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USACE / NAVFAC / AFCEC / NASA | UFGS-33 05 23 (August 2015)
Change 2 - 08/16

Preparing Activity: NAVFAC | Superseding
UFGS-33 05 23.19 (April 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 33 05 23

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08/15, CHG 2: 08/16

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SECTION 33 05 23

TRENCHLESS UTILITY INSTALLATION
08/15, CHG 2: 08/16

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NOTE: This guide specification covers the requirements for work related to the installation of utility pipelines (i.e., electrical power, communications, water, gas, oil, petroleum products, steam, sewage, drainage, irrigation, and similar facilities) utilizing microtunneling or boring and jacking trenchless construction methods.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS and Section 23 03 00.00 20 BASIC MECHANICAL MATERIALS AND METHODS, apply to this section with additions and modifications specified herein.
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NOTE: Boring and jacking is a term applied to a horizontal auger boring process characterized as mechanically boring and casing a hole through the soil with a cutting head on a continuous flight of augers mounted inside the casing pipe. The casing is advanced simultaneously with the boring operation via a hydraulic jacking system. Line and grade

accuracy may not be achieved to the degree of microtunneling, but this method is often used to economically install 100 mm to 1.8 m 4 inch to 72 inch diameter casing pipe under roads and railroads through a wide variety of soil types (including weathered rock and small cobbles/gravels) up to distances of 122 m 400 feet.

Microtunneling is a process characterized as a highly sophisticated, laser guided, remote controlled system using a microtunnel boring machine (MBTM) and providing the capability of continuous accurate monitoring and control of alignment and grade. MBTMs are categorized as being either slurry-type or auger-type, referring to the method in which spoil material is carried from the cutter head to the jacking pit area.

There are a limited number of manufacturers of equipment that can perform the work described in this specification; a few of those manufacturers are located in the United States.

Use ASCE Standard 36-15, Standard Construction Guidelines for Microtunneling for the planning, design, and construction of microtunneling projects.

Microtunneling can be used to install larger diameter gravity pipelines. Pipes used in microtunneling can range in diameter from a minimum of 300 mm 12 inches to a maximum of 3454 mm 136 inches. Microtunneling is ideally suited for placing 600 mm 24 inch to 2438 mm 96 inch diameter gravity carrier pipes and 600 to 2438 mm 24 to 96 inch casing pipe for containing utility lines. Distances can exceed 300 m 1000 linear feet. Large diameter, straight gravity pipelines under highly congested roadways, railroad crossings and wetlands are typical microtunneling projects. Section 33 05 23.13 UTILITY HORIZONTAL DIRECTIONAL DRILLING should be considered for use for smaller diameter pipelines.

Microtunneling is typically not suited for installations with soil cover less than 1.8 m 6 feet or twice the diameter of the pipe being installed due to concerns of heave or settlement of the ground surface or installations with numerous service laterals located between manholes.

Microtunneling is generally well suited for use in sands, clays, and gravel soils. In soils containing rock, cobbles, boulders, or in mixed-face soils (softer overlying harder material) in-depth consideration given to ground conditions, proper cutter head and guidance equipment selection is recommended in order to achieve desired results. When microtunneling is utilized, also include Section 33 01 30.16 TV INSPECTION OF SEWER LINES.

In microtunneling boring and jacking permanent pipe casing can be used as the carrier pipe or a separate pipe may be placed inside the casing. The Designer of Record specifies the pipe materials to be used. The Contractor is responsible for proper selection of equipment and methods for installation.

In microtunneling boring and jacking the Contractor typically uses a lubricating fluid to reduce friction on the pipe/soil interface. The possible damage to the exterior of the pipe due to stresses and friction should be accounted for in the design.

In "dry boring and jacking" operations, water or other fluids are not used in the removal of spoils. Dry boring and jacking is often specified for highway and railroad crossings.

Cathodic protection for steel pipes should be considered where the anticipated degree of corrosion is so great that coating systems are not adequate to protect the piping for the desired life of the system.

Jacking and receiving shafts are required to be clear of all obstructions in the shafts and above the shafts - including overhead lines.

Microtunneling Boring and jacking through contaminated soils or areas anticipated to have numerous underground obstructions is not recommended unless special provisions for handling, disposal, or treatment of contaminated soil or obstructions encountered are included in the contract documents.

Refer to ASCE Standard 36-15 for guidance on addressing obstructions anticipated during construction.

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NOTE: Project Drawings:

1. The following information should be shown on the project drawings:

a. Plan and location of all new pipelines, including size of pipe casing and carrier pipe.

b. Location and profiles of soil sampling and bore holes.

c. Location, size, and type of service of existing connecting, intersecting, and adjacent pipelines and other utilities.

d. Paved areas and railroads which pass over new pipelines.

e. New pipeline profiles, to show existing conditions.

f. Monitoring survey test locations to check for heave and settlement before, during and after microtunneling.

g. Manhole and lateral piping bedding conditions.

h. Details for the connection of the pipe casing to manholes and infiltration control.

i. Location of surrounding structures (including foundation type) and any sensitivity to settlement and any subsurface structures that could be affected by the operation.

j. Show traffic plans for work near roadways or railroads. Show possible equipment staging areas and spoil storage areas. Spoil storage and removal requires a relatively large area for dewatering and must be strictly controlled. This should be addressed in Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS. Refer to applicable sections for specific removal and disposal of hazardous materials. Spoil storage locations and construction operations need to consider possible runoff into wetlands, streams, or storm drains.

k. Class or thickness of pipe used in the work, including material identification, and limits for same where class or thickness will differ along length of pipeline.

l. Designate Shaft Locations. Most microtunneling boring and jacking equipment requires unobstructed overhead clearance, free of overhead lines and trees. Large equipment (excavators, cranes, etc.,) and vehicular access to the shafts as well as adequate surface workspace adjacent to jacking shaft work area, is critical. The microtunneling boring and jacking system requires adequate shaft construction areas to successfully complete the operations. For pipe diameters of less than 1200 mm 48 inches, a minimum area needed is approximately 650 square meters 7000 sf. For pipe diameters of 1200 mm 48 inches to 2438 mm 96 inches, the minimum jacking shaft work area is approximately 929 square meters 10,000 sf.

m. All construction requirements conforming to the standards of the railroad or highway owner. Indicate limits of right-of-way and any other site requirements or dimensions.

