
USACE / NAVFAC / AFCEC / NASA UFGS-33 30 00 (April 2008)
Change 4 - 02/16

Preparing Activity: USACE Superseding
UFGS-33 30 00 (July 2006)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2017

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SECTION 33 30 00

SANITARY SEWERS
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NOTE: This guide specification covers the requirements for piping and appurtenant structures for an exterior sanitary sewer system.

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).

PART 1 GENERAL

NOTE: The following is applicable to USACE project designs.

All pipe materials specified will be retained except under conditions where they would not be suitable; see UFC 3-240-01. Where it is determined that a pipe material would be altogether unsuitable, every mention of the unsuitable material and referenced publications that pertain only to the unsuitable material will be deleted. If a material would be suitable in a part of the system and unsuitable in other parts, the locations where the material may and may not be used will be shown on the contract drawings and stated in the contract specifications.

A study of the conditions will be made to determine the suitability of the materials. If doubt remains after the study, because of exceptional conditions, a report should be submitted to HQUSACE (CECW-EW).

Consider the following in NAVFAC project designs.

1. Allowable piping materials:

a. The project specification should allow the use of piping materials for each application which are suitable for the project, each to be permitted as a Contractor's option.

b. Refer to the appropriate NAVFACENGCOM Design Manual/Military Handbook for general information on piping materials suitable for use on the applications covered by this specification.

c. Pipe materials which are known to be unsuitable for local conditions (i.e., corrosion, root penetration, etc.) should not be permitted for the project. However, consideration should be given to use of more effective protective coatings and jointing methods where economically feasible.

d. In areas where problems with root penetration are anticipated, specify pipe which has the kind of joint which will successfully resist root penetration. Generally speaking, the more watertight the joint, the greater will be the resistance to root penetration. Rubber-gasketed and compression-type joints are considered to give the best performance for this application.

e. It is assumed that corrosive fluids (acids, alkalies, toluene, etc.) will not be reaching the exterior sewer system in relatively undiluted condition. If such will not be the case, investigate the materials specified herein for resistance to the particular chemical involved. If necessary, corrosion-resistant materials other than those specified herein may be used.

f. Further information on clay pipe may be found in the Clay Pipe Engineering Manual (1985 Edition) of the National Clay Pipe Institute.

g. For further information on the selection of concrete sewer pipe and jointing materials, see the Concrete Pipe Design Manual (1980 Edition) and the Concrete Pipe Handbook (1980 Edition), both published by the American Concrete Pipe Association.

h. Where required for special applications, reinforced concrete arch pipe conforming to ASTM C506 or reinforced concrete elliptical pipe conforming to ASTM C507 may be specified.

i. Plastic pipe is subject to temperature limitations which must be observed when specifying plastic pipe for service from laundries, kitchens, and other facilities discharging large quantities of water at elevated temperatures (the temperature limit given is for short-time, nonpressure use only; lower temperature limit is required for long-time use or for pressure use):

ABS	82 degrees C 180 degrees F
PVC	71 degrees C 160 degrees F
PP	60 degrees C 140 degrees F

j. Do not use ABS pipe for applications where high chemical resistance is desired, such as in lines from laboratories or hospitals.

k. Use caution if considering concrete pipe for septic flows. Depending on septicity, these pipes may not be satisfactory.

2. Pipe design:

a. Specify equivalent pipe design for the project conditions (using the applicable criteria for each pipe material) for each pipe material insofar as is practicable. American Society of Civil Engineers (ASCE Manual No. 37, "Design and Construction of Sanitary and Storm Sewers," contains methods of calculation for structural requirements of pipe; from these, the required strengths for pipe of various materials may be determined. Investigate external loads, including earth loads, truck loads, seismic loads, and impact, in the design stage of the project.

b. Give special attention in the design stage of project to plastic pipe materials, particularly with respect to superimposed external loads which could cause excessive deflection of the pipe. The degree of sidefill compaction should be considered realistically, particularly in marginal cases.

c. Where different classes, strengths, etc., of pipe are required for different sections of long pipelines due to significant differences in external loading, expand or modify the applicable paragraphs of this specification accordingly. Show the limits for each class, strength, etc., either on the project drawings or appropriately describe them in the applicable paragraph of the project specification.

3. Pipe joints: When more than one type of joint is applicable for the specified piping, permit each

as a Contractor's option except where watertight joints are necessary in areas where root penetration problems are anticipated. In these cases, rubber-gasketed or compression-type, or solvent-cemented joints are preferred. Use fuel resistant joint gaskets when required.

4. It may be necessary to modify chemical requirements for cement under certain conditions. Sulfate resistance is required for concrete pipe when pipe is carrying sulfate-bearing waters, or when pipe is buried in soil containing sulfates. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as SO₄) in the soil are in the range of 0.1 to 0.2 percent and, for water, are in the range of 150 to 1000 parts per million. Specify Type V (sulfate resisting) cement when soils contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1000 parts per million. In areas where reactive aggregates are known to occur, specify low alkali cement.

On the project drawings, show:

1. Plan and location of new pipelines, including type of service and size of pipe
2. Location, size, and type of service of existing connecting, intersecting, or adjacent pipelines and other utilities
3. Paved areas and railroads which pass over new pipelines
4. Profile, where necessary to show unusual conditions
5. Invert elevations at beginning and end of pipelines and at manholes or similar structures
6. Class or strength of pipe and limits for same where class or strength will be different for different sections of pipeline
7. Design details for pertinent manholes, septic tank(s), and sewage absorption trench
8. Bedding conditions, where different from those specified in the appropriate specification and location of cradle(s), when cradle is required, if not covered
9. Maximum working pressure for pressure sewers
10. Location and size of thrust blocks on pressure lines
11. Location of flanged joints on pressure sewers

12. Location of mechanical joints on ductile-iron piping (when used on only part of the system).

1.1 SUMMARY

1.1.1 Sanitary Sewer Gravity Pipeline

[Provide [mains and laterals] [[_____] mm inch lines] of [clay pipe] [concrete pipe] [ductile-iron pipe] [acrylonitrile-butadiene-styrene (ABS) composite plastic pipe] [polypropylene pipe] [or] [polyvinyl chloride (PVC) plastic pipe]. Provide building connections [[_____] mm inch lines] of [cast iron soil pipe] [clay pipe] [concrete pipe] [acrylonitrile-butadiene-styrene (ABS) solid-wall plastic pipe] [or] [polyvinyl chloride (PVC) plastic pipe].] [Provide new and modify existing exterior sanitary gravity sewer piping and appurtenances. Provide each system complete and ready for operation. The exterior sanitary gravity sewer system includes equipment, materials, installation, and workmanship as specified herein more than 1.5 m 5 feet outside of building walls.]

1.1.2 Sanitary Sewer Pressure Lines

Provide pressure lines of [ductile iron pressure pipe] [concrete pressure pipe] [or] [polyvinyl chloride (PVC) plastic pressure pipe].

1.1.3 USACE Project

The construction required herein shall include appurtenant structures and building sewers to points of connection with the building drains 1.5 m 5 feet outside the building to which the sewer system is to be connected. Replace damaged material and redo unacceptable work at no additional cost to the Government. Backfilling shall be accomplished after inspection by the Contracting Officer. Before, during, and after installation, plastic pipe and fittings shall be protected from any environment that would result in damage or deterioration to the material. Keep a copy of the manufacturer's instructions available at the construction site at all times and shall follow these instructions unless directed otherwise by the Contracting Officer. Solvents, solvent compounds, lubricants, elastomeric gaskets, and any similar materials required to install the plastic pipe shall be stored in accordance with the manufacturer's recommendation and shall be discarded if the storage period exceeds the recommended shelf life. Solvents in use shall be discarded when the recommended pot life is exceeded.

1.2 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.

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 CONCRETE PIPE ASSOCIATION (ACPA)

ACPA 01-102	(2000) Concrete Pipe Handbook
ACPA 01-103	(2000) Concrete Pipe Installation Manual

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

AREMA Eng Man	(2015) Manual for Railway Engineering
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AMERICAN WATER WORKS ASSOCIATION (AWWA)

AWWA C104/A21.4	(2016) Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water
AWWA C105/A21.5	(2010) Polyethylene Encasement for Ductile-Iron Pipe Systems
AWWA C110/A21.10	(2012) Ductile-Iron and Gray-Iron Fittings for Water
AWWA C111/A21.11	(2017) Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
AWWA C115/A21.15	(2011) Flanged Ductile-Iron Pipe With Ductile-Iron or Gray-Iron Threaded Flanges
AWWA C151/A21.51	(2017) Ductile-Iron Pipe, Centrifugally Cast
AWWA C153/A21.53	(2011) Ductile-Iron Compact Fittings for Water Service
AWWA C302	(2016) Reinforced Concrete Pressure Pipe, Noncylinder Type
AWWA C600	(2010) Installation of Ductile-Iron Water Mains and Their Appurtenances
AWWA C605	(2013) Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVC0) Pressure Pipe and Fittings
AWWA C606	(2015) Grooved and Shouldered Joints

AWWA C900	(2016) Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm)
AWWA M23	(2002; 2nd Ed) Manual: PVC Pipe - Design and Installation
AWWA M9	(2008; Errata 2013) Manual: Concrete Pressure Pipe

ASME INTERNATIONAL (ASME)

ASME B1.20.1	(2013) Pipe Threads, General Purpose (Inch)
ASME B1.20.2M	(2006; R 2011) Pipe Threads, 60 Deg. General Purpose (Metric)
ASME B16.1	(2015) Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250
ASME B18.2.2	(2015) Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASME B18.5.2.1M	(2006; R 2011) Metric Round Head Short Square Neck Bolts
ASME B18.5.2.2M	(1982; R 2010) Metric Round Head Square Neck Bolts

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A47/A47M	(1999; R 2014) Standard Specification for Ferritic Malleable Iron Castings
ASTM A48/A48M	(2003; R 2012) Standard Specification for Gray Iron Castings
ASTM A536	(1984; R 2014) Standard Specification for Ductile Iron Castings
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A74	(2016) Standard Specification for Cast Iron Soil Pipe and Fittings

ASTM A746	(2009; R 2014) Standard Specification for Ductile Iron Gravity Sewer Pipe
ASTM C12	(2016a) Standard Practice for Installing Vitrified Clay Pipe Lines
ASTM C14	(2015) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C14M	(2014) Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe (Metric)
ASTM C150/C150M	(2017) Standard Specification for Portland Cement
ASTM C260/C260M	(2010a; R 2016) Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C270	(2014a) Standard Specification for Mortar for Unit Masonry
ASTM C33/C33M	(2016) Standard Specification for Concrete Aggregates
ASTM C361	(2016) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe
ASTM C361M	(2016) Standard Specification for Reinforced Concrete Low-Head Pressure Pipe (Metric)
ASTM C425	(2004; R 2013) Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings
ASTM C443	(2011) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C443M	(2012) Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets (Metric)
ASTM C478	(2015a) Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C478M	(2015a) Standard Specification for Precast Reinforced Concrete Manhole Sections (Metric)
ASTM C564	(2014) Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings
ASTM C700	(2013) Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated

ASTM C76	(2015) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C76M	(2014) Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe (Metric)
ASTM C828	(2011) Low-Pressure Air Test of Vitrified Clay Pipe Lines
ASTM C923	(2008; R 2013; E 2016) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals
ASTM C923M	(2008b; R 2013) Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals (Metric)
ASTM C924	(2002; R 2009) Testing Concrete Pipe Sewer Lines by Low-Pressure Air Test Method
ASTM C924M	(2002; R 2009) Testing Concrete Pipe Sewer Liner by Low-Pressure Air Test Method (Metric)
ASTM C94/C94M	(2017) Standard Specification for Ready-Mixed Concrete
ASTM C969	(2017) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
ASTM C969M	(2017) Standard Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines (Metric)
ASTM C972	(2000; R 2011) Compression-Recovery of Tape Sealant
ASTM C990	(2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C990M	(2009; R 2014) Standard Specification for Joints for Concrete Pipe, Manholes and Precast Box Sections Using Preformed Flexible Joint Sealants (Metric)
ASTM D1784	(2011) Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
ASTM D1785	(2012) Standard Specification for

	Poly(Vinyl Chloride) (PVC), Plastic Pipe, Schedules 40, 80, and 120
ASTM D2235	(2004; R 2016) Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings
ASTM D2241	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
ASTM D2321	(2014; E 2014) Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications
ASTM D2412	(2011) Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
ASTM D2464	(2015) Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2466	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40
ASTM D2467	(2015) Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80
ASTM D2680	(2001; R 2014) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping
ASTM D2751	(2005) Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings
ASTM D2996	(2015) Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D2997	(2015) Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe
ASTM D3034	(2016) Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3139	(1998; R 2011) Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
ASTM D3212	(2007; R 2013) Standard Specification for Joints for Drain and Sewer Plastic Pipes

Using Flexible Elastomeric Seals

ASTM D3262	(2016) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D3350	(2012) Polyethylene Plastics Pipe and Fittings Materials
ASTM D3753	(2012; E 2013) Glass-Fiber-Reinforced Polyester Manholes and Wetwells
ASTM D3840	(2014) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications
ASTM D4101	(2014; E 2016) Standard Specification for Polypropylene Injection and Extrusion Materials
ASTM D412	(2016) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D4161	(2014) "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D624	(2000; R 2012) Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM F1417	(2011a) Standard Test Method for Installation Acceptance of Plastic Gravity Sewer Lines Using Low Pressure Air
ASTM F2736	(2013; E 2014) Standard Specification for 6 to 30 in. (152 To 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe And Double Wall Pipe
ASTM F2764/F2764M	(2017) Standard Specification for 6 to 60 in. [150 to 1500 mm] Polypropylene (PP) Corrugated Double and Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F402	(2005; R 2012) Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings
ASTM F477	(2014) Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667/F667M	(2016) Standard Specification for 3 through 24 in. Corrugated Polyethylene

Pipe and Fittings

ASTM F714	(2013) Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter
ASTM F758	(2014) Smooth-Wall Poly(Vinyl Chloride) (PVC) Plastic Underdrain Systems for Highway, Airport, and Similar Drainage
ASTM F794	(2003; R 2014) Standard Specification for Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F894	(2013) Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	(2015) Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

CAST IRON SOIL PIPE INSTITUTE (CISPI)

CISPI 301	(2009) Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications
CISPI 310	(2011) Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR 1910.27	Fixed Ladders
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UNI-BELL PVC PIPE ASSOCIATION (UBPPA)

UBPPA UNI-B-6	(1998) Recommended Practice for Low-Pressure Air Testing of Installed Sewer Pipe
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1.3 SUBMITTALS

NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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" designation; submittals not having a "G" designation are for [Contractor Quality Control approval.] [information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Existing Conditions

SD-02 Shop Drawings

Drawings

Precast Concrete Manhole

Metal Items

Frames, Covers, and Gratings

SD-03 Product Data

Pipeline Materials

SD-06 Test Reports

Reports

SD-07 Certificates

Portland Cement

Gaskets

Request for Field Support; G[, [____]]

Request for Pre-Connection Inspection; G[, [____]]

Post-Construction Inspection; G[, [____]]

1.4 QUALITY ASSURANCE

1.4.1 Installer Qualifications

Install specified materials by a licensed underground utility Contractor licensed for such work in the state where the work is to be performed. Installing Contractor's License shall be current and be state certified or state registered.

1.4.2 Drawings

NOTE: Include subparagraph c. on NASA projects.

- a. Submit Installation Drawings showing complete detail, both plan and side view details with proper layout and elevations.
- b. Submit As-Built Drawings for the complete sanitary sewer system showing complete detail with all dimensions, both above and below grade, including invert elevation.
- c. Sign and seal As-Built Drawings by a Professional Surveyor and Mapper. Include the following statement: "All potable water lines crossed by sanitary hazard mains are in accordance with the permitted utility separation requirements."

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery and Storage

1.5.1.1 Piping

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

1.5.1.2 Metal Items

Check upon arrival; identify and segregate as to types, functions, and sizes. Store off the ground in a manner affording easy accessibility and not causing excessive rusting or coating with grease or other objectionable materials.

1.5.1.3 Cement, Aggregate, and Reinforcement

NOTE: Delete these paragraphs if not used or insert applicable concrete requirements here.

As specified in Section [03 30 00.00 10 CAST-IN-PLACE CONCRETE] [03 30 00 CAST-IN-PLACE CONCRETE].

1.5.2 Handling

Handle pipe, fittings, and other accessories in such manner as to ensure delivery to the trench in sound undamaged condition. [Take special care not to damage linings of pipe and fittings; if lining is damaged, make satisfactory repairs.] Carry, do not drag, pipe to trench.

1.6 PROJECT/SITE CONDITIONS

Submit drawings of existing conditions, after a thorough inspection of the area in the presence of the Contracting Officer. Details shall include the environmental conditions of the site and adjacent areas. Submit copies of the records for verification before starting work.

PART 2 PRODUCTS

2.1 PIPELINE MATERIALS

Pipe shall conform to the respective specifications and other requirements specified below. Submit manufacturer's standard drawings or catalog cuts.

2.1.1 Cast-Iron Soil Piping

2.1.1.1 Cast-Iron Hub and Spigot Soil Pipe and Fittings

ASTM A74, [service] [extra heavy], with ASTM C564 compression-type rubber gaskets.

2.1.1.2 Cast-Iron Hubless Soil Pipe and Fittings

NOTE: Delete this paragraph for areas where hubless fittings are considered inappropriate due to failure of coupling by corrosion.

CISPI 301 with CISPI 310 coupling joints.

2.1.2 Clay Piping

2.1.2.1 Clay Pipe and Fittings

NOTE: Tables of trench loadings, trench backfill loads, and supporting strengths of clay pipe are included in the Clay Pipe Engineering Manual (1982 edition) of the National Clay Pipe Institute. The required strength of clay pipe can be derived from these tables when depth of trench is known.

Specify "bell-and-spigot piping only" in areas where corrosion problems may be anticipated with the

stainless steel parts of the couplings used for
plain-end piping.

ASTM C700, [standard strength] [extra strength] [bell-and-spigot piping
only].

2.1.2.2 Clay Piping Jointing Materials

ASTM C425.

2.1.3 Concrete Gravity Sewer Piping

NOTE: Not allowed for NAVFAC LANT projects. Not
normally allowed on NASA projects

2.1.3.1 Concrete Gravity Pipe and Fittings

NOTE: The D-load (load per linear meter foot of
diameter) must be calculated on the basis of project
conditions to determine the applicable Class or
strength of pipe. The Concrete Pipe Design Manual
(1980 edition) of the American Concrete Pipe
Association contains design information and methods
by which the applicable Class or strength of pipe
can be determined when depth of trench is known.

It may be necessary to modify chemical requirements
for cement under certain conditions. Sulfate
resistance is required for concrete pipe when pipe
is carrying sulfate-bearing waters, or when pipe is
buried in soil containing sulfates. Specify Type II
(moderate sulfate resisting) cement when
water-soluble sulfates (as SO₄) in the soil are in
the range of 0.1 to 0.2 percent and, for water, are
in the range of 150 to 1000 parts per million.
Specify Type V (sulfate resisting) cement when soils
contain in excess of 0.2 percent water-soluble
sulfate and water samples contain in excess of 1000
parts per million. In areas where reactive
aggregates are known to occur, specify low alkali
cement.

Pipe shall be [nonreinforced concrete pipe conforming to ASTM C14M ASTM C14,
Class [____]][reinforced concrete pipe conforming to ASTM C76M ASTM C76,
Class [____]]. Circular pipe with elliptical reinforcement shall have a
readily visible line at least 300 mm 12 inches long painted or otherwise
applied on the inside and outside of the pipe at each end so that when the
pipe is laid in the proper position, the line will be at the center of the
top of the pipe. Fittings and specials shall conform to the applicable
requirements specified for the pipe and shall be of the same strength as
the pipe. [Cement used in manufacturing pipe and fittings shall be [Type
II] [Type V] [low alkali cement] conforming to ASTM C150/C150M.]

2.1.3.2 Jointing Materials for Concrete Gravity Piping

Gaskets and pipe ends for rubber gasket joint shall conform to ASTM C443M ASTM C443. Gaskets shall be suitable for use with sewage.

Submit certificates of compliance stating that the fittings or gaskets used for waste drains or lines designated on the plans as [_____] are [oil] [_____] resistant.

2.1.4 Concrete Pressure Piping

NOTE: Not allowed for NAVFAC LANT projects.

2.1.4.1 Concrete Pressure Pipe and Fittings

NOTE: Delete reference to AWWA C302 within brackets when pressure rating greater than 310 kPa 45 psi is required.

It may be necessary to modify chemical requirements for cement under certain conditions. Sulfate resistance is required for concrete pipe when pipe is carrying sulfate-bearing waters, or when pipe is buried in soil containing sulfates. Specify Type II (moderate sulfate resisting) cement when water-soluble sulfates (as S04) in the soil are in the range of 0.1 to 0.2 percent and, for water, are in the range of 150 to 1000 parts per million. Specify Type V (sulfate resisting) cement when soils contain in excess of 0.2 percent water-soluble sulfate and water samples contain in excess of 1000 parts per million. In areas where reactive aggregates are known to occur, specify low alkali cement.

For concrete pressure piping, ASTM C361M C361 covers pipe for up to 37.5 m 125 feet of hydrostatic head, approximately 379 kPa 55 psi; AWWA C302 covers pipe and fittings for 310 kPa 45 psi pressure rating, 30 m 100 feet of hydro-static head) only. ASTM C361M ASTM C361 contains tables giving design requirements for pipe in all combinations of 30 and 37.5 m 100 and 125 feet of hydrostatic head with 1.5, 3.0, 4.5, 6.0 m 5, 10, 15, and 20 feet of earth cover. Where higher pressure ratings are necessary, piping conforming to AWWA C300, C301, or C303 should be specified.

Pipe shall conform to [AWWA C302 or to] ASTM C361M ASTM C361. Pipe shall be designed for hydrostatic head of [30] [38] m [100] [125] feet and external loading of [1.5] [3.0] [4.5] [6.0] m [5] [10] [15] [20] feet of earth cover. Circular pipe with elliptical reinforcement shall have a readily visible line at least 300 mm 12 inches long painted or otherwise applied on the inside and outside of the pipe at each end so that when the pipe is laid in the proper position, the line will be at the center of the

top of the pipe. [Cement used in manufacturing pipe and fittings shall be [Type II] [Type V] [low alkali cement] conforming to ASTM C150/C150M.] Fittings shall conform to AWWA C302.

2.1.4.2 Jointing Materials for Concrete Pressure Piping

NOTE: Use first bracketed wording when pressure rating greater than 310 kPa 45 psi is not required. Use second bracketed wording when pressure rating greater than 310 kPa 45 psi is required.

Gaskets shall be as specified in [the referenced specification for the pipe] [ASTM C361M ASTM C361] and shall be suitable for use with sewage.

2.1.5 Ductile Iron Gravity Sewer Pipe and Associated Fittings

2.1.5.1 Ductile Iron Gravity Pipe and Fittings

NOTE: ASTM A746 also contains design information and methods by which the required Thickness Class of Pipe can be determined when depth of trench is known.

Delete requirements for and references to push-on joints for ductile-iron gravity sewer pipe and associated fittings when the greater deflection afforded by the mechanical joint is considered necessary throughout.

Ductile iron pipe shall conform to ASTM A746, Thickness Class [_____]. Fittings shall conform to AWWA C110/A21.10 or AWWA C153/A21.53. [Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, [except that the bell design shall be modified, as approved by the Contracting Officer, for push-on joint].] Fittings shall have strength at least equivalent to that of the pipe. Ends of pipe and fittings shall be suitable for the joints specified hereinafter. Pipe and fittings shall have cement-mortar lining conforming to AWWA C104/A21.4, standard thickness.

2.1.5.2 Ductile Iron Gravity Joints and Jointing Materials

NOTE: Delete requirements for and references to push-on joints for ductile-iron gravity sewer pipe and associated fittings when the greater deflection afforded by the mechanical joint is considered necessary throughout.

Pipe and fittings shall have [push-on joints] [or] [mechanical joints], except as otherwise specified in this paragraph. [Mechanical joints only shall be used where indicated.] [Push-on joint pipe ends and fitting ends, gaskets, and lubricant for joint assembly shall conform to AWWA C111/A21.11.] [Mechanical joint requirements for pipe ends, glands, bolts and nuts, and gaskets shall conform to AWWA C111/A21.11.]

2.1.6 Ductile Iron Pressure Piping

NOTE: Ductile iron pipe is used for sizes 75 mm 3 inches to 1600 mm 64 inches.

2.1.6.1 Ductile Iron Pressure Pipe and Fittings

NOTE: Use Thickness Class 52 for NAVFAC LANT projects.

Ductile-iron pipe shall conform to AWWA C151/A21.51, Thickness Class [____]. [Flanged pipe shall conform to AWWA C115/A21.15.] Fittings shall conform to AWWA C110/A21.10 or AWWA C153/A21.53. [Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except that the bell design shall be modified, as approved, for push-on joint.] Fittings shall have pressure rating at least equivalent to that of the pipe. Ends of pipe and fittings shall be suitable for the joints specified hereinafter. Pipe and fittings shall have cement-mortar lining conforming to AWWA C104/A21.4, standard thickness.

2.1.6.2 Ductile Iron Pressure Joints and Jointing Materials

- a. Joints, general: Joints for pipe and fittings shall be [push-on joints] [or] [mechanical joints] except as otherwise specified in this paragraph. [Joints shall be mechanical-joints where indicated.] [Joints shall be flanged joints where indicated.] [Joints made with sleeve-type mechanical coupling may be used in lieu of push-on joint.] [[Grooved] [or] [shouldered] type joints may be used in lieu of push-on joint [or flanged joint], except where joint is buried.]
- b. Push-on joints: Shape of pipe ends and fitting ends, gaskets, and lubricant for joint assembly shall conform to AWWA C111/A21.11.
- c. Mechanical joints: Dimensional and material requirements for pipe ends, glands, bolts and nuts, and gaskets shall conform to AWWA C111/A21.11.
- d. Flanged joints: Bolts, nuts, and gaskets for flanged connections shall be as recommended in the Appendix to AWWA C115/A21.15. Flange for setscrewed flanges shall be of ductile iron, ASTM A536, Grade 65-45-12, and shall conform to the applicable requirements of ASME B16.1, Class 250. Setscrews for setscrewed flanges shall be 1310 MPa 190,000 psi tensile strength, heat treated, and zinc-coated steel. Gasket for setscrewed flanges shall conform to the applicable requirements for mechanical-joint gaskets specified in AWWA C111/A21.11. Design of setscrewed gasket shall provide for confinement and compression of gasket when joint to adjoining flange is made.

NOTE: At the text below, delete "or steel" when middle ring of cast iron only is considered necessary due to anticipated corrosion problems. Delete requirement for strength of steel when steel is not allowed as a material for middle ring.

At the text below, minimum numbers of bolts for each pipe size should be as follows:

75 mm 3 inch	3
100 mm 4 inch	4
150 mm 6 inch	5
200 mm 8 inch	6
250 mm 10 inch	7
300 and 350 mm 12 and 14 inch	8
400 mm 16 inch	9
450 mm 18 inch	10
500 mm 20 inch	12
550 mm 22 inch	13
600 mm 24 inch	14

- e. Joints made with sleeve-type mechanical couplings: Couplings shall be designed to couple plain-end piping by compression of a ring gasket at each end of the adjoining pipe sections. The coupling shall consist of one middle ring flared or beveled at each end to provide a gasket seat, two follower rings, two resilient tapered rubber gaskets, and bolts and nuts to draw the follower rings toward each other to compress the gaskets. The middle ring and the follower rings shall be true circular sections free from irregularities, flat spots, and surface defects; the design shall provide for confinement and compression of the gaskets. Middle ring shall be of cast-iron [or steel], and the follower rings shall be of malleable iron or ductile iron. Cast iron shall conform to ASTM A48/A48M and shall be not less than Class 25. Malleable iron shall conform to ASTM A47/A47M. Ductile iron shall conform to ASTM A536. [Steel shall have a strength not less than that of the pipe.] Gaskets shall be designed for long life and resistance to set after installation and shall meet the applicable requirements specified for gaskets for mechanical joint in AWWA C111/A21.11. Bolts shall be track-head type; bolts and nuts shall be either of the following: bolts conforming to the tensile requirements of ASTM A307, Grade A, with nuts conforming to the tensile requirements of ASTM A563M ASTM A563, Grade A; or round-head square-neck type bolts conforming to ASME B18.5.2.1M and ASME B18.5.2.2M with hex nuts conforming to ASME B18.2.2. Bolts shall be 16 mm 5/8 inch in diameter; minimum number of bolts for each coupling shall be [_____] [for [_____] mm inch pipe [, [_____] for [_____] mm inch pipe,] and [_____] for [_____] mm inch pipe]. Bolt holes in follower rings shall be of a shape to hold fast the necks of the bolts used. Sleeve-type mechanical couplings shall not be used as an optional method of jointing except where pipeline is adequately anchored to resist tension pull across the joint.

- f. [Grooved] [and] [Shouldered] Type Joints: [Grooved pipe ends] [Shouldered pipe ends] and couplings shall conform to AWWA C606. Joint dimensions shall be as specified in AWWA C606 for rigid joints.

2.1.7 ABS Composite Plastic Piping

2.1.7.1 ABS Composite Plastic Pipe and Fittings

ASTM D2680.

2.1.7.2 Jointing Materials for ABS Composite Plastic Piping

Solvent cement and primer shall conform to ASTM D2680.

2.1.8 ABS Solid-Wall Plastic Piping

2.1.8.1 ABS Solid-Wall Plastic Pipe and Fittings

ASTM D2751, SDR 35, with ends suitable for either solvent cement joints or elastomer joints.

2.1.8.2 ABS Solid-Wall Plastic Joints and Jointing Materials

Solvent cement for solvent cement joints shall conform to ASTM D2235. Elastomeric joints shall conform to ASTM D3212. Gaskets for elastomeric joints shall conform to ASTM F477.

2.1.9 PVC Plastic Gravity Sewer Piping

2.1.9.1 PVC Plastic Gravity Pipe and Fittings

[ASTM D3034, SDR 35, or ASTM F949 with ends suitable for elastomeric gasket joints.] [ASTM F794, Series 46, for ribbed sewer pipe with smooth interior, size 200 mm 8 inch through 1200 mm 48 inch diameters.]

2.1.9.2 PVC Plastic Gravity Joints and Jointing Material

Joints shall conform to ASTM D3212. Gaskets shall conform to ASTM F477.

2.1.10 PVC Plastic Pressure Pipe and Associated Fittings

2.1.10.1 PVC Plastic Pressure Pipe and Fittings

2.1.10.1.1 Pipe and Fittings Less Than 100 mm 4 inch Diameter

Pipe, couplings and fittings shall be manufactured of materials conforming to ASTM D1784, Class 12454B.

2.1.10.1.1.1 Screw-Joint

Pipe shall conform to dimensional requirements of ASTM D1785, Schedule 80, with joints meeting requirements of 1.03 Mpa 150 psi working pressure, 1.38 Mpa 200 psi hydrostatic test pressure, unless otherwise shown or specified. Fittings for threaded pipe shall conform to requirements of ASTM D2464, threaded to conform to the requirements of ASME B1.20.2M ASME B1.20.1 for use with Schedule 80 pipe and fittings. Pipe couplings when used, shall be tested as required by ASTM D2464.

2.1.10.1.1.2 Push-On Joint

ASTM D3139, with ASTM F477 gaskets. Fittings for push-on joints shall be iron conforming to AWWA C110/A21.10 or AWWA C111/A21.11. Iron fittings and specials shall be cement-mortar lined (standard thickness) in accordance with AWWA C104/A21.4.

2.1.10.1.1.3 Solvent Cement Joint

Pipe shall conform to dimensional requirements of ASTM D1785 or ASTM D2241 with joints meeting the requirements of 1.03 Mpa 150 psi working pressure and 1.38 Mpa 200 psi hydrostatic test pressure. Fittings for solvent cement jointing shall conform to ASTM D2466 or ASTM D2467.

2.1.10.1.2 Pipe and Fittings 100 mm 4 inch Diameter to 300 mm 12 inch

Pipe shall conform to AWWA C900 and shall be plain end or gasket bell end, Pressure Class 150 (DR 18), with cast-iron-pipe-equivalent OD. Fittings shall be gray-iron or ductile-iron conforming to AWWA C110/A21.10 or AWWA C153/A21.53 and shall have cement-mortar lining conforming to AWWA C104/A21.4, standard thickness. Fittings with push-on joint ends shall conform to the same requirements as fittings with mechanical-joint ends, except that bell design shall be modified, as approved, for push-on joint suitable for use with the PVC plastic pressure pipe specified in this paragraph.

2.1.10.2 PVC Plastic Pressure Joints and Jointing Material

Joints for pipe, 100 mm 4 inch to 300 mm 12 inch diameter, shall be push-on joints as specified in ASTM D3139. Joints between pipe and fittings shall be push-on joints as specified in ASTM D3139 or shall be compression-type joints/mechanical-joints as respectively specified in ASTM D3139 and AWWA C111/A21.11. Each joint connection shall be provided with an elastomeric gasket suitable for the bell or coupling with which it is to be used. Gaskets for push-on joints for pipe shall conform to ASTM F477. Gaskets for push-on joints and compression-type joints/mechanical-joints for joint connections between pipe and fittings shall be as specified in AWWA C111/A21.11, respectively, for push-on joints and mechanical-joints.

2.1.11 High Density Polyethylene Pipe (HDPE)

ASTM F894, Class 63, size 450 mm 18 inch through 3000 mm 120 inch. ASTM F714, size 100 mm 4 inch through 1200 mm 48 inch, will have pipe stiffness greater than or equal to 1170/D for cohesionless material pipe trench backfills. For all PE pipes, the polyethylene shall be certified by the resin producer as meeting the requirements of ASTM D3350, cell Class 334433C or higher. Fittings for High Density Polyethylene Pipe shall meet the same material specifications as the pipe class. Joints for HDPE meeting ASTM F894 will be rubber gasket joints conforming to ASTM F477. HDPE meeting ASTM F714 will have fused joints per manufacturer's instruction.

2.1.12 Reinforced Plastic Mortar Pipe (RPMP)

Reinforced plastic mortar pipe shall be produced be in accordance with ASTM D3262 and shall have an outside diameter equal to ductile iron pipe dimensions from 450 mm 18 inch to 1200 mm 48 inch. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner. The minimum pipe stiffness shall be 248 kPa 36 psi. RPMP shall be in accordance with ASTM D3262. Fittings for RPMP: ASTM D3840. Joints for

RPMP: Bell and spigot gasket coupling utilizing an elastomeric gasket in accordance with ASTM D4161 and ASTM F477.

2.1.13 Reinforced Thermosetting Resin Pipe (RTRP)

RTRP pipe: ASTM D3262. Fittings for RTRP: ASTM D3262. Joints for RTRP: Bell and spigot type utilizing an elastomeric gasket in accordance with ASTM F477.

2.1.13.1 Filament Wound RTRP-I

RTRP-I shall conform to ASTM D2996, except pipe shall have an outside diameter equal to cast iron outside diameter or standard weight steel pipe. The pipe shall be suitable for a normal working pressure of 1.03 MPa 150 psi at 22.8 degrees C 73 degrees F. The inner surface of the pipe shall have a smooth uniform continuous resin-rich surface liner conforming to ASTM D2996.

2.1.13.2 Centrifugally Cast RTRP-II

RTRP-II shall conform to ASTM D2997. Pipe shall have an outside diameter equal to standard weight steel pipe.

2.1.14 Dual Wall and Triple Wall Polypropylene

300 to 750 mm12 to 30 inch polypropylene pipe shall have a smooth interior and annular exterior corrugations, in compliance with ASTM F2736. 750 to 1500 mm30 to 60 inch polypropylene pipe shall have a smooth interior and exterior surfaces with annular inner corrugations, in compliance with ASTM F2764/F2764M. Pipe is suitable for gravity flow only and shall have a minimum pipe stiffness of 46 pii when tested in accordance with ASTM D2412. Pipe sizes 300 to 1500 mm 12- through 60-inch diameters shall have a reinforced bell, manufacturer's pre-installed polymer composite band or a manufacturer's compatible pipe polymer composite band.

2.1.15 Piping Beneath Railroad Right-of-Way

Where pipeline passes under the right-of-way of a commercial railroad, piping shall conform to the specifications for pipelines conveying nonflammable substances in AREMA Eng Man, except as otherwise specified in this paragraph. For casing pipe provide ductile-iron pipe in lieu of cast-iron soil pipe. Ductile-iron pipe shall conform to and have strength computed in accordance with ASTM A746.

2.2 CONCRETE MATERIALS

2.2.1 Cement Mortar

Cement mortar shall conform to ASTM C270, Type M with Type II cement.

2.2.2 Portland Cement

NOTE: Type II cement normally will be specified, but Type V cement will be specified when the soils contain in excess of 0.2 percent water-soluble sulfate as SO(4), or the waste water contains in excess of 1000 parts per million sulfates. Type I cement may be permitted when it can be assured that

the water soluble sulfates in the soil will be less than 0.1 percent and the waste water will contain less than 150 parts per million sulfates over the design life of the project.

Submit certificates of compliance stating the type of cement used in manufacture of concrete pipe, fittings and precast manholes. Portland cement shall conform to ASTM C150/C150M, Type [II] [V] for concrete used in concrete pipe, concrete pipe fittings, and manholes and type optional with the Contractor for cement used in concrete cradle, concrete encasement, and thrust blocking. [Air-entraining admixture conforming to ASTM C260/C260M shall be used with Type V cement.] [Where aggregates are alkali reactive, as determined by Appendix XI of ASTM C33/C33M, a cement containing less than 0.60 percent alkalies shall be used.]

2.2.3 Portland Cement Concrete

NOTE: When ready-mix concrete conforming to ASTM C94/C94M is not economically available, rewrite this paragraph to permit use of concrete mixed onsite. Specify concrete aggregates conforming to ASTM C33/C33M and concrete consisting of 1 part portland cement, 2-1/2 parts sand, and 5 parts gravel, with just enough water for workable consistency

Portland cement concrete shall conform to ASTM C94/C94M, compressive strength of 28 MPa 4000 psi at 28 days, except for concrete cradle and encasement or concrete blocks for manholes. Concrete used for cradle and encasement shall have a compressive strength of 17 MPa 2500 psi minimum at 28 days. Concrete in place shall be protected from freezing and moisture loss for 7 days.

2.3 MISCELLANEOUS MATERIALS

2.3.1 Precast Concrete Manholes & Glass-Fiber-Reinforced Polyester Manholes

Precast concrete manhole risers, base sections, and tops shall conform to ASTM C478MASTM C478 and be manufactured in accordance with Section 03 42 13.00 10 PLANT-PRECAST CONCRETE PRODUCTS FOR BELOW GRADE CONSTRUCTION; base and first riser shall be monolithic. Glass-Fiber-Reinforced Polyester Manholes shall conform to ASTM D3753.

2.3.2 Gaskets and Connectors

Gaskets for joints between manhole sections shall conform to ASTM C443M ASTM C443. Resilient connectors for making joints between manhole and pipes entering manhole shall conform to ASTM C923M ASTM C923 or ASTM C990M ASTM C990.

2.3.3 External Preformed Rubber Joint Seals

An external preformed rubber joint seal shall be an accepted method of sealing cast iron covers to precast concrete sections to prevent ground water infiltration into sewer systems. All finished and sealed manholes constructed in accordance with paragraph entitled "Manhole Construction" shall be tested for leakage in the same manner as pipelines as described in

paragraph entitled "Leakage Tests." The seal shall be multi-section with a neoprene rubber top section and all lower sections made of Ethylene Propylene Diene Monomer (EPDM) rubber with a minimum thickness of 1.5 mm 60 mils. Each unit shall consist of a top and bottom section and shall have mastic on the bottom of the bottom section and mastic on the top and bottom of the top section. The mastic shall be a non-hardening butyl rubber sealant and shall seal to the cone/top slab of the manhole/catch basin and over the lip of the casting. Extension sections shall cover up to two more adjusting rings. Properties and values are listed in the following table:

Properties, Test Methods and Minimum Values for Rubber used in Preformed Joint Seals				
Physical Properties	Test Methods	EPDM	Neoprene	Butyl Mastic
Tensile, kPa psi	ASTM D412	12,6841840	15,1322195	--
Elongation, percent	ASTM D412	553	295	350
Tear Resistance, N/mm ppi	ASTM D624 (Die B)	49280	29160	--
Rebound, percent, 5 minutes	ASTM C972 (mod.)	--	--	11
Rebound, percent, 2 hours	ASTM C972	--	--	12

2.3.4 Metal Items

2.3.4.1 Frames, Covers, and Gratings for Manholes

[Submit certification on the ability of frame and cover to carry the imposed live load.] Frame and cover must be cast gray iron, ASTM A48/A48M, Class 35B, cast ductile iron, ASTM A536, Grade 65-45-12, or reinforced concrete, ASTM C478 ASTM C478M. Frames and covers must be circular [with] [without] vent holes. Size must be [as indicated on the plans] [for 24 inch opening]. The words "Sanitary Sewer" shall be stamped or cast into covers so that it is plainly visible.

2.3.4.2 Manhole Steps

[Zinc-coated steel] [as indicated] conforming to 29 CFR 1910.27. [As an option, plastic or rubber coating pressure-molded to the steel may be used. Plastic coating shall conform to ASTM D4101, copolymer polypropylene. Rubber shall conform to ASTM C443M ASTM C443, except shore A durometer hardness shall be 70 plus or minus 5.] Aluminum steps or rungs will not be permitted. Steps are not required in manholes less than 1.2 m 4 feet deep.

2.3.4.3 Manhole Ladders

A steel ladder shall be provided where the depth of a manhole exceeds 3.6 m 12 feet. The ladder shall not be less than 406 mm 16 inches in width, with 19 mm 3/4 inch diameter rungs spaced 305 mm 12 inches apart. The two stringers shall be a minimum 10 mm 3/8 inch thick and 51 mm 2 inches wide.

Ladders and inserts shall be galvanized after fabrication in conformance with ASTM A123/A123M.

2.3.4.4 Septic Tank Piping

Cast iron soil pipe and fittings.

2.3.4.5 Siphon for Septic Tank

Welded steel or close-grained cast iron free from flaws, of an approved standard design, and prompt and positive in action.

2.3.5 Sewage Absorption Field Materials

[Pipe shall be perforated bell-and-spigot clay pipe conforming to ASTM C700, clay drain tile, perforated corrugated polyethylene tubing conforming to ASTM F667/F667M. Covering for open joints in drain tile lines shall be asphalt-treated paper or asphalt-covered fibrous glass cloth. Wire for fastening covering to tile shall be 1.2 mm No. 18 American Wire Gage, nonferrous metal composition.] [Pipe shall be perforated bell-and-spigot clay pipe conforming to ASTM C700, clay drain tile or PVC plastic pipe conforming to ASTM F758. Covering for open joints in drain tile lines shall be asphalt-treated paper or asphalt-covered fibrous glass cloth. Wire for fastening covering to tile shall be 1.2 mm No. 18 American Wire Gage, nonferrous metal composition.]

2.4 REPORTS

[Compaction and density test shall be in accordance with Section 31 00 00 EARTHWORK. Submit Test Reports.]Submit Inspection Reports for daily activities during the installation of the sanitary system. Information in the report shall be detailed enough to describe location of work and amount of pipe laid in place, measured in linear meters feet.

PART 3 EXECUTION

3.1 INSTALLATION OF PIPELINES AND APPURTENANT CONSTRUCTION

3.1.1 Connections to Existing Lines

**NOTE: For Navy, Use BMS B-5.2.19 to determine
Installation requirements for connecting to existing
sanitary sewer lines and incorporate into this
paragraph. In accordance with BMS B-5.2.19 a Utility
Connection Permit must be submitted during design.**

Obtain approval from the Contracting Officer before making connection to existing line. Conduct work so that there is minimum interruption of service on existing line.

Submit request for field support from the Installation's Utilities Field Support two weeks prior to making connection. Submit request for pre-connection inspection to be conducted after trenching and layout is completed, but before the proposed service has been connected.

3.1.2 General Requirements for Installation of Pipelines

These general requirements apply except where specific exception is made in the following paragraphs entitled "Special Requirements."

3.1.2.1 Location

NOTE: Choose one of the following options.

The work covered by this section shall terminate at a point approximately 1.5 m 5 feet from the building [, unless otherwise indicated]. [Where the location of the sewer is not clearly defined by dimensions on the drawings, do not lay sewer line closer horizontally than 3 m 10 feet to a water main or service line.] [Install pressure sewer lines beneath water lines only, with the top of the sewer line being at least 0.60 m 2 feet below bottom of water line.] [Where sanitary sewer lines pass above water lines, encase sewer in concrete for a distance of 3 m 10 feet on each side of the crossing, or substitute rubber-gasketed pressure pipe for the pipe being used for the same distance.] [Where sanitary sewer lines pass below water lines, lay pipe so that no joint in the sewer line will be closer than 0.9 m 3 feet, horizontal distance, to the water line.]

NOTE: Include the subparts below for NAVFAC projects.

[3.1.2.1.1 Sanitary Piping Installation Parallel with Water Line

3.1.2.1.1.1 Normal Conditions

Sanitary piping or manholes shall be laid at least 3 m 10 feet horizontally from a water line whenever possible. The distance shall be measured edge-to-edge.

3.1.2.1.1.2 Unusual Conditions

When local conditions prevent a horizontal separation of 3 m 10 feet, the sanitary piping or manhole may be laid closer to a water line provided that:

- a. The top (crown) of the sanitary piping shall be at least 450 mm 18 inches below the bottom (invert) of the water main.
- b. Where this vertical separation cannot be obtained, the sanitary piping shall be constructed of AWWA-approved ductile iron water pipe pressure tested in place without leakage prior to backfilling.
- c. The sewer manhole shall be of watertight construction and tested in place.

]3.1.2.1.2 Installation of Sanitary Piping Crossing a Water Line

3.1.2.1.2.1 Normal Conditions

Lay sanitary sewer piping by crossing under water lines to provide a separation of at least 450 mm 18 inches between the top of the sanitary piping and the bottom of the water line whenever possible.

3.1.2.1.2.2 Unusual Conditions

When local conditions prevent a vertical separation described above, use the following construction:

- a. Sanitary piping passing over or under water lines shall be constructed of AWWA-approved ductile iron water pipe, pressure tested in place without leakage prior to backfilling.
- b. Sanitary piping passing over water lines shall, in addition, be protected by providing:
 - (1) A vertical separation of at least 450 mm 18 inches between the bottom of the sanitary piping and the top of the water line.
 - (2) Adequate structural support for the sanitary piping to prevent excessive deflection of the joints and the settling on and breaking of the water line.
 - (3) That the length, minimum 6.1 m 20 feet, of the sanitary piping be centered at the point of the crossing so that joints shall be equidistant and as far as possible from the water line.

]3.1.2.1.3 Sanitary Sewer Manholes

No water piping shall pass through or come in contact with any part of a sanitary sewer manhole.

]3.1.2.2 Earthwork

**NOTE: Earthwork requirements, including bedding,
for pipe trenches and utility structures are covered
in Section 31 00 00 EARTHWORK.**

Perform earthwork operations in accordance with Section 31 00 00 EARTHWORK.

3.1.2.3 Pipe Laying and Jointing

**NOTE: Delete requirement for tongue-and-groove pipe
(concrete pipe) when not allowed for the project.**

Inspect each pipe and fitting before and after installation; replace those found defective and remove from site. Provide proper facilities for lowering sections of pipe into trenches. Lay nonpressure pipe with the bell [or groove] ends in the upgrade direction. Adjust spigots in bells [and tongues in grooves] to give a uniform space all around. Blocking or wedging between bells and spigots [or tongues and grooves] will not be permitted. Replace by one of the proper dimensions, pipe or fittings that do not allow sufficient space for installation of joint material. At the end of each work day, close open ends of pipe temporarily with wood blocks or bulkheads. Provide batterboards not more than 7.50 m 25 feet apart in trenches for checking and ensuring that pipe invert elevations are as indicated. Laser beam method may be used in lieu of batterboards for the same purpose. Branch connections shall be made by use of regular fittings

or solvent cemented saddles as approved. Saddles for ABS and PVC composite pipe shall conform to Figure 2 of ASTM D2680; saddles for ABS pipe shall comply with Table 3 of ASTM D2751; and saddles for PVC pipe shall conform to Table 4 of ASTM D3034.

3.1.3 Special Requirements

3.1.3.1 Installation of Cast Iron Soil Piping

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the recommendations of the pipe manufacturer. Make joints with the rubber gaskets specified for cast iron soil pipe joints and assemble in accordance with the recommendations of the pipe manufacturer.

3.1.3.2 Installation of Clay Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM C12 for pipe laying. Make joints with a compression joint material specified for clay pipe joints and assemble in accordance with the recommendations of the manufacturer of the pipe.

3.1.3.3 Installation of Concrete Gravity Sewer Piping

NOTE: Not allowed for NAVFAC LANT projects.

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the provisions for rubber gasket jointing and jointing procedures of ACPA 01-103 or of ACPA 01-102, Chapter 9, "Installation, Inspection and Construction Testing." Make joints with the gaskets specified for concrete gravity sewer pipe joints. Clean and dry surfaces receiving lubricants, cements, or adhesives. Affix gaskets to pipe not more than 24 hours prior to the installation of the pipe. Protect gaskets from sun, blowing dust, and other deleterious agents at all times. Before installation of the pipe, inspect gaskets and remove and replace loose or improperly affixed gaskets. Align each pipe section with the previously installed pipe section, and pull the joint together. If, while pulling the joint, the gasket becomes loose and can be seen through the exterior joint recess when the pipe is pulled up to within 25 mm 1 inch of closure, remove the pipe and remake the joint.

3.1.3.4 Installation of Concrete Pressure Lines

NOTE: Not allowed for NAVFAC LANT projects.

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the laying and joining requirements specified in the guide specifications for installation of pipe given in AWWA M9, Chapter 14, "Guide Specifications for Installation of Pipe."

3.1.3.4.1 Joints

Make joints with the gaskets specified for concrete pressure pipe joints, using an approved lubricant recommended by the pipe manufacturer. Assemble these joints in accordance with the joining requirements specified in the guide specifications for installation of pipe given in AWWA M9, Chapter 14, "Guide Specifications for Installation of Pipe," and with the recommendations given for laying the pipe in AWWA M9, Chapter 6, "Installation by Trenching or Tunneling -- Methods and Equipment."

3.1.3.4.2 Pipe Anchorage

Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 13.80 MPa 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.1.3.5 Installation of Ductile Iron Gravity Sewer Pipe

Unless otherwise specified, install pipe and associated fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of AWWA C600 for pipe installation and joint assembly.

NOTE: At the text below, delete requirements for and references to push-on joints for ductile-iron gravity sewer pipe and associated fittings when the greater deflection afforded by the mechanical joint is considered necessary throughout.

- a. [Make push-on joints with the gaskets and lubricant specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.] Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11.

NOTE: At the text below, delete the paragraph except when required. See AWWA C105/A21.5 for guidance on selecting Class of polyethylene film.

- b. Exterior protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet in accordance with AWWA C105/A21.5, using [Class A] [Class C] polyethylene film.

3.1.3.6 Installation of Ductile-Iron Pressure Lines

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of AWWA C600 for pipe installation, joint assembly, and valve-and-fitting installation.

- a. [Make push-on joints with the gaskets and lubricant specified for this type joint and assemble in accordance with the applicable requirements of AWWA C600 for joint assembly.] Make mechanical-joints with the gaskets, glands, bolts, and nuts specified for this type joint; assemble in accordance with the applicable requirements of AWWA C600 for joint assembly and the recommendations of Appendix A to AWWA C111/A21.11. [Make flanged joints with gaskets, bolts, and nuts specified for this type joint. Make flanged joints up tight, taking care to avoid undue strain on flanges, fittings, and other accessories. Align bolt holes for each flanged joint. Use full size bolts for the bolt holes; use of undersized bolts to make up for misalignment of bolt holes or for any other purpose will not be permitted. Do not allow adjoining flange faces to be out of parallel to such degree that the flanged joint cannot be made watertight without overstraining the flange. When flanged pipe or fittings have dimensions that do not allow the making of a proper flanged joint as specified, replace it by one of proper dimensions.] [Assemble joints made with sleeve-type mechanical couplings in accordance with the recommendations of the coupling manufacturer, as approved.] [Make [grooved] [and] [shouldered] type joints with the couplings previously specified for this type joint connecting pipe with the [grooved] [or] [shouldered] ends specified for this type joint and assemble in accordance with the recommendations of the coupling manufacturer, as approved. [Groove pipe in the field only with approved groove cutting equipment designed especially for the purpose and produced by a manufacturer of grooved joint couplings; secure approval for field-cut grooves before assembling the joint.]]

NOTE: Delete the text below except when required.
See Foreword to AWWA C105/A21.5 for guidance on
selecting Class of polyethylene film.

- b. Exterior protection: Completely encase buried ductile iron pipelines with polyethylene tube or sheet in accordance with AWWA C105/A21.5, using [Class A] [Class C] polyethylene film.
- c. Pipe anchorage: Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 13.80 MPa 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.1.3.7 Installation of ABS Composite Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the recommendations of the plastic pipe manufacturer. Make joints with the primer and solvent cement specified for this joint and assemble in accordance with the recommendations of the pipe manufacturer. Handle solvent cement in accordance with ASTM F402.

3.1.3.8 Installation of ABS Solid-Wall Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the recommendations of the plastic pipe manufacturer. Make solvent cement

joints with the solvent cement previously specified for this type joint. Make elastomeric joints with the gaskets specified for this type joint and assemble in accordance with the recommendations of the pipe manufacturer. Handle solvent cement in accordance with ASTM F402.

3.1.3.9 Installation of PVC Plastic Piping

Install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Make joints with the gaskets specified for joints with this piping and assemble in accordance with the requirements of ASTM D2321 for assembly of joints. Make joints to other pipe materials in accordance with the recommendations of the plastic pipe manufacturer.

3.1.3.10 Installation of PVC Plastic Pressure Pipe and Fittings

Unless otherwise specified, install pipe and fittings in accordance with paragraph entitled "General Requirements for Installation of Pipelines" of this section; with the requirements of AWWA C605 for laying of pipe, joining PVC pipe to fittings and accessories, and setting of hydrants, valves, and fittings; and with the recommendations for pipe joint assembly and appurtenance installation in AWWA M23, Chapter 7, "Installation."

3.1.3.10.1 Pipe Less Than 100 mm 4 Inch Diameter

3.1.3.10.1.1 Threaded Joints

Make by wrapping the male threads with joint tape or by applying an approved thread lubricant, then threading the joining members together. Tighten the joints with strap wrenches which will not damage the pipe and fittings. Tighten the joint no more than 2 threads past hand-tight.

3.1.3.10.1.2 Push-On Joints

The ends of pipe for push-on joints shall be beveled to facilitate assembly. Pipe shall be marked to indicate when the pipe is fully seated. The gasket shall be lubricated to prevent displacement. Care shall be exercised to ensure that the gasket remains in proper position in the bell or coupling while making the joint.

3.1.3.10.1.3 Solvent-Weld Joints

Comply with the manufacturer's instructions.

3.1.3.10.2 Pipe 100 mm 4 Inch Diameter Joints

Make push-on joints with the elastomeric gaskets specified for this type joint, using either elastomeric-gasket bell-end pipe or elastomeric-gasket couplings. For pipe-to-pipe push-on joint connections, use only pipe with push-on joint ends having factory-made bevel; for push-on joint connections to fittings, cut spigot end of pipe off square and re-bevel pipe end to a bevel approximately the same as that on ductile-iron pipe used for the same type of joint. Use an approved lubricant recommended by the pipe manufacturer for push-on joints. Assemble push-on joints for pipe-to-pipe joint connections in accordance with the requirements of AWWA C605 for laying the pipe and the recommendations in AWWA M23, Chapter 7, "Installation," for pipe joint assembly. Assemble push-on joints for connection to fittings in accordance with the requirements of AWWA C605 for

joining PVC pipe to fittings and accessories and with the applicable requirements of AWWA C600 for joint assembly. Make compression-type joints/mechanical-joints with the gaskets, glands, bolts, nuts, and internal stiffeners specified for this type joint and assemble in accordance with the requirements of AWWA C605 for joining PVC pipe to fittings and accessories, with the applicable requirements of AWWA C600 for joint assembly, and with the recommendations of Appendix A to AWWA C111/A21.11. Cut off spigot end of pipe for compression-type joint/mechanical-joint connections and do not re-bevel.

3.1.3.10.3 Pipe Anchorage

Provide concrete thrust blocks (reaction backing) for pipe anchorage. Size and position thrust blocks as indicated. Use concrete conforming to ASTM C94/C94M having a minimum compressive strength of 13.80 MPa 2,000 psi at 28 days; or use concrete of a mix not leaner than one part cement, 2 1/2 parts sand, and 5 parts gravel, having the same minimum compressive strength.

3.1.3.11 Installation of Dual Wall and Triple Wall Polypropylene

Installation shall be in accordance with "General Requirements for installation of Pipelines" of this section, with the polypropylene pipe manufacturer's recommendations, and with the requirements of ASTM D2321 for laying and joining pipe and fittings. Place a minimum of 150 mm 6 inches of Class 1 or Class 2 backfill over the crown of the pipe with minimum 90 percent compaction.

3.1.3.12 Pipeline Installation Beneath Railroad Right-of-Way

Where pipeline passes under the right-of-way of a commercial railroad, install piping in accordance with the specifications for pipelines conveying nonflammable substances in AREMA Eng Man.

3.1.4 Concrete Work

**NOTE: Delete these paragraphs if not used or insert
applicable concrete requirements here.**

Cast-in-place concrete is included in Section [03 30 00.00 10 CAST-IN-PLACE CONCRETE][03 30 00 CAST-IN-PLACE CONCRETE][03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE]. The pipe shall be supported on a concrete cradle, or encased in concrete where indicated or directed.

3.1.5 Manhole Construction

Construct base slab of cast-in-place concrete or use precast concrete base sections. Make inverts in cast-in-place concrete and precast concrete bases with a smooth-surfaced semi-circular bottom conforming to the inside contour of the adjacent sewer sections. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert of as large a radius as manhole size will permit. For cast-in-place concrete construction, either pour bottom slabs and walls integrally or key and bond walls to bottom slab. No parging will be permitted on interior manhole walls. For precast concrete construction, make joints between manhole sections with the gaskets specified for this purpose; install in the manner specified for installing joints in concrete

piping. Parging will not be required for precast concrete manholes. Cast-in-place concrete work shall be in accordance with the requirements specified under paragraph entitled "Concrete Work" of this section. Make joints between concrete manholes and pipes entering manholes with the resilient connectors specified for this purpose; install in accordance with the recommendations of the connector manufacturer. Where a new manhole is constructed on an existing line, remove existing pipe as necessary to construct the manhole. Cut existing pipe so that pipe ends are approximately flush with the interior face of manhole wall, but not protruding into the manhole. Use resilient connectors as previously specified for pipe connectors to concrete manholes.

3.1.6 Miscellaneous Construction and Installation

3.1.6.1 Connecting to Existing Manholes

Pipe connections to existing manholes shall be made so that finish work will conform as nearly as practicable to the applicable requirements specified for new manholes, including all necessary concrete work, cutting, and shaping. The connection shall be centered on the manhole. Holes for the new pipe shall be of sufficient diameter to allow packing cement mortar around the entire periphery of the pipe but no larger than 1.5 times the diameter of the pipe. Cutting the manhole shall be done in a manner that will cause the least damage to the walls.

3.1.6.2 Metal Work

3.1.6.2.1 Workmanship and Finish

Perform metal work so that workmanship and finish will be equal to the best practice in modern structural shops and foundries. Form iron to shape and size with sharp lines and angles. Do shearing and punching so that clean true lines and surfaces are produced. Make castings sound and free from warp, cold shuts, and blow holes that may impair their strength or appearance. Give exposed surfaces a smooth finish with sharp well-defined lines and arises. Provide necessary rabbets, lugs, and brackets wherever necessary for fitting and support.

3.1.6.2.2 Field Painting

After installation, clean cast-iron frames, covers, gratings, and steps not buried in concrete to bare metal of mortar, rust, grease, dirt, and other deleterious materials and apply a coat of bituminous paint. Do not paint surfaces subject to abrasion.

3.1.7 Sewage Absorption Trench Construction

Grade pipe lines uniformly downward to the outlet. Lay perforated pipe with the perforations downward. Lay drain tile with 6 mm 1/4 inch open joints. Cover open joints of drain tile with the cover material specified so that it extends not less than 1.75 rad 100 degrees on each side of the vertical center line of the tile. Wire covering in place.

3.1.8 Installations of Wye Branches

Cutting into piping for connections shall not be done except in special approved cases. When the connecting pipe cannot be adequately supported on undisturbed earth or tamped backfill, the pipe shall be encased in concrete backfill or supported on a concrete cradle as directed. Concrete required

because of conditions resulting from faulty construction methods or negligence shall be installed at no additional cost to the Government. The installation of wye branches in an existing sewer shall be made by a method which does not damage the integrity of the existing sewer. One acceptable method consists of removing one pipe section, breaking off the upper half of the bell of the next lower section and half of the running bell of wye section. After placing the new section, it shall be rotated so that the broken half of the bell will be at the bottom. The two joints shall then be made with joint packing and cement mortar.

3.2 FIELD QUALITY CONTROL

3.2.1 Field Tests and Inspections

The Contracting Officer will conduct field inspections and witness field tests specified in this section. 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 [____]]. Be able to produce evidence, when required, that each item of work has been constructed in accordance with the drawings and specifications.

[3.2.2 Post-Construction Inspection

**NOTE: For Navy, contact Installation staff to
determine if dye testing or smoke testing is
required by either state, local, or Navy requirements
at the specific project location.**

Submit post-construction inspection request for field support from the Installation's Utilities Field Support two weeks prior to post-connection inspection.

[Perform a dye test from the projects sanitary sewer point of connection to the first downstream manhole on the next active sanitary sewer branch main. Dye must be a nontoxic non-staining sewer tracing dye. Test results are to be noted in the daily Construction Quality Control (CQC) Report.

- a. Continue testing until it can be visually confirmed by way of the dye that the sewer connection is appropriate or until deficiencies are discovered.
- b. During the test, monitor the storm drainage system downstream from the project, either manholes or outfalls, for any sign of cross-connection.

][Perform a smoke test on the relevant portion of the sewer system. Test results are to be noted in the daily Construction Quality Control (CQC) Report.

- a. Continue testing until it can be visually confirmed that the projects sanitary sewer point of connection has not been cross-connected to the storm drainage system.
- b. During the test, monitor the storm drainage system, either manholes or outfalls, for any sign of cross-connection.

]]3.2.3 Tests for Nonpressure Lines

Check each straight run of pipeline for gross deficiencies by holding a light in a manhole; it shall show a practically full circle of light through the pipeline when viewed from the adjoining end of line. When pressure piping is used in a nonpressure line for nonpressure use, test this piping as specified for nonpressure pipe.

3.2.3.1 Leakage Tests

Test lines for leakage by either infiltration tests or exfiltration tests, or by low-pressure air tests. Prior to testing for leakage, backfill trench up to at least lower half of pipe. When necessary to prevent pipeline movement during testing, place additional backfill around pipe sufficient to prevent movement, but leaving joints uncovered to permit inspection. When leakage or pressure drop exceeds the allowable amount specified, make satisfactory correction and retest pipeline section in the same manner. Correct visible leaks regardless of leakage test results.

3.2.3.1.1 Infiltration Tests and Exfiltration Tests

Perform these tests for sewer lines made of the specified materials, not only concrete, in accordance with ASTM C969M ASTM C969. Make calculations in accordance with the Appendix to ASTM C969M ASTM C969.

3.2.3.1.2 Low-Pressure Air Tests

perform tests as follows:

3.2.3.1.2.1 Clay Pipelines

Test in accordance with ASTM C828. Allowable pressure drop shall be as given in ASTM C828. Make calculations in accordance with the Appendix to ASTM C828.

3.2.3.1.2.2 Concrete Pipelines

Test in accordance with ASTM C924M ASTM C924. Allowable pressure drop shall be as given in ASTM C924M ASTM C924. Make calculations in accordance with the Appendix to ASTM C924M ASTM C924.

3.2.3.1.2.3 Ductile-Iron Pipelines

Test in accordance with the applicable requirements of ASTM C924M ASTM C924. Allowable pressure drop shall be as given in ASTM C924M ASTM C924. Make calculations in accordance with the Appendix to ASTM C924M ASTM C924.

3.2.3.1.2.4 ABS Composite Plastic Pipelines

Test in accordance with the applicable requirements of UBPPA UNI-B-6. Allowable pressure drop shall be as given in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

3.2.3.1.2.5 PVC Plastic Pipelines

Test in accordance with UBPPA UNI-B-6. Allowable pressure drop shall be as given in UBPPA UNI-B-6. Make calculations in accordance with the Appendix to UBPPA UNI-B-6.

3.2.3.1.2.6 Polypropylene

Test in accordance with ASTM F1417 or UBPPA UNI-B-6. Allowable pressure drop shall be as given in ASTM F1417 or UBPPA UNI-B-6 depending on the specification chosen to follow. Make calculations in accordance with the Appendix to ASTM F1417 or UBPPA UNI-B-6 depending on the specification chosen to follow.

3.2.3.2 Deflection Testing

**NOTE: Specify deflection testing only when
warranted by scope or size of project.**

Perform a deflection test on entire length of installed plastic pipeline on completion of work adjacent to and over the pipeline, including leakage tests, backfilling, placement of fill, grading, paving, concreting, and any other superimposed loads determined in accordance with ASTM D2412. Deflection of pipe in the installed pipeline under external loads shall not exceed 4.5 percent of the average inside diameter of pipe. Determine whether the allowable deflection has been exceeded by use of a pull-through device or a deflection measuring device.

3.2.3.2.1 Pull-Through Device

This device shall be a spherical, spheroidal, or elliptical ball, a cylinder, or circular sections fused to a common shaft. Circular sections shall be so spaced on the shaft that distance from external faces of front and back sections will equal or exceed diameter of the circular section. Pull-through device may also be of a design promulgated by the Uni-Bell Plastic Pipe Association, provided the device meets the applicable requirements specified in this paragraph, including those for diameter of the device, and that the mandrel has a minimum of 9 arms. Ball, cylinder, or circular sections shall conform to the following:

- a. A diameter, or minor diameter as applicable, of 95 percent of the average inside diameter of the pipe; tolerance of plus 0.5 percent will be permitted.
- b. Homogeneous material throughout, shall have a density greater than 1.0 as related to water at 4 degrees C 39.2 degrees F, and shall have a surface Brinell hardness of not less than 150.
- c. Center bored and through-bolted with a 6 mm 1/4 inch minimum diameter steel shaft having a yield strength of not less than 483 MPa 70,000 psi, with eyes or loops at each end for attaching pulling cables.
- d. Each eye or loop shall be suitably backed with a flange or heavy washer such that a pull exerted on opposite end of shaft will produce compression throughout remote end.

3.2.3.2.2 Deflection Measuring Device

Sensitive to 1.0 percent of the diameter of the pipe being tested and shall be accurate to 1.0 percent of the indicated dimension. Deflection measuring device shall be approved prior to use.

3.2.3.2.3 Pull-Through Device Procedure

Pass the pull-through device through each run of pipe, either by pulling it through or flushing it through with water. If the device fails to pass freely through a pipe run, replace pipe which has the excessive deflection and completely retest in same manner and under same conditions.

3.2.3.2.4 Deflection measuring device procedure

Measure deflections through each run of installed pipe. If deflection readings in excess of 4.5 percent of average inside diameter of pipe are obtained, retest pipe by a run from the opposite direction. If retest continues to show a deflection in excess of 4.5 percent of average inside diameter of pipe, replace pipe which has excessive deflection and completely retest in same manner and under same conditions.

3.2.4 Tests for Pressure Lines

Test pressure lines in accordance with the applicable standard specified in this paragraph, except for test pressures. For hydrostatic pressure test, use a hydrostatic pressure 345 kPa 50 psi in excess of the maximum working pressure of the system, but not less than 690 kPa 100 psi, holding the pressure for a period of not less than one hour. For leakage test, use a hydrostatic pressure not less than the maximum working pressure of the system. Leakage test may be performed at the same time and at the same test pressure as the pressure test. [Test ductile-iron pressure lines in accordance with the requirements of AWWA C600 for hydrostatic testing. Leakage on ductile-iron pipelines with mechanical-joints [or push-on joints] shall not exceed the amounts given in AWWA C600; allow no leakage at joints made by other methods.] [Test concrete pressure lines in accordance with the recommendations in AWWA M9, Chapter 10, "Hydrostatic Testing and Disinfection of Mains." Leakage on concrete pipelines shall not exceed 1.88 L/24 hours per mm of pipe diameter per kilometer 20 gallons per 24 hours per inch of pipe diameter per mile of pipeline.] [Test PVC plastic pressure lines in accordance with the requirements of AWWA C605 for pressure and leakage tests, using the allowable leakage given therein.]

3.2.5 Field Tests for Concrete

**NOTE: Delete this paragraph if not used or insert
applicable concrete requirements here.**

Field testing requirements are covered in Section [03 30 00 CAST-IN-PLACE
CONCRETE] [03 30 53 MISCELLANEOUS CAST-IN-PLACE CONCRETE] [03 30 00.00 10
CAST-IN-PLACE CONCRETE]

-- End of Section --