been factory satisfactorily hydrostatically tested. 10 seconds is the minimum time allowable for pressure to drop from 3.5 psig to 2.5 psig.
- D. For pipe smaller than 36-inch inside diameter, test in accordance with the following:
 - 1. Determine ground water level.
 - 2. Plug both ends of pipe. For concrete pipe, flood pipe and allow 2 hours to saturate concrete. Then drain and plug concrete pipe.
 - 3. For rehabilitated sewers, after manhole-to-manhole section of sanitary sewer main has been sliplined and prior to any service lines being connected to new liner, plug liner at each manhole with pneumatic plugs.
 - 4. Pressurize rehabilitated or new pipe to 4.0 psig. Increase pressure 1.0 psi for each 2.3 feet of ground water over highest point in system. Allow pressure to stabilize for 2 to 4 minutes. Adjust pressure to start at 3.5 psig (plus adjustment for ground water table). See Table 1 below:
 - 5. To determine air loss, measure time interval for pressure to drop to 2.5 psig. Time must exceed that listed in the table below for pipe diameter and length. For lined pipes, use diameter of host pipe.

Table 1 Low Pressure Air Test (Time Allowed For Pressure Loss From 3.5 Psig To 2.5 Psig)														
Pipe Diam. (in)	Min. Time (min /sec)	Length for min. time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) shown (min:sec)										
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	500 ft	550 ft	600 ft
6	5:40	398	0.854	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07	7:50	8:33
8	7:33	298	1.519	7:33	7:33	7:33	7:33	7:36	8:52	10:08	11:24	12:40	13:56	15:12
10	9:27	239	2.374	9:27	9:27	9:27	9:54	11:52	13:51	15:50	17:48	19:47	21:46	23:45
12	11:20	199	3.419	11:20	11:20	11:20	14:15	17:06	19:57	22:48	25:39	28:30	31:20	34:11
15	14:10	159	5.342	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31	48:58	53:25
18	17:00	133	7.692	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06	70:31	76:56
21	19:50	114	10.47	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15	95:59	104:42
24	22:40	99	13.67	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58	125:22	136:46
27	25:30	88	17.30	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	144:14	158:40	173:05
30	28:20	80	21.36	35:37	53:25	71:14	89:02	106:51	124:39	142:28	160:16	178:05	195:53	213:41
33	31:10	72	25.85	43:06	64:38	86:11	107:44	129:17	150:50	172:23	193:55	215:28	237:01	258:34

3.03 HYDROSTATIC PRESSURE TESTING FOR SANITARY SEWER FORCE MAINS AND LOW PRESSURE SANITARY SEWER MAINS

- A. Perform Hydrostatic pressure testing in accordance with the latest version of applicable AWWA standard.
- B. Pressurize line to 1.5 times the stated working pressure of the pipeline at the lowest elevation or 100 psi whichever is greater.
- C. Maintain pressure for a minimum of 4 hours with no more than a 5 psi variance for the duration of the test.
- D. Introduce water slowly to vent all air for the section of pipe being tested.
- E. If permanent air vents such as air release valves, are not located at all high points on the section, install corporation cocks at points to expel air as the line is filled with water. Remove corporation cock and plug the line after pressure test has passed.
- F. If the specified testing pressure cannot be maintained, makeup water may be added into the pipeline to main the pressure as directed by the on-site project representative. No more than the amount shown Table 2, Pressure Testing Make Up Allowance, below shall be allowed as make up water. The quantity shown is the maximum amount allowed per hour per 1,000 feet for the 4-hour test. The addition of makeup water shall be done only one time and in the presence of MWS allowing visual measurement of the amount added.

Table 2 Pressure Testing Make Up (Allowance) Water to Maintain Testing Pressure*										
Gallons allowed per hour per 1,000 feet of main tested										
Pipe Diameter	Average Test Pressure (psi)									
	100	125	150	175	200	225	250	275	300	350
1"	0.07	0.08	0.08	0.09	0.10	0.10	0.11	0.11	0.12	0.13
1.25"	0.08	0.09	0.10	0.11	0.12	0.13	0.13	0.14	0.15	0.16
1.5"	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19
2"	0.14	0.15	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.25
2.5"	0.17	0.19	0.21	0.22	0.24	0.25	0.27	0.28	0.29	0.32
3"	0.20	0.23	0.25	0.27	0.29	0.30	0.32	0.34	0.35	0.38
4"	0.27	0.30	0.33	0.36	0.38	0.41	0.43	0.45	0.47	0.51
6"	0.41	0.45	0.50	0.54	0.57	0.61	0.64	0.67	0.70	0.76
8"	0.54	0.60	0.66	0.72	0.76	0.81	0.85	0.90	0.94	1.01
10"	0.68	0.76	0.83	0.89	0.96	1.01	1.07	1.12	1.17	1.26
12"	0.81	0.91	0.99	1.07	1.15	1.22	1.28	1.37	1.40	1.52
16"	1.08	1.21	1.32	1.43	1.53	1.62	1.71	1.79	1.87	2.02
18"	1.22	1.36	1.49	1.61	1.72	1.82	1.92	2.02	2.11	2.28
20"	1.35	1.51	1.66	1.79	1.91	2.03	2.14	2.24	2.34	2.53
24"	1.62	1.81	1.99	2.15	2.29	2.43	2.56	2.69	2.81	3.03
30"	2.03	2.27	2.48	2.68	2.87	3.04	3.21	3.36	3.51	3.79
36"	2.43	2.72	2.98	3.22	3.44	3.65	3.85	4.03	4.21	4.55
42"	2.84	3.17	3.48	3.75	4.01	4.26	4.49	4.71	4.92	5.31
48"	3.24	3.63	3.97	4.29	4.59	4.86	5.13	5.38	5.62	6.07
54"	3.65	4.08	4.47	4.83	5.16	5.47	5.77	6.05	6.32	6.83
60"	4.05	4.53	4.97	5.36	5.73	6.08	6.41	6.72	7.02	7.58

* Source: ANSI/AWWA C600-11 Table 5A

3.04 INTERNAL VIDEO OBSERVATIONS

- A. For all new gravity sewer pipe, provide a color video media compatible with MWS current operating software and devices.
- B. Identify each media with labels showing project name, contractor's name, and each manhole-to-manhole pipe segment of sewer line.
- C. Audio commentary in video media to be sufficiently free from electrical interference and background noise to provide complete intelligibility of oral report.
- D. Visually display and provide commentary in video media which contain the following: narrative of location, direction of view, manhole numbers/stations, length of segment, pipe diameter and material, date, time of observation, and location of laterals and other key features.
- E. Utilize video observation equipment with current technology and standards including rotating head, capable of 90-degree rotation from horizontal and 360-degree rotation about its centerline.
- F. Utilize video observation equipment capable of measuring distance traveled the in sewer, accurate to plus or minus 2 feet in 1,000 feet.
- G. Provide 360-degree sweep of pipe interior, each pipe joint, each lateral connection and provide commentary on points of interest and document with PACE standard notations.
- H. Points of interest may include, but are not limited to, the following: defects, encrustations, mineral deposits, debris, sediment, and any location determined not to be installed to specifications and drawings.
- I. Maximum recording rate of travel shall be 30 feet per minute.
- J. Do not exceed depth of flow shown in Table 3 below for respective pipe sizes as measured in manhole during the CCTV.
- K. When depth of flow at upstream manhole of sewer line section being worked is above maximum allowable, reduce flow to level shown in Table 3 below, by plugging or blocking of flow, or by pumping and bypassing of flow as specified.

Nominal Pipe Diameter	Maximum Depth of Flow
6" - 10"	20 percent of pipe diameter
12" - 24"	25 percent of pipe diameter

3.05 VACUUM TESTING FOR MANHOLES

- A. Install vacuum test head assembly at top access point of manhole and adjust for proper seal on straight top section of manhole structure. Following manufacturer's instructions and safety precautions, inflate sealing element to recommended maximum inflation pressure; do not over-inflate.

- B. Evacuate manhole with vacuum pump to 10 inches mercury (Hg), disconnect pump, and monitor vacuum for time period specified in Vacuum Test Time Table 4 below:
- C. If drop in vacuum exceeds 1 inch Hg over specified time period tabulated in Table 4 below, locate leaks, complete repairs necessary to seal manhole and repeat test procedure until satisfactory results are obtained.

Table 4 Minimum Testing Times For Sanitary Manholes – Vacuum Test			
DEPTH (FT)	TIME IN SECONDS BY DIAMETER		
	48"	60"	72"
4	10	13	16
8	20	26	32
12	30	39	48
16	40	52	64
20	50	65	80
24	60	78	96
*	5.0	6.5	8.0

*Add T times for each additional 2-foot depth.
(The values listed above have been extrapolated from ASTM C924-85)

3.06 EXFILTRATION TEST

- A. Determine ground water elevation.
- B. Plug sewer in downstream manhole and plug incoming pipes in upstream manhole
- C. Install riser pipe in outgoing pipe of upstream manhole when highest point in service lead (house service) is less than 2 feet below bottom of manhole cone.
- D. Fill sewer pipe and manhole of pipe riser with environmentally acceptable biodegradable dyed water to point 2-1/2 feet above highest point in sewer pipe, house lead, or ground water table, whichever is highest.
- E. Allow water to stabilize for one to two hours. Take water level reading to determine drop of water surface, in inches, over one-hour period, and calculate water loss (1 inch of water in 4 feet diameter manhole equals 8.22 gallons) or measure quantity of water required to keep water at same level. Loss shall not exceed that calculated from allowable leakage according to the Table 5 - Water Test Allowable Leakage below.

3.07 INFILTRATION TEST

- A. Determine ground water elevation. Ground water elevation must be not less than 2 feet above highest point of sewer pipe or service lead (house service).
- B. Plug incoming pipes in upstream manhole.
- C. Insert calibrated 90-degree V-notch weir in pipe on downstream manhole.
- D. Allow water to rise and flow over weir until it stabilizes.

- E. Take five readings of accumulated volume over period of 2 hours and use average for infiltration. Average must not exceed that calculated for 2 hours from allowable leakage according to Table 5 - Water Test Allowable Leakage below.

Table 5 - Water Test Allowable Leakage				
Diameter Of Riser Or Stack In Inches	Volume Per Inch Of Depth		Allowance Leakage*	
	Inch	Gallons	Pipe Size In Inches	Gallons/Minute Per 100ft.
1	0.7854	.0034	6	0.0039
2	3.1416	.0136	8	0.0053
2.5	4.9087	.0212	13	0.0066
3	7.0686	.0306	12	0.0079
4	12.5664	.0306	15	0.0099
5	19.6350	.0544	18	0.0118
6	28.2743	.1224	21	0.0138
8	50.2655	.2176	24	0.0158
			27	0.0177
			30	0.0197
			36	0.0237
			42	0.0276
For other diameters, multiply square of diameters by value of 1" diameter			Equivalent to 50 gallons per inch of inside diameter per mile per 24 hours	
* Allowable leakage rate shall be reduced to 10 gallons per inch of inside diameter per mile per 24 hours, when sewer is identified as located within 25-year flood plain				

3.08 SMOKE TEST PROCEDURE FOR POINT REPAIRS

- A. Perform smoke test under the direction of Construction Manager, if the Drawings indicate such is required.
- B. Utilize Smoke generator that produces a minimum of 2500 standard cubic feet per minute
- C. Give written notices to area residents no fewer than 2 days prior to proposed testing. Also give notice to local police and fire departments 24 hours prior to actual smoke testing.
- D. Operate equipment according to manufacturer's recommendation
- E. Conduct test by forcing smoke from smoke generators through sanitary sewer main and service connections. Operate smoke generators for minimum of 5 minutes.
- F. Introduce smoke into upstream and downstream manhole as appropriate. Monitor tap/connection for smoke leaks. Note sources of leaks.
- G. Repair and replace taps or connections noted as leaking and then retest. Taps and connections may be left exposed in only one manhole section at time. When repair or replacement, testing or retesting, and backfilling of excavation is not completed within one work day, properly barricade and cover each excavation.

- H. For houses where smoke does not issue from plumbing vent stacks to confirm reconnection of sewer service to newly installed liner pipe, perform dye test to confirm reconnection. Introduce dye into service line through plumbing fixture inside structure or sewer cleanout immediately outside structure and flush with water. Observe flow at service reconnection or downstream manhole. Detection of dye confirms reconnection.

FOR INFORMATION ONLY

Mandrel Test Data Sheet

Metro Water Service

Date: _____

Project: _____

Material: _____

Sheet #: _____

Max Allowed Deflection: _____

Upstream MH Sta. #	Downstream MH Sta. #	Pipe Dia. (inches)	Length (feet)	Pass or Fail

MWS Representative:

_____ (Signature) _____ (Date)

Contractor:

_____ (Signature) _____ (Date)

FOR INFORMATION ONLY

PIPE VS. MANDREL DIAMETER			
Material and Wall Construction	Nominal Size(Inches)	Average I.D. (Inches)	Minimum Mandrel Diameter (Inches)
PVC-Solid (SDR 26)	6	5.764	5.476
	8	7.715	7.329
	10	9.646	9.162
PVC-Solid (SDR 35)	12	11.737	11.150
	15	14.374	13.655
	18	17.629	16.748
	21	20.783	19.744
	24	23.381	22.120
	27	26.351	25.033
PVC-Profile (ASTM F 794)	30	29.500	28.025
	36	35.500	33.725
	42	41.500	39.425
	48	47.500	45.125
HDPE-Profile	30	30.000	28.500
	36	36.000	34.200
	42	42.000	39.900
	48	48.000	45.600
	54	54.000	51.300
	60	60.000	57.000
Fiberglass-Centrifugally Cast (Class 46)	27	26.48	25.156
	30	30.68	29.146
	36	36.74	34.903
	42	42.70	40.565
	48	48.76	46.322
	54	54.82	52.079
	60	60.38	57.361

**Leakage Testing for Sanitary Sewer Lines
Metro Water Service**

Project: _____
Inspector: _____

Sheet #: _____
Date: _____

Location: _____
Contractor: _____

Line Test Log

Test #	Manhole UP	Manhole Down	Line Length	Line Diameter	Avg. Depth of Line	Avg. Depth of Ground-water	Start Air Pressure	End Air Pressure	Time Elapsed	Time Allowed (per table*)	Pass or Fail	Inspector	Contractor
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
13													
14													
15													

FOR INFORMATION ONLY

TABLE 1 - LOW PRESSURE AIR TEST (TIME ALLOWED FOR PRESSURE LOSS FROM 3.5 PSIG TO 2.5 PSIG)

Pipe Diam. (in)	Min. Time (min /sec)	Length for min. time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) shown (min:sec)										
				100 ft	150 ft	200 ft	250 ft	300 ft	350 ft	400 ft	450 ft	500 ft	550 ft	600 ft
6	5:40	398	0.854	5:40	5:40	5:40	5:40	5:40	5:40	5:42	6:25	7:07	7:50	8:33
8	7:33	298	1.519	7:33	7:33	7:33	7:33	7:36	8:52	10:08	11:24	12:40	13:56	15:12
10	9:27	239	2.374	9:27	9:27	9:27	9:54	11:52	13:51	15:50	17:48	19:47	21:46	23:45
12	11:20	199	3.419	11:20	11:20	11:20	14:15	17:06	19:57	22:48	25:39	28:30	31:20	34:11
15	14:10	159	5.342	14:10	14:10	17:48	22:16	26:43	31:10	35:37	40:04	44:31	48:58	53:25
18	17:00	133	7.692	17:00	19:14	25:39	32:03	38:28	44:52	51:17	57:42	64:06	70:31	76:56
21	19:50	114	10.47	19:50	26:11	34:54	43:38	52:21	61:05	69:48	78:32	87:15	95:59	104:42
24	22:40	99	13.67	22:48	34:11	45:35	56:59	68:23	79:47	91:10	102:34	113:58	125:22	136:46
27	25:30	88	17.30	28:51	43:16	57:42	72:07	86:33	100:58	115:24	129:49	144:14	158:40	173:05
30	28:20	80	21.36	35:37	53:25	71:14	89:02	106:51	124:39	142:28	160:16	178:05	195:53	213:41
33	31:10	72	25.85	43:06	64:38	86:11	107:44	129:17	150:50	172:23	193:55	215:28	237:01	258:34

END OF SECTION

FOR INFORMATION ONLY

SECTION 33 34 00
SEWER FORCE MAINS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope (1.02)
- C. Submittals (1.03)
- D. Measurement and Payment (1.04)
- E. General (1.05)

1.02 SCOPE

- A. Sewer force mains, connections, abandonments, and excavation and backfill. Does not include small diameter grinder systems.

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittals.
- B. Submit manufacturer's product data for proposed force main pipe, joints, joint materials, specials, and fittings for approval.
- C. Submit crushed stone bedding and envelope material sieve analysis and compaction methods.
- D. Submit abandonment plan, bypass pumping requirements, and plugging, if any, and other information pertinent to completion of the Work.
- E. Submit asphaltic binder information certifying material is in conformance with the most recent revision of Metro Public Works' standard specification Section 02575 if the force main is to be installed within a Metro Public Works roadway or the most recent revision of the applicable TDOT asphaltic binder specification if force main is to be installed within a TDOT roadway
- F. Submit flowable fill information certifying material is in conformance with the most recent revision of Metro Public Works standard specification Section 02225 if the force main is to be installed within a Metro Public Works roadway or the most recent revision of the applicable TDOT flowable specification if force main is to be installed within a TDOT roadway.
- G. Submit outside roadway backfill material source, quality information, and compaction methods.
- H. Submit Proctor Density Test results in accordance with the most recent revision of ASTM D698 or ASTM D1557 when required by MWS.
- I. Submit compaction field testing results in accordance with the most recent revision of ASTM D6938 or other approved method when required by MWS.

1.04 MEASUREMENT AND PAYMENT

- A. MWS will compensate for Work only if unit price items are set forth in the Bid documents and allow NO separate payment to be made otherwise.
- B. MWS will compensate for furnishing and installing force mains at the contract unit price per linear foot for the force main installed complete and ready for operation. Measure the force main horizontally along the centerline of the pipe in place including valves, bends, reducers, and offsets.
1. Include cost in the unit price for force mains for labor, equipment, material, cutting, laying, joints, lowering, raising, other offsets necessary to avoid obstructions, field adjustments of alignment, bypass pumping, standby time and delay in MWS isolation of existing sewer system, blow-offs with manholes, hydrostatic testing and other testing required, and all incidentals necessary for a complete and operable installation.
 2. Include cost in the unit price for force mains for fittings whether fittings and/or offsets are indicated on the Drawings or not.
 3. Include cost in the unit price for force mains for excavation. Excavation is unclassified with no distinction made between rock and/or dirt excavation.
 4. Include cost in the unit price for force mains for crushed stone bedding, crushed stone envelope, and additional crushed stone used as backfill material when force main exceeds minimum depths.
 5. Include cost in the unit price for force mains for outside of roadway backfill material.
 6. Include cost in the unit price for force mains for dewatering operations including but not limited to water filtration systems for groundwater, obtaining permits with appropriate agencies on dewatering activities, and appropriately filtering and properly disposing of groundwater in accordance with permits.
 7. Undercutting of undesirable material at the trench base and approved refill material to be paid with Unforeseen Work Elements Allowance bid item.
- C. MWS will compensate for furnishing and installing connections at the contract unit price per each for each connection complete and ready for operation.
1. Include all costs in the unit price for connections for labor, equipment, excavation, material, backfilling, bypass pumping, and all incidentals necessary for a complete and operable installation.
- D. MWS will compensate for cutting and plugging in order to abandon a force main at the contract unit price of each for each cutting and plugging operation.
1. Include all costs in the unit price for cutting and plugging for labor, equipment, materials, permanent solid force main plug, removing valve boxes over valves on abandoned force mains, bypass pumping, and all incidentals necessary for a complete force main abandonment operation.
- E. MWS will compensate for furnishing and installing flowable fill in pipe trenches at the contract unit price per theoretical cubic yard calculated utilizing the specified trench width per

force main size, the length of force main installed, and the specified flowable fill depth; not the actual amount of flowable fill if more material is installed.

1. Include all costs in the unit price for flowable fill for excavation, material, labor, and all incidentals necessary for a complete installation.
- F. MWS will compensate for furnishing and installing asphalt binder at the contract unit price per theoretical cubic yard calculated utilizing the specified trench width per force main size and the length of force main install, not the actual amount of asphalt binder if more material is installed.
1. Include all costs in the unit price for asphalt binder for excavation, material, labor, and all incidentals necessary for a complete installation.
- G. MWS will compensate for furnishing and installing miscellaneous concrete at the contract unit price per cubic yard for concrete installed between a proposed force main traversing perpendicular and above an existing water main.
1. Include all costs in the unit price for miscellaneous concrete for excavation, materials, labor, and all incidentals necessary for a complete installation.

1.05 GENERAL

- A. Calculate Bid Schedule payment items of flowable fill and asphalt binder by the following table. If a wider than indicated trench width is utilized during construction, payment will only be compensated based on the trench width limits detailed in the following table.

Nominal Pipe Diameter (inches)	Trench Width (feet)
12 and smaller	2.5
14	3.0
16	3.0
18	3.0
20	3.5
24	4.0
30	4.5
36	5.0
42	6.0
48	6.5
54	7.0
60	8.0
64	8.5

- B. Bury force main and backfill trench in roadways in accordance with the following table and to the slope and alignment requirements indicated on the Drawings. Bury pipe at minimum depths unless additional depth is required to avoid an obstruction. Utilize crushed stone material compacted in maximum 8-inch lifts at the proper moisture content as the

supplementary trench backfill material when force main must be installed below the minimum depths.

Nominal Pipe Size	MPW Roadway		TDOT Roadway
	Smaller than 12"	12" and Larger	All Pipe Sizes
Asphalt Binder above Flowable Fill to Grade	8"	8"	11"
Flowable Fill above Crushed Stone Envelope	14"	20"	23"
Crushed Stone Envelope above Top of Pipe	8"	8"	8"
Total Cover (Min Depths)	30"	36"	42"
Crushed Stone Bedding Below Bottom of Pipe	6"	6"	6"

- C. Bury force main and backfill trench outside of roadways in accordance with the following table and to the slope and alignment requirements indicated on the Drawings. Bury pipe at minimum depths unless additional depth is required to avoid an obstruction. Utilized suitable native backfill material compacted in 12 inch lifts as the supplementary trench backfill material when force main must be installed below the minimum depths.

Nominal Force Main Size	Total Cover (Minimum Depth)	Crushed Stone Bedding below Bottom of Pipe	Crushed Stone Envelope above Top of Pipe	Native Soil above Crushed Stone Envelope to Finished Grade
Smaller than 12"	30"	6"	8"	22"
12" and Larger	36"	6"	8"	28"

- D. Request shut down isolation times and durations in writing to MWS 7 days in advance for approval.
- E. Do not make connections to the existing sewer system until applicable tests including hydrostatic testing have been performed and reported to MWS and found to be in compliance.
- F. Install a solid permanent force main plug on the end of an existing force main when performing a cutting and plugging operation for abandonment of an existing force main.
- G. Properly abandon valve boxes and/or manholes over valves on abandoned force mains.
- H. Perform Proctor Density Test in accordance with the most recent revision of ASTM D698 or ASTM D1557 when required by MWS. Test to be performed by an independent MWS approved materials testing firm. Pay for test if Work is found to be noncompliance.
- I. Perform compaction field testing results in accordance with the most recent revision of ASTM D6938 or other approved method when required by MWS. Compaction tests to be performed

by an independent MWS approved materials testing firm. Pay for test if Work is found to be noncompliance.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide force main products and accessories from manufacturers in accordance with MWS Approved Material List.
- B. Provide PVC or ductile iron restrained joint pipe for force mains if indicated on the Drawings.
- C. Provide No. 57 or No. 67 crushed stone for pipe bedding, pipe envelope, and additional backfill material when force main exceeds minimum buried depths.
- D. Provide asphaltic binder in conformance with the most recent revision of Metro Public Works standard specification Section 02575 when the force main is to be installed within a Metro Public Works roadway and provide asphaltic binder in conformance with the most recent revisions of the applicable TDOT specification when the force main is to be installed within a TDOT roadway.
- E. Provide excavatable flowable fill in conformance the most recent revision of Metro Public Works standard specification Section 02225 when a force main is to be installed within a Metro Public Works roadway and provide excavatable flowable fill in conformance with the most recent revisions of the applicable TDOT specification when the force main is to be installed within a TDOT roadway.

PART 3 - EXECUTION

3.01 GENERAL

- A. Deliver force main products and accessories to job site free of damages and/or defects. If damages or defects are discovered, provide new material at no cost to MWS.
- B. Store materials on site in enclosures or under protective above ground coverings.
- C. Keep interiors of force main products free of dirt and debris.
- D. Install force main, joints, and fittings per manufacturer's recommendations.
- E. Install force main with spigot ends toward the direction of flow. Form a concentric joint with each section of adjoining pipe.
- F. Install force main to maintain minimum cover and to the grades and alignment indicated on the Drawings as specified.
- G. Install force main pipe in crushed stone gravel bedding in the dry.
- H. Install dewatering systems, if necessary, for excavation and force main installation. Provide water filtration systems for groundwater, obtain permits with appropriate agencies for dewatering activities and appropriately filter and properly dispose of groundwater in accordance with permits.

- I. Do not deflect force mains in excess of the manufacturer's recommendations.
- J. Clean the inside of the bell and the outside of the plain end of the pipe with a wire brush and wipe clean prior to joint assembly.
- K. Clean all gaskets prior to joints and/or fittings assembly.
- L. Grind all rough edges of the plain end of a field cut pipe.
- M. Maintain a minimum of 10 feet horizontal separation when installing a force main sharing a parallel alignment with a water main or water service line.
- N. Install the force main under existing water mains or water service lines when sharing perpendicular alignments. Maintain a minimum vertical separation of 18 inches from the bottom of the water main or water service line to the top of the force mains.

3.02 EXCAVATION

- A. Construction Manager may limit blasting and require alternate rock breakage methods if conditions warrant such as trenching within areas of high concentration of utilities, major transmission level utility line(s) or proximity to structures and permit conditions.
- B. Construction Manager may limit the method of excavation if conditions warrant such as trenching within areas of high concentration of utilities.
- C. Contact Tennessee One Call Center (1-800-351-1111) for the locations of buried facilities pursuant to TCA 65-31-101 through TCA 65-31-133; however, take sole responsibility for the location of all affected underground utilities.
- D. Locate and preserve existing utilities. The types and locations of known existing utilities as indicated on the Drawings are approximate. Repair or replace damaged utilities, whether shown on the Drawings or not, at no cost to MWS.
- E. Notify Construction Manager immediately, stop the Work, secure the safety of the site, and wait for Construction Manager direction before resuming the Work if solvents, petroleum products, or any unknown chemical substance is discovered during excavation.
- F. Do not remove any structures unless the structure is indicated to be removed on the Drawings or written approval is provided by Construction Manager.
- G. Consider all excavation material unclassified, whether a geotechnical report is provided or not.
- H. Saw cut pavement to trench width limits when excavation is within a roadway.
- I. Excavate trench width to permit a minimum of 6 inches between the edge of the trench and the outside of the force main.
- J. Excavate to allow for a minimum of 6 inches of crushed stone bedding below the bottom of the force main.
- K. Remove unstable soil at the trench bottom if discovered and refill area with appropriate material. Notify and receive approval from MWS prior to undercutting and removing undesirable material at the trench base and utilizing approved refill material.

- L. Remove all loose material from the trench bottom. Do not lay force mains and accessories directly on rock.
- M. Excavate to allow minimum force main cover per force main size and roadway conditions as indicated.
- N. Excavate in accordance with Trench Safety Systems, TOSHA and OSHA regulations, and permits.
- O. Do not place excavated material on roadway surfaces.
- P. Dispose of surplus excavated material at a Metro approved permitted site. Do not place excess excavated material on private property inside 100-year floodplain.

3.03 BACKFILL WITHIN ROADWAY

- A. Take precautions not to damage the force main and accessories during backfill operations. Replace damaged items at no cost to MWS.
- B. Install specified backfill material for the full width of the excavated trench and to specified depths.
- C. Install No. 57 or No. 67 crushed stone compacted to 95% Standard Proctor Density in 8-inch lifts for pipe bedding and pipe envelope. Place crushed stone bedding 6 inches below the bottom of the force main. Place crushed stone envelope to a height of 8 inches above the top of the force main. Utilize crushed stone material compacted in maximum 8-inch lifts at the proper moisture content as the supplementary trench backfill material when force main must be installed below the minimum depths.
- D. Install flowable fill above crushed stone envelope at indicated depths.
- E. Install asphalt binder above flowable fill at the indicated depths compacted flush with the roadway surface elevation. Maintain smooth driving surface until final paving is complete.
- F. Remove the indicated thickness of asphalt binder as part of the milling operations when preparing to pave the roadway.
- G. Install the indicated thickness of asphaltic surface mix as part of the paving operations in accordance with Metro Public Works or TDOT specifications.
- H. Remediate any settlement of backfill material for a period of one year after final completion and final acceptance of the Work by MWS.

3.04 BACKFILL OUTSIDE OF ROADWAY

- A. Take precautions not to damage the force main and accessories during backfill operations. Replace damaged items at no cost to MWS.
- B. Install specified backfill material for the full width of the excavated trench.
- C. Install No. 57 or No. 67 crushed stone compacted to 95% Standard Proctor Density in 8-inch lifts for pipe bedding and pipe envelope. Place crushed stone bedding 6 inches below the bottom of the force main. Place crushed stone envelope to a height of 8 inches above the top of the force main.

- D. Install native soil compacted to 90% maximum Proctor Density in 12-inch lifts above the crushed stone envelope to finished grade. Utilize native soil material as the supplementary trench backfill material when force main must be installed below the minimum depths. Do not utilize rock greater than 8 inches as backfill.
- E. Remediate any settlement of backfill material for a period of one year after final completion and final acceptance of the Work by MWS.
- F. Seed and straw disturbed area to reestablish growth. Replace trees and vegetation removed during clearing and excavation with trees and vegetation as shown on the Drawings' revegetation plan.

END OF SECTION

SECTION 33 35 20

SEWER LINE CLEANING FOR PREPARATION OF SEWER REHABILITATION

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Clean all sewer pipe for proposed CIPP lining rehabilitation.
- B. Cleaning shall include properly high-pressure water jetting, rodding, bucketing, brushing, and flushing sewers and manholes prior to inspection by closed circuit television (CCTV), pipeline rehabilitation or replacement, point repairs, manhole preparation, and testing operations.
- C. The goal is to remove all debris, roots intruding services, deposits, and other blockages to a 95 percent minimum open area so the CIPP can be successfully installed without any significant installation issues or post lining defects. On all sewers, perform sewer cleaning work to an acceptable level as necessary to perform a thorough television inspection of the sewer and to install a CIPP liner. If the pipe condition is such that cleaning may cause a potential collapse, the pipe shall be televised without attempting to clean it to the 95 percent condition, pending Construction Manager's approval.
- D. Cleaning may involve preparatory or light sewer cleaning (small amounts of debris and/or light root growth existing within the sewer line) or heavy sewer cleaning (large amounts of debris, grease, large size stones and bricks, and/or heavy root growth existing within the sewer line).
 - 1. The bid price for pipeline installation and/or replacement and/or rehabilitation shall include preparatory cleaning for all sewers completely. Preparatory or light cleaning is defined as all cleaning up to and including 3 high-pressure water-jetting passes.
 - 2. If the sewer is still not clean after 3 high-pressure water-jetting passes, inform the Construction Manager about the condition and the reason(s) for the failure to fully clear the line. The Construction Manager may direct heavy cleaning of the problem sewer section. Alternatively, the Construction Manager may direct the Contractor to perform a point repair in the problem section.
- E. Cleaning shall dislodge, transport, and remove all sludge, mud, sand, gravel, rocks, bricks, grease, roots, sticks, and all other debris from inside the sewer pipe and manholes.

1.02 RELATED WORK

- A. Pre-rehabilitation sewer television inspection is specified in Section 33 01 51.
- B. Cured-in-place pipe lining (CIPP) is specified in Section 33 01 40.
- C. Manhole rehabilitation is specified in Section 33 01 44.
- D. Flow maintenance in existing sewers is specified in Section 33 01 48.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. High Velocity Hydro-Cleaning Equipment shall have the following:
1. A minimum 750-foot high pressure hose
 2. Two or more high velocity nozzles able to produce a scouring action from 15 to 45 degrees in all size lines to be cleaned
 3. A high velocity gun for washing and scouring manhole walls and floor
 4. Ability to produce flows from a fine spray to a long distance solid stream
 5. A water tank, auxiliary engines and pumps and a hydraulically driven hose reel
 6. Equipment operating controls located above ground
- B. Mechanical cleaning equipment shall be either power buckets or power rodders manufactured by the Flexible Tool Division of Rockwell Manufacturing Co. or equal.
1. Bucket machines shall:
 - a. Be furnished with buckets in pairs and with sufficient dragging power to perform the work efficiently
 - b. Use V-belts for power transmission or have an overload device. No direct drive machines will be permitted.
 - c. Be equipped with a take up drum and a minimum 500-foot cable
 2. Power rodding machine shall:
 - a. Be either sectional or continuous
 - b. Hold 750 feet minimum of rod
 - c. Have rods made from treated steel
 - d. Be fully enclosed and have an automatic safety throw out clutch

PART 3 - EXECUTION

3.01 PERFORMANCE

- A. Cleaning Precautions: During sewer cleaning operations, satisfactory precautions shall be taken when using cleaning equipment.
1. When hydraulically propelled cleaning tools (which depend on water pressure to provide their cleaning force) or tools which retard the flow in the sewer line are used, precautions shall be taken to ensure the water pressure created does not damage or cause flooding of public or private property being served by the sewer.

2. When possible, sewage flow in the sewer shall be used to provide the necessary pressure for hydraulic cleaning devices.
3. When it is necessary to use water from fire hydrants in order to avoid delays in normal work procedures, the water shall be conserved and not used unnecessarily. No fire hydrant shall be obstructed. Access to the fire hydrant shall be available at all times.

B. Sewer Cleaning

1. The designated sewer manhole sections shall be cleaned using hydraulically propelled, high velocity jet, or mechanically powered equipment.
2. Cleaning equipment selection shall be based on the conditions of lines at the time the work commences.
3. The equipment and methods selected shall be satisfactory to the Construction Manager.
4. The equipment shall be able to remove dirt, grease, rocks, sand, and other materials and obstructions from the sewer lines and manholes.
5. If cleaning of an entire section cannot be successfully performed from one manhole, the equipment shall be set up on the other manhole and cleaning again attempted. If successful cleaning still cannot be performed or the equipment fails to traverse the entire manhole section, it will be assumed a major blockage exists, and the cleaning effort shall be repeated with other equipment types.

C. Cleaning equipment selection shall be based on the conditions of the manholes and sewer lines at the time the work commences based on the pre-construction CCTV inspection to be conducted.

1. Light cleaning (small amounts of debris existing within the sewer line)
 - a. Use high-pressure water jetting equipment (3 passes), brushes, and swabs.
 - b. "Light Cleaning" will be defined and managed as follows:
 - 1) Sewer reaches that do not require heavy cleaning, as defined below, and produce little or no debris shall be categorized as "light cleaning."
 - 2) Costs related to cleaning such sewers shall be included in bid unit prices for CCTV and CIPP Lining.
2. Heavy cleaning (large deposits of debris or heavy root growth existing within the sewer line)
 - a. Use bucket machines, scrapers, hydraulic pressure jetting with special aggressive root cutting nozzles, or tools and augers. Cleaning requiring more than 3 passes with hydraulic cleaning equipment to achieve acceptable results shall be considered heavy cleaning.
 - b. Heavy cleaning will be conducted only with Construction Manager's approval and direction. "Heavy Cleaning" will be defined and managed as follows:
 - 1) Sewer reaches requiring debris removal for depths up to 25 percent of the pipe height shall be categorized as "heavy cleaning."

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- 2) Sewer reaches requiring root removal for lengths up to 25 percent of the pipe segment shall be categorized as “heavy cleaning.”
 - 3) Costs related to cleaning such sewers shall be included in bid unit prices for Heavy Cleaning.
 - 4) Costs related to televising such sewers following heavy cleaning shall be included in bid unit prices for CIPP Lining.
 - 5) Compensation for heavy cleaning a particular line will only be paid if:
 - a) The Construction Manager has provided written authorization for the heavy cleaning prior to performing the work
 - b) Contractor proves significant time AND effort were necessary to clean the line (i.e., the time required to clean and inspect the line must be at least 3 times the average time required to clean and inspect comparable length/ diameter sewers in the project area)
 - c) Contractor shall provide adequate video proof that the blockage, debris, grit roots or grease build-up, or other condition exists
3. Contractor may obtain video proof for heavy cleaning by acquiring a “before” video for all accessible portions of the obstructed reach and submitting it to Construction Manager with the completed inspection. A submerged camera does not justify a need for heavy cleaning. Proof the submergence was due to a blockage and/or heavy debris and not a sag in the line will be required.
- D. Provide appropriate screening to stop materials from passing into downstream sewers. All solid or semisolid materials dislodged during cleaning operations shall be removed from the sewer at the downstream manhole in the sewer section being cleaned. These materials shall be removed from the site at the end of each workday and shall be properly disposed. Passing dislodged materials downstream from the sewer segment being cleaned shall not be permitted. In such an event, as observed or detected by the Construction Manager or Metro, Contractor shall be responsible for cleaning the affected downstream sewers in their entirety, at no additional cost to Metro.
- E. Use properly selected equipment to remove all dirt, grease, rock, and other deleterious materials and obstructions.
- F. Protect existing sewer lines from damage caused by improper using cleaning equipment.
- G. Take precautions to avoid damage or flooding to public or private property being served by the line being cleaned.
- H. Use sewage flow in the sewer lines to provide necessary pressures for hydraulic cleaning devices whenever possible.
- I. Material Removal
1. Remove all solids and semi-solids at the downstream manhole in the section being cleaned.
 2. Passing material from one line section to another will not be permitted.

J. Material Disposal

1. Remove from the site and properly dispose of all solids or semi-solids recovered during the cleaning operation.
2. The Contractor shall be responsible for properly disposing of all collected material.
3. Waste material removed from the sewer during the cleaning process may be disposed of by hauling it to the Metro Central Wastewater Treatment Plant complex's grit and solids woodchip mixing area off Cement Plant Road.
4. Specifics regarding scheduling, monitoring, and approved methods and procedures for disposal must be arranged with Metro System Services Division prior to beginning cleaning operations.

K. No sewer cleaning shall take place in a particular sewer segment until all upstream pipe segments have been cleaned. If cleaning is performed in a downstream pipe segment to facilitate overall cleaning operations, the segment shall be re-cleaned at no additional cost, after all pipes upstream of that segment have been cleaned.

3.02 WATER

- A. Water for all construction operations shall be available from identified Metro fire hydrants at normal commercial rates.
- B. Water usage shall be in accordance with Metro backflow and metering policies.

3.03 FIELD QUALITY CONTROL

- A. Acceptance for this work portion shall depend on the results from the pre-rehabilitation television inspection.
- B. The cleaning goal is to remove all necessary debris, roots intruding services, deposits, and other blockages to a 95 percent minimum open area so the CIPP can be successfully installed without any significant installation issues or post lining defects due to cleaning quality.
- C. Lines not acceptably clean as to permit television inspection shall be re-cleaned and re-inspected at no additional cost to Metro.

3.04 CLEANUP

- A. Upon cleaning acceptance, restore the project area affected by the operations to a condition at least equal to that existing prior to the work.

3.05 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 33 39 13

MANHOLES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Listing of all other Major Section Headers
- B. Scope (1.02)
- C. Submittals (1.03)
- D. Measurement and Payment (1.04)
- E. General (1.05)

1.02 SCOPE

- A. Precast concrete manholes and accessories.

1.03 SUBMITTALS

- A. Conform to the requirements of Section 01 33 00 Submittals.
- B. Submit manufacturer's product data for proposed manhole and accessories for approval.
- C. Submit crushed stone bedding, backfill material sieve analysis, and compaction methods.

1.04 MEASUREMENT AND PAYMENT

- A. MWS will compensate for furnishing and installing new manholes up to 6 feet in depth and accessories at the contract unit price per each for the manhole and accessories installed complete and ready for operation.
 - 1. Include all costs in the unit price for labor, excavation, bedding, backfill, restoration, manhole including any reinforcement, waterproofing admixture, manhole base, fillet (invert), manhole steps, pipe resilient connectors, stub-outs, plugs, sealants, testing, and any incidentals needed for a complete installation.
 - 2. Undercutting of undesirable material at the trench base and crushed stone refill material to be paid with Unforeseen Work Elements allowance bid item.
- B. MWS will compensate for furnishing and installing frames and covers and accessories at the contract unit price per each installed complete and ready for operation of the type indicated.
 - 1. Include all costs in the unit price for labor, materials, equipment, sealants, testing, and any incidentals needed for a complete installation.
- C. MWS will compensate for furnishing and installing additional manhole sidewall at the contract unit price per vertical foot that exceeds the 6-foot manhole depth, complete in place.

Measurement of additional manhole sidewall will be made vertically in place from the invert of the outlet sewer pipe to the bottom side of the frame and cover, excluding the initial 6 feet.

1. Include all costs in the unit price for additional manhole sidewall for labor, equipment, excavation, material, backfilling, and all incidentals necessary for a complete and operable installation.
- D. MWS will compensate for furnishing and installing manhole connections to existing sewers at the contract unit price per each for the manhole connection made complete and ready for operation.
1. Include all costs in the unit price for manhole connections to the existing system for labor, equipment, excavation, material, precast or cored hole, resilient connector, stainless steel external band, insulator ring, backfilling, and all incidentals necessary for a complete and operable installation.
 2. Separate direct compensation for sewer connections to proposed or existing manholes will not be permitted and is merged into the Work.
- E. MWS will compensate for furnishing and installing manhole vent pipe assemblies at the contract unit price per each for each manhole vent pipe assembly installed complete and ready for operation.
1. Include all costs in the unit price for manhole vent pipe assemblies for labor, pipe, fittings, interior and exterior coatings, connection the manhole, concrete foundation, excavation, bedding, insect screen, and all incidentals necessary for a complete and operable installation.
- F. Separate direct compensation for furnishing and installing manhole stub outs for future sewer connections will not be permitted and is merged into the Work.
- G. MWS will compensate for furnishing and installing drop pipe assemblies at the contract unit price per each assembly installed complete and ready for operation.
1. Include all costs in the unit price for labor, excavation, bedding, backfill, pipe material, pipe bends, hand formed mortar stop, manhole connections, and all incidentals necessary for a complete and operable installation.

1.05 GENERAL

- A. Use various lengths of manhole sections in combination to provide correct height with fewest joints.
- B. For stub outs provide a 24-inch long stub out with resilient connector to the size, line, and gradient indicated on the Drawings for future sewer mains. Provide a bell end of a joint of pipe and plug and seal the bell with a plug. Consider the stub out as a part of the manhole when performing vacuum testing.
- C. Construct drop pipe assemblies when the upstream proposed sewer invert is 2 feet or greater above the downstream discharging sewer invert where indicated on the Drawings. Inside manhole drop pipe assemblies are not permitted.
- D. Backfill drop assembly with 3000 psi concrete to form solid encasement for all drop connections. Extend concrete encasement minimum of 4-inches outside bells as indicated on the Drawings.

- E. Locate vent pipes outside of roadway as indicated on the Drawings and provide vent outlet assemblies as indicated on the Standard Details with the opening of the vent pipe no less than 9 feet above the existing ground and a minimum of 1 foot above the 100-year flood plain elevation.
- F. For manholes in conjunction with water main use, cutouts or holes should be 6-inches or greater from the floor base.
- G. Provide water additive, pre-packaged, inorganic, flowable, non-gas liberating, non-metallic, cement-based non-shrink grout having a minimum 28-day compressive strength of 7,000 psi meeting the most recent revision of ASTM Designation C1107 when connecting to existing structures.

PART 2 - PRODUCTS

2.01 MANHOLES

- A. Provide concentric manholes with steps.
- B. Provide a minimum 4,000 psi, 28-day compressive strength precast concrete manholes to support an AASHTO H-20 vehicle loading.
- C. Brick masonry materials for manholes or manhole adjustments are not permitted.
- D. Provide manhole waterproofing admixture of XYPEX C1000 or approved equal at 3% during the batching operation. Add dye to verify XYPEX C1000 admixture was added during batching operation.
- E. Provide manholes and accessories conforming to the most recent requirements of ASTM C478 and ASTM C913.
- F. Provide precast base riser section with integral floors.
- G. Provide adjustment rings set to the cone section by low strength waterproof and water tight epoxy.
- H. Provide a double seal of flexible bitumastic joint sealant joints between the sections of precast manhole sidewalls and provide a single seal with 2 rounds of flexible bitumastic joint sealant between the precast concrete sidewall and manhole cover frame conforming to the most recent revisions of ASTM C990.
- I. Mark the date of manufacture and name or trademark of manufacturer on inside of the manhole barrel.
- J. Provide manhole sections without penetrations for lifting.
- K. Provide a flexible connector assembly with a 2-foot section of piping immediately outside of the manhole.
- L. For manholes larger than 48-inch diameter, provide precast base sections with flat slab top precast sections when transitioning to 48-inch diameter manhole access riser sections. Provide concentric transitions located to provide minimum of 7-foot head clearance from base to underside of transition section.

2.02 DOG HOUSE MANHOLES

- A. Provide dog house manholes only at locations where indicated on the Drawing and only with Construction Manager approval.
- B. Spray or trowel apply coating to the dog house manhole interior base section the greater of 4 feet or 2 feet above the largest diameter pipe. Provide epoxy resin, similar to Warren Environmental Systems S-301, polyurea similar to SpectraShield, or a urethane similar to Sprayroq SprayWall system formulated for application within a sanitary sewer environment or approved equals.
- C. The cured epoxy or urethane resin system shall conform to the following minimum structural standards:

Minimum Requirements			
Cured Product	Test Method	Urethane Results	Epoxy Results
Compressive Strength	ASTM D695	10,500 psi	12,000 psi
Tensile Strength	ASTM D638	7,000	7,000
Flexural Strength	ASTM D790	12,000 psi	11,000 psi
Flexural Modulus	ASTM D790	550,000 psi	500,000 psi
Shore D Hardness	ASTM D2240	90	83 - 85
Adhesion to Concrete	ASTM D4541	Substrate failure	Substrate failure

2.03 FRAMES AND COVERS

- A. Provide cast iron frames, grates, rings, and covers in conformance with the MWS Approved Materials List and as indicated on the Standard Details and conforming to the most recent requirements of ASTM A48, Class 30 and AASHTO H-20 vehicle loading.
- B. Provide castings that conform to the shapes and dimensions with the logos and wording indicated on the Standard Details. Provide castings that are smooth, clean, complete, free from blisters, defects, and any other surface imperfections. Defective castings will not be permitted.
- C. Provide frames and covers where the cover securely rests on the frame without rocking and the cover is in complete contact with the frame for the entire perimeter of the contact surface.
- D. When inside roadways, secure the frame and cover to the manhole cone section with high strength waterproof epoxy.
- E. When outside roadways, provide flexible bitumastic joint sealant between manhole frame and top cone section.
- F. When outside roadways, secure the frame and cover to the manhole cone section with a minimum of two concrete anchors 7/8 inch in diameter spaced 180 degrees apart imbedded a minimum of 3 inches.
- G. Use concrete adjustment rings when vertical adjustments are 2 inches or greater with a maximum total adjustment ring usage of 12 inches.

- H. Provide two non-penetrating pick holes in manhole covers as indicated on the Standard Details.
- I. Provide watertight manhole frames and covers where indicated on the Drawings or when subjected to ponding. Provide watertight frames and covers with exterior cover having non-penetrating concealed pick holes and the interior cover being a solid, gasketed lid with locking T-bar design as indicated on the Standard Details. Watertight manhole frames and covers shall be provided with minimum of four bolts and flexible bitumastic joint sealant designed to seal frame to cone.

2.04 PIPE CONNECTIONS TO MANHOLE

- A. Provide connectors from the MWS Approved Materials List.
- B. Provide Kor-N-Seal resilient connector, A-Lok resilient connector, or an approved equal conforming to the most recent revisions of ASTM Designation C 923 for pipe to manhole connections.
- C. Provide a stainless steel external band around the resilient connector and external band around the pipe.
- D. Provide the manhole manufacturer's insulator ring.
- E. Fill the void between the pipe and the connector with an approved flexible gasket material.
- F. Where rigid joints between pipe and cast-in-place manhole base are specified, provide polyethylene-isoprene water-stops in conformance with the most recent revisions of ASTM C923.
- G. For water main to manhole connections, seal the space between the pipe and the manhole sidewall with an assembly consisting of a rubber gasket and a stainless steel clamp with a minimum width of 9/16 inches.
- H. Provide a distance of at least 16 inches measured from the top of the pipe opening to the top of the base or sidewall section.

2.05 STEPS

- A. Insert and securely embed steps in the manhole sidewall as indicated on the Standard Details.
- B. Provide non-skid design steps manufactured of either plastic coated steel constructed of ½-inch steel reinforcing rods encapsulated in polypropylene plastic or aluminum magnesium silicide alloy in conformance with Federal Specifications QQ-A-200/8.
- C. Provide steps that will support a 1,000 pound load.

2.06 VENT PIPES

- A. Provide 4" diameter class 350 ductile iron pipe.
- B. Apply two coats of aluminum epoxy at a thickness of 5.0 millimeters and a top coat of dark green asphaltic polyurethane at 3.0 to 5.0 millimeters to the exposed vent pipe.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install and verify that lines and grades are constructed in accordance with the Drawings.
- B. Provide an adequate foundation for all manhole structures by removing and replacing unsuitable material with well-graded granular material, by tightening with TDOT #357 or #57 crushed stone, or by such other means as provided for foundation preparation of the connected sewers, or as directed by Construction Manager.

END OF SECTION

FOR INFORMATION ONLY

SECTION 33 40 00

STORM DRAINAGE UTILITIES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. This work shall include installing storm sewer pipe and connecting to storm sewer structures.
- B. This work shall include constructing manholes, catch basins, inlets, and pipe end walls structures to storm sewer pipe.
- C. Section includes
 - 1. Storm drainage piping, fittings, and accessories
 - 2. Storm drainage manholes, catch basins, inlets, and pipe end walls and accessories

1.02 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)
 - 1. M36: Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains
 - 2. M198: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
 - 3. M207: Standard Specifications for Elliptical Culvert, Storm Drain, and Sewer Pipe
 - 4. M274: Standard Specification for Steel Sheet, Aluminum-Coated (Type 2), for Corrugated Steel Pipe
- B. American Society of Testing and Materials (ASTM)
 - 1. A48: Standard Specification for Gray Iron Castings
 - 2. A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
 - 3. A536: Standard Specification for Ductile Iron Castings
 - 4. A929: Standard Specification for Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe
 - 5. C32: Standard Specification for Sewer and Manhole Brick (Made From Clay or Shale)
 - 6. C76: Sewer Pipe
 - 7. C139: Standard Specification for Concrete Masonry Units for Construction of Catch Basins and Manholes
 - 8. C150: Standard Specification for Portland Cement

9. C207: Standard Specification for Hydrated Lime for Masonry Purposes
 10. C361: Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
 11. C443: Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
 12. C478: Standard Specification for Precast Reinforced Concrete Manhole Sections
 13. C506: Standard Specifications for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
 14. C507: Standard Specifications for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
 15. C890: Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
 16. C923: Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
 17. C990: Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
- C. Tennessee Department of Transportation (TDOT)
1. Standard Specifications for Road and Bridge Construction, Sections 303, 501, and 604, latest edition and Standard Specification for Reinforced Concrete Culvert, Storm Drain
 2. Standard drawings, D-PE-4
- D. Local Municipality
1. Metropolitan Government of Nashville and Davidson County
 - a. Metro Water Services (Metro), The Stormwater Management Manual, latest edition
 - b. Metro Water Services (Metro), Standard drawings, latest edition
 - c. Metro Public Works (MPW), Standard drawings, latest edition

1.03 SUBMITTALS

- A. Product Data: Submit data on pipe, fittings, and accessories.
- B. Manufacturer's Installation Instructions: Submit special procedures required to install products specified.
- C. Submit compaction test results.
- D. Submit the following in accordance with Section 01 33 00.
 1. Shop drawings for precast concrete structures: Indicate locations, dimensions, configuration, thicknesses, elevations, sizes, and penetration elevations

2. Product Data
 - a. Brick: Material product data
 - b. Castings: Material product data
 - c. Concrete: Aggregate, cement, and admixtures product data
3. Certificates: Manufacturer's certificate stating the product meets or exceeds specified requirements
4. Project Record Documents: Provide record drawings for actual pipe run locations, connections, structures, and invert elevations.
5. Test results

1.04 CLOSE-OUT SUBMITTAL

- A. Comply with Section 01 77 00 requirements.
 1. Accurately record actual locations for pipe runs, connections, and invert elevations.
 2. Identify and describe unexpected variations to subsoil conditions or discovery of uncharted utilities.

1.05 DELIVERY STORAGE AND HANDLING

- A. Comply with Section 01 66 10 requirements.

PART 2 - PRODUCTS

2.01 CONCRETE CULVERT PIPE

- A. Pipe: ASTM C76, minimum Class III, unless noted otherwise, nominal inside diameter as indicated
- B. End Joints: Tongue and groove. Seal all joints during the same day the pipe is laid. Construct the joints so a watertight joint will result.
 1. Soil Tight: ASTM C990, AASHTO M198, preformed flexible joint sealant
 2. Water Tight: ASTM C443, rubber compression gasket
 3. Low-Pressure Application: ASTM C361

2.02 STEEL CULVERT PIPE

- A. Corrugated Steel Pipe
 1. Fabricated AASHTO M36, ASTM A929 galvanized steel sheet, or AASHTO M274 aluminized steel (Type 2) with helical lock seam
 2. Nominal inside diameter as indicated on the Drawings

B. Gauge: As shown in the following table:

Pipe Diameter	Gauge
48 inches and less	16-gauge
54 inches	14-gauge
60 inches	12-gauge

C. Average inside diameter for circular pipe shall not vary +/-1/2-inch, or 1 percent from nominal diameter, whichever is greater.

D. Joints

1. AASHTO M36 coupling bands
2. Coating same as pipe
3. Thickness equal to pipe thickness or up to two numerical thicknesses lighter
4. Minimum width 7 inches for 12- to 30-inch diameter pipe and 10-1/2 inches for 36- to 120-inch diameter pipe connected with 2 neoprene "O" ring gaskets and galvanized steel bolts to form leak-resistant joint

E. Tapered Ends: Same material as pipe, machine cut for joining to pipe end

F. Coupling Bands

1. AASHTO M36, 7 inches wide with two 1/2-inch galvanized bolts
2. Coupling bands are permitted to be 2 numerical thicknesses lighter than that used for pipe, but not less than 18-gauge.

2.03 MANHOLES, CATCHBASINS, INLETS, AND PIPE END WALLS STRUCTURES

- A. Metro Public Works standard drawings DR-105, DR-106, DR-110, DR-111, DR-115, DR-116, DR-120, DR-121, DR-129, DR-131, DR-132, and DR-137 and Metro standard drawings
- B. Precast or cast-in-place drainage structures

2.04 PIPE CONNECTIONS

- A. Connections between drainage structures and pipe, ASTM C923
 1. For storm drains 42-inch diameter and smaller, grout pipe at manhole to form a watertight connection.
 2. For storm drains larger than 42-inch diameter, grout 4 feet spool piece into place on manhole. Connect pipe to spool piece using flexible connection.

2.05 PRECAST STRUCTURES

- A. Manhole Sections: Reinforced precast concrete in accordance with ASTM C478, with resilient connectors complying with ASTM C923
- B. Invert shapes shall conform uniformly to inlet and outlet pipes with a smooth and uniform finish.

C. Joints: ASTM C443, watertight

2.06 CAST-IN-PLACE STRUCTURES

A. Materials

1. Concrete: Section 03 30 00, minimum 4,500 psi compressive strength
2. Portland cement: ASTM C150, Type II
3. Hydrated lime: ASTM C207, Type S
4. Sand: ASTM C33, fine aggregate, except all passes No. 8 sieve
5. Water: Potable, not detrimental to concrete
6. Brick: ASTM C32, grade MS, maximum 8 percent absorption computed from 5-cycle average

B. Components

1. Bases: Cast-in-place concrete, one piece, as indicated
2. Walls: Brick
3. Frames and Grates: As indicated and specified

C. Mixes

1. Concrete: Section 03 30 00
2. Mortar for Brickwork: Mix Portland cement, hydrated lime and sand.
 - a. Sand volume is not to exceed three times sum of cement and lime volumes.
 - b. Proportion cement and lime as directed.
 - c. Cement to lime proportions may vary between 1 part cement to 1/4 part lime for dense hard burned brick and 1 part cement to 3/4 part lime for softer brick.
 - d. Generally mix mortar in proportion of 1 part cement to 1/2 part lime to 4-1/2 parts sand.
 - e. Use sufficient water to form a workable mixture.

2.07 END WALLS

- A. Concrete End Wall: Comply with TDOT Specifications Section 611, Metro standard drawings, and Metro Public Works standard drawings
- B. Walls and Base: Cast-in-place concrete or precast

2.08 MIXES

- A. Mortar for Plugging Lift Holes: Mix Portland cement and sand, 1 part cement to 1/2 part sand, with sufficient water to make mortar damp without “balling.”

2.09 COMPONENTS

A. Frame and Cover

1. ASTM A48/A48M, Class 30 cast iron construction or ASTM A536, Grade 65-45-12 ductile iron construction
2. Machined flat bearing surface, removable lid, rated for AASHTO HS20-44 loading unless noted otherwise
3. Castings shall be as follows:
 - a. Free from scale, lumps, blisters, and sand holes
 - b. Machine contact surfaces to prevent rocking
 - c. Thoroughly clean and hammer inspect

B. Manhole Steps: ASTM C478

PART 3 - EXECUTION

3.01 EXAMINATION

- A. Section 01 32 23 -- Verify existing conditions before starting work.
- B. Underground Service Alert Requirements: Comply with Underground Utility Damage Prevention Act of Tennessee requirements for notification prior to excavation. Contact Tennessee 811 at 800.351.111 (or dial 811) no less than 3 working days and no more than 10 working days prior to starting exploratory excavation. Verify whether or not a representative from each utility or agency will be present during excavation and coordinate with said individual(s). Take any precautions required by the utility owner.
- C. Verify that the trench cut and/or excavation base is ready to receive work and that excavations, dimensions, and elevations are as indicated on Drawings.
- D. Verify that the storm sewer drainage structure excavation is ready to receive work and that excavations, dimensions, and elevations are as indicated on Drawings.

3.02 PREPARATION

- A. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.
- B. Do not lay pipe in water or in frozen bedding conditions.

3.03 EXCAVATION

- A. See Section 31 23 00 for additional requirements.

- B. Hand trim excavation to accurately place storm sewer structures and pipes to indicated elevations.

3.04 PIPE INSTALLATION

- A. Bedding stone shall be installed on prepared subgrade.
- B. Begin laying pipe from lowest point.
- C. Inspect pipe for cracks or defects, clean any debris from interior and bell end and remove undesirable material from gasket and gasket recess.
- D. Lay pipe uniformly to line and grade so finished culvert will present uniform bore.
- E. As work progresses, clean all pipe interiors in place.
- F. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.
- G. Shore pipe to required position; retain in place until adjacent fills have been installed. Ensure pipe remains in correct position and to required slope.
- H. Install cover at sides and over top of pipe.
- I. Backfill and compact in accordance with Section 31 23 33.
- J. Install culvert end structures.

3.05 PIPE ENDS

- A. Place fill at pipe ends, as indicated on Drawings.
- B. Installed thickness: 8 inches

3.06 PRECAST STRUCTURES

- A. Provide bedding according to Section 31 23 33.
- B. Place manhole or inlet sections plumb and level on prepared bedding.
- C. Orient manhole or inlet to allow for connection with pipe.

3.07 CAST-IN-PLACE STRUCTURES

- A. Brickwork
 - 1. Bricks
 - a. Do not construct brick masonry in freezing weather or when the bricks contain frost.
 - b. All brick and foundation shall be thoroughly cleaned.
 - c. Moisten bricks to prevent water absorption from mortar. Limit moisture to prevent bricks from becoming slippery during placement.

- d. Lay each brick in full mortar bed and joint without requiring subsequent grouting, flushing or filling; bond thoroughly.
- B. Plastering and Curing Brick Masonry
1. Plaster outside faces with mortar not less than 1/2-inch thick.
 2. Moisten brick masonry before applying mortar, if required.
 3. Carefully spread and trowel plaster.
 4. Check for bond and soundness after hardening, by tapping.
 5. Remove and replace unbonded and unsound plaster.
 6. Protect from too rapid drying by using moist burlap or other accepted means.
 7. Protect from weather and frost.
- C. Provide bedding according to Section 31 23 33.
- D. Orient manhole to allow for connection with pipe.
- E. Form and place cast-in-place concrete base pad.
- F. Construct walls around storm drainage pipe sections to prevent leakage.
- G. Establish top elevation and mount frame and cover.
- H. Mount frame level in grout, secured to top cone section.
- I. Setting Frames, Grates, and Curb Inlets
1. Set inlets and frames with tops conforming accurately to finished ground or pavement surface as indicated and directed.
 2. Set circular frames concentric with top of masonry.
 3. Set frames in full mortar bed to fill and make watertight completely the space between top of masonry and the frame's bottom flange.
 4. Place a thick mortar ring extending to the outer masonry edge, around bottom flange. Finish mortar smoothly and give a slight slope to shed water away from the frame.
 5. Place grates in the frames after completing all other work at the structure.

3.08 ERECTION TOLERANCES

- A. Section 01 43 00 – Quality Requirements: Tolerances
- B. Lay pipe to alignment and slope gradients noted on Drawings with maximum variation from indicated slope of 1/8 in 10 feet.
- C. Maximum variation from intended culvert invert elevation: 1/2 inch

- D. Maximum pipe offset from indicated alignment: 1 inch
- E. Maximum variation in structure profile from intended position: 1 percent

3.09 FIELD QUALITY CONTROL

- A. Section 01 43 00 – Quality Requirements
- B. Request inspection prior to and immediately after placing aggregate cover over pipe.
- C. Refer to Section 31 23 00 for additional compaction requirements.
- D. When tests indicate work does not meet specified requirements, remove work, replace and retest.
- E. Test frequency: As determined by Construction Manager
- F. Pipe Displacement Test
 - 1. Construction Manager will test pipe for displacement after trench has been backfilled and compacted and after silt and debris have been cleaned from the pipe.
 - 2. Construction Manager will visually inspect pipe. Pipes not presenting a uniform bore due to displacement and misalignment shall be replaced.

3.10 DISPOSAL OF EXCESS EXCAVATED MATERIALS

- A. Dispose of excavated materials off-site in permitted sites in non-wetland areas and above the 100-year, Federal Emergency Management Agency floodplain.
- B. Waste disposal areas shall not affect any state/U.S. waters unless these areas are specifically covered by a Contractor obtained ARAP, 404, or NPDES permit.

3.11 PROTECTION

- A. Protect structures, pipe, and bedding from damage or displacement until backfilling operation is completed.

3.12 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 40 23 19.04

DUCTILE IRON PIPE AND FITTINGS FOR PROCESS PIPING

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide and test ductile iron pipe, fittings, and appurtenances as specified.
- B. Options
 - 1. For buried exterior gravity flow pipelines, provide push-on joint pipe with mechanical joint fittings.
 - 2. For buried exterior pressure flow pipelines, provide restrained push-on joint pipe with restrained mechanical joint or restrained push-on joint fittings.
 - 3. For exposed piping as in buildings and galleries, provide flanged pipe and fittings.
 - 4. Cast iron pipe and fittings are not acceptable.

1.02 REFERENCES

- A. American Society of Mechanical Engineers (ASME)
 - 1. B16.1: Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800
 - 2. B16.21: Nonmetallic Flat Gaskets for Pipe Flanges
 - 3. B16.42: Ductile Iron Pipe Flanges and Flanged Fittings
 - 4. B31.1: Power Piping
- B. American Society for Testing and Materials (ASTM)
 - 1. A240: Specification for Heat Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
 - 2. A307: Carbon Steel Bolts and Studs, 60,000 psi Tensile
 - 3. A380: Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
 - 4. A530: Specification for General Requirements for Specialized Carbon and Alloy Steel Pipe
 - 5. A774: Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures
 - 6. A778: Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products

C. American Water Works Association (AWWA)

1. A21.4: Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
2. A21.10: Ductile-Iron and Gray-Iron Fittings, 3" through 48", for Water and Other Liquids
3. A21.11: Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe Fittings
4. A21.15: Flanged Ductile-Iron Pipe with Threaded Flanges
5. A21.50: Thickness Design of Ductile-Iron Pipe
6. A21.51: Ductile-Iron Pipe, Centrifugally Cast in Metal Molds, or Sand-Lined Molds, for Water or Other Liquids
7. A21.53: Ductile-Iron Compact Fittings, 3" through 16" for Water and Other Liquids
8. C600: Installation of Ductile Iron Water Mains and their Appurtenances

D. Fluid Sealing Association: Technical Handbook

1.03 SUBMITTALS

A. Submit the following in accordance with Section 01 33 00:

1. Pipe manufacturer's technical specification and product data
2. Certified shop and erection drawings: Contractor shall submit the piping layout including the following.
 - a. Pipe layouts in full detail
 - b. Location for hangers and supports
 - c. Anchor location and types
 - d. Couplings and expansion joint locations
 - e. 1/2-inch = 1 foot-0 inch (25) scale details for all wall penetrations and special fittings
 - f. Schedules for pipe, fittings, special castings, couplings, expansion joints and other appurtenances
3. Certificates: Sworn certificates in duplicate showing compliance with material used and shop tests performed
4. Catalog cuts and technical data for expansion joints, couplings, gaskets, pipe supports, and other accessories
5. Brochures and technical data on coatings, linings, and proposed application method
6. Manufacturer's descriptive literature and technical data on installation practices and proposed installation method

B. Material Certification

1. Provide certification from the pipe and fittings manufacturer stating the construction materials specified are recommended and designed for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification showing the proposed materials are recommended and designed for the service conditions specified and indicated. Include an installation list with 5 minimum installations in operation for 5 years minimum. Provide proposed materials at no additional cost to Metro.
2. Where materials are not specified, provide technical data and certification stating the proposed materials are recommended and designed for the service conditions specified and indicated.

C. Submit a copy of the contract mechanical process, civil and structural drawings, with addenda applicable to the equipment specified in this Section, marked to show all changes necessary for the equipment proposed for this Section. If no changes are required, mark all drawings with "No changes required" or provide a written statement saying no changes are required.

1. Failure to include all drawings or a statement applicable to the equipment specified in this Section will result in submittal return without review until a complete package is submitted.
2. A copy of this Section with addenda and all referenced Specification Sections with addenda, with each paragraph check-marked to indicate specification compliance, or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
 - a. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 - b. Failure to include a copy of the marked-up Specification Sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 QUALITY ASSURANCE

- A. Provide in accordance with Section 01 43 00 and as specified.
- B. Provide manufacturer's certification in writing, stating materials meet or exceed minimum requirements as specified.
- C. Inspect and test at foundry according to applicable standard specifications.
- D. Metro reserves the right to inspect and test by independent service at manufacturer's plant or elsewhere at their own expense.
- E. Visually inspect before installation.

F. Job Conditions

1. Coordinate dimensions and drillings for pipe flanges with flanges for valves, pumps, and equipment to be installed in the piping systems.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 01 66 10 requirements.
- B. During loading, transportation, and unloading, prevent damage to pipes and fittings. Load and unload each pipe under control at all times. Under no circumstances will a dropped pipe be used unless inspected and accepted by Construction Manager. Place skids or blocks under each pipe in the shop and securely wedge pipe during transportation.

PART 2 - PRODUCTS

2.01 PIPE

- A. Ductile Iron
 1. Design conforming to AWWA A21.50.
 2. Manufacture conforming to AWWA A21.15 or AWWA A21.51.
 3. Gravity flow pipeline pressure class, unless otherwise indicated or specified, is minimum 150. Minimum special thickness Class 53 for use with threaded flanges and flanged pipe.
 4. Pressure flow pipeline pressure class, unless otherwise indicated or specified is minimum 150. Minimum special thickness Class 53 for use with threaded flanges and flanged pipe.

2.02 FITTINGS

- A. Provide fittings conforming to AWWA A21.10 or AWWA A21.53, at least Class 150, and match piping class.
- B. Provide all bell push-on or mechanical-joint fittings unless otherwise indicated or specified.
- C. Face and drill flanged fittings conforming to AWWA A21.10, except special drilling or tapping for correct alignment and bolting.
- D. If flanged fittings are not available under AWWA A21.10, provide fittings conforming to ASME B16.1 in 125 lb. pressure class.
- E. Provide standard base fittings where indicated.

2.03 NONSTANDARD FITTINGS

- A. Acceptable design
- B. Same diameter and thickness as standard fittings
- C. Manufactured to meet standard fittings specifications, except for laying length and end types.

2.04 WALL CASTINGS

- A. Provide size and type indicated.
- B. Wall Castings: Conform to AWWA A21.10 or fabricate of Pressure Class 250 ductile iron pipe with screwed on flanges and welded on waterstop.
- C. Provide waterstop centered in wall. Weld waterstops on in factory under controlled conditions to ensure adequate strength to permit waterstop to absorb thrust up to the pipe's pressure rating.

Wall Castings with Annealed Ductile Iron Water Stops	
Pipe Size	Waterstop thickness (inches)
4"-12"	0.50
14"-24"	0.75
30"-36"	1.00
42"-48"	1.25

Wall Castings with Fabricated Steel Water Stops	
Pipe Size	Waterstop thickness (inches)
4"-16"	0.25
18"-24"	0.38
30"-36"	0.50
42"-48"	0.75
54"-64"	1.00

- D. On flanged wall castings, provide space between the wall and flange to permit mounting the nuts on the flange bolts.
- E. Flanged wall castings located with the flange flush with the wall are not acceptable.
- F. Locate push-on joint wall castings with space between the bell and the wall to insert the follower bolts.
- G. As an option, Schedule 40 Type 316L stainless steel fabricated wall pipe may be substituted for wall castings specified above. Provide with waterstops with above dimensions and welded continuously on both sides of stop. Provide Type 316 stainless steel flanges and bolts for connection to buried pipe Type 316 stainless steel. Provide flange insulation gaskets, sleeves, and washers for all flanges.

2.05 ADAPTERS

- A. Furnish and install for joining different type pipes, unless solid sleeves are indicated.
 - 1. Provide ends conforming to above specifications for the correct joint type to receive adjoining pipe.

2. Joining two pipe classes may be a lighter class, provided annular space in bell-and-spigot type joints are sufficient for jointing.

2.06 JOINTS

- A. Provide push-on joint and mechanical joint pipe with necessary accessories, conforming to AWWA A21.11.
 1. Provide gasket composition designed for exposure to liquid within pipe.
 2. Provide mechanical joint gaskets with copper tips to provide electrical continuity.
 3. Provide serrated brass wedges for push-on joints to provide electrical continuity—2 per joint for pipe 12-inch diameter and smaller and 4 per joint for larger diameter pipe.
- B. Provide pipe flanges and accessories conforming to AWWA A21.15.
 1. Provide flat faced flanges.
 2. Provide 1/8-inch thick, full faced gaskets designed for exposure to liquid within pipe.
- C. Provide restrained joints on pipe and fittings where indicated. Provide restrained joints that are:
 1. Boltless
 2. Able to be deflected after assembly
 3. Designs using set screws or requiring field welding are not acceptable.
 4. Manufacturers
 - a. American Cast Iron Pipe Co. Flex-Ring
 - b. U.S. Pipe TR FLEX
 - c. Clow Super-Lock
 - d. Substitutions: See Section 01 25 00 – Substitution Procedure.

2.07 MECHANICAL JOINT FITTINGS – RESTRAINT SYSTEM

- A. Provide restraint devices for pipe with multiple gripping wedges incorporated into a follower gland meeting AWWA A21.10 requirements.
 1. Mechanical joint restraint shall require conventional tools and installation procedures per AWWA C600. Retain full mechanical joint deflection during assembly and allow joint deflection after assembly.
 2. Provide actuation for the gripping wedges ensured with torque limiting twist off nuts.
 3. Provide restraint devices listed by Underwriters Laboratories (UL) (3-inch through 24-inch size) and Designed by Factory Mutual (3 inch through 12 inch size).

B. Working Pressure Rating

1. 24-inch and Smaller: 350 psi.
2. 30-inch and Larger: 250 psi
3. Minimum safety factor shall be 2 to 1.

C. Materials

1. Gland body, wedges, and wedge actuating components: Grade 65-45-12 ductile iron in accordance with ASTM A536
2. Ductile iron gripping wedges: Heat treated, 370 to 470 BHN
3. Provide 3 test bars incrementally poured per production shift as per UL specifications and ASTM A536. Test for tensile, yield, and elongation in accordance with ASTM E8.
4. Provide chemical and nodularity tests performed as recommended by the Ductile Iron Society, on a per ladle basis.
5. Provide an identification number with year, day, plant, and shift (YYMMDD) (plant designation) (Shift number) cast into each gland body.
6. Record all physical and chemical test results so they can be accessed via the identification number on the casting. Provide the Material Traceability Records (MTRs) available, in hard copy.

D. Manufacturer

1. EBAA Iron MegaLug Series 1100
2. Substitutions: Section 01 25 00 – Substitution Procedure

2.08 FLANGE ADAPTORS

A. Provide restrained flange adaptors for pipe with multiple individual gripping wedges incorporated into a follower gland meeting AWWA A21.10 requirements.

1. Provide actuation for the gripping wedges ensured with torque limiting twist off nuts.
2. Provide UL listed restraint devices (3-inch through 12-inch size) and designed by Factory Mutual (4-inch through 12-inch size).

B. Joint Deflection capability

1. 3-inch thru 8-inch: 5 degrees
2. 10-inch and 12-inch: 3 degrees
3. 14-inch and 16-inch: 2 degrees
4. 18-inch and 20-inch: 1.5 degrees
5. 30-inch, 36-inch, 42-inch and 48-inch: 1 degree

C. Provide flange adaptor to maintain seal with a 0.6 inch gap between pipe end and mating flange.

D. Working Pressure Rating

1. 16-inch and Smaller: 350 psi
2. 18-inch: 300 psi
3. 20-inch: 250 psi
4. 24-inch: 200 psi
5. 30-inch thru 48-inch: 150 psi
6. Minimum safety factor shall be 2 to 1.

E. Materials

1. Gland body, wedges, and wedge actuating components: Grade 65-45-12 ductile iron in accordance with ASTM A536.
2. Ductile iron gripping wedges: Heat treated, 370 to 470 BHN
3. Provide 3 test bars incrementally poured per production shift as per UL specifications and ASTM A536. Test for tensile, yield, and elongation in accordance with ASTM E8.
4. Provide chemical and nodularity tests performed as recommended by the Ductile Iron Society, on a per ladle basis.
5. Provide an identification number with year, day, plant, and shift (YYMMDD) (plant designation) (Shift number) cast into each gland body.
6. Record all physical and chemical test results so they can be accessed via the identification number on the casting. Provide the Material Traceability Records (MTRs) available, in hard copy.

F. Manufacturer

1. EBAA Iron MegaFlange, Series 2100
2. Substitutions: See Section 01 25 00 – Substitution Procedure.

2.09 EXPANSION JOINTS

A. Pressure rating at least equal to that of related pipeline

2.10 FILLING RINGS

- A. Provide where necessary.
- B. Materials, workmanship, facing, and drilling shall conform to 125-lb. ANSI (PN 10).
- C. Suitable length with nonparallel faces and corresponding drilling, if necessary, to correctly assemble adjoining piping or equipment

2.11 CONNECTIONS – TAPPED

- A. Provide service saddles for all taps for 24-inch diameter and smaller lines.
 - 1. Body: Ductile iron ASTM A395 or Bronze
 - 2. Straps and Hardware: Type 316 stainless steel
- B. For 30-inch diameter and larger, provide watertight joint with adequate strength against pullout. Use only tapered thread taps.
 - 1. Maximum tap size in pipe or fittings without bosses is not to exceed that listed in table of Appendix to AWWA A21.51 based on 2 full threads.
 - 2. Where connection size exceeds that given above for pipe, provide boss on pipe barrel or use tapping saddle. Make tap in flat part of tee's run and branch intersection or cross; or connect by means of tapped tee, branch fitting, and tapped plug or reducing flange or tapping tee and tapping valve; or as permitted by Metro.
 - 3. Provide taps and piping for gauges and pressure sensing instruments in accordance with ANSI/HI standards to prevent erroneous readings.

2.12 CERAMIC EPOXY LINING AND COATING

- A. Material
 - 1. A polyamine cured novalac modified epoxy containing at least 20 percent by volume of ceramic quartz pigment or quartz microspheres, Induron Protecto 401, Themec Perma Shield 431 PL or equal
 - 2. Permeability rating: 0.00 when tested according to ASTM E-96, Method A, Procedure A with a 30-day test duration
 - 3. Provide the following testing performed on coupons from factory lined ductile iron pipe:
 - a. ASTM B-117 salt spray (scribed panel): Results shall equal 0.0 undercutting after 2 years.
 - b. ASTM G-95 Cathodic Disbondment 1.5 volts at 77 degree F: Results shall equal no more than 0.5 mm undercutting after 30 days.
 - c. Immersion Testing rated using ASTM D-714.
 - 1) 20 percent sulfuric acid: No effect after 2 years
 - 2) 140°F 25 percent sodium hydroxide: No effect after 2 years
 - 3) 160 °F distilled water: No effect after 2 years
 - 4) 120 °F tap water (scribed panel): 0.0 undercutting after 2 years with no effect
 - 5) An abrasion resistance of no more than 3 mils loss after one million cycles using European Standard EN 598: 2007 + A1 2009 Section 7.8 Abrasion Resistance

B. Lining Thickness

1. Lining thickness shall be 40 mils nominal dry film thickness. No lining shall take place when the substrate or ambient temperature is below 40°F. The surface must also be dry and dust free.
2. Provide the number of lining material coats recommended by the lining manufacturer.

C. Preparation and Application: As recommended by the lining manufacturer

D. Lining Inspection

1. Check all ductile iron pipe and fittings for thickness with a magnetic film thickness gauge using the method outlined in SSPC-PA-2 Film Thickness Rating.
2. Using a nondestructive 4,000 volt test on all pipe barrels and fittings, test the interior lining for pinholes. Any pinholes found shall be repaired prior to shipment at no additional cost to Metro.
3. Mark each pipe joint and fitting with the lining system's application date along with its numerical application sequence on that date. The applicator shall maintain records of their work.
4. Certification: The pipe or fitting manufacturer must supply a certificate stating that the applicator met this Section's requirements and the lining manufacturer's recommendations for preparation and application and that the material used is as specified.

E. Outside pipe and fittings within structures: Clean and apply one shop coat with a 3 to 5 mil DFT of moisture cured urethane.

F. Outside casting surfaces shall be encased in concrete with no coating.

G. Machined surfaces shall be cleaned and coated with rust-preventative compound at shop.

H. Outside buried pipe and fittings: Standard bituminous coating conforming to AN Standard

2.13 GASKETS, BOLTS, AND NUTS

A. Provide ring or full face synthetic rubber gaskets for flanged joints and neoprene faced phenolic for insulating gaskets in accordance with AWWA A21.11 and ASME B16.21.

1. 1/8 inch thick

B. Make flanged joints with the following:

1. Bolts
2. Bolt studs with nut on each end
3. Studs with nuts where flange is tapped
4. Plastic bolt sleeves and washers for insulating joints

C. Bolts number and size shall conform to same ANS as flanges.

- D. Provide bolts and nuts Grade B, ASTM A307, except as specified or indicated.
- E. Provide bolt studs and studs of same quality as machine bolts.
- F. Provide Type 316 stainless steel bolts, washers, and nuts in the following areas:
 - 1. Submerged
 - 2. Wet Wells
 - 3. Chemical Area
 - 4. Piping exposed to weather

2.14 ELECTRICAL CONDUCTORS

- A. Provide 1/16-inch by 3/4-inch copper strip conductors for joints indicated to have electrical continuity.
- B. Weld terminal strips to pipe bell ends and spigot ends in the foundry. Provide jumper strips and silicon bronze bolts and nuts to complete the connections.
- C. If field cutting pipe is necessary, weld terminal strip to cut spigot end using thermit weld or other designed process.

PART 3 - EXECUTION

3.01 HANDLING AND CUTTING

- A. Mark pipe and fittings "Rejected" and remove from site when cracked or has received a severe blow.
- B. If permitted, cut on sound barrel at a point at least 12 inches from visible crack limit at Contractor's expense.
- C. Machine cut with milling type cutters, knives, or saws. Snap cutters, torch, or hammer and chisel are NOT ALLOWED. Examine for possible cracks.
- D. Chamfer cut ends if used for push-on joints.

3.02 INSTALLATION

- A. Visually inspect before installation.
- B. Ensure pipelines are parallel to building walls wherever possible. Install piping to accurate lines and grades. Where temporary supports are used, ensure rigidity to prevent shifting or distorting the pipe. Provide for expansion where necessary.
- C. Pitch piping toward low points. Provide draining for low points.
- D. Before assembly, remove dirt and chips from inside pipe and fittings.
- E. Piping Support: Provide as shown.

F. Pipe and Fittings

1. Remove and replace defective pieces.
2. Clear all debris and dirt before installing and keep clean until accepted.
3. Lay accurately to lines and grades indicated or required. Provide accurate horizontal and vertical alignment.
4. Provide firm bearing along entire length of buried pipelines.
5. Do not allow alignment deflection at joints to exceed permissible deflection as specified below:

Pipe Deflection Allowances		
Maximum permissible deflection, in.*		
Size of pipe, inches	Push-on joint	Mechanical joint
4	19	31
6	19	27
8	19	20
10	19	20
12	19	20
14	11	13 ½
16	11	13 ½
18	11	11
20	11	11
24	11	9
30	11	9
36	11	8
42	7 ½	7 ½
48	7 ½	7 ½
54	7 ½	0

*Maximum permissible deflection for 20-foot lengths. For other lengths—in proportion of such lengths to 20-feet.

- a. For push-on joint or similar pipe, clean excess tar or other obstruction from bell and wipe out before inserting next pipe spigot. Shove new pipe into place until properly seated and hold securely until joint is completed.
 - b. Set castings to be accurately encased in concrete with carefully aligned bolt holes, if any. Clean off rust and scale before setting.
- G. Temporary Plugs: When pipe laying is not in progress, close open pipe ends with temporary watertight plugs. If water is in trench, do not remove plug until danger of water entering the pipe passed.
- H. Appurtenances: Set valves, fittings, and appurtenances as indicated.

3.03 JOINTS AND COUPLINGS

A. Push-on Joints

1. Insert gasket into groove bell. Apply thin film of nontoxic gasket lubricant over gasket's inner surface in contact with spigot end.
2. Insert chamfered end into gasket. Force pipe past it until it seats against socket bottom.

B. Bolted Joints

1. Remove rust-preventive coatings from machined surfaces.
2. Clean pipe ends, sockets, sleeves, housings, and gaskets and smooth all burrs and other defects.
3. Use torque wrench to tighten to correct torque range, not to exceed values specified below:

Torque Range Values		
Nominal Pipe Size (inches)	Bolt Diameter (inches)	Torque Range (foot per pound)
3	5/8	40-60
4-24, incl.	3/4	75-90
30, 36	1	100-120
42, 48	1-1/4	120-150

C. Flanged Joint

1. Make up tight.
2. Do not put strain on nozzles, valves, and other equipment.

D. Mechanical Joints

1. Wire brush surfaces in contact with gasket and clean gasket.
2. Lubricate gasket, bell, and spigot with soapy water.
3. Slip gland and gasket over spigot and insert spigot into bell until seated.
4. Seat gasket and press gland firmly against gasket.
5. After bolts have been inserted and nuts made finger-tight, tighten diametrically opposite nuts progressively and uniformly around joint by torque wrench. Torque bolts to values specified above.

E. Tapped Connection

1. Drill and tap normal to longitudinal axis.
2. Drill by skilled mechanics using proper tools.
3. Use only tapered threads.

F. Electrical Conductors

1. Install pipes so terminal strips are aligned.
2. Install jumper strips and tighten bolts.

3.04 FIELD TESTING

A. Clean off all dirt, dust, oil, grease and other foreign material before conducting pressure and leakage tests.

B. Pressure and Leakage Tests

1. Conduct combined pressure and leakage test in pipelines for pump stations or equalization basins.
 - a. Furnish and install temporary testing plugs or caps, pressure pumps, pipe connections, meters, gages, equipment, and labor.
 - b. Test when desired and comply with specifications.
 - c. Test pipelines in excavation or embedded in concrete before backfilling or placing concrete and test exposed piping before field painting.
 - d. Fill pipe section with water and expel air. If hydrants or blowoffs are not available at high points for releasing air, make necessary taps and plug after test completion.
 - e. Maintain section full of water for 24 hours before conducting combined pressure and leakage test.
2. Conduct pressure and leakage test by first raising water pressure (based on lowest point elevation for section under test and corrected to gauge location) to pressure in psi numerically equal to pipe pressure rating, but not more than 150 psi.
3. Maintain pressure and perform leakage test by metering water flow into pipe. Acceptable results:
 - a. Average leakage during test: Less than 10 gallons per inch of diameter per 24 hours per mile
 - b. No visible leakage in joints
4. If unable to achieve and maintain specified pressure for 1 hour with no additional pumping, the section fails test.
5. If section fails pressure and leakage test, locate, uncover, and repair or replace defective pipe, fitting, or joint at no additional expense and without time extension. Conduct additional tests and repairs until section passes test.
6. Modify test procedure only if permitted by Construction Manager.

3.05 DISINFECTING AND FLUSHING

A. Disinfect potable water lines using procedures and materials conforming to AWWA C651.

- B. Dosage shall produce minimum 10 ppm after a 24-hour minimum contact period.
- C. After treatment, flush with clean water until residual chlorine content is less than 0.2 ppm.
- D. Prevent water contamination in existing water mains. Neutralize chlorine content in water used in disinfecting and flushing accordance with AWWA C651.

3.06 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

FOR INFORMATION ONLY

SECTION 43 21 00.07

WET PIT SUBMERSIBLE PUMPS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide and test wet-pit submersible solids handling pumps, motors, discharge base elbows, guide bar brackets, variable frequency motor controllers, and appurtenances suitable for pumping unscreened wastewater as indicated and specified.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM) International
 - 1. A36: Standard Specification for Carbon Structural Steel
 - 2. A48: Standard Specification for Gray Iron Castings
 - 3. A576: Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality
 - 4. A743: Standard Specification for Castings, Iron-Chromium, Iron-Chromium Nickel, Corrosion Resistant, for General Application
 - 5. D2240: Standard Test Method for Rubber Property – Durometer Hardness
- B. American National Standards Institute (ANSI)
 - 1. B16.1: Standard for Cast-Iron Pipe Flanges and Flanged Fittings, 125 lb
- C. Hydraulic Institute: Current Standards
 - 1. HI 1.4: American National Standard for Centrifugal Pumps for Installation, Operation, and Maintenance
 - 2. HI 1.6: Centrifugal Pump Tests
 - 3. HI 9.6.2: American National Standard for Rotodynamic Pumps for Assessment of Applied Nozzle Loads
 - 4. HI 9.6.6: American National Standard for Rotodynamic Pumps for Pump Piping
 - 5. HI 9.8: American National Standard for Rotodynamic Pumps for Pump Intake Design
 - 6. HI 11.6: Submersible Pump Tests
- D. National Electrical Manufacturers Association (NEMA)
 - 1. MG1: Motors and Generators

1.03 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01 33 00.
1. Data regarding pump and motor characteristics and performance
 - a. Prior to fabrication and testing, provide manufacturer's guaranteed performance curves based on actual shop tests of mechanically duplicate pumps, showing they meet indicated and specified requirements for head, capacity, horsepower, efficiency, and NPSHr.
 - 1) For units of same size and type, provide curves for a single unit only.
 - b. Provide catalog performance curves at maximum pump speed indicated and specified for each service showing maximum and minimum impeller diameters available, acceptable operating range (AOR), and preferred operating range (POR).
 - c. Shop performance test results as specified
 - d. Submit curves for manufacturer's guaranteed performance and shop performance tests on 8-1/2-inch by 11-inch sheets, one curve per sheet.
 2. Characteristic curves for variable speed pumps for maximum pump speed and for speeds required to obtain minimum pump flow and head conditions specified and indicated. Identify curves by speed and provide all curves on one sheet. Provide NPSHr curve for each speed.
 3. Shop drawing data for accessory items
 4. Certified setting plans with tolerances for anchor bolts
 5. Manufacturer's literature as needed to supplement certified data
 6. Operating and maintenance instructions and parts lists
 7. Listing of reference installations as specified with contact names and telephone numbers.
 8. Certified results of hydrostatic testing
 9. Certified results of dynamic balancing
 10. List with recommended spare parts other than those specified
 11. Shop and field inspection reports
 12. Bearing Life: Certified by the pump manufacturer. Include design data.
 13. Pump shop test results
 14. Motor shop test results
 15. Field service engineer's qualifications
 16. Recommendations for short- and long-term storage

17. Resonant frequency analysis
 18. Shop and field testing procedures, pump and piping set up, equipment to be used, and ANSI/HI testing tolerances to be followed
 19. Special tools
 20. Number of service person-days provided and per diem field service rate
 21. Shop vibration test data results for each pump and drive assembly
 22. Recommended location for discharge pressure gauges
 23. Manufacturer's product data, specifications, and color charts for shop painting
 24. Provide a list with materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
 25. Current ISO 9001 series certification
 26. Provide a scaled drawing for each pump service showing the pumps, motors, hoists, and bridge cranes including equipment weights, lifting attachments, slings, and clearances for equipment removal and maintenance.
 27. Material Certification
 - a. Provide certification from the equipment manufacturer stating the specified construction materials are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and certification showing the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list with 50 minimum installations in operation for a 5-year minimum. Provide proposed materials at no additional cost to Metro.
 - b. Where materials are not specified, provide technical data and certification showing the proposed materials are recommended and suitable for the service conditions specified and indicated.
- B. Provide a copy of the contract mechanical process, electrical and instrumentation drawings, with addenda applicable to the equipment specified in this Section, marked to show all changes necessary for the equipment proposed for this Section. If no changes are required, mark all drawings with "No changes required" or provide a statement saying no changes are required.
1. Failure to include all drawings or a statement applicable to the equipment specified in this Section will result in submittal return without review until a complete package is submitted.

C. Submit a copy of this Section with addenda and all referenced Sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.

1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
2. Failure to include a copy of the marked-up Sections and or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS

- A. Comply with requirements specified in Section 01 61 00.
- B. Provide spare parts identical to and interchangeable with similar parts installed.
 1. For each pump
 - a. One complete set of gaskets and O-rings
 - b. One set of wearing rings
 2. For each set of pumps of the same size and performance
 - a. One set of all special tools required
 3. Provide spare pumps and rotating assemblies as presented in the Process Pump Schedule.
 - a. Spare rotating assemblies: Provide the assembly including impeller, motor and control and power cables for the length as provided for all pumps.

1.05 QUALITY ASSURANCE

- A. Comply with requirements specified in Section 01 43 00.
- B. Pumps shall be the product from one manufacturer.
- C. Pumps shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications, and the service conditions specified and indicated.
- D. Welding: In accordance with latest applicable American Welding Society Code or equivalent
- E. Shop tests as specified

- F. The Contractor shall obtain the pumps, motors, and appurtenances from the pump manufacturer, as a complete and integrated package to insure proper coordination, compatibility, and system operation.
1. Variable frequency motor controllers can be supplied by the Contractor or the pump manufacturer at the Contractor's option. The pumping system must be a complete and integrated package to insure proper coordination, compatibility, and system operation.
 - a. The Contractor shall coordinate the variable frequency motor controllers with the pump and motor manufacturer. As part of the shop drawings, submit a written statement signed by the Contractor, pump manufacturer, motor manufacturer, and variable frequency motor controller manufacturer stating that the variable frequency motor controller manufacturer has received the required information from the pump and motor manufacturers and that all parties have reviewed the system and coordinated the equipment selection. Also, include all motor data and information used for the coordination.
 - b. Provide variable frequency motor controllers in accordance with Section 26 29 23.
 2. Guide cables or rails and hatches can be supplied by the Contractor or the pump manufacturer at the Contractor's option. The pumping system must be a complete and integrated package to insure proper coordination, compatibility, and system operation.
 - a. The Contractor shall coordinate the hatch size with the pump manufacturer. As part of the shop drawings, submit a written statement signed by the Contractor and pump manufacturer stating that the Contractor has received the required information from the pump manufacturer and that all parties have reviewed the hatch size and coordinated the hatch size, bridge crane, and equipment removal.
 - b. The Contractor shall coordinate the cable or rail size with the pump manufacturer. As part of the shop drawings, submit a written statement signed by the Contractor and pump manufacturer stating that the Contractor has received the required information from the pump manufacturer and that all parties have reviewed the cable or rail size and coordinated the size and equipment removal.
- G. Manufacturer's representative services as stated in Section 01 43 00 and as specified herein
- H. Provide services by a factory-trained service technician, specifically trained on specified equipment type.
1. Service Technician must be present on site for all items listed below. Person-day requirements listed exclude travel time and do not relieve Contractor of the obligation to place equipment in operation as specified.
 2. Installation: Inspect grouting, anchor bolt locations, setting, leveling, alignment, field erection; coordinate piping and electrical: 0.25 person-days.
 3. Functional Testing: Calibrate, check alignment, and perform a functional test with water. Tests are to include all items specified: 0.5 person-days.
 4. Performance Testing: Field performance test equipment specified: 0.5 person-days
 5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts, and preparation to lead and teach classroom sessions: 0.25 person-days.

6. Credit to Metro all unused service person-days specified above, at the manufacturer's published field service rate.
 7. Any additional time required by the factory-trained service technician to assist in placing the equipment in operation or testing, or to correct deficiencies in installation, equipment, or material shall be provided at no additional cost to Metro.
- I. Pump manufacturer shall have 5 minimum operating installations with pumps the size specified and in the same service as specified operating for not less than 5 years.
 - J. If equipment proposed is heavier or taller, different rotation, or discharge arrangement than specified and indicated, provide all structural, architectural, mechanical, electrical, and plumbing revisions at no additional cost to Metro.
 1. If equipment is heavier than specified, the Contractor shall provide all hoisting equipment sized to maintain the minimum safety factor between the specified maximum equipment weight and the lifting capacity for the hoisting equipment indicated and specified.
 - K. For variable speed pump systems, the pump manufacturer must analyze the combined motor and pump assembly for resonant frequency or their harmonics independent of a structure.
 1. Submit a copy of these calculations for the record.
 2. Should calculations indicate the probability of encountering such frequencies within the speed range required, provide all additional supporting devices necessary to affect the unit mass and raise or lower resonant point to be within the speed range required.
 3. Provide and install such additional devices at no additional cost to Metro.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements specified in Section 01 66 10.

1.07 WARRANTY

- A. Provide a manufacturer's extended 5-year warranty bond.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Pump capacities and operating data are indicated in the Process Pump Schedule.
- B. Raw Wastewater Pumps: Pump unscreened raw wastewater from wet wells.
- C. Equipment Limitations
 1. Pumps: [_____]
 - a. Maximum Total Pump and Motor Weight for Lifting: [_____] lbs.
 - b. Maximum Overall Pump Assembly Length: [_____] in.

- D. Coordinate pump dimensions and weights with hoists and bridge cranes as specified and as indicated.
- E. Pumps normally operate with a flooded suction, except the pumps will be subject to a suction lift if indicated in the Process Pump Schedule.
- F. Design pumps so future conditions specified can be achieved by the following:
 - 1. Installing future impellers only
 - 2. Installing future motors only

2.02 MANUFACTURERS

- A. Submersible Solids Handling Pumps
 - 1. ITT Flygt, Model CP [_____]
 - 2. Substitutions: Not permitted.
 - 3. **This is a proprietary specification. No other manufacturers or model numbers are acceptable.**

2.03 LOAD AND SEISMIC DESIGN REQUIREMENTS

- A. Conform to requirements indicated on the structural drawings.
- B. The Contractor shall conform to the load and seismic design requirements for this project and for the work in this Section.
- C. Provide all equipment bases, anchorage, supports, and foundations designed in accordance with the load and seismic requirements indicated and specified.
- D. Additionally, provide with the Certificate of Unit Responsibility certification for all equipment signed by a registered structural engineer stating that the computations were performed and that all components have been sized for the load and seismic forces specified and indicated.

2.04 PUMP CONSTRUCTION

- A. Pumps: Solids handling radial and mixed flow single-stage, centrifugal pumps. Driven as indicated in the Process Pump Schedule
- B. Design and proportion all pump parts specially adapted for the service specified and indicated.
- C. Pump Mounting: Provide type as indicated and specified.
 - 1. Mount each pump on a discharge elbow with discharging vertically.
- D. Pump Casing, Fronthead, Backhead, and Lower Housing
 - 1. Cast iron, ASTM A48 Class 30 or 35
 - 2. Provide lifting devices on pump/motor assembly for handling.
 - a. Type 316 stainless steel

3. Casings are to be a one-piece casting with center discharge nozzle.
4. Volute shall be designed for efficient conversion of kinetic to potential energy and with clear passageways designed to pass a solid sphere size as indicated in the Process Pump Schedule. The cutwater shall be designed for use with stringy solids and rags.
5. Provide ribs or reinforcing, if required, to withstand the specified hydrostatic test pressure, to prevent deflection caused by hydraulic thrust, and to support the motor.
6. Face and drill discharge connection flanges in accordance with 125 lb ANSI B16.1 Standard.
7. Where a rail pipe is required, face and drill suction in accordance with 125 lb ANSI B16.1 Standard.
8. Provide components with machined registered concentric shoulder fits for precision alignment. Equipment without registered fits is not acceptable.
9. Pumps with splitter vanes in casing are not acceptable unless specifically indicated in the Process Pump Schedule.

10. Lining

a. Manufacturer

- 1) Belzona Supermetalglide
- 2) Devcon Brushable Ceramic Blue
Substitutions: Not permitted
Type: Ceramic filled epoxy

c. Percent Solids By Volume: 100 percent

d. Provide two coats 8 to 15 mils thick with total minimum DFT of 20 mils.

e. Cured Hardness: 90D in accordance with ASTM D2240

f. Surface preparation, mixing, application, and safety requirements shall be in accordance with the lining manufacturer's printed instructions and as specified.

E. Impellers

1. Type: Enclosed radial, enclosed mixed flow, or semi-open single vane solids handling single suction
2. Provide vanes with wide suction and waterways that will pass solids and stringy materials without clogging.
3. Provide pumps able to pass a solid sphere size as indicated in the Process Pump Schedule.
4. Pumps only able to pass a deformable sphere are not acceptable.
5. Provide impellers not greater than 95 percent, or the percentage indicated in the Process Pump Schedule, of the maximum diameter impeller available.

6. Do not design hub with ports for reducing thrust on impeller.
7. Key-seat and hold the impeller to shaft using a streamlined bolt or locknut able to hold in event of motor reversal under full torque.
8. Impeller Fasteners: Type 416 stainless steel or Type 316Ti stainless steel
9. Statically and dynamically balance each impeller.
10. Enclosed Impellers
 - a. Material
 - 1) Cast iron, ASTM A48 Class 30 with ceramic coating as specified above for pump casing
 - 2) Pump services: Raw wastewater
 - b. Wearing Rings
 - 1) Provide on impeller and in-pump casing at suction side.
 - 2) Provide impeller and casing wearing rings/grit wear ring for all raw wastewater pumps.
 - 3) Pumps 24-inch and smaller: Type 440C stainless steel with a 600 BHN
 - 4) Pumps larger than 24-inch: Type 410 stainless steel 450-490 BHN or Type 440 stainless steel with a 600 BHN
 - 5) Impeller and Casing Wearing Rings for All Other Pumps
 - a) Impeller: Stainless steel ASTM A743 Grade CA-40 with a 300 to 350 BHN
 - b) Casing Wearing Rings for All Other Pumps: Stainless steel ASTM A743 Grade CA-40 with a 450 to 480 BHN
 - 6) Grit Wear Ring
 - a) Provide a grit wear ring located outside the wearing rings on the pump fronthead.
 - b) Grit ring is to include the casing wearing ring.
 - c) Provide the grit ring with vanes to break up the swirling pattern outside the wear rings.
 - d) Material: Type 440C stainless steel with a 600 BHN
11. Semi-Open Impellers
 - a. Type: Semi-open, solids handling, single vane
 - b. Material: ASTM A-48, Class 35B cast iron

c. Wear Plate

- 1) Provide adjustable wear plate mounted to volute.
- 2) Provide wear plate designed to shred and pass stringy solids outward from the impeller.
- 3) Provide suction flange integral to the wear plate and drilled and threaded to accept ANSI class 125 flanged fittings.
- 4) Materials
 - a) Wear Plate: ASTM A-48, Class 35B cast iron
 - b) Wear Plate Fasteners: Type 416 stainless steel or Type 316Ti stainless steel

2.05 MOTORS

- A. Provide as specified and indicated.
- B. Horsepower Rating for Motors: Not less than maximum brake horsepower requirements of pumps under any operating condition specified and indicated without operating in the motor service factor
- C. Maintain motor speed as stated in the Process Pump Schedule.
- D. Enclosure: Explosion proof, Class I, Division 1, Group D; UL or FM certified
- E. In addition to bearing requirements specified under Electric Motors in Section 26 20 10, provide pump motors with ball or roller bearings. Provide vertical motors with at least one bearing designed for thrust with bearings. Provide bearing with a minimum 100,000-hour B-10 life.
- F. Operate without overheating at the speeds specified and indicated.
- G. Service Factor: 1.15 with 1.0 inverter duty rating for pumps equipped with variable frequency motor controllers
- H. Minimum Efficiency
 1. 100 percent load - ___%
 2. 75 percent load - ___%
 3. 50 percent load - ___%
- I. Rating: 460V, 3 PH, 60 Hz
- J. Insulation: Class F with Class B temperature rise, 40 degrees Centigrade ambient
- K. Site Altitude: Less than 3,300 feet above sea level

L. Motors

1. Provide complete sealed electric submersible squirrel cage induction motors in accordance with the above and as specified herein.
2. Provide all components housed in an air or oil filled cast-iron watertight electric submersible squirrel cage induction motor in accordance with the above and as specified herein.
3. Provide a suitable cooling system to cool the motor. A self-cleaning means to internally pump a portion of the pumped liquid for cooling the motor is acceptable. Provide a means to purge air from the jacket at motor start.
4. Insulate stator-winding and lead with moisture resistant Class F or Class H insulation for continuous duty in 40 degrees C rise liquids.
5. Provide motor capable of 10 starts per hour at maximum speed.
6. Motor Shaft: Type 416 or Type 420 stainless steel or ASTM A576 Cr 1040 with Type 420 stainless steel sleeve.
 - a. One piece internal pump/motor shaft
 - b. Provide shaft with sufficient diameter so the ratio of the shaft overhand, distance from lowest bearing to the impeller hub, to the shaft diameter through the seal area will not exceed 2.5.
7. Dynamically balance rotor to within NEMA vibration limits.
8. All Hardware: Type 316 stainless steel
9. Provide all multi-conductor SOW-A, G-GC or W cables with sufficient length to extend from pump motor to a junction box above flood elevation noted. Cable size shall be in accordance with NEC specifications.
10. Cable Entry
 - a. Provide all power and control lead wires double sealed entering the motor in a method that prevents cable wicking.
 - b. Provide the sealing system consisting of a rubber grommet to seal the cable exterior followed by interior epoxy seal.
 - c. Provide each cable wire with an insulation section removed to establish a bare wire window area and each wire surrounded by epoxy potting material.
 - d. Provide a cable strain relief mechanism as an integral part of this sealing system.
 - e. Provide the cable sealing system able to withstand a 1,200 psi external pressure test and a cable assembly pull test as required by UL or FM.
 - f. Provide the cable entry rated by UL or FM for submerged operating depths to 85 feet.
 - g. Singular grommet or other similar sealing systems are not acceptable.

11. Seals

- a. Provide two separate tandem-mounted mechanical seals with the upper and lower seals mounted to rotate in the same direction.
- b. Upper Seals
 - 1) Provide seal completely immersed in an oil or glycol bath sealing the oil chamber and motor housing.
 - 2) Materials: Tungsten-carbide or silicon-carbide rotating and stationary faces
- c. Lower Seals
 - 1) Provide lower seal with mating faces immersed in the oil or glycol bath sealing the pump volute and oil chamber.
 - 2) Materials: Tungsten-carbide or silicon carbide rotating and stationary faces
 - 3) Provide a cover extending completely over the lower seal spring.
- d. Springs: Type 316 stainless steel
- e. Elastomers: Viton

12. Moisture and Temperature Probes

- a. Provide two moisture detection probes to detect moisture in the seal and stator cavity measuring conductivity.
- b. Provide moisture detection panel and one-piece cable from pump to panel; see electrical drawings for panel location. Contractor is to provide conduit and cable from pump to control panel.
- c. Provide sufficient cable length to extend from the pump assembly to a junction box above top of wet well.
- d. Provide O-ring sealed plugged fill and drain inspection ports.
- e. Provide winding over temperature protection.
- f. Moisture detection to alarm, over temperature to shut down pumps, indicate condition and alarm
- g. Provide NEMA 4X Type 316L stainless steel panel with moisture detection system.

13. Bearings

- a. Provide 2 bearings minimum, permanently lubricated but able to be regreased.
- b. 100,000-hour minimum B-10 bearing life
- c. Provide RTD for thrust bearing.

14. Provide all mating surfaces machined and fitted with O-rings. All fittings shall be metal to metal contact between each machine surface.
15. Provide a Type 316 lifting attachment able to lift the entire pump and motor assembly.
16. Motors shall conform to UL or FM quality assurance specifications and be manufactured by an ISO-9001 company.
17. Provide a motor resistance monitor.

2.06 DISCHARGE BASE

- A. Provide an ASTM A48 Class 30 cast-iron discharge base assembly including a 90-degree elbow and base to support the entire weight of the pump and motor and to secure the lower end of the guide rails.
- B. Provide base machined to receive sliding bracket of pump discharge.
- C. Provide seat constructed of bronze or non-metallic O-ring that is self-cleaning, non-clogging and non-sparking UL or RM certified explosion proof.
- D. Bolt to floor with Type 316 stainless steel anchors.

2.07 GUIDE ASSEMBLY

- A. Provide Schedule 40 Type 316L stainless steel guide rails or Type 316 cables for each pump discharge assembly.
 1. Guide Rail: Pump manufacturer's standard size but not less than 2-inch diameter.
- B. Provide Type 316L stainless steel intermediate supports for guide rails with a maximum 10-foot spacing between supports.
- C. Provide Type 316L stainless steel top guide rail retainer brackets to support the guide rails or cables. Bracket is to be attached to top slab of wet well.
- D. Provide Type 316 stainless steel chain in a sufficient length to reach from pump to top of wet well plus 10 feet and with the strength to lift the pump and motor. Provide a chain designed for attaching to lifting bail provided on motor and to the guide rail retainer bracket.

2.08 PUMP LIFTING/DOCKING DEVICE

- A. Provide a chain and latch mechanism to allow the pumps and motors to be removed in one pull without re-rigging the system. Provide a device that is lowered along the guide cables or rails and can be remotely latched to the pump lifting bail without the need to enter the wet well.
- B. Materials
 1. Lifting Bail: ASTM A248 B
 2. Hook, Shackle, Counterweight and Chain: ASTM A322
 3. Guide Ropes: Stainless steel

4. Latch Operating Rope: Polyamid

C. Mechanism's lifting capacity is to be suitable for equipment provided.

D. Provide 1 device for each size pump.

2.09 HARDWARE

A. Type 316 stainless steel

2.10 GAUGES

A. Provide gauges assemblies for discharging each pump in accordance with Section 40 23 19.04 and as indicated.

B. Discharge Gauges: Compound type with operating range with top limit above pump shutoff head at maximum pump speed

1. Scale: _____ psi to _____ psi.

2.11 SHOP PAINTING

A. Primer and Finish Paint: Shop apply high solids epoxy to all exterior ferrous surfaces.

B. Ferrous surfaces not to be painted shall be given a shop applied coat of grease or rust resistant coating.

C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is complete and equipment accepted.

2.12 SHOP TESTING

A. Provide motor shop testing as specified.

1. Conduct motor efficiency and power factor tests at full load 100 and 50, 75 percent load.

2. Provide the following motor tests in accordance with ANSI/HI 11.6:

a. Test motor integrity in a submerged condition.

b. Dry run no load test

c. Motor electrical integrity test

d. Moisture and temperature sensors integrity test

B. Pump Tests

1. Test pump casings under a hydrostatic head of at least 150 percent of rated shutoff head, whichever is greater. Test casing with pump assembled.

2. Provide certified performance tests as specified herein for all pumps and spare rotating assemblies, except those specified to be witness tested.

3. Certified Performance Testing

- a. Test submersible pumps with pump operating under minimum submergence conditions to demonstrate the motor's ability to operate without overheating.
- b. Run pump at full speed rating point for 60 minutes prior to starting any testing.
- c. Full Speed Tests
 - 1) Test pumps at the conditions specified and indicated and take not less than 7 operating points between shut-off and run out. Test points must be at the conditions specified and indicated.
 - 2) Take readings to determine flow, differential pressure, rpm, horsepower, and wire to water efficiency.
 - 3) Operate each pump for not less than one hour and take readings to determine the pump will operate as specified and indicated without cavitation at the specified minimum head condition with not more than the specified NPSH available.
- d. Variable Speed Tests
 - 1) Conduct tests as specified above for full speed at reduced speeds, except the tests for cavitation at run out are not required.
 - 2) Run one speed test at speed required to discharge the minimum rating point specified and indicated with one test point at the minimum rating point.
 - 3) Run a second test at a speed approximately midway between full and minimum speed.
 - 4) Run additional tests for each reduced speed operating condition specified and indicated.
- e. Conduct additional tests as follows.
 - 1) Run each pump at the minimum speed rating point for 4 hours and continuously record motor temperature. Pumps must be run submerged at LWL submergence as indicated.
- f. Factory Tests on Pumps
 - 1) Use tested job motors and job variable frequency drives shipped to the pump testing facility for use in these pump tests.
 - 2) Use factory calibrated test drives.
- g. Provide a 30-day minimum written notice to the Construction Manager prior to shop testing. Do not factory test without Metro's representative present or without Metro's approval.

4. Run all tests in accordance with the latest Hydraulic Institute standards and as referenced and specified.

5. Testing Tolerances
 - a. ANSI/HI 1.6 and 11.6 Acceptance Level: A
 - b. Tolerance: Pump test results shall be judged at flow and rpm rate with applicable total head and efficiency as defined by ANSI/HI 1.6 for the pump conditions specified and indicated.
 - c. If pumps do not meet the tolerances specified, trim the impeller and retest until the specified results are obtained.
6. Provide variable frequency motor controller tests specified in Section 26 29 23.
7. If specified tests indicate the pump, motor, or variable frequency drive will not meet specifications, Construction Manager has the right to require additional complete witnessed tests for all pumps, motors, and variable frequency drives at no additional cost to Metro.
8. Repeat tests until specified results are obtained.
9. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to Metro.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install items in accordance with shop drawings and manufacturer's printed instructions.
- B. Install pumping units and align.
 1. Set base on metal shims placed directly under the part of the base carrying the greatest weight and spaced close enough to provide uniform support.
- C. After alignment is correct, grout using high grade non-shrink grout.
 1. Do not imbed leveling nuts in grout.

3.02 FIELD TESTING

- A. Test piping connections to prove the pump nozzles are installed with the pipe in a free supported state and without need to apply vertical or horizontal pressure to align piping with pump nozzles. Pump discharge piping shall be in accordance with referenced HI standards. Tests must be performed and the piping acceptable prior to any field performance testing.
- B. Field testing will not be conducted without an accepted procedure, calibration certificates for all testing equipment, gauges and flow meters, and a completed and signed pretesting check list.
- C. After installing pumping equipment and after inspection, operation, testing and adjustment have been completed by the manufacturer's field service technician, conduct a running test for each pump in the Construction Manager's presence to determine its ability to operate within

the vibration and temperature limits specified and to deliver its rated capacity under specified conditions.

1. During tests, observe and record head, capacity, and motor inputs.
 - a. Test Duration: Determined by the Construction Manager, but not less than 3 hours of continuous operation at each condition specified and indicated.
2. Immediately correct or replace all defects or defective equipment revealed by or noted during tests at no additional cost to Metro.
3. Repeat tests until specified results are obtained.
4. Contractor shall provide potable water, all labor, piping, testing equipment, equipment, flow meters, and test gauges for conducting tests.
 - a. Contractor shall provide calibrated test gauges for all permanently installed gauges and portable calibrated flow meters for all pumping systems even in those cases where permanent flow meters are installed.
 - b. All calibrations must be performed within 30 days of the field testing.
 - c. The testing will not be started and will not be accepted until the calibrated testing equipment stated above is operational and all certifications have been submitted.
- D. Make all adjustments necessary to place equipment in specified working order during above tests.
- E. Water for testing is to be furnished by the Contractor.
- F. Remove all like equipment and replace all like equipment at no additional cost to Metro with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Construction Manager that equipment will perform the service specified, indicated and as submitted and accepted.

3.03 FIELD TOUCH-UP PAINTING

- A. After installation and accepted testing by the Construction Manager, apply touch-up paint to all scratched, abraded, and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION

SECTION 46 42 26.02

CHANNEL GRINDERS AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide and test channel grinders, controls, and appurtenances as indicated and specified.

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM)
 - 1. A36: Standard Specification for Carbon Structural Steel
 - 2. A351: Standard Specification for Castings, Austenitic, for Pressure-Containing Parts
 - 3. A536: Standard Specification for Ductile Iron Castings
- B. American National Standards Institute (ANSI)
 - 1. S1.11: Standard Octave-Band and Fractional-Octave-Band and Digital Filters
- C. National Electrical Manufacturers Association (NEMA)
 - 1. MG1: Motors and Generators
- D. Society of Automotive Engineers (SAE)
 - 1. 660: Bearing Bronze
- E. Underwriters' Laboratories (UL)
 - 1. 508: Industrial Control Equipment

1.03 SUBMITTALS

- A. Submit the following shop drawings in accordance with Section 01 33 00.
 - 1. Certified Shop and Erection Drawings: Contractor shall submit electronic files for the proposed equipment in the capacity, size, and arrangement as indicated and specified.
 - 2. Data regarding grinder, screen drum, gear reducer and motor characteristics and performance:
 - a. Prior to fabrication and testing, provide guaranteed performance curves based on actual shop or field tests for mechanically duplicate grinders, showing they meet indicated and specified requirements for capacity, pressure drop, and horsepower.
 - 1) For units of same size and type, provide curves for a single unit only.
 - b. Shop performance tests results as specified

- c. Submit curves for guaranteed performance and shop performance tests on 8-1/2-inch by 11-inch sheets, one curve per sheet.
3. Shop drawing data for accessory items
4. Certified setting plans with tolerances for anchor bolts
5. Manufacturer's literature as needed to supplement certified data
6. Operating and maintenance instructions and parts lists
7. List with reference installations as specified with contact names and telephone numbers
8. Bearing temperature operating range for the service conditions specified
9. List with recommended spare parts other than those specified
10. Shop and field inspection reports
11. Bearing Life: Certified by the grinder manufacturer. Include design data.
12. Grinder shop test results
13. Motor shop test results
14. Qualifications for field service engineer
15. Recommendations for short- and long-term storage
16. Shop testing procedures and equipment to be used including the details for all equipment and testing set up
17. Field testing procedures and equipment to be used including the details and calibration certificated for all equipment and portable flow meter locations
18. Special tools
19. Number of service person-days provided and per diem field service rate
20. Schematic control and power wiring diagrams
21. Manufacturer's product data and specifications for painting
22. Provide a list with the materials recommended for each service specified and indicated. Provide documentation showing compatibility with process fluid and service specified and indicated.
23. The latest ISO 9001 series certification or quality system plan
24. Material Certification
 - a. Provide certification from the equipment manufacturer stating the specified construction materials are recommended and suitable for the service conditions specified and indicated. If materials other than those specified are proposed based on incompatibility with the service conditions, provide technical data and

certification showing the proposed materials are recommended and suitable for the service conditions specified and indicated including an installation list with 5 installations minimum in operation for a 5-year minimum. Provide proposed materials at no additional cost to METRO.

- b. Where materials are not specified, provide technical data and certification stating the proposed materials are recommended and suitable for the service conditions specified and indicated.
25. Submit a copy of the contract mechanical process and electrical and instrumentation drawings with addenda applicable to the equipment specified in this Section, marked to show all changes necessary for the equipment proposed for this Section. If no changes are required, mark all drawings with "No changes required" or provide a statement saying no changes are required.
- a. Failure to include all drawings or a statement applicable to the equipment specified in this Section will result in submittal return without review until a complete package is submitted.
- B. Submit a copy of this Section with addenda and all referenced Sections with addenda, with each paragraph check-marked to indicate specification compliance or marked and indexed to indicate requested deviations and clarifications from the specified requirements.
- 1. If deviations and clarifications from the specifications are indicated, therefore requested by the Contractor, provide a detailed written justification for each deviation and clarification.
 - 2. Failure to include a copy of the marked-up Sections and/or the detailed justifications for any requested deviation or clarification will result in submittal return without review until marked up specifications and justifications are submitted in a complete package.

1.04 SPARE PARTS

- A. Provide in accordance with Section 01 61 00 and as specified herein.
- B. Provide spare parts identical to and interchangeable with similar parts installed.
 - 1. For each grinder
 - a. One complete set of gaskets
 - b. One set of cutters
 - c. One set of spacers
 - 2. For each set of grinders of the same size and performance
 - a. One set of all special tools required
 - 3. Provide spare rotating assemblies as indicated.

1.05 QUALITY ASSURANCE

- A. Comply with requirements specified in Section 01 43 00 and as specified herein.

- B. Channel grinders and control panels shall be the product from one manufacturer.
- C. Channel grinders shall be manufacturer's standard cataloged product and modified to provide compliance with the drawings, specifications, and the service conditions specified and indicated.
- D. Welding: In accordance with latest applicable American Welding Society Code or equivalent
- E. Shop tests as specified
- F. The Contractor shall obtain the channel grinders, motors, gear reducers, and controls from a single grinder manufacturer, as a complete and integrated package to insure proper coordination, compatibility, and system operation.
- G. Services by manufacturer's representative as stated in Section 01 43 00 and as specified herein
- H. Provide services by factory-trained service technician specifically trained on specified equipment type.
1. Service Technician must be present on site for all items listed below. Person-day requirements listed exclude travel time and do not relieve Contractor of the obligation to place equipment in operation as specified.
 2. Installation: Inspect anchor bolt locations, equipment setting, leveling, alignment, field erection; coordinate piping, electrical, and miscellaneous utility connections: 0.25 person-days.
 3. Functional Testing: Calibrate, check alignment, and perform a functional test with water. Tests are to include all items specified: 0.25 person-days.
 4. Performance Testing: Field performance test equipment specified: 0.25 person-days.
 5. Vendor Training: Provide classroom and field operation and maintenance instruction including all materials, slides, videos, handouts, and preparation to lead and teach classroom sessions: 0.25 person-days.
 6. Credit Metro for all unused service person-days specified above at the manufacturer's published field service rate.
 7. Any additional time required by the factory-trained service technician to assist in placing the equipment in operation, or testing or to correct deficiencies in installation, equipment, or material shall be provided at no additional cost to METRO.
- I. Channel grinder manufacturer shall have 25 operating installations minimum with channel grinders the size specified and in the same service as specified operating for not less than 5 years.
- J. If equipment proposed is heavier or taller or has a different rotation or discharge arrangement than specified and indicated, provide all structural, architectural, and mechanical revisions at no additional cost to METRO.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the requirements specified in Section 01 66 10 and as specified herein.

PART 2 - PRODUCTS

2.01 SYSTEM DESCRIPTION

- A. Channel grinder capacities and operating data are indicated in the Channel Grinder Schedule in this Section.
- B. Raw Wastewater: Grinders will be upstream of wet well and pumping equipment.
- C. Equipment Limitations
 - 1. Channel Grinders: [_____]
 - a. Maximum Grinder Capacity: [_____] gpm
 - b. Maximum Grinder Headloss: [_____] in. of water column
 - c. Maximum Assembly Weight: [_____] lbs.
 - d. Maximum Assembly Height: [_____] in.

2.02 MANUFACTURERS

- A. JWC Environmental
- B. Moyno
- C. Substitutions: Not permitted

2.03 LOAD AND SEISMIC DESIGN REQUIREMENTS

- A. Conform to the requirements indicated on the structural drawings.
- B. The Contractor shall conform to the load and seismic design requirements for this project and for the work in this Section.
- C. Provide all equipment bases, anchorage, supports, and foundations designed in accordance with the load and seismic requirements indicated and specified.
- D. With the Certificate of Unit Responsibility, provide certification for all equipment signed by a registered structural engineer stating that the computations were performed and that all components have been sized for the load and seismic forces specified and indicated.

2.04 CHANNEL GRINDER CONSTRUCTION

- A. General
 - 1. Type
 - a. Two-shaft design and capable of continuous operation. The two-shaft design shall consist of two parallel shafts alternately stacked with intermeshing cutters and spacers positioned on the shaft to form a helical pattern. The two shafts shall counter-rotate with the driven shaft operating at approximately two-thirds the drive shaft speed.

- b. Provide grinder with individual motors and speed reducers for cutter drive shaft.
2. Able to operate with or without flow and without an external water source
- B. Housing and Cover
1. End Housing and Top Cover Material: ASTM A536 ductile iron
 2. Bottom Cover Material: ASTM A36 rolled steel
 3. Provide end housings with integral bushing deflector.
 4. One piece flanged able to remain in-line when the cutter cartridge and drive assembly is removed for service
 5. Provide a covered gasketed access port for equipment inspection. Access port cover: ASTM A536 ductile iron
 6. Side Rails
 - a. Material: ASTM A536 ductile iron
- C. Cutters and Spacers
1. Materials
 - a. Cutters: AISI 4130 alloy steel, Hardness Rockwell C 60-65
 - b. Spacers: AISI 4130 alloy steel, Hardness Rockwell C 34-38
 2. Provide a cutter cartridge and drive assembly that is removable from the housing as a complete unit.
 3. Provide cutters with 7 cam shaped teeth including a maximum tooth height of 1/2-inch above the cutter's root diameter.
 4. Tooth height is not to exceed 1/2-inch above the root diameter.
 5. Provide spacers as an individual disc ground to a 0.446-inch thickness.
 6. Provide spacers with a smooth outside diameter with no tooth profiles.
 7. Provide cutter to exert a continuous 450-lbs/hp minimum force and 1,430 lbs/hp at momentary peak loads at the tooth tip.
- D. Shafts
1. Material: AISI 4140 heat treated hexagon steel
 2. Hardness: 38-42 Rockwell C
 3. Shaft shall measure a nominal 2.5 inches across flats of hex.
 4. Provide shaft to exert a 4,106 lb-in/hp maximum shaft torque.

5. Intermediate Shaft Supports

- a. Material: ASTM 743 stainless steel, AISI 17-4 stainless steel, and SAE 660 bearing bronze.
- b. Provide shaft supports lubricated with high temperature marine grade grease.

E. Bearings and Seals

1. Materials

- a. Seal Faces: Tungsten carbide with 6 percent nickel
- b. O-Rings: Buna-N (nitrile)

2. Provide seal cartridges rated for 90 psi maximum.

3. Seal cartridges requiring flushing or lubrications are not acceptable.

4. Radial and axial loads shall be supported by sealed, oversized, deep-groove ball bearings.

F. Frame and Supports

1. Material: AISI 304 stainless steel

G. Driver

1. Provide separate speed reducers for cutters.

a. Manufacturer: Sumitomo

2. Provide grease lubricated speed reducers.

3. Cutters

a. Planetary reduction gear with trochoidal curved tooth profile

b. Reduction Rating: 29:1 single reduction, vertically mounted

H. Controllers

1. Provide a programmable logic controller (PLC) with ladder logic programming.

2. Provide thermal motor overload protection and single-phase protection.

3. Furnish all controls for operating unit, circuit breaker, motor starter, control transformer, pushbuttons, and relays.

4. Provide the following control functions:

a. Grinder on-off-remote switch

b. Start/Stop pushbutton

c. Reset pushbutton

- d. Motor heater coils as an integral part of an adjustable overload relay
5. Jam Condition
 - a. For grinder jam conditions, design the controller to stop the grinder and reverse its rotation. If the jam is cleared, program the controller to return to normal operation.
 - b. If 3 grinder reverses occur within a 30-second interval, design the controller to stop the grinder motor and activate the grinder fail indicator and relay.
6. Power Failure
 - a. If a power failure occurs while the grinder is running, the grinder shall resume running when power is restored.
 - b. If the grinder is stopped due to a fail condition and a power failure occurs, the fail indicator shall reactivate when power is restored.
7. Provide one free digital input and one output each able to interface with the PLC's monitored functions and full programmable capabilities.
8. Provide the following indicating lights:
 - a. Power on
 - b. Each overload/fail
 - c. Grinder Run
 - d. Each maintenance condition
9. Provide momentary contact stop/reset and start pushbuttons.
10. Provide an auxiliary overload relay for remote, overload, and/or alarm indication.
11. Enclosure
 - a. NEMA 4X
 - b. For panels located within structures, provide fiberglass reinforced polyester or Type 316L stainless steel. For panels located outside, provide Type 316L stainless steel.
 - c. Hardware: Type 316 stainless steel
 - d. Comply with U.L. 508 Standards.
12. Provide a reversing motor starter, full voltage reversing type.
13. Provide lamp test button.

2.05 MOTORS

- A. Provide Electric Motors and as specified and indicated, except as modified herein.

B. Immersible Motors

1. Scope: The motors shall be horizontal, TEBC immersible motors. Motors shall be squirrel cage induction motors suitable for the application intended. This Section details the electrical and mechanical requirements for totally enclosed fan cooled immersible squirrel cage induction motors.
2. General: All motors defined under this Section shall conform to the latest applicable NEMA, ANSI, IEEE, and NEC requirements.
3. Motors are to be designed for continuous duty for 3-phase, 60 Hz, 460 V operation. NEMA design B
4. Ratings are to be based on a 40 degree C ambient, 1,000-meter altitude or lower operation with a maximum 85 degree C winding temperature rise by resistance at 1.0 service factor.
5. Motors shall have a high efficiency design, using low loss silicon lamination steel.
6. Motors shall be equipped with space heaters and be appropriate for the frame size and 3 thermostats in series.
7. The no-load sound pressure level based on the A-weighted scale at 3 feet when measured in accordance with IEEE Standard 85 shall not exceed 85 dBA.

C. Enclosure

1. Motor enclosure including frame, end brackets, fan shroud and conduit box and the motor cover shall be cast-iron type ASTM A48 class 25 or better.
2. Motor main conduit box shall be cast-iron construction, rotatable in 90-degree increments with a bolted and sealed cover. Motor leads will be potted into the motor frame to prevent any moisture leakage into the motor frame. Power leads into the conduit box shall be through either a sealable watertight gland or a potted hub that will be bolted and gasketed to the conduit box while still allowing the power cable to be removable. Conduit box and covers shall be designed to prevent moisture leakage up to a 30-foot submergence for a 2-week period. Any required connection diagrams shall be affixed to the inside of the conduit box or on the nameplate.
3. Motor shall be fan cooled, so when the motor is submerged the fan may disable without overloading the main motor. The fan may be unidirectional or bi-directional. The main motor shaft will not protrude through the opposite drive end bracket, and there will be no running fit to allow water entrance into the motor. Once the motor is submerged, the blower motor and/or fan may require servicing following a return to an unflooded state.
4. The motor shall be designed to prevent water infiltration along the shaft by using a tandem lip seal arrangement with pressurized grease. As an added precaution, the motor shall be designed to prevent any liquid from coming into contact with the lower lip seals. Pressurized grease and lip seals shall be able to withstand a 30-foot submergence for a 2-week period.
5. All mounting hardware shall be hex head, high strength, SAE Grade 5 and plated for protection. Screwdriver slot fasteners are prohibited on all frames.

6. Corrosion resistant stainless steel nameplates shall be affixed to the motor.
 - a. Nameplate information shall include all required NEMA data and AFBMA numbers.
7. All mating frame parts shall have rabbet joints with O-rings to ensure a watertight design.
8. All motor parts including frame, bracket, fan cover, and terminal box are to be painted with a severe duty, catalyzed urethane enamel. All motor parts in frame size 449 and smaller shall be primed with an electrostatically applied epoxy primer. These parts include the stator/ frame assembly, rotor assembly, end brackets, fan cover, conduit box, and conduit box cover. Completed motor assembly must successfully withstand corrosion salt spray tests for 96 hours per ASTM B 117.

D. Bearings and Lubrication

1. Bearings shall be either double shielded or open construction, deep groove Conrad type and have a Class 3 internal fit conforming to AFBMA Standard 20.

2.06 SHOP PAINTING

- A. Primer and Finish Paint: Shop-apply to all exterior ferrous surfaces, high solids epoxy.
- B. Ferrous surfaces not to be painted shall be given a shop-applied coat of grease or rust resistant coating.
- C. Provide additional shop paint coating for touch-up to all surfaces after installation and testing is complete and equipment accepted.

2.07 SHOP TESTING

- A. Provide motor shop testing as specified.
- B. Grinder Tests
 1. Test casings under a hydrostatic head of at least 75 psi.
 2. Test all functions for each controller.
 3. Repeat tests until specified results are obtained.
- C. Correct or replace promptly all defects or defective equipment revealed by or noted during tests at no additional cost to METRO.

2.08 CHANNEL GRINDER SCHEDULE

A. Service: Raw Wastewater

Channel Grinder Schedule Raw Wastewater Service	
Tag Numbers:	
Location:	
Solids Concentration:	
Design Flow, MGD:	
Pressure Drop, max, inches @ design flow:	
Screen Drum Motor HP: Quantity:	
Grinder Motor HP:	
Motor Enclosure:	
Motor RPM, max:	

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install items in accordance with manufacturer's printed instructions, as indicated and specified.
- B. Install grinders on a concrete pad and align thereon.
 1. Set base on metal shims placed directly under the part of the base carrying the greatest weight and spaced close enough to provide uniform support.
- C. After alignment is correct, grout using high-grade non-shrink grout.
 1. Do not imbed leveling nuts in grout.

3.02 FIELD TESTING

- A. After installing grinders and after inspection, operation, testing, and adjustments have been completed by the manufacturer's field service technician, conduct running test for each grinder in the Construction Manager's presence to determine its ability to:
 1. Deliver its rated capacity under specified conditions
 2. Operate within the vibration and temperature limits specified
 3. The performance test should be a dry test. The test shall be conducted so test materials are fed into the grinder by item. Each item's full quantity shall be fed at one time, and each set of items shall be fed at separate times. The grinder shall be allowed to clear after each item's full quantity has been fed through.
 4. The following occurrences shall be recorded:
 - a. Alarms (based on 3 reversals)
 - b. Motor overheat
 - c. Motor overload

5. Immediately correct or replace all defects or defective equipment revealed by or noted during tests, at no additional cost to METRO. Repeat tests until specified results and results acceptable to the Construction Manager are obtained.
6. Contractor shall provide all labor, equipment, and materials for conducting tests.
7. The test items shall be as specified below, but not limited to the following:
 - a. Five soda cans
 - b. Five each 12-inch square rags (mechanical shop rags)
 - c. Eight pairs pantyhose (four pairs tied into three knots each)
 - d. One 20-foot long ¼-inch plastic rope
 - e. Two pairs long athletic socks
 - f. One 5-foot long ½-inch wide steel strapping band
 - g. One woman's wig (synthetic or human hair)
 - h. One box of 12 plastic tampons with applicators
 - i. One wooden broom handle cut into 1-foot length
 - j. Five medium size disposable diapers
 - k. One pair size 8 canvas tennis shoes
 - l. The individually grinded material shall be kept segregated to evaluate particle size.
 - m. A final list with materials to be tested and their quantities shall be supplied by Construction Manager 2 weeks prior to the test.
 - n. Test results evaluation categories shall include the following.
 - 1) Provide number of alarm status occurrences with number of motor overheat and motor overload situations counted. The alarm status shall be limited to 2 alarms during the entire test. The alarm activation shall be based on 3 reversals.
 - 2) Before and after the test, inspect and record grinder motor amperage to verify motor nameplate data, cutter rpms, and motor reversal amperage. Motor reversal amperage shall be not more than 80 percent of locked rotor amperage.
8. Bearing and Motor Temperature
 - a. Run each grinder for 4-hours minimum prior to taking gear and motor temperature readings.
 - b. Bearing temperature is not to exceed 180°F.
9. Test Duration: Determined by the Construction Manager, but not less than 3 hours of continuous operation at each condition specified and indicated.

- B. Make all necessary adjustments to place equipment in specified working order at time of above tests.
- C. Remove all like equipment and replace all like equipment at no additional cost to METRO with equipment that will meet all requirements specified and indicated if unable to demonstrate to the satisfaction of the Construction Manager that equipment will perform the service specified, indicated and as submitted and accepted.

3.03 FIELD TOUCH-UP PAINTING

- A. After installation and accepted testing by the Construction Manager, Contractor shall apply touch-up paint to all scratched, abraded, and damaged shop painted surfaces. Coating type and color shall match shop painting.

3.04 CLOSEOUT ACTIVITIES

- A. Provide in accordance with Section 01 77 00.

END OF SECTION