****

PART 1 GENERAL

Provide utility installation using microtunneling boring and jacking

techniques at locations indicated. The Contractor is responsible for all work related to the provision of utilities installed, including assessing surface, subsurface, and environmental (seasonal) conditions.

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN PETROLEUM INSTITUTE (API)

API Spec 5L	(2018; 46th Ed; ERTA 2018) Line Pipe
API Spec 13A	(2010; Errata 1 2014; Errata 2-3 2015) Specification for Drilling-Fluid Materials

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE-OF-WAY ASSOCIATION (AREMA)

AREMA Eng Man	(2017) Manual for Railway Engineering

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 27-00	(2000) Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
ASCE 28-00	(2001) Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction
ASCE 36-15	(2015) Standard Design and Construction Guidelines for Microtunneling

AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C200	(2012) Steel Water Pipe - 6 In. (150 mm)

	and Larger
AWWA C203	(2020) Coal-Tar Protective Coatings and Linings for Steel Water Pipelines - Enamel and Tape - Hot-Applied

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.5M/D1.5	(2020; Errata 1 2022) Bridge Welding Code

ASTM INTERNATIONAL (ASTM)

ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A139/A139M	(2022) Standard Specification for Electric-Fusion (ARC)-Welded Steel Pipe (NPS 4 and over)
ASTM A716	(2018; R 2022) Standard Specification for Ductile Iron Culvert Pipe
ASTM A746	(2018; R 2022) Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM C33/C33M	(2018) Standard Specification for Concrete Aggregates
ASTM C76	(2022a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C76M	(2022a) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C150/C150M	(2022) Standard Specification for Portland Cement
ASTM C1091	(2003a; R 2013) Standard Test Method for Hydrostatic Infiltration Testing of Vitrified Clay Pipe Lines

U.S. ARMY CORPS OF ENGINEERS (USACE)

EM 385-1-1	(2014) Safety -- Safety and Health Requirements Manual

1.2 DEFINITIONS

As used herein, the terms "shaft" and "pit" are synonymous.

1.2.1 Microtunneling

Unless otherwise specified or indicated, see ASCE 36-15 for definitions.

1.2.2 Jacking Precast Concrete Pipe

Unless otherwise specified or indicated, see ASCE 27-00 for definitions.

1.2.3 Jacking Precast Concrete Box Sections

Unless otherwise specified or indicated, see ASCE 28-00 for definitions.

1.3 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Microtunneling Plan; G[, [_____]]

Boring and Jacking Plan; G[, [_____]]

Statement of Contractor Qualifications; G[, [_____]]

SD-03 Product Data

****
NOTE: Use other specifications to require submittals for the actual carrier pipe unless the pipe casing is going to act as the carrier pipe.
****

Pipe casing [and couplings]; G[, [_____]]

Lubricating Fluid for pipe exterior; G[, [_____]]

Submit manufacturer's standard drawings or catalog cuts, except submit both drawings and cuts for push-on [and rubber-gasketed bell-and-spigot] joints. Include information concerning gaskets with submittal for joints and couplings.

SD-05 Design Data

****
NOTE: Suggested Submittals:

1. Submit the following for review by the designer:

a. Manufacturer's literature describing in detail the microtunneling boring and jacking system to be used. Detailed descriptions of projects on which this system has been successfully used, giving total pipe length, soil conditions, accuracy achieved, project duration, and number of restarts.

b. Method of spoil removal (from the boring to final disposition).

c. Anticipated jacking loads.

d. Method(s) of controlling surface and groundwater throughout the work, including at access shafts and adjacent surface workspaces.

e. Shaft dimensions, locations, surfaced construction, profile, depth, method of excavation, shoring bracing, and thrust block design.

f. Verification that the pipe complies with the specification.
****

Design calculations for pipe casing; G[, [_____]]

Access Shaft Construction Plan; G[, [_____]]

SD-06 Test Reports

Monitoring Survey; G[, [_____]]

SD-08 Manufacturer's Instructions

Installation procedures for pipe casing; G[, [_____]]

Safety Data Sheets; G[, [_____]]

SD-11 Closeout Submittals

Record Drawings; G[, [_____]]

Daily Work Logs of installation operations, including records of the volume of materials removed, daily progress and grout volumes used, and as-built drawings of location and alignment of [casing][pipeline]; G[, [_____]]

1.4 PRE-CONSTRUCTION

No later than 45 days prior to commencement of the work, submit the following to the Contracting Officer for review and approval:

Microtunneling Plan

Boring and Jacking Plan

Access Shaft Construction Plan

Statement of Contractor Qualifications

Submit a complete list of all drilling fluids, additives, and mixtures to be used along with Safety Data Sheets.

1.5 QUALITY CONTROL

1.5.1 STATEMENT OF CONTRACTOR QUALIFICATIONS

Contractors are required to have proven and successful experience in microtunneling boring and jacking. The experience is the successful completion of similar projects to the tolerances indicated for the size of pipe and quantities shown on the plans, in the anticipated soil conditions indicated in the geotechnical report included in the contract documents. Submit a description of at least three such projects which include, at a minimum, a listing of the location(s), date of projects, owner with contact information, pipe type, size installed, length of installation, type, and manufacturer of equipment used, and other information relevant to the successful completion of the project.

1.5.2 RECORDS

1.5.2.1 DAILY WORK LOG

Maintain a work log of construction events and observations. Include the following information for each days work:

a. Hours worked.

b. Location of boring machine face or shield by station and progress made in advancing pipe.

c. Completed field forms, such as steering control logs, for checking line and grade of boring operation, showing achieved alignment relative to design alignment.

d. Maximum pipe jacking pressures per drive.

e. Ground water control operations and piezometric levels.

f. Descriptions of soil conditions encountered.

g. Any unusual conditions or events, including observed ground movement.

h. Reasons for operational shutdown in event drive is halted.

1.6 DELIVERY, STORAGE, AND HANDLING

Inspect materials delivered to site for damage. Unload and store with minimum handling. Store materials on site in enclosures or under protective covering. Store [jointing materials and] rubber gaskets under cover out of direct sunlight. Do not store materials directly on the ground. Keep inside of pipes free of dirt and debris.

1.6.1 Handling

Handle pipe in a manner to ensure delivery to the excavation site in sound undamaged condition. Avoid damage to coatings and linings on pipe; make repairs if coatings or linings are damaged. Carry, do not drag pipe to the excavation site. [Store jointing materials and] [rubber gaskets that are not to be installed immediately, under cover out of direct sunlight.] [Handle steel pipe with [coal-tar enamel] [coal-tar epoxy] coating in accordance with the provisions for handling coal-tar enamel coated pipe in AWWA C203. Handling coal-tar epoxy coated steel is not permitted below 4.4 degrees C 40 degrees F.]

1.7 SAFETY

1.7.1 General

Provide procedures for safe conduct of the work in accordance with EM 385-1-1. When and where installations temporarily disrupt pedestrian use of sidewalk areas for periods exceeding two consecutive work days, provide an alternate route that meets current ABA Accessibility Standard for Department of Defense Facilities.

1.7.2 Equipment

Utilize equipment that employs a common grounding system to prevent electrical shock in the event of underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operators booth, worker grounding mats, and any other interconnected equipment to a common ground. Utilize equipment having an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

1.7.3 Sheeting, Shoring and Dewatering

Provide sheeting, shoring and dewatering as specified in Section 31 00 00 EARTHWORK, and as specified herein.

1.7.4 Tunnel Bore

Unprotected mining of the tunnel bore is not permitted. Fully support the tunnel face and bore at all times.

1.8 QUALITY ASSURANCE

1.8.1 Microtunneling PlanBoring and Jacking Plan

Provide a plan prepared, signed and sealed by a licensed Professional Engineer and include the following:

1.8.1.1 Operational Layout

1.8.1.1.1 Layout Plan

Provide a plan location of the operation, discussing relationship of equipment, the method of construction and details for the following:

a. Access pits configurations and details, including equipment layout.

b. Location of intermediate jacking stations, if required.

c. Casing pipe with connection details.

1.8.1.1.2 Pedestrian Access Around Site

When and where installations disrupt pedestrian use of sidewalk areas for periods exceeding two consecutive days, provide an alternate route that meets current ADA requirements.

1.8.1.2 Method and Procedures

Provide an outline of the methods and procedures, including drawings, schedule of operations, specifications, and manufacturer's catalog data for products in lieu of specifications, methods of operation for microtunneling boring and jacking operations, and specifically the following:

a. Jacking Equipment and Methods: Provide drawings of the jacking frame, jacking head, reaction blocks, jacking installation, pipe guides, procedures for lubricating exterior of pipe during jacking (if applicable), maximum force that jacking equipment can deliver.

b. Boring Equipment and Methods: Provide a discussion of the methods of operation, design and specifications for boring operation, steerage control, line and grade control methods, proposed procedures for removing or clearing obstructions, and a description of proposed methods for ground stabilization and minimizing overexcavation and loss of ground. Submit safety data sheets for fluids, grout, or chemical products.

c. Casing Annulus and Interior Space Grouting: Identify casing insulators/spacers/centralizers/tiedowns (type, number, spacing and installation instructions,) grout materials and method of placement, description of equipment used and grout pressure employed.

d. Survey Alignment Control: Identify method and equipment to install

pipe within specified tolerances.

e. Ground Stabilization: Discuss dewatering and grouting, identification of measures and methods used to stabilize face at heading (if necessary), narrative of equipment, procedure and grout mix, and identification of subcontractor who will perform any required stabilization grouting.

f. Excavation Support System Plan: Provide a plan and discussion of methods to be employed, including design drawings and calculations, sealed and signed by a licensed Professional Engineer.

g. Monitoring/Survey Plan: Develop and provide a discussion of the monitoring/survey plan to be employed to protect structures and utilities from settlement and/or heave, including the following. Incorporate into the plan any supplemental requirements specified in Part 3, paragraph entitled "Field Quality Control".

(1) Structures Assessment: Provide a discussion of structures and utilities to be protected, and measures to be employed for preconstruction and postconstruction assessment of critical structures, namely those located within the [zone of active excavation][a distance equal to [5] [_____] times the depth of the boring from the ground surface] from proposed pipe centerline. Include photographs or video of existing damage to structures in the vicinity of sewer alignment in assessment reports.

(2) Instrumentation Monitoring Plan: Describe of instrumentation design, layout of instrumentation points, equipment installation details, manufacturer's catalog literature, and monitoring report forms.

(3) Surface Settlement Monitoring Plan: Identify on a plan the location of settlement monitoring points, reference benchmarks, survey frequency and procedures, and reporting formats.

[h. Contingency Plan: Provide a plan and discuss protection of pavements, adjacent structures, and utilities affected by adverse movements detected by instrumentation. As a minimum, include the following:

(1) Names, telephone numbers, and locations of persons responsible for implementation of contingency plans.

(2) Materials and equipment required to implement contingency plans. Identify the location of all required materials and equipment.

(3) Step-by-step procedure for performing work involved in implementation of the contingency plans.

(4) Clear identification of the objectives of the contingency plans and methods to measure plan success.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The work includes providing labor, materials, and specialized equipment for the installation of utility pipelines utilizing the boring and jacking

microtunneling methods of installation.

2.1.1 Design Requirements

****
NOTE: Use ASCE 36-15, ASCE 27-00, ASCE 28-00 as applicable.
****

2.1.1.1 Excavations

Design excavations, including access shaft walls, considering loadings from reaction blocks, traffic loads and any surcharge loads.

2.1.1.1.1 Highway Crossing Criteria

For loadings under highways use HS20 vehicle loading distribution in accordance with AASHTO.

2.1.1.1.2 Railway Crossing Criteria

For pipe crossings under railways use Cooper E-80 locomotive loading distributions in accordance with AREMA Eng Man specifications for culverts. Account for loading due to any multiple tracks.

2.1.1.2 Design Calculations of Pipe Casing

Submit design calculations for pipe casing demonstrating that the equipment used in installing the pipe will not distort or otherwise damage the pipe. Provide calculations of maximum allowable jacking force to be used based on pipe materials to be used. The calculations are to be sealed by a licensed Professional Engineer using soil properties derived from subsurface investigations performed along the utility route.

2.2 EQUIPMENT

2.2.1 Microtunneling System

2.2.1.1 General Requirements

Utilize a continuously monitored laser guided Microtunneling Boring Machine (MTBM) system matched to the expected subsurface conditions, a hydraulic jacking system to jack the pipeline, a process to remove the slurry from the slurry water, a guidance system to provide installation accuracy to within the indicated tolerances, excavation equipment, material handling equipment, a dewatering system, and sheeting/shoring required to provide the work indicated and meet the following minimum performance requirements:

a. Capable of providing positive face support both during excavation and during shutdown regardless of the MTBM type.

b. Capable of handling and removing materials of high water content from the machine head.

c. All functions are controlled remotely from a surface control unit.

d. Capable of controlling rotation utilizing a bidirectional drive on the cutter head or by using anti-roll fins or grippers.

e. Capable of injecting lubricant around the exterior of the pipe being jacked.

f. Capable of controlling heave and settlement.

****

NOTE: Specify the maximum allowable overcut of the advancing equipment to satisfy settlement or heave tolerances. usually overcut is not to exceed 25 mm1 inch on the radius of the pipe.

****

g. Minimize overcut during the operation. Do not exceed 25 mm1 inch [_____] on the radius, unless approved by the Contracting Officer.

2.2.1.2 Control System

The main control system of the MTBM is to provide the following information to the operator, as the minimum, required for successful operation of the MTBM:

a. Deviation of the MTBM from the required line and grade of the pipeline (normally by reference to a laser beam).

b. Grade and roll of the MTBM.

c. Jacking load.

d. Torque and RPM of the cutter head.

e. Instantaneous jacking rate and total distance jacked.

f. Indication of steering direction.

g. Progress of pipe advancement via CCTV at the pipe head.

2.2.2 Boring and Jacking System

Utilize a continuously monitored boring and jacking system matched to the expected subsurface conditions, a hydraulic jacking system to jack the pipeline, an auger to remove boring spoils, a guidance system to provide installation accuracy within the indicated tolerances, excavation equipment, material handling equipment, a dewatering system, and sheeting/shoring required to provide the work indicated.

2.2.3 Pipe Jacking Equipment

Provide main jacking equipment with a capacity greater than the anticipated jacking load. Provide intermediate jacking stations when the total anticipated jacking force needed to complete the installation may exceed the capacity of the main jacks or the designed maximum jacking force for the pipe. The jacking system is to supply a uniform distribution of jacking forces on the end of the pipe by use of thruster rings and cushioning material.

2.3 MATERIALS

2.3.1 Pipe Casing

Provide straight wall pipe casing [of type and diameter indicated] of [reinforced concrete pipe (RCP)] [steel pipe].

[2.3.1.1 Reinforced Concrete Pipe

****
NOTE: This section covers tongue and groove, straight wall reinforced concrete pipe intended for use as conveyance systems of sewage and storm water, and for the construction of culverts and industrial casings installed and constructed by microtunneling boring and jacking methods.
****

2.3.1.1.1 Pipe

Pipe, [[_____] mm inch inside diameter,] class [_____], nominal length [_____] and concrete strength [_____] MPa psi in accordance with ASTM C76M ASTM C76.

2.3.1.1.2 Joints and Jointing Material

Form joints of concrete and as detailed in the Contract drawings. Utilize a rubber gasket or mastic to provide the seal. [Incorporate an assembly of [steel bands] [or] [steel bell ends] and spigot rings and rubber gaskets in accordance with Contract drawings.]

2.3.1.1.3 Internal Diameter

The internal diameter of [300 to 600 mm 12 to 24 inch pipe cannot vary by more than plus 6 mm 1/4 inch from the design diameter.][600 mm 24 inch and larger pipe cannot vary from the design diameter by more than plus one percent or plus 10 mm 3/8 inch, whichever is less.]

2.3.1.1.4 Wall Thickness

At any location along the length of the pipe, or at any point around its circumference, the wall thickness cannot vary by more than plus five percent of the design diameter.

2.3.1.1.5 End Squareness

Ensure that each pipe end lies within two planes perpendicular to the longitudinal center line of the pipe, spaced at 10 mm 3/8 inches apart. Square the tongue or spigot end to within 5 mm 3/16 inches and the groove or bell end of the pipe to within 5 mm 3/16 inches.

2.3.1.1.6 Roundness

Ensure that the outside diameter of the pipe does not vary from a true circle by more than one percent. Permissible out-of-round dimensions are one half the difference between the maximum and minimum outer diameter of the pipe at any one location along the barrel.

2.3.1.1.7 Length of Pipe

Do not deviate from the finished pipe design length by more than plus 3 mm per 300 mm 1/8 inch per foot with a maximum variation of plus 13 mm 1/2 inch in any length of pipe.

2.3.1.1.8 Length of Two Opposite Sides

Variations in laying length of two opposite sides of the pipe cannot exceed [6 mm1/4 inch for all sizes through 600 mm 24 inches internal diameter] [3 mm per 300 mm1/8 inch per foot for all sizes larger than 600 mm 24 inches in internal diameter], with a maximum of 10 mm 3/8 inches in any length of pipe.

][2.3.1.2 Steel Pipe

****
NOTE: This section covers steel pipe used as a casing pipe for other carrier pipes. This section also covers steel as the carrier pipe for stormwater, sanitary sewer or other utility lines.
****

2.3.1.2.1 Pipe

Provide steel pipe in conformance with [ASTM A139/A139M, Grade B with a minimum yield strength of 242 MPa 35,000 psi] [AWWA C200] [API Spec 5L Grade B] [ASTM A53/A53M] [ASTM A716] [ASTM A746]. [Weld steel pipe seamless, square cut with even lengths that complies with Articles 4.2, 4.3, and 4.4 of the API Spec 5L]. Pipe shall have an inside diameter of [_____] mm[_____] inches and a minimum wall thickness of [_____] mm[_____] inches [as indicated].

****
NOTE: Choose the first paragraph for microtunneling and the second for boring and jacking. Modify as needed.
****

2.3.1.2.2 Joints

[Accomplish the connection of adjacent pieces of microtunneling steel pipe by [field buttwelding,] [internal weld sleeves,] [integral press fit connectors,] by a certified welder, in compliance with AWS D1.1/D1.1M as long as loading and installation design criteria are met.

][Utilize casing pipe having beveled ends with a single V-groove for field welding. Butt weld joints using a full-penetration weld on the outside circumference of the pipe prior to jacking. The welds are to conform to the latest AWS Welding Code by a certified welder. Unless otherwise specified, inspect and test welds using a non-destructive testing method consisting of magnetic particle examination (MT), in compliance with the AWS code. Visually inspect in compliance with AWS D1.1/D1.1M visual inspection criteria by a certified welder and by the QC manager welds on casing pipe that is sacrificial (fully grouted internally). Non-destructive testing is not required on welds on casing pipe that is sacrificial.

] Grouting Plugs: On large pipe, (600-mm24-inch diameter or greater),

provide pipe with 51-mm 2-inch diameter tapped holes with threaded plugs for exterior grouting.

2.3.1.2.3 Roundness

The maximum difference between the major and minor outside diameters cannot exceed one percent of the specified nominal outside diameter or 6 mm 0.25 inch, whichever is less. [For pipe exceeding 1200 mm 48 inches in diameter, a maximum deviation of 13 mm 1/2 inch is permitted provided the circumference tolerance is maintained within 6 mm 1/4 inch.]

2.3.1.2.4 Circumference

Ensure that the outside circumference is within plus one percent of the nominal circumference or within plus 13 mm 0.50 inches, whichever is less.

2.3.1.2.5 Straightness

The maximum allowable straightness deviation in any 3 m 10 foot length cannot exceed 3 mm 1/8 inch. [For lengths over 3 m 10 feet, the maximum allowable deviation of the entire pipe length is computed by the following formula, but not to exceed 10 mm 3/8 inch in any length exceeding 9.1 m 30 foot length: Maximum Allowable Deviation in mm equals (1/8) times (total length in meters) divided by 0.125 Maximum Allowable Deviation in inches equals (1/8) times (total length in feet) divided by 10.]

2.3.1.2.6 Pipe Ends

Ensure that the end of the pipe is perpendicular to the longitudinal axis of the pipe and within 5 mm per meter 1/16 inch per foot of diameter, with a maximum allowable deviation of 6 mm 1/4 inch measured with a square and straightedge across the end of the pipe.

]2.3.2 Grout

Provide cement grout for pressure grouting to fill the voids around the casing and for filling the interior annular space between carrier pipe and the casing composed of Portland cement conforming to ASTM C150/C150M, Type II, and sand meeting requirements of ASTM C33/C33Mfor fine aggregate, sufficiently fluid to inject through the casing and fill voids, with prompt setting to control grout flow. Utilize a grout with a minimum compressive strength of 0.70 MPa 100 psi attained within 24 hours. Admixtures are to be free of chlorides, corrosive or other material detrimental to the materials the grout contacts.

2.3.3 CONCRETE

Provide 25 MPa 3000 psi concrete in accordance with Section 03 30 00 CAST-IN-PLACE CONCRETE.

2.3.4 Lubricating Fluid (Bentonite or Polymer)

Provide material for lubricating the exterior of pipe. Provide bentonite machine requirements of API Spec 13A and having the capacity of mixing with water to form a stable and homogeneous suspension.

2.3.5 SOIL MATERIALS

Provide soil materials in accordance with the requirements specified in

Section 31 00 00 EARTHWORK.

2.4 Incidental Materials

2.4.1 Casing Insulators/Bore Spacers

Provide carbon steel with polyvinyl chloride coating or stainless steel casing insulators/bore spacers 200 mm 8 inches in length for pipe 300 mm 12 inches and less in diameter, and 300 mm 12 inches in length for pipe 350 mm 14 inches and greater in diameter, having a 51 mm 2 inch minimum runner width. Orient spacers to allow for grout to flow easily to completely fill the casing pipe with grout throughout its length.

****

NOTE: If casing pipe transitions to carrier pipe/utility duct without a structure, provide an end closure/bulkhead detail for the casing pipe transition and modify the following as to suit the detail.

****

2.4.2 End Closures/Bulkheads

Provide Temporary End Closures to contain grout used for filling the annular space between conduits and the casing. Provide Permanent End Closures of [_____] meters [_____] feet length as indicated consisting of brick and mortar (one part cement/two parts sand/water) to completely encapsulate the conduits transition into the casing. Center the closure on the casing pipe end.

PART 3 EXECUTION

3.1 PREPARATION

3.1.1 Access Shaft and Pit Construction Plan

No later than 45 days prior to start of construction submit an Access Shaft Construction Plan. Include in the plan a discussion of the method of construction of access shafts used for microtunneling boring and jacking. Address the excavation methods, dewatering system, sheeting/shoring and bracing systems proposed for use, and any ground stabilization to be employed for the shaft work area or thrust block. Acceptable construction methods include the use of interlocked steel sheetpiling or precast circular concrete segments lowered in place during excavation.

3.1.1.1 Design Requirements

a. Construct shafts of a size commensurate with safe working practices [at locations indicated]. [Coordinate shaft locations with the Contracting Officer.] The Contractor may propose to relocate shafts to better suit the capabilities of the equipment/methods proposed, but may not alter either the indicated pipeline alignment or structures associated with the installed pipeline, nor result in additional claims for compensation.

b. To the extent possible, keep shaft locations clear of pavements [and within a single traffic lane,] in order to minimize disruption to the flow of traffic. Locate support equipment, spoil piles, and materials to minimize disruption to traffic.

c. Support all excavations and prevent movement of the soil, pavement, utilities or structures outside of the excavation. Furnish, place, and maintain sheeting, bracing, and lining required to support the sides of all shafts and to provide adequate protection of the work, personnel, and the general public. Provide a concrete floor in the jacking access shaft. Design loads on the sides of the jacking and receiving pit walls are dependent on the construction method and flexibility of the wall systems.

d. Consider the loading from boring or pipe jacking when preparing the design of the jacking and receiving pit supports as well as special provisions and reinforcement around the breakout location. Design the base of the pits to withstand uplift forces from the full design head of water, unless approved dewatering or other ground modification methods are employed.

e. Construct a thrust block to transfer jacking loads into the soil. Ensure that the backstop and the proposed pipe alignment are square to each other and are designed to withstand the maximum jacking pressure to be used with a factor of safety of at least 2.5. Also, design the thrust block to minimize excessive deflections in such a manner as to avoid disturbance of adjacent structures or utilities or excessive ground movement. Begin jacking operations only after concrete thrust block or treated soil has attained the required strength.

[f. If tremie concrete sealing slabs are placed within the earth support system to prevent groundwater inflow when access shafts are dewatered, furnish and install sealing slabs of sufficient thickness to provide a minimum factor of safety of 1.2 against hydrostatic uplift in order to prevent bottom blowout when the excavation is completely dewatered.

]3.2 CONSTRUCTION

3.2.1 Access Shafts

3.2.1.1 Construction Requirements

a. Provide ground stabilization in the work area and the thrust block as required to accomplish the work.

b. Construct a jacking access shaft to accommodate the installation of pipe casings, equipment and piping jacking device. Install thrust blocks(s) as required and consolidate the ground (grout) where the casings exit the shaft. Provide a dry jacking work area having a stable concrete floor that drains to a recessed sump pump to handle nuisance inflow. Groundwater inflows into the jacking shaft are not to exceed 0.32 Liter/second 5 gallons/minute; soil inflows are not to exceed a total volume of 57 Liters 2 cubic feet.

c. Construct a receiver shaft to accommodate the installation of pipe casings and the equipment used in the work. Consolidate the ground (grout) where the casings enter the shaft.

d. Furnish, install, and maintain equipment to keep the jacking shaft free of excess water. Provide surface protection during the period of construction to ensure that surface runoff does not enter shafts. Adhere to the dewatering plan and do not affect surrounding soils or structures beyond the tolerances stated in paragraph entitled

"Tolerances."

e. Provide security fence around all access shaft areas and provide shaft cover(s) when the shaft area is not in use.

f. Pit Backfill and Compaction: Upon completion of the pipe jacking and all tests or inspections are complete remove all equipment, debris, and unacceptable materials from the pits and commence backfilling operation. Complete backfilling, compaction, and pavement repairs in accordance with Section 31 00 00 EARTHWORK.

3.3 INSTALLATION

3.3.1 Installation of Tracer Wire

Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe in accordance with the American Public Works Association Uniform Color Code. Attach wire to top of pipe in such a manner that will not be displaced during construction operations.

3.3.2 Connections to Existing Lines

Schedule connections to existing lines with the Contracting Officer to cause a minimum interruption of service on the existing line. [Make connections to existing lines under pressure [in accordance with the recommended procedures of the manufacturer of the pipe being tapped] [as indicated].]

3.3.3 Advancing the Pipe

Jack each pipe casing section forward as the excavation progresses in such a way to provide complete and adequate, ground support at all times. Utilize a bentonite slurry applied to the external surface of the pipe to reduce skin friction. Provide a jacking frame for developing a uniform distribution of jacking forces around the periphery of the pipe. Place a plywood spacer on the outer shoulder of the pipe casing joint. Design and construct the thrust reaction backstop to withstand the jacking forces. Continuously maintain a square alignment between the backstop and pipe casing and support the maximum obtainable jacking pressure with a safety factor at least 2.0. Continuously monitor the jacking pressure and rate of cutter head advancement. Exercise special care when setting the pipe guard rails in the jacking pit to ensure correctness of the alignment, grade and stability.

3.3.3.1 Installation Requirements

a. Utilize boring equipment capable of fully supporting the face of the tunnel.

b. Maintain face pressure exerted at the heading by the MTBM as required to prevent loss of ground, groundwater inflows, and settlement or heave of the ground surface by balancing soils and groundwater pressures present.

c. Dewatering for groundwater control is allowed at the jacking and receiving pits only.

d. Do not jack pipe casing until the concrete thrust block and tremie seal (if selected), and grouted soil zone in jacking and receiving

shafts have attained the required strength.

e. Jack the pipe into place without causing damage to the coatings, joints or completed pipe section.

f. After completion of the jacking operation between jacking and receiving shafts, displace the lubricate material from between the pipe casing exterior and the surrounding ground with a cement grout. Control pressure and the amount of grout to avoid pipe damage and displacement of the pipe and soil beyond the tolerances specified in paragraph "Tolerances." Grout within 48 hours after pipe installation has been completed to prevent any surface settlement due to movement of soil material into the void space or loosened zone around the pipe casing.

g. Replace pipe casings damaged during installation.

h. Ensure that the welds of steel pipe attain the full strength of the pipe and are watertight before jacking of the pipe section. Ensure that the inner face of the internal weld seam is flush with the pipe to facilitate the installation of the carrier pipe in the pipe casing.

i. Perform all welding in accordance with requirements for shielded metal arc welding of AWS D1.5M/D1.5 for bridges and AWS D1.1/D1.1M for buildings and other structures.

j. Provide a pipeline that has a consistent diameter across assembled joints.

k. Once the tunneling process has begun, continue with that process uninterrupted until the pipe reaches the receiving shaft. Continue to push any damaged pipe until that damaged pipe section is pushed into the receiving shaft and is removed. Notify the [Contracting Officer][Engineer] immediately if any pipe is known to be or believed to be damaged.

3.3.4 [Carrier Pipe] [Conduit] Installation

3.3.4.1 Cleaning

Clean the inside of the casing of all foreign matter by using a pipe cleaning plug.

3.3.4.2 [Carrier Pipe] [Conduit Joints]

[Bond all metallic conduit joints within the casing pipe.] Inspect with the Contracting Officer, prior to backfilling trenches, the transition of [carrier pipe] [conduit] within the casing to non-cased trenching.

3.3.4.3 Casing Insulators/Spacers

Install casing insulators/spacers in accordance with approved submittals and the drawings. On center spacing is not to exceed 1.2 meters 4 feet.

3.3.4.4 End Closures/Bulkheads and Grouting of Casing Pipe

a. Closures: Seal ends of casing with [brick and mortar][_____].

b. After installing, inspecting and acceptance of the [carrier

pipe][conduit] and spacers within the casing pipe, pressure fill the annular space between the [carrier pipe][conduit] and the casing pipe, with cement grout specified herein. Regulate pump pressures to refusal or in accordance with the approved grouting plan. Place grout in a sequence and manner that will preclude voids or pockets of entrapped air or water. Use a refusal pressure equal to 8.0 kg/sm per meter 0.5 psf per foot of overburden.

3.3.5 Ventilation

Provide adequate ventilation for all tunnels and shafts, following confined space entry procedures. Include such factors as the volume required to furnish fresh air in the shafts, and the volume to remove dust that may be caused by the cutting of the face and other operations which may impact the laser guidance system. In the design of the ventilation system, the minimum amount of fresh air to be supplied is [_____] cubic m/s CFM. [Routinely test the air in areas accessed by workers in accordance with the most current OSHA methods and standards. The current OSHA allowable gas concentrations or those presented below, whichever are more stringent, shall be met:

Carbon Monoxide	≤0.005 percent
Methane	≤0.25 percent
Hydrogen Sulfide	≤0.001 percent
Oxygen	≥20.0 percent

]

3.3.6 Lighting

Provide adequate lighting for the nature of the activity being conducted by workers. Separate and insulate with ground fault interrupters power and lighting circuits. Comply with requirements with regards to shatter resistance and illumination requirements.

3.3.7 Spoil Transportation

Match the excavation rate with rate of spoil removal. Utilize a system capable of balancing groundwater pressures and adjustment to maintain face stability for the particular soil conditions of the project.

3.4 TOLERANCES

****

NOTE TO DESIGNER - The tolerances for a typical MTBM project are 125 mm 5 inches on line and 38 mm 1 1/2 inches on grade in a 91.4 m 300 foot installation. In order to meet local sewerage regulations regarding slope, it is recommended to design at the desired slope plus tolerances. Also, consider adding between 30 - 75 mm 0.1 - 0.25 foot drop across manholes.

****

3.4.1 Tolerances

Maximum allowable lateral deviation is [125][_____] mm [5][_____] inches; maximum allowable vertical deviation is [_____] mm [_____] inches in the position of every completed 91.4 m 300 foot section of jacked pipe casings. [Water must be free draining between any two points at the pipe invert. Reverse grades are not permitted.]

3.5 FIELD QUALITY CONTROL

Employ the monitoring/survey plan. Maintain daily records in accordance with the paragraph titled RECORDS.

3.5.1 Instrumentation/Survey

****
NOTE: The Engineer should specify minimum monitoring requirements using the following, supplemental as required by the project specific conditions.
****

3.5.1.1 Mandatory Requirements

[Include the following, as a minimum, to supplement Contractor Quality Control measures employed to monitor ground surface heave or settlement in the monitoring/survey plan.

] a. Monitor ground movements associated with the project using established survey points and make changes in the construction methods that control ground movements and prevent damage or detrimental movement to the work and adjacent structures and pavements.

b. Record in the daily work log a summary of monitoring survey results. Clearly identify work not meeting specified requirements, out-of-tolerance results, and impacts on new or existing work from settlement or heave.

c. Install instrumentation and perform monitoring to determine ground settlement surrounding each jacking and receiving pit.

d. Prior to any excavation activities, perform a pre-construction survey of the areas in and surrounding excavations and along the proposed utility alignment to identify any structures, facilities, underground or above ground utilities to be protected within a radius of [five] [_____] times either the depth of any excavation or the depth of trenchless excavation.

3.5.1.2 Supplemental Requirements

[a. Prior to the start of advancing the pipe or any dewatering operation, install surface settlement markers along the trenchless excavation centerline using the following guidelines:

(1) Locate surface settlement markers in a grid, spaced 3.0 [_____] m by 3.0 [_____] m 10 [_____] feet by 10 [_____] feet extending not less than 9.1 [_____] m 30 [_____] feet on either side of the trenchless excavation centerline. Use wooden hubs in unpaved areas with the hubs driven flush with the surface and a tack

driven in the top for level rod placement. Use temporary paint or other approved materials in pavement areas. Minimize the size of temporary markings to the greatest extent practical. Remove all markers and markings prior to completion of work.

b. Prior to the start of advancing the pipe or dewatering operations, survey all monitoring points a minimum of three times to establish baseline readings. Perform all surveys to an accuracy of 3.0 mm 0.01 foot. Survey [daily][every [_____]] m feet of casing pipe advancement. In addition, if settlement exceeds Limit Level 2 survey all monitoring points within 6.1 [_____] m 20 [_____] feet of the heading hourly when the heading is approaching or passing beneath the monitoring points.

c. Evaluate all monitoring survey data immediately to determine corrective or mitigation action should be taken using the following evaluation criteria:

TYPE OF MONITORING POINT	LIMIT LEVEL 1	LIMIT LEVEL 2
Surface - Unpaved	+/- 6 [_____] mm +/- 1/4 [_____] inch	+/- 19 [_____] mm +/- 3/4 [_____] inch
Surface - Paved	+/- 6 [_____] mm +/- 1/4 [_____] inch	+/- 13 [_____] mm +/- 1/2 [_____] inch

d. If the survey readings indicate settlement or heave is greater than Limit Level 1 in the above table, provide notification to the Contracting Officer immediately and increase the monitoring frequency of the instruments as directed. Proceed with advancing the pipe after providing mitigating measures to limit additional movements.

e. If the survey readings indicate settlement or heave is greater than Limit Level 2 in the above table, cease work and provide notification to the Contracting Officer immediately and implement the Contingency Plan.

f. Perform all repairs and/or rebuilding of the pavement or adjacent structures to their condition existing prior to settlement/lifting.

g. Continue to monitor by the survey at two week intervals for a period of six [_____] weeks after tunneling. When the survey identifies that heave or settlement has occurred that is greater than Limit Level 2 values, make repairs to new or existing work that is affected. Discontinue topographic surveys when settlement is no longer detected.

]3.5.2 Field Tests

****
NOTE: Indicate appropriate Section number and title in blank below. Specify testing of gravity mains in accordance with ASTM C1091.
****

Perform field tests, and provide labor, equipment, and incidentals required for testing [, except that water and electric power needed for field tests will be furnished as set forth in [_____]] Section. Submit

test results, identifying any results that do not meet specified requirements, to the Contracting Officer within four days of test completion. Provide corrective action and retest pipe not meeting specified requirements. Provide corrective action as recommended by the pipe manufacturer and subject to approval by the Contracting Officer.

3.5.2.1 Pipe Casing

Inspect and verify that pipe material meets the dimensional tolerances specified prior to use. Record each days inspection results in the daily work log.

3.5.2.1.1 Testing Requirements for Gravity Mains

Perform low pressure air test of all gravity mains (structure to structure) in accordance with ASTM C1091 Standard Test method for Hydrostatic Infiltration testing of Vitrified Clay Pipe Lines.

3.5.2.1.2 Non-Standard Pipe Lengths

Cut non-standard joint lengths from full length pipe having satisfactorily passed the hydrostatic test.

3.5.2.1.3 Elevations

Prior to removal of MTBM equipment, sheeting, and backfilling of access shafts, collect invert information on pipeline installed. Confirm that the elevations meet stated tolerances.

3.5.3 Inspections

Prior to the removal of MTBM equipment, sheeting, and backfilling of access shafts, conduct CCTV inspection of the mains installed in accordance with Section 33 01 30.16 TV INSPECTION OF SEWER LINES.

3.6 CLEANUP AND FINAL CLOSEOUT

3.6.1 Site Cleanup

Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and fill depressions with satisfactory fill material. Dispose of all drilling fluids, soils, and separated materials in compliance with Federal, State, and local environmental regulations.

3.6.2 Drilling Fluid

Immediately upon completion of work of this section, remove all rubbish and debris from the job site. Remove all construction equipment and materials leaving the entire area involved in a neat condition equal to existing conditions prior to construction, unless indicated otherwise.

3.6.3 Record Drawings and Daily Work Logs

Submit an electronic copy and three hard copies of the record drawings to the Contracting Officer within five days after completing the work. Include in the record drawings a plan, profile, and all information recorded during the progress of the work. Clearly tie the record drawings

to the project's survey control. Maintain and submit upon completion final Daily Work Logs of installation operations, signed by the superintendent.

3.7 DISPOSITION OF MATERIAL

[Dispose of waste in Government disposal area] [as indicated on the drawings] [which is located within a haul distance of [_____] kilometers miles]. Remove [from Government property] surplus or other soil material not required or suitable for fill or backfilling.

Store or legally dispose of excavated material and fluids used in the boring process and shaft construction [away from the construction site and] in compliance with all permits and applicable Federal, State, and local regulations. [Comply with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.] [Only store or stockpile materials in areas shown on Contract drawings.] [Stockpiling is permitted on the construction site provided material is removed at regular intervals not exceeding 48 hours.]

-- End of Section